Jan. 29, 1946. J. F. HOFFER 2,393,773

REACTION RING

Filed Aug. 26, 1942 2 Sheets-Sheet 1

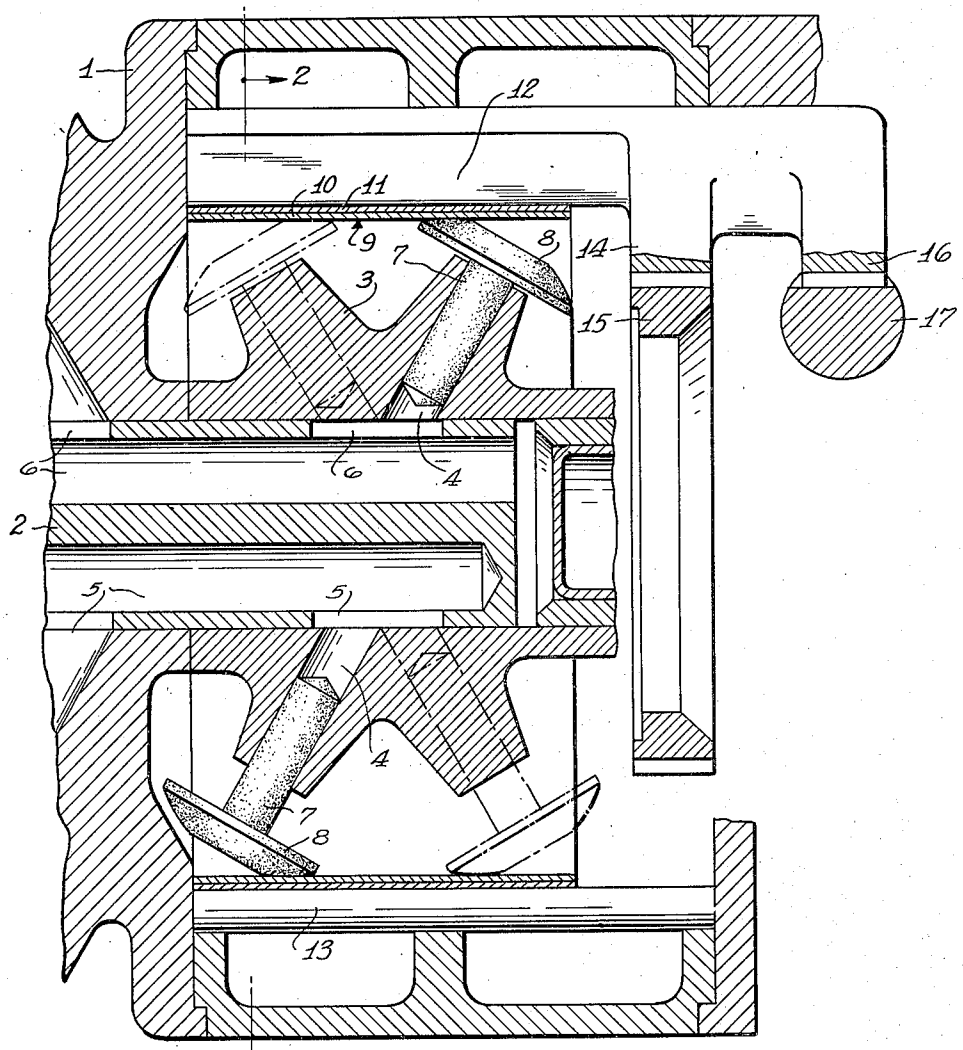


Fig. 1.

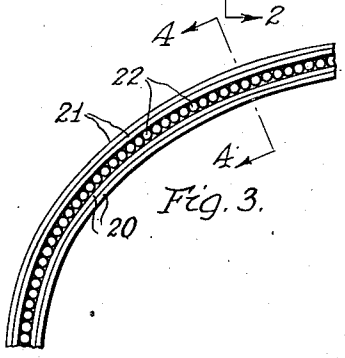


Fig. 3.

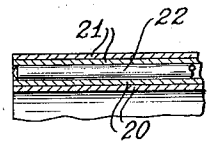


Fig. 4.

