April 11, 1961 S. A. NOREN 2,979,036

HYDRAULIC ROTARY ENGINE

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FIG.1.

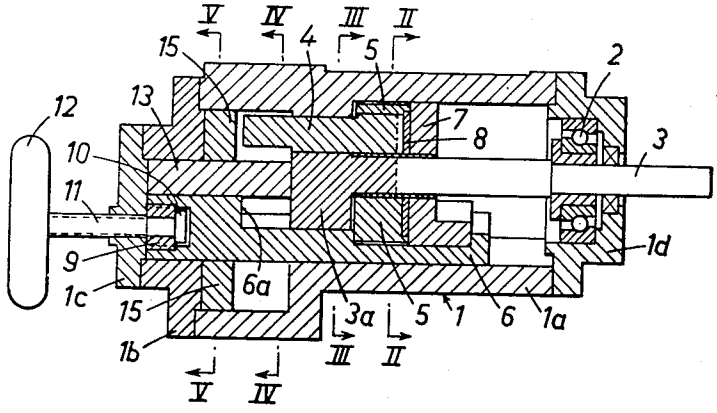


FIG.2.

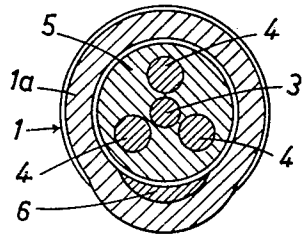


FIG.3.

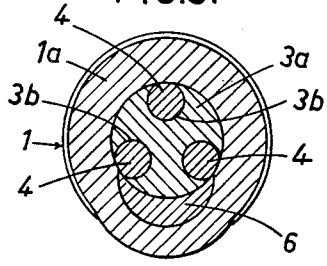


FIG.4.

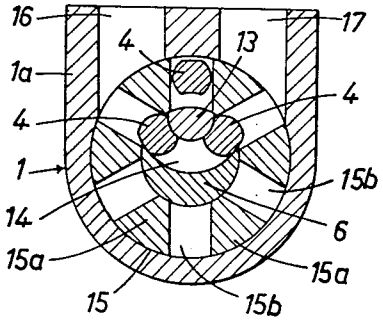
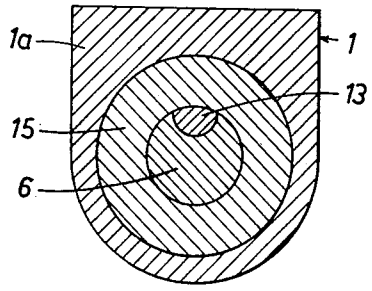


FIG.5.



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FIG. 6.

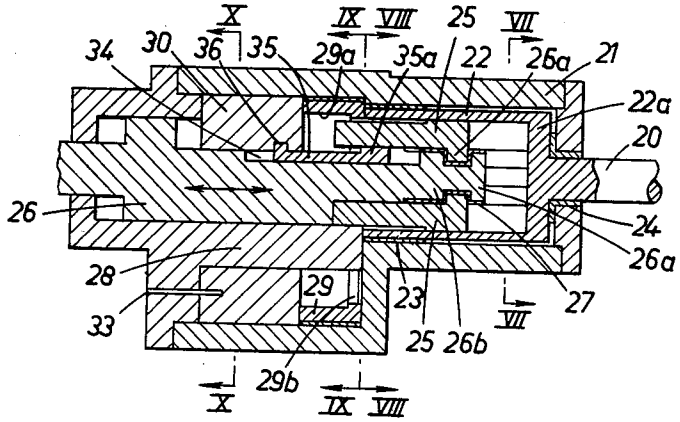


FIG. 7.

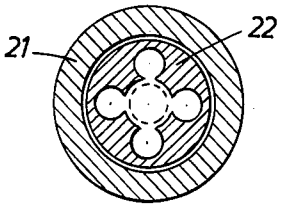


FIG. 8.

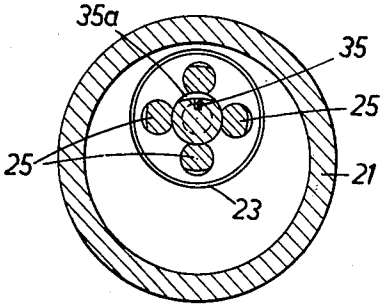


FIG. 9.

