

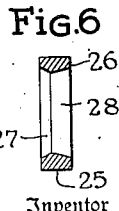
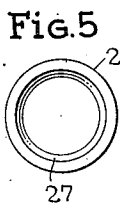
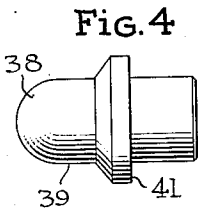
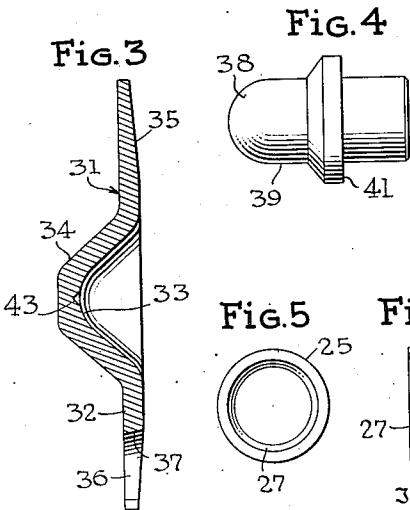
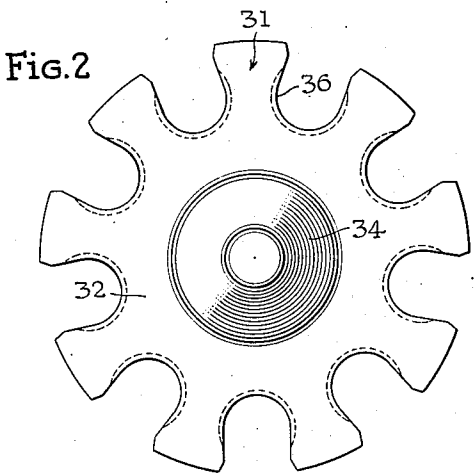
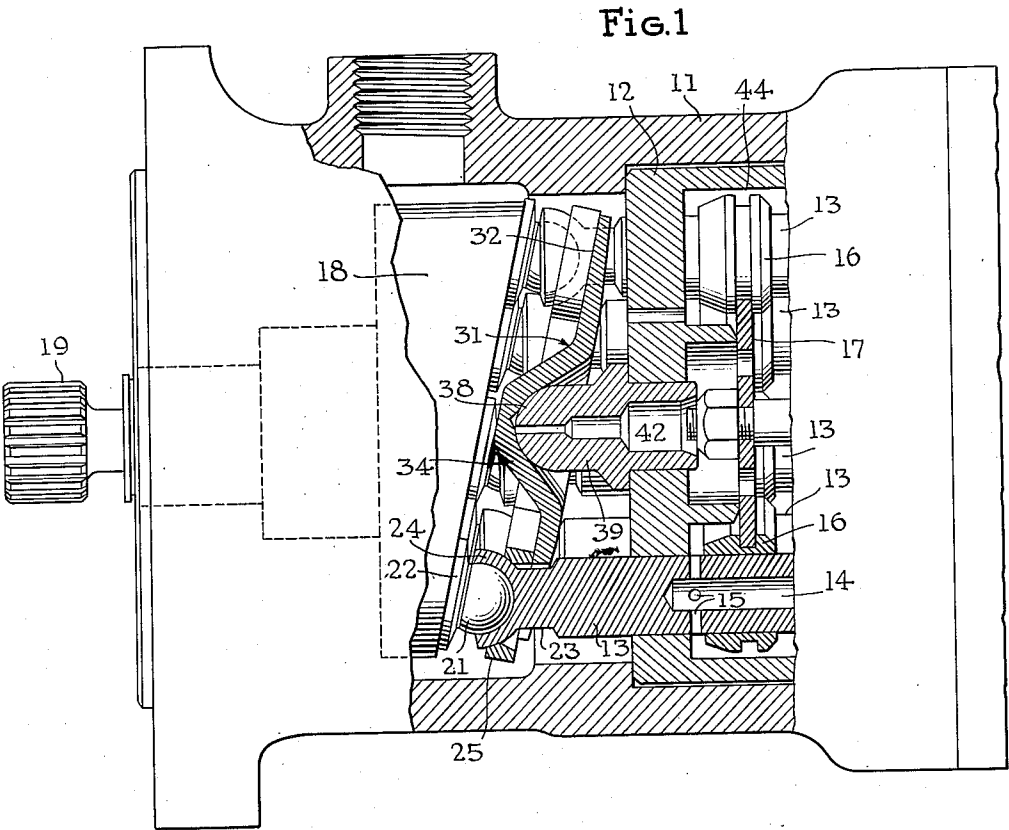
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PARALLEL PLUNGER PUMP WITH POSITIVE PLUNGER ACTUATION