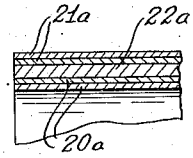


Fig. 5.

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REACTION RING

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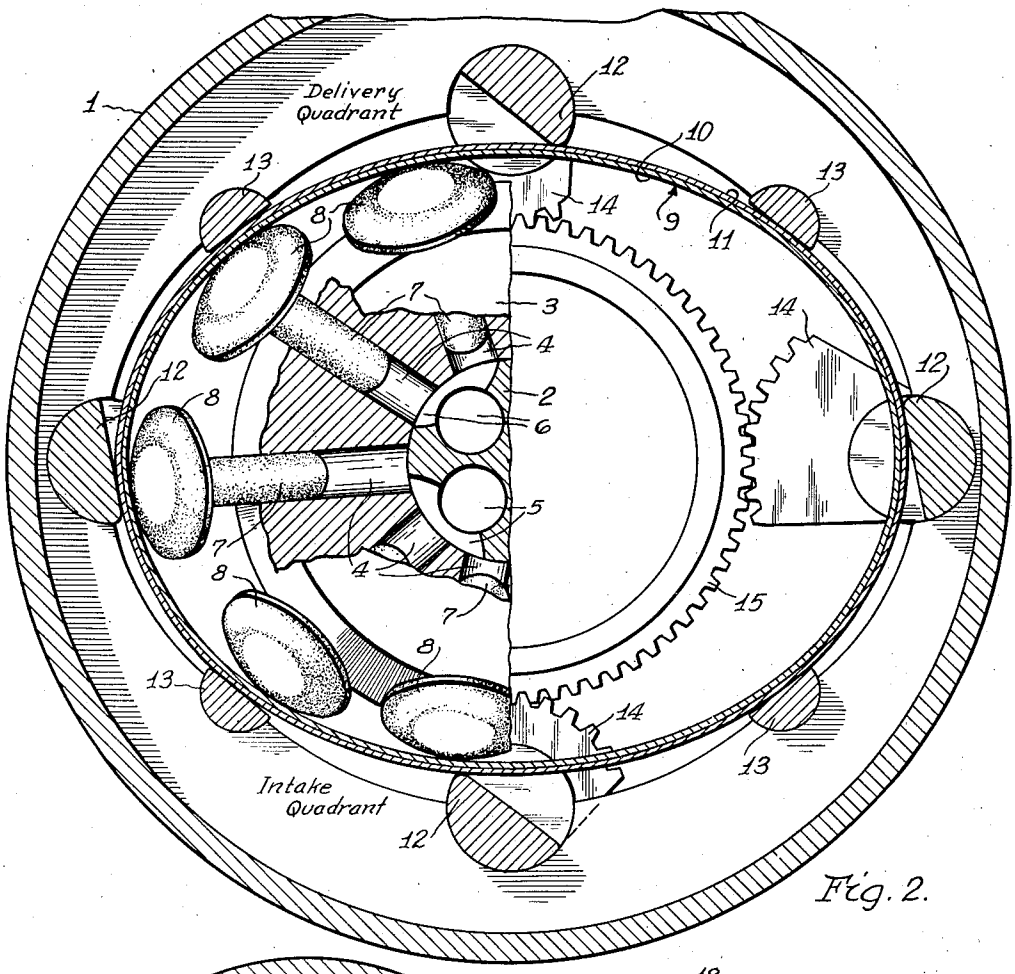


Fig. 2.

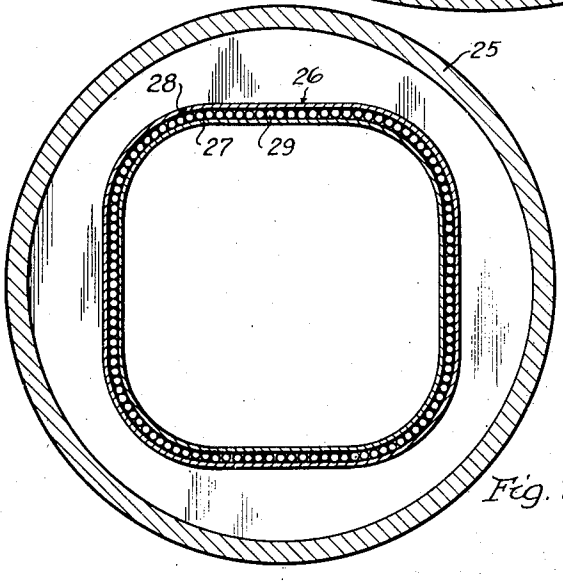


Fig. 7.