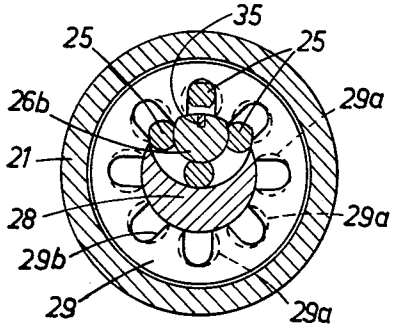
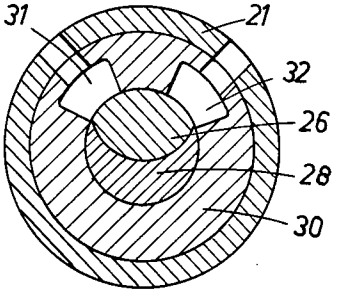


FIG. 10.



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FIG.12.

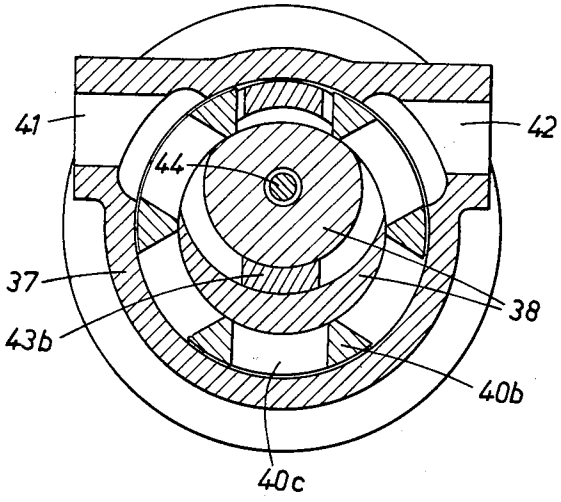


FIG.13.

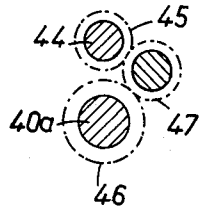
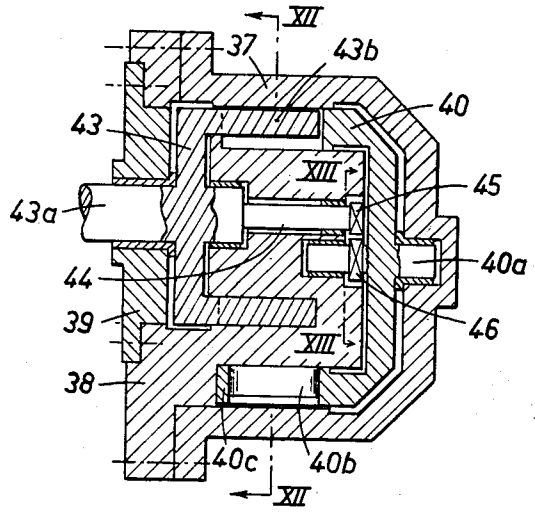


FIG.11.



United States Patent Office

2,979,036

Patented Apr. 11, 1961

2,979,036

HYDRAULIC ROTARY ENGINE

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Filed May 6, 1959, Ser. No. 811,375

Claims priority, application Sweden May 9, 1958

5 Claims. (Cl. 121—53)

This invention relates to hydraulic rotary engines, such as pumps, motors and the like of the type comprising a cylindrical working chamber in which there rotates an array of blades making with their outer sides a sealing fit with the circumferential wall of the chamber and with their inner sides a sealing fit with the convex surface of a crescent-shaped central portion, said array of blades cooperating with a smaller rotor having blades meshing in sealing relation with the tooth spaces of said first array of blades and making a sealing fit with the concave surface of said crescent-shaped central portion.

In such types of hydraulic rotary engines a pulsating discharge flow is obtained which results in undesired pressure pulsations, vibrations and noise.

Moreover in gear pumps of the above mentioned type fluid may be trapped at the meshing point of the gear teeth due to the necessary double sealing engagement of the meshing teeth. Such trapped fluid gives rise to damaging excessive pressure forces especially at high rotational speeds.

The object of the invention is to provide a rotary engine of said general type which is free from pulsations in the flow of liquid and in which the fluid may not be trapped at the gear teeth meshing point.

To this end the rotary engine of the type referred to comprises according to the invention a first rotor having an outer array of blades making a sealing fit not only with the outer circumferential wall of the working chamber but also with the circumferential wall of the central hub portion having a groove therein eccentric with respect to the axis of the working chamber, and a second rotor having an inner array of blades making a sealing fit only with said eccentric groove and engaging into the spaces between the blades of said outer array.