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UNITED STATES PATENT OFFICE

2,620,738

PARALLEL PLUNGER PUMP WITH POSITIVE
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1 Claim. (Cl. 103—173)

1

This invention relates to parallel plunger pumps of the type in which the plungers are actuated by a rotating swash plate. A highly developed pump of this description is disclosed in Patent No. 2,433,222 issued to M. W. Huber on December 23, 1947. This pump is of the variable displacement type and has demonstrated many valuable attributes when operated at rotary speeds exceeding 3000 R. P. M. and at head pressures of the order of 3000 p. s. i.

Reliable as the Huber pumps with spring-retained plungers have proved to be, the demand for higher rotary speeds has already made it desirable to perfect positive actuation of the plungers in both directions.

Geometrically the problem is simple enough, but at the speeds and loads contemplated more is involved than geometry. Small parts and adjustable parts must be eliminated. To keep side-thrust on the plungers to a minimum, plunger overhang must be minimized. Simplicity of form and rugged strength are matters of primary importance.

The invention provides a nutating plate mechanism arranged to return the plungers positively, and so compact that the space required for it (measured in the direction of the plunger axes) is not greater, and indeed is somewhat less than the space required by the springs which it displaces. The features which make this possible are the essence of the inventive concept and can best be explained by reference to a typical embodiment.

In the accompanying drawings a pump having the capacity control mechanism of Patent 2,433,222 and the piston-actuating mechanism of the present invention is illustrated so far as is necessary to disclose the principles of the invention.

In the drawings:

Fig. 1 is a fragmentary view of the pump partly in side elevation and partly in axial section.

Fig. 2 is a face view of the nutating plate.

Fig. 3 is a diametric section thereof.

Fig. 4 is a side elevation of the strut on which is formed the spherical journal for the nutating plate.

Figs. 5 and 6 are respectively a face view and an axial sectional view of a sliding thrust ring used as the motion transmitting connection between each plunger and the nutating plate.

A portion of the housing of the pump appears at 11 and sustains the guide block 12 through which the plungers 13 reciprocate. Nine such plungers are commonly used. Each plunger 13

2

has an axial bore 14 leading from the cylinder in which it works. Cross ports 15 are controlled by sleeve-like spill-back valves 16. A spider 17 engages grooves in the valves 16 and shifts them in unison to vary the effective strokes of the various plungers 13.

The swash plate or cam 18 is sustained by the usual radial and thrust bearings (not visible in the drawing) and is driven through the self-aligning coupling member 19. The plungers 13 have spherical sockets at their ends and these receive spherical heads 21 of slippers which engage the face of swash plate 18, the engaging portions of each slipper being a disc 22 formed integrally with the spherical heads 21.

As so far described the construction is basically the same as that shown in said Huber patent.

Each plunger 13 has a reduced portion or "neck" 23 behind a convex hemi-spherical enlargement 24 in which the spherical socket for the head 21 is formed. For manufacturing reasons it is desirable that the spherical surface of the socket and the exterior spherical surface of the enlargement 24 be concentric. Both must be located on the plunger axis and all the plungers must be identically dimensioned. The geometry of the mechanism does not require concentricity.

The necks 23 afford clearance for the floating rings 25 one of which co-acts with each spherical enlargement 24. These rings are solids of revolution and each has two opposite bearing surfaces, a plane surface 26 which engages the nutating plate (to be described) and a concave spherical zone 27 bounded by planes which are parallel with the plane of surface 26. The radius of surface 27 is the same as the radius of the convex spherical surface on enlargement 24 on which the ring seats. The surface 28 is conical to afford clearance for the rocking motion of the ring. This allows the neck 23 to be of larger diameter than otherwise it could be, since the center opening of the rings 25 is only large enough to permit the ring to be slipped over the plunger 13. The effect is to secure the maximum bearing surface practicable with a ring of reasonable thickness and diameter.

The nutating disc generally indicated by the numeral 31 is best shown in Figs. 2 and 3. It is generally circular in form and has on one side a plane surfaced annular bearing area 32 and on the other side a spherical bearing socket 33 whose geometric center is in the plane of area 32 and, of course, also at the center of the nutating disc as clearly shown.