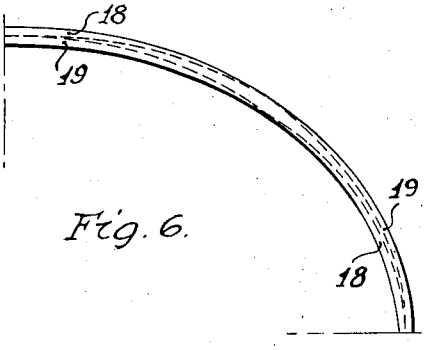


Fig. 6.

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2,393,773

UNITED STATES PATENT OFFICE

2,393,773

REACTION RING

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Application August 26, 1942, Serial No. 456,223

10 Claims. (Cl. 103—161)

This invention relates to a reaction ring for hydraulic or pneumatic pumps, motors, transmissions, prime movers and the like. It is adapted for use with pumps, motors, or transmissions which have fluid impelling means movable radially as they are revolved with a rotor, such for example as the vanes of a vane pump or the pistons of a radial piston pump. For purposes of explanation, the reaction ring is shown in conjunction with a pump or motor such as disclosed in my prior application, Serial No. 425,090, filed December 31, 1941. It will be understood, however, that the disclosure with regard to the pump mechanism is solely for purposes of explanation and is not in any way intended to restrict use of the invention to this particular pump mechanism.

Generally described, the pump or motor of the application above referred to comprises a rotor having a multiplicity of radial plungers or pistons and a reaction ring surrounding the rotor and with which the pistons coact to provide a fluid pumping action. The reaction ring comprises a normally cylindrical, resiliently flexible body concentric with the rotor, and means is provided for changing the shape of the reaction ring from circular to elliptical as viewed in transverse cross section. When the reaction ring is elliptical in form the pistons move outwardly under the influence of centrifugal force as the rotor carries them through two opposite quadrants of a revolution, and they are caused by the reaction ring to move inwardly as they are carried through the two remaining quadrants. The main advantages of a reaction ring of this character are that all mechanical and hydraulic forces are in balance about the pintle, both statically and dynamically, two pump strokes are provided per revolution, and the ellipticity may be infinitely varied from zero ellipticity to maximum ellipticity to cause an infinite variation of the piston stroke. Thus the piston strokes may be regulated to infinitely vary the pump delivery.

With a reaction ring of the character above referred to there are two important factors which must be taken into consideration, because the ring is subjected to varying stresses as its shape is changed from circular to elliptical. For example, the metal of the ring is subjected to tension in some regions and compression in other regions. For a given deflection these stresses increase approximately as the square of the thickness of the ring and yet there is a limitation as to how thin the ring can be made because the ring from a mechanical standpoint must be of a thickness providing sufficient metal to incorporate the strength necessary to withstand the pressure of the pistons. Further, because the ring is flexed in varying amounts the steel of which it is formed must be tough, and because of the frictional contact of the pistons therewith it must be wear resistant. Maximum toughness and wear resistant qualities cannot be present in one steel at the same time.

This invention has for its primary object to provide a reaction ring of the character above referred to in which the stresses are reduced to a point well below a safe maximum, while a thickness of metal is present which provides mechanical strength well above a safe minimum.

Another and equally important object is to provide a reaction ring of the character above referred to embodying both maximum toughness and maximum wear resistant qualities.

Both of the above mentioned objects are accomplished by the provision of what might be termed a laminated ring. In other words the reaction ring is composed of two or more resiliently flexible rings, disposed one within another, with one or more embodying the requisite toughness and the other or others embodying the requisite wear resistant qualities. As compared with a single ring of a given thickness, a ring of two laminations would reduce the stresses to approximately one fourth, and it therefore becomes possible by increasing the laminations to provide a ring of any desired thickness without increasing the stresses above referred to beyond a safe maximum.