Thereby the outer array serves merely the purpose of a valve and does not affect the flow capacity of the rotary engine which is exclusively determined by the dimension of the axial sectional area of that portion of blades of the inner array extending into the working chamber.

Said last named blades need not extend along the whole axial width of the working chamber.

Another object of the invention is to provide regulating means whereby the capacity of the rotary engine may be varied. This regulating means comprises slide means for axially moving the second rotor so that its blades take up a smaller or larger volume of the working space, said slide means forming the bottom of the groove in said central hub portion thereby securing the sealing fit of the blades in said groove.

According to the invention the blades of the inner array may engage the blades of the outer array for driving the latter or the two rotors may be synchronized in any other way to prevent engagement between the blades of the two arrays.

The rotary engine according to the invention may be carried into practice in various ways and three embodiments according to the invention are illustrated by way of example in the accompanying drawings, in which

Figure 1 is a sectional view of a rotary engine according to the invention in a plane passing through the axis of rotation of the engine,

Figures 2 to 5 are cross sectional views on the lines II—II, III—III, IV—IV and V—V respectively of Figure 1,

Figure 6 is a sectional view of a second embodiment of the rotary engine in a plane passing through the axis of rotation of the engine,

Figures 7 to 10 are cross sectional views on the lines VII—VII, VIII—VIII, IX—IX and X—X respectively of Figure 6,

Figure 11 is a sectional view of a third embodiment of the rotary engine in a plane passing through the axis of rotation of the engine,

Figure 12 is a cross sectional view on the line XII—XII of Figure 11, and

Figure 13 is a part sectional view showing some details of the rotary engine shown in Figure 11.

Referring now particularly to Figures 1–5 the rotary engine comprises a housing generally designated **1** and including a shell **1***a* and end portions **1***b*, **1***c* and **1***d*. A bearing **2** for a rotating shaft **3** is mounted in the rear end portion **1***d*. The shaft **3** may be connected to a prime mover or an apparatus to be driven. Within the housing **1** the shaft **3** is formed as a cylindrical carrier or flange member **3***a* (Figs. 1 and 3). An array of circular holes 3b (Fig. 3) parallel with the axis of the shaft **3** extends through said flange member **3***a*. The peripheries of said holes **3***b* may suitably intersect the periphery of said flange **3***a*.

Cylindrical pins **4** are movably inserted in said holes **3***b* so that they project to both sides therefrom. The rearwardly (to the right in Fig. 1) projecting end portions of the pins **4** are secured in correspondingly shaped holes in a circular holding element **5** being slidable along the shaft **3** (see Figures 1 and 4). The holder **5** is supported by a bracket **7** and an interconnected thrust bearing **8** so that the holder **5** can freely rotate with respect to the bracket **7**. The holder **5** and the bracket **7** engage a suitable recess in a slide **6**, movable along the shaft **3** and extending into the forward end portion **1***b* (the left end portion in Figure 1) of the housing **1**. A threaded spindle **11** engages the thread of a threaded hole in the forward end cover **1***c* and is rotatably connected to the slide **6** by means of a reduced portion between its threaded part and its end **10**, said reduced portion cooperating with a bushing **9** secured to said slide **6**. Thereby the axial movement of said spindle **11** is transmitted to the slide **6** when the spindle **11** is operated by its handle **12**.

The last mentioned end portions of the pins **4** extend into the cylindrical working chamber of the rotary engine, said chamber suitably having a larger diameter than said carrier flange member **3***a*. The cylindrical working chamber is defined by the shell **1***a* and the front end portion **1***b* of the housing. The portions of the pins **4** extending into the working chamber engage the spaces **15***b* between axial teeth **15***a* at the circumference of a cylindrical element **15** rotatably mounted in said cylindrical working chamber. The teeth **15***a* of said element **15** engage with their outer surfaces the peripheral surface of said working chamber and with their inner surfaces the convex cylindrical face of a crescent shaped portion of the slide **6** (Figure 4). The concave cylindrical surface of said crescent-shaped portion defines together with the above mentioned centre hub **13** an arcuate channel forming a sliding fit for the pins **4**.

It is to be noticed that the slide **6** is axially movable along said centre hub **13** together with the rotor **5** and its pins **4** and has an end wall **6***a* between its concave sur-

face of the crescent shaped portion and said hub 13 forming a tight sliding fit with the end surface of said pins 4. The surface of said hub 13 opposite said channel 14 is shaped to form part of the convex cylindrical surface of said crescent shaped portion of the slide 6, and has an extension sufficient to bridge the tooth space 15*b* between two teeth 15*a* (compare Figures 4 and 5).

