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Barnéoud-Arnoulet

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[54] **ROTARY EXPANSIBLE CHAMBER DEVICE WITH VARIABLE ECCENTRICITY**

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[30] **Foreign Application Priority Data**

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[51] **Int. Cl.²** **F01C 21/10;** F01C 21/16

[58] **Field of Search** ..... 418/159, 22, 31; 192/58 R; 74/730, 188

[56] **References Cited**

UNITED STATES PATENTS

2,368,223	1/1945	Kendrick	418/31
2,842,064	7/1958	Wahlmank	418/31

FOREIGN PATENTS OR APPLICATIONS

1,073,662	9/1954	France	
1,000,591	8/1965	United Kingdom	418/31

OTHER PUBLICATIONS

W. H. Gibson & L. Fox, *A New Development in High Speed Variable Delivery Vane Pumps*, S.A.E. National Aeronautic and Space Engineering Meeting, Los Angeles, Calif., 1970, (8 pages).

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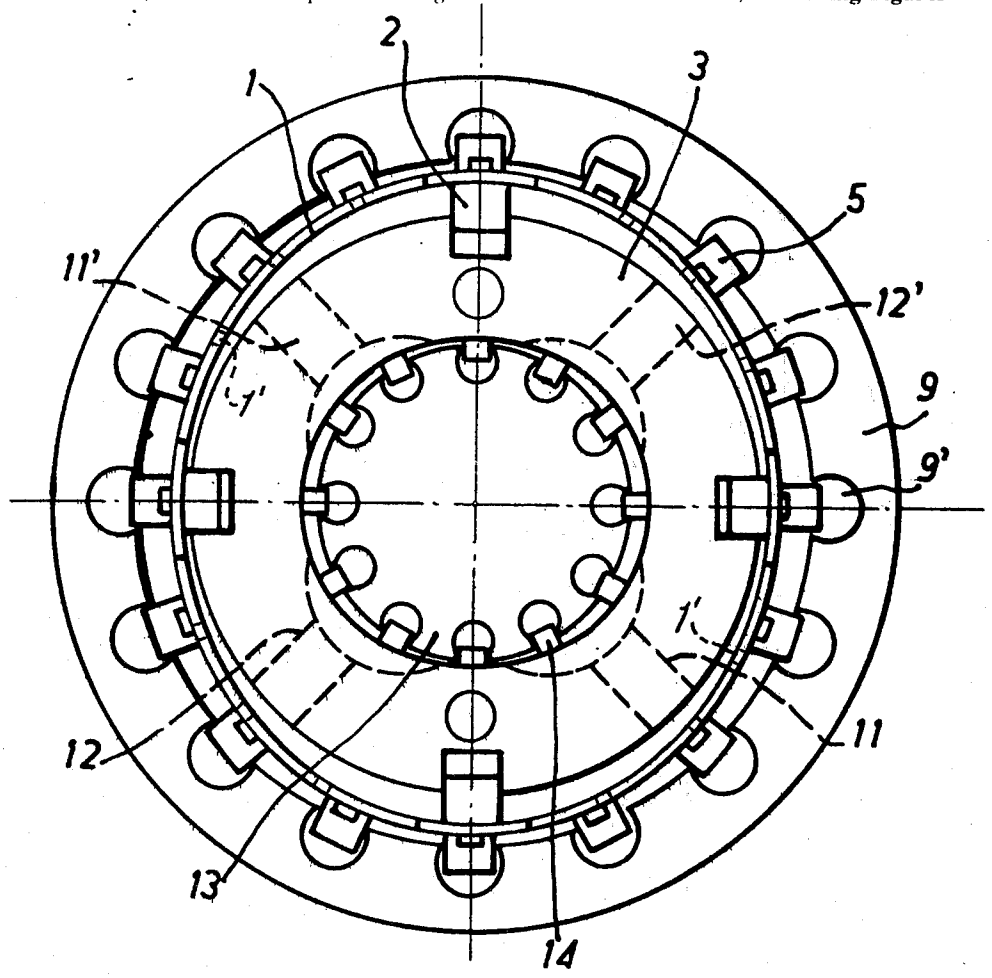
[57] **ABSTRACT**