Another object is to provide a reaction ring of the character above referred to embodying relatively rotatable rings. In this respect the reaction ring has an inner ring composed of a wear resistant steel, an outer ring of a tough steel and anti-friction means between the rings. The anti-friction means may be in the form of a plain bearing ring of bronze, babbitt, etc., or may take the form of roller or ball bearings. The presence of the anti-friction means not only makes the reaction ring easier to flex, but enables the inner ring which is contacted by the pistons to rotate relative to the outer ring.

With the above and other ends in view the invention is more fully disclosed with reference to the accompanying drawings, in which

Fig. 1 is a fragmental longitudinal cross section of a pump embodying the present reaction ring;

Fig. 2 is a transverse cross section of the pump;

Fig. 3 is a side elevation of a reaction ring em-

bodying multiple rings and anti-friction bearings;

Fig. 4 is a section taken on the line 4—4 of Fig. 3;

Fig. 5 is a section similar to Fig. 4, illustrating a different anti-friction bearing;

Fig. 6 is a diagram used for purposes of explanation, and

Fig. 7 is a schematic view illustrating the fact that the reaction ring might well be changed from circular to other forms than elliptical.

More specifically, 1 designates a pump casing supporting a stationary pintle 2 upon which a rotor 3 is rotatably mounted. When the pump is placed in operation the rotor is caused to rotate by power supplied thereto from an external source and not here illustrated. The rotor is formed with a multiplicity of substantially radially extending cylinder bores 4 whose inner ends successively communicate, as the rotor rotates, with fluid inlet ports 5 and fluid outlet ports 6, formed in the pintle. In each cylinder bore 4 is a piston 7 having a head 8 extended outwardly of the rotor and contacting a resiliently flexible reaction ring 9, which surrounds the rotor. The reaction ring 9, for reasons hereinafter explained, is formed of inner and outer laminations 10 and 11.

As may be seen by reference to Fig. 2, the reaction ring 9 is of elliptical shape. Therefore, as the rotor revolves the pistons move outwardly as they pass through the opposed intake quadrants and are forced inwardly as they pass through the opposed delivery quadrants. The reaction ring 9 is normally circular and is flexed from circular to the elliptical condition shown.

The reaction ring 9 is supported by a multiplicity of cams 12 and a multiplicity of bearing members 13. The cams 12 each have a gear sector 14 connected thereto and the several sectors thus provided mesh with a common ring gear 15 so that all of the cams 12 move in unison. One of the cams 12 has a second gear sector 16 connected thereto which meshes with a lengthwise slidable rack 17. Movement of the rack 17 lengthwise, by means not shown, causes rotation of the cams 12, and causes the cams to vary the ellipticity of the reaction ring.

The above description, with exception to the reference to the laminated ring 9, amounts to a brief explanation of the pump structure shown in my co-pending application above referred to. It serves to illustrate one use of a reaction ring of the type here concerned and from this it is believed that those skilled in the art will readily conceive its use with various other types of devices.

Referring to Fig. 6, it will be seen that when a metal ring is flexed from a circular condition to an elliptical condition the regions 18 are placed under compression, while the regions 19 are placed under tension. As above pointed out, these stresses increase approximately as the square of the thickness for a given deformation. Therefore, as the thickness of the ring is increased, the stresses become factors which tend to decrease the useful life of the ring. By forming the ring of two laminations 10 and 11, as explained above, the tension and compression becomes approximately one fourth of what it would be in a single ring of equal thickness. Obviously, by increasing the number of laminations the stresses would be still further reduced.

The reaction ring 9, because of contact of the pistons therewith, must be wear resistant. It must also be made of steel which is tough, in order that it may be flexed as often as required. These two steels vary considerably as may be seen by comparison of the type analysis of three commercial steels, two being tough and wear resistant respectively, and the third being a steel that might be termed a good compromise tough and wear resistant steel, or an intermediate type analysis.