Inlet and outlet openings 16 and 17 respectively are provided as shown in Figure 4 at opposite sides of a line through the centres of said hub 13 and said slide 6. These openings are separated by a partition wall which is sufficiently thick to bridge the tooth space 15*b* between each pair of teeth 15*a*.

In the rotary engine according to the invention the larger or outer toothed rotor 15 serves merely as a valve while the flow capacity of the engine is exclusively determined by the smaller or inner toothed rotor 3—3. The flow capacity may be calculated by the volume of the ring-shaped body generated by rotation of the portions of the pins 4 projecting into the working chamber times the number of revolutions per time unit.

From this condition it is apparent that the discharged flow will be constant as exclusively determined by the uniformly rotating rotor 3—3. No pulsation will occur provided the rotational speed of said rotor is uniform.

Since in fact the outer rotor 15 only acts as a valve and does not influence the flow, the shape of its tooth spaces need not be accurate, and the rotor 15 is also permitted to rotate irregularly without resulting in an uneven flow.

Moreover the fluid cannot be trapped as suitable clearances may be left around each pin 4 in engaged position in the tooth spaces of the rotor 15.

These features are of special importance when the rotary engine acts as a pump where an irregular flow may give rise to injurious cavitation phenomena and noise or when the rotary engine forms part of a hydraulic transmission that must not be subjected to any vibrations or when the rotary engine acts as a flow meter, where the angular movement thus corresponds exactly to the quantity of fluid passing through the meter.

By adjusting the length of the parts of the pins 4 projecting into the working chamber with the aid of the slide 6 and its adjustment members 9—12 the flow capacity can be continuously regulated from full capacity to approximately zero.

In Figures 6–10 a second embodiment of the rotary engine according to the invention is shown. This engine comprises a housing 21, having an end portion including a bearing 24 for a shaft 20, which within the housing is provided with a cylindrical carrier member 22, 22*a* (Figures 6 and 7) rotatably supported by a bearing 23 and provided with axial holes in which the pins 25 are slidably mounted. The pins 25 have a shape corresponding to that of the pins 4 of the first embodiment and engage with fingers 25*a* a reduced portion formed between shoulders 26*a* and 26*b* of a slide 26. The slide 26 is axially movable by adjustment means (not shown). Suitable bearing surfaces 27 are provided between the fingers 25*a* and the reduced portion of the slide 26 to permit the assembly of pins 25 to rotate freely.

The pins 25 extend into a working chamber and mesh with radial tooth spaces 29*b* of an annular rotatable valve 29 of larger diameter corresponding to the rotor 15 of the first embodiment.

In this second embodiment the slide 26 forms the centre hub 26*b* and has a groove 34 engaged by a key 35 being at one end provided with a crescent-shaped head 35*a* (Figures 6 and 8) and at its other end with a projection 36 engaging a stationary member 30 of the housing. Said stationary member 30 is by means of a pin 33 prevented from moving angularly. A portion 28 of one end wall of the housing forms a crescent-shaped-projection extending into the correspondingly shaped space between the inner surface of the valve 29 and the outer surface of the pins 25 so that an arcuate channel is formed between said crescent-shaped projection 28 and the centre hub 26 (see Figures 1 and 9).

Suitably the tooth spaces in the valve 29 are widened along an axial portion of their length so that clearances are formed around the pins 25 in engaged positions.

Axial inlet and outlet channels 31 and 32 are provided in the stationary member 30 and discharge through the wall of the housing 21 (Figure 10) to be connected to suitable conduits.

The operation of the rotary engine shown in Figures 6–10 corresponds to that of the first embodiment described in connection with Figures 1–5.

Due to the central location of the slide the adjustment forces will be transmitted to the inner rotor 22—25 symmetrically about its axis of rotation so that no distorting forces appear.

In Figures 11–13 a third embodiment is shown which is especially suitable for metering purposes.

A cup-shaped shell member 37 of the housing is at its open end provided with a member 38 having projections forming the crescent-shaped portion between an outer valve 40 and an inner rotor 43 as well as the centre hub.