A hydraulic transmission or speed-change device or the like, of the type comprising a stator, an input rotor to which an input shaft is connected, and an output rotor to which an output shaft is connected, with expansible chambers between adjacent pairs of these members, is characterized by a flexible annulus fixed against rotation relative to one of the members but radially deformable relative thereto. Deformation of the annulus is effected by means of fluid pressure jacks that actuate wedges in a direction parallel to the common axis of rotation. At least some of the relatively movable portions of at least some of the expansible chambers slide against this annulus with a stroke that varies as the deformation of the annulus.

5 Claims, 3 Drawing Figures



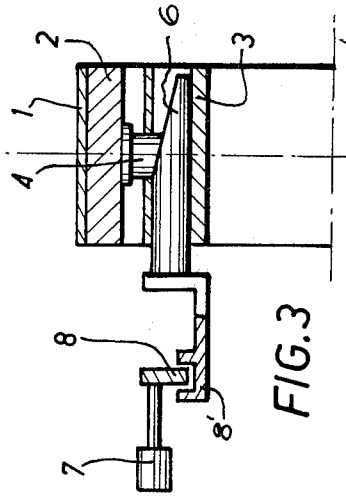


FIG.3

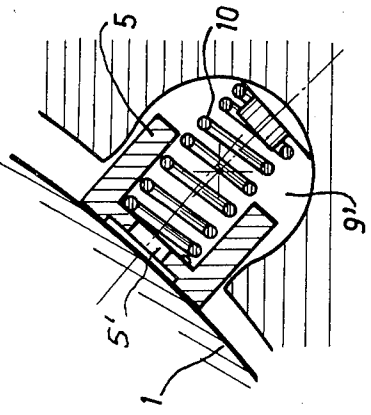


FIG.2

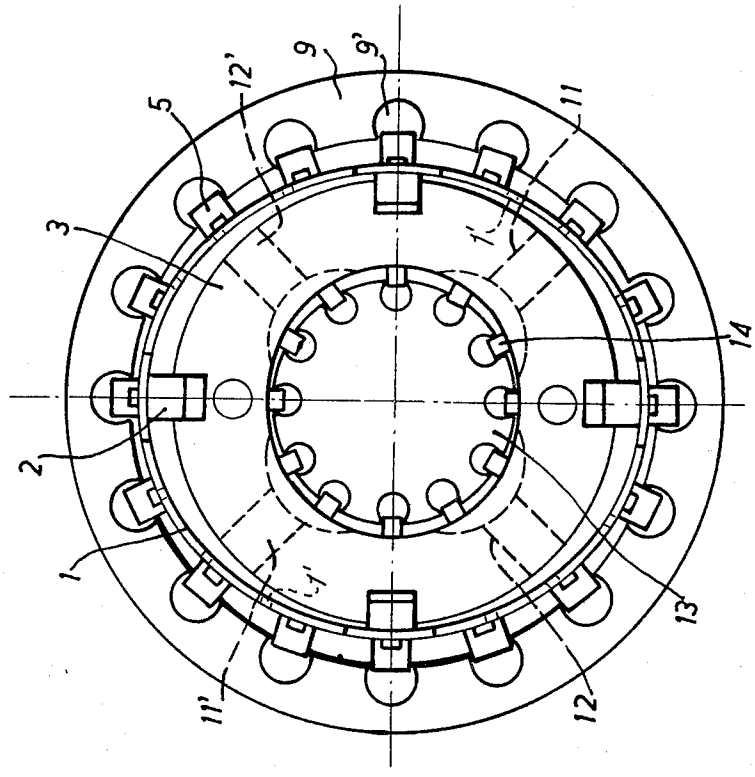


FIG.1

ROTARY EXPANSIBLE CHAMBER DEVICE WITH VARIABLE ECCENTRICITY

The present invention relates to rotary expansible chamber devices of the type in which relatively rotatable members have nonconcentric guide surfaces for causing cyclic expansion and contraction of chambers into which the working fluid is drawn and from which the working fluid is expelled. Devices of this type are well known as speed-change mechanisms or hydraulic transmissions or the like. One such mechanism to which the present invention is applicable is disclosed in my French Pat. No. 1,073,662, to which reference will be had for further disclosure of the environment of my invention, thereby to avoid the need for such further disclosure in the present application.