	Tough	Wear resistant	Intermediate
	Per cent	*Per cent*	*Per cent*
Carbon	0.75	2.10	0.90
Manganese	.30	.25	1.60
Silicon	.25	.25	.25
Chromium	1.00	12.50	
Nickel	1.75	.50	

The inner ring lamination 10 might well be made of a wear resistant steel such as above disclosed, while the ring lamination 11 might well be formed of the tough steel. It will be understood, however, that the type analysis of tough and wear resistant steel varies as between different manufacturers, and that the comparison above drawn is to illustrate the difference, rather than to restrict the invention to use of these particular steels.

The reaction ring shown in Fig. 3 is composed of two inner laminations 20 and two outer laminations 21 separated by needle bearings 22. Thus the inner and outer sets of laminations may rotate with respect to each other. Alternatively, the two laminations 20*a* may be separated from the laminations 21*a* by a bronze bearing 22*a*, as shown in Fig. 5. The presence of the anti-friction bearing means has two advantages. It makes flexing of the multiple rings easier, and it also permits what might be termed the inner race to rotate relative to the outer race.

As shown in Fig. 7 the reaction ring herein disclosed can be changed to other forms than elliptical. In this view the housing 25 has what might loosely be termed a square opening 26 with rounded corners. The reaction ring, composed of an inner race 27, and outer race 28 and roller bearings 29 is pressed into the opening and takes the same general shape as the opening. A ring of the shape here shown will provide four pump strokes per revolution of the rotor.

Although specific embodiments of the invention have been illustrated and described it will be understood that various structural changes may be made within the scope of the appended claims without departing from the spirit of the invention, and such changes are contemplated.

What I claim is:

1. A deformable reaction ring of the character described comprising a multiplicity of continuous, ring-like bodies having smooth and uninterrupted inner and outer surfaces and closely fitting one within another each of said bodies being flexibly deformable throughout its length.

2. An elliptical reaction ring composed of a multiplicity of continuous, ring-like laminations having smooth and uninterrupted inner and outer surfaces closely fitting one within the other each of said laminations being flexibly deformable throughout its length.

3. A deformable reaction ring of the character described comprising a multiplicity of continuous, ring-like bodies closely fitting one within another and having smooth and uninterrupted inner and outer surfaces, each of said bodies being flexibly deformable throughout its length, at least one of said bodies being composed of wear resistant

steel, and at least one of said bodies being formed of tough steel as compared to the one composed of wear resistant steel.

4. An elliptical reaction ring composed of a multiplicity of continuous laminations having smooth and uninterrupted inner and outer surfaces and closely fitting one within the other, each of said laminations being flexibly deformable throughout its length, at least one lamination being composed of wear resistant steel, and at least one lamination being composed of tough steel as compared to the one composed of wear resistant steel.

5. A deformable reaction ring of the character described comprising a multiplicity of ring-like bodies separated by anti-friction bearing means, each of said bodies being flexibly deformable throughout its length.

6. An elliptical reaction ring comprising a multiplicity of ring-like laminations, at least two of said laminations being separated by anti-friction bearing means, each of said laminations being flexibly deformable throughout its length.

7. A deformable reaction ring of the character described comprising a multiplicity of rings disposed one within another, each of said rings being flexibly deformable throughout its length, and a bronze bearing sleeve interposed between two of said rings.

8. A deformable reaction ring of the character described comprising a multiplicity of rings disposed one within another, each of said rings being flexibly deformable throughout its length, and needle bearings interposed between two of said rings.

9. A reaction ring of the character described comprising an outer race member having a shape other than round as viewed in transverse cross section, an inner race member comprising a ring-like body flexibly deformable throughout its length, and roller bearings interposed between the inner and outer race members in such manner that they confine the inner race member to a shape corresponding to that of the outer race member and support the inner race member for rotation relative to the outer race member.

10. A reaction ring of the character described comprising an outer race member having a shape other than round as viewed in transverse cross section, an inner race member comprising a ring-like body flexibly deformable throughout its length, and an anti-friction member interposed between the inner and outer race members in such manner that they confine the inner race member to a shape corresponding to that of the outer race member and support the inner race member for rotation relative to the outer race member.

JAMES F. HOFFER.