The spherical bearing socket is located in a

3

conical offset 34 formed for the purpose of receiving it. The rear face 35 of the disc is slightly conical so that the marginal portion of the disc is tapered outward. Formed in the margin of the disc are notches 36, one for each plunger in the pump. In the nine-cylinder pump illustrated by way of example there are nine such notches spaced at uniform intervals around the disc to correspond with the spacing of the plungers 13. As indicated in Figs. 1, 2 and 3, the inner portions of these openings are flared or conical as shown at 37.

In assembling the pump the necks 23 on the plungers enter the notches and the entrance portions of the notches are dimensioned accordingly. The bearing surfaces 26 of the rings 25 seat on the face 32 of the disc in areas surrounding the margins of the inner portions of the opening 36. The concave spherical zones 27 seat on the spherical surfaces of the enlargements 24 as best shown with reference to the lower plunger in Fig. 1.

The spherical bearing seat 33 of the nutating disc seats on the spherical journal portion 38 (see Figs. 1 and 4) formed on the end of a stud 39. This stud is pressed into an opening at the center of the guide member 12 and is positively positioned by a flange 41 which seats against the face of the guide member 12.

The center of the spherical bearing surface or journal 38 is located precisely on the axis of the rotary swash plate 18 and in such position that the surface 32 is parallel with the surface of the swash plate and spaced therefrom precisely the interval filled by the slippers 21, 22, spherical end members 24 and rings 25. The stud 39 is provided with an axial passageway 42 which leads through the end of the journal member 38 in position to feed oil to the small cavity 43 formed in the bearing socket 33.

Since the space 44 is oil-filled in the plunger constructed according to the Huber patent, the passage 42 provides for lubrication of the journal 38 at all times.

The operation of the piston actuating mechanism will be readily understood from the above description. Considering any plunger, it is obvious that as that plunger is forced inward, the plungers diametrically opposite it are forced outward by the rocking motion of the nutating plate.

Probably the most important aspect of the invention is the simplicity and the rugged strength of the parts. The plungers project beyond the guides by the minimum practicable distance. All bearing areas on the swash plate, slippers, nutating plate and floating rings are of substantial extent. No adjustments are provided.

Particular attention is called to the clearance around the neck 23 of the bottom plunger shown in Fig. 1. The tapered surface 23 in the floating ring and the taper 37 of the apertures in the nutating disc 31 afford adequate clearances for the necks 23 without requiring an undesirable reduction in the cross-section of the neck.

Even assuming that the cam 18 and the journal 38 are precisely positioned, it is obvious that tolerances on the slippers, slipper sockets, rings 25 and nutating plate 31 must be held within close limits because the cumulative effect of small errors all in the same direction would otherwise be substantial. However, the requirements for precision are not quite as severe as was anti-

4

cipated and it is possible to meet them by the use of precise commercial methods.

As a consequence, no adjustment of the thrust bearing for the swash plate 18 and no adjustment of the stud 39 is necessary. The advantage of a permanently rigid construction in a high-speed, high-pressure pump is so great as to justify the expense of the necessary precision in manufacture.

It has already been demonstrated that the pump mechanism here described can be operated at speeds materially higher than those possible where the plungers are spring-returned, and that such pumps develop satisfactory volumetric efficiencies when so operated.

No attempt has been made to illustrate the flow of the hydraulic liquid, which has lubricating properties, through the cam space of the pump but that action is present in parallel plunger pumps manufactured by applicant's assignee and is well known in the art. It appears unnecessary to complicate the present disclosure as to that detail.

I claim:

In a pump, the combination of a rotary drive shaft; a swash plate carried thereby and turning therewith; a plurality of reciprocable pump plungers arranged with their axes parallel with, and in circular series around, the geometrical axis of said shaft, each of said plungers having a cup-like terminal portion whose internal and external surfaces are spherical, concentric and centered on the longitudinal axis of the plunger; means for guiding said plungers in longitudinal reciprocations; a fixed thrust member having a thrust surface which is a segment of a sphere centered on said shaft axis and presented toward said swash plate; a nutating disc tiltable on said spherical thrust member, said disc being peripherally apertured at intervals to clear and at least partially encircle respective plungers, said disc having on its face proximate to the swash plate, and in the apertured peripheral area thereof, a plane bearing surface in the plane of which the center of the spherical surface of said thrust member is located; slippers universally tiltable in the cup-like terminal portions of respective plungers, said slippers having plane surfaces which engage said swash plate; and thrust rings universally tiltable on the exterior spherical surfaces of the terminal portions of respective plungers, each thrust ring having a plane surface engaging the plane bearing surface on said nutating disc.

MATTHEW W. HUBER.

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