Devices of the type of the present invention comprise generally a stator, a rotor connected to an input and another rotor connected to an output. Expansible chambers are formed between these elements, the elements having nonconcentric surfaces thereon such that upon relative rotation of the elements, the chambers will expand or contract thereby to admit and expell the working fluid. It is of course well known in such devices that the greater is the eccentricity or nonconcentricity of the surfaces, the greater will be the volume of fluid flow, with corresponding changes in the speeds and power ratios that are obtainable.

The present invention has as its object the provision of such a device, in which the displacement of the working fluid is readily regulable.

Another object of the present invention is the provision of such a device which will be relatively simple and inexpensive to manufacture, easy to operate, maintain and repair, compact in configuration, and rugged and durable in use.

Briefly, the objects of the invention are achieved by providing a deformable annulus connected to but radially movable relative to one of the three principal elements (stator, input rotor, output rotor), thereby to provide in effect a working surface on that associated element which is of variable curvature. Wedge means are provided, movable parallel to the common axis of rotation of the rotors to deform the annulus. The deformation is symmetrical relative to the axis of rotation and so the forces remain in balance.

In a preferred embodiment of the invention, the deformable annulus is provided with blocks that slide in corresponding recesses in the number with which the annulus is associated. Wedge means are provided for moving the blocks in and out of their associated recesses in a manner that is symmetrical with respect to the axis of rotation, the wedge means moving in a direction parallel to that axis under the influence of operating means such as jacks such as fluid cylinders.

Actuation of the jacks to a controlled degree accordingly alters the curvature of the deformable annulus to a corresponding degree, thereby to regulate the stroke of the expansible chambers and correspondingly to regulate the pressure and speed relationships of the device.

In a still more particular embodiment, the three principal elements overlap each other axially, the stator being outermost and the two rotors being innermost. The inner surface of the stator has inwardly opening recesses in which sliding blocks are disposed for radial movement, these blocks sliding on the outer surface of the flexible annulus which has blocks secured to its inner surface that are received in recesses in the outer surface of the outer of the two rotors, the two rotors having further recess and sliding block assemblies between themselves.

The invention may for example be embodied in a motor having a volumetric pump integral with a rotatable portion of the motor, thereby to constitute a speed-change mechanism.

Other objects, features and advantages of the present invention will become apparent from a consideration of the following description, taken in connection with the accompanying drawing, in which:

FIG. 1 is a schematic axial view of a device according to the present invention;

FIG. 2 shows an enlarged cross section of one of the slide blocks between the flexible annulus and the surrounding stator; and

FIG. 3 is an enlarged cross-sectional view in the plane of the axis of rotation, showing one of the wedge devices to vary the shape of the flexible annulus.

Referring now to the drawing in greater detail, the device of the present invention comprises a stator **9** or outer ring in the form of an exterior cage, in which are concentrically disposed an input rotor **3** and an output rotor **13**, which may be fixed either directly or through suitable speed-change devices (not shown) to input and output shafts (not shown) respectively.

A flexible annulus **1**, for example of spring steel, is provided in axially overlapping relationship with the members **3, 9** and **13** and has fixed to its inner surface four blocks **2** which slide in recesses provided in rotor **3.** Two wedges **4** are provided in recesses in diametrically opposed blocks **2.** Wedges **6** slide on wedges **4** and are actuated by stationary fluid pressure jacks **7** that move members **8** parallel to the axis of rotation. Members **8,** in turn, are received in an annular ring **8'** to which the wedges **6** are secured, the ring **8'** thus rotating with rotor **3.** The degree to which jacks **7** are actuated by a source of fluid under pressure (not shown) thus regulates the eccentricity of annulus **1** by moving the blocks **2** in or out of their recesses, the resilience of the annulus **1** maintaining wedges **4** and **6** in contact with each other.