The working chamber of the flow meter is formed between the shell 37 and its end member 38. In said working chamber the obturator 40 is rotatably mounted by means of its shaft 40*a* supported by bearings in the shell 37 and said member 38. The obturator 40 comprises a disk having axial teeth 40*b* at its peripheral edge meshing with axial pins 43*b* of the inner rotor 43. The shaft 43*a* of said inner rotor 43 is rotatably mounted in a cover member 39 secured to said member 38.

To obtain a synchronized movement of the two rotating elements 40 and 43 the shaft of the inner rotor has an inwardly extended portion 44 provided at its end with a gear wheel 45 meshing with a gear wheel 46 of the valve 40 through an intermediate gear 47 rotatably mounted in the stationary member 38.

Since the pins 43*b* of the inner rotor 43 only mesh with every second of the spaces between the teeth 40*b* of the valve 40 the spaces not engaged by the pins 43*b* may be provided with an end portion 40*c* thereby making the valve 40 more rigid. It is to be noticed that the teeth 40*b* must have a small circumferential extension and be uniformly spaced as in other case the outlet from the channel formed between the central hub and the crescent-shaped portion will be temporarily closed.

By the synchronizing means 45—47 the surfaces of the tooth spaces of the valve and of the teeth 43*b* of the inner rotor may be rough as the surfaces of said elements do not come into contact with each other. Thus said elements may be molded and only the faces having a sealing action need be machined.

I claim:

1. A hydraulic rotary engine comprising in combination a cylindrical working chamber, a cylindrical hub portion concentric with said chamber so as to form an annular working space therein, said hub portion including two parts defining therebetween an arcuate groove eccentric with respect to the axis of said hub portion and intersecting said annular working space within the outer circumference thereof, a first rotor having axial teeth extending into said annular working space and making a sealing fit with said annular space, and a second rotor having axial teeth extending into said arcuate groove and its portion intersecting the annular working space from one side thereof to cooperate with the tooth spaces of said first rotor and making a sealing fit only with said arcuate groove.

2. A hydraulic rotary engine comprising in combination a cylindrical working chamber, a cylindrical hub portion concentric with said chamber so as to form an annular working space therein and defining in said hub portion an arcuate groove eccentric with respect to the axis of said hub portion and intersecting said annular

working space within the outer circumference thereof, a first disk shaped rotor having a peripheral array of axial teeth extending into said annular working space from one side thereof and making a sealing fit with said annular space, and a second rotor having axial teeth extending into said arcuate groove and its portion intersecting the annular working space from the opposite side thereof to cooperate with the tooth spaces of said first rotor and making a sealing fit only with said arcuate groove.

3. A hydraulic rotary engine comprising in combination a cylindrical working chamber, a cylindrical hub portion concentric with said chamber so as to form an annular working space therein and defining in said hub portion an arcuate groove eccentric with respect to the axis of said hub portion and intersecting said annular working space within the outer circumference thereof, a first annular rotor rotatably mounted in said cylindrical working chamber to form the outer circumferential wall of said annular working space, said first rotor having axial teeth formed at its inner circumferential surface, and a second rotor having axial teeth extending into said arcuate groove and its portion intersecting the annular working space from one side thereof to cooperate with the tooth spaces of said first rotor and making a sealing fit only with said arcuate groove.

4. A hydraulic rotary engine comprising in combination a cylindrical working chamber, a cylindrical hub portion concentric with said chamber so as to form an annular working space therein and defining in said hub portion an arcuate groove eccentric with respect to the axis of said hub portion and intersecting said annular working space within the outer circumference thereof, the part of said central hub comprising the bottom of said groove and the portion at one side thereof being

slidable parallel with the axis of the working chamber, a first rotor having axial teeth extending into said annular working space and making a sealing fit with said annular space, and a second rotor rotatably connected with the slidable part of said central hub so as to be moved by the same, said second rotor having axial teeth extending into said arcuate groove and its portion intersecting the annular working space to cooperate with the tooth spaces of said first rotor and making a sealing fit with said arcuate groove only.

5. A hydraulic rotary engine comprising in combination a cylindrical working chamber, a cylindrical hub portion concentric with said chamber so as to form an annular working space therein, said hub portion including two parts defining therebetween an arcuate groove eccentric with respect to the axis of said hub portion and intersecting said annular working space within the outer circumference thereof, a first rotor having axial teeth extending into said annular working space and making a sealing fit with said annular space, a second rotor having axial teeth extending into said arcuate groove and its portion intersecting the annular working space to cooperate with the tooth spaces of said first rotor and making a sealing fit only with said arcuate groove, and means operable for synchronizing the movements of said first and said second rotor.

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