Stator **9** has recesses **9'** which are of cylindrical cross section as best seen in FIG. **2** and that have rounded edges. Segments **5** are disposed in recesses **9'** and are urged slidably against annulus **1** by springs **10** or other conventional devices such as magnets. Only a relatively small surface area of segments **5** is applied against annulus **1** thanks to communication opening **5'** through segments **5** which balances the forces and reduces friction.

The blocks **2** and the segments **5** near these blocks delimit between the rotor **3** and the stator **9** four compartments. In each of these compartments, recesses or holes **1'** through annulus **1** permit the circulation of fluid such as hydraulic fluid. Canals **11** and **11'** bring the fluid into two opposed compartments and canals **12** and **12'** evacuate the fluid from the other two compartments. Lateral seals (not shown) are carried by stator **9** on either side of the assembly and thus assure lateral fluid tightness.

The rotor **13** is concentric within rotor **3** and may with the rotor **13** comprise a pump. In the illustrated embodiment, the pump has segments **14** of the same type as the segments **5.** The pump has an output flow

proportional to the relative rotation of the two rotors.

An oil inlet (not shown) through the shaft of rotor **13** supplies to the pump sufficient fluid to make up losses.

The operation of the device according to the present invention is as follows:

The output rotor **3** behaves as a rotatable piston and modifies the speed and force exerted by the input rotor **13** according to the eccentricity of the annulus **1**, which in turn is regulated by the FIG. **3** mechanism. When the eccentricity, that is, the deformation from circular configuration, is at a maximum, the fluid flow is also at the maximum and the speed is at a minimum. But when the annulus **1** is circular or nearly circular, then there is no substantial output flow from the pump and the rotor **3** turns at substantially the same speed as the rotor **13**, except of course for a small slippage due to losses. It would of course be possible to provide an automatic interlock (not shown) for the two rotors, to ensure their conjoint rotation in this position, with no slippage. The jack **7** can also unlatch the stator **9** at a predetermined point, so that the latter can turn freely and thus reduce slippage.

Means (not shown) are of course provided for controlling the jack **7** to modify the shape of annulus **1**. Among these might of course be means responsive to the speed of the input shaft which would be detected and would control the outflow of an auxiliary pump driven by the input shaft. The detector would act on a distributor which would charge or discharge the jack **7**. Other such systems of course can be devised.

From a consideration of the foregoing disclosure, therefore, it will be evident that all of the initially recited objects of the present invention have been achieved.

Although the present invention has been described and illustrated in connection with a preferred embodiment, it is to be understood that modifications and variations may be resorted to, without departing from the spirit of the invention, as those skilled in this art will readily understand. Such modifications and variations are considered to be within the purview and scope of the present invention as defined by the appended claims.

Having described my invention, I claim:

1. A fluid transmission comprising an annular stator, a first annular rotor within said stator, a second rotor within said first rotor, a flexible annulus surrounding said first roto between said stator and said first rotor, means defining between said annulus and said first rotor a plurality of expansible chambers, means defining between said rotors spaced chambers that vary in volume upon relative rotation of said rotors, said spaced chambers communicating through passageways through said first rotor with said expansible chambers, blocks secured to said annulus and slidable radially in recesses in said first rotor thereby to fix said annulus against rotation relative to said first rotor, and means for deforming said annulus from circular form thereby to regulate the expansion and contraction of said expansible chambers upon rotation of said first rotor, said deforming means comprising means bearing against said blocks to impart to said blocks a non-circular path upon rotation of said first rotor.

2. A transmission as claimed in claim **1**, said bearing means comprising fluid pressure jacks that act in a direction parallel to the axis of the rotor to urge wedges against said blocks.

3. A transmission as claimed in claim **1**, and segments disposed in cylindrical recesses in said stator and spring means urging said segments into sliding contact with the outer surface of said annulus.

4. A transmission as claimed in claim **3**, each of said segments having spaced lips thereon that bear slidably against said annulus.

5. A transmission as claimed in claim **1**, said annulus having passageways therethrough for the circulation of fluid.

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