March 28, 1944. M. W. HUBER 2,345,125

HIGH PRESSURE PUMP

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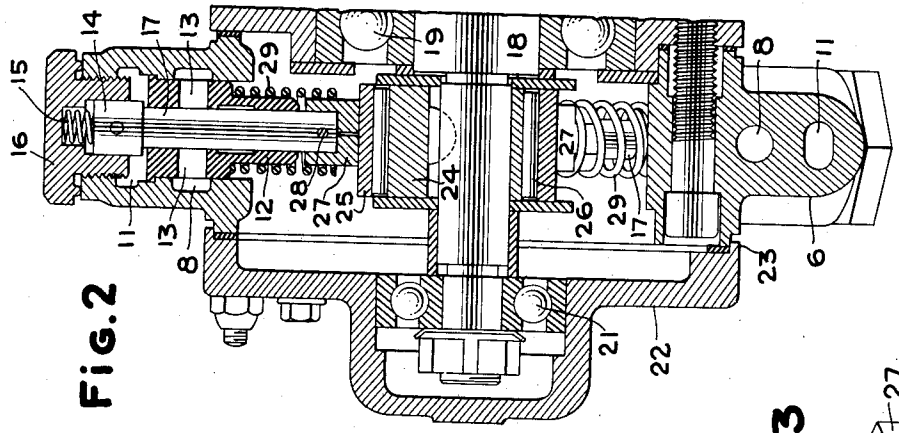


Fig. 2

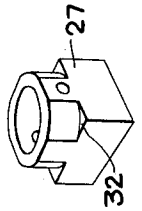


Fig. 3

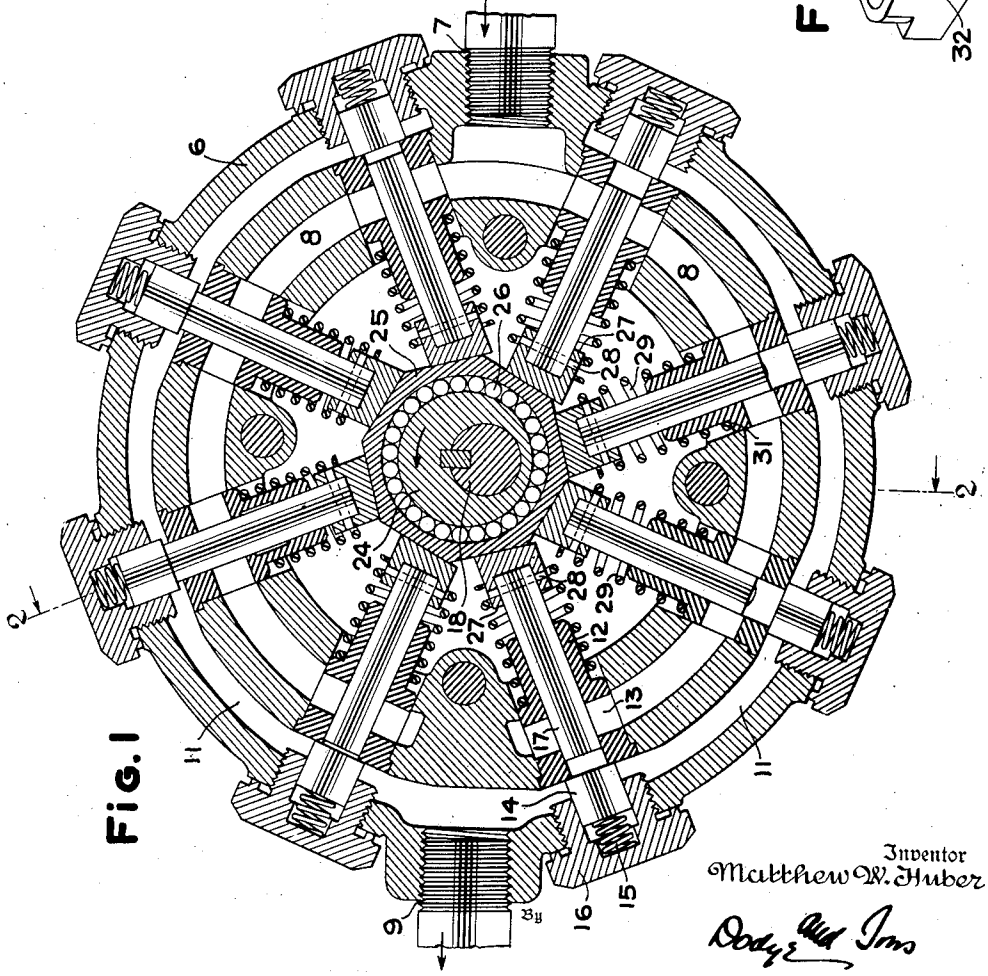


Fig. 1

Inventor
Matthew W. Huber

By Dodge and Sons

Attorneys

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## HIGH PRESSURE PUMP

Matthew W. Huber, Chicago, Ill., assignor, by mesne assignments, to The New York Air Brake Company, a corporation of New Jersey

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2 Claims. (Cl. 74—50)

This invention relates to high pressure, high speed pumps and particularly to the mechanism for actuating the pump plungers.

In hydraulic pumps operating against head pressures of the order of 2000 to 3000 pounds per square inch and at speeds of from 1750 to 3500 R. P. M., the unit pressures in the plunger drive mechanism are high, and the lateral thrusts on the plungers are apt to be excessive, particularly near the end of the displacement stroke.

The present invention provides a pump in which the unit pressures are not unduly high and in which the use of an oblique plunger thrust face, preferably in conjunction with a cylinder which is offset from a radial line, affords thrusts which are better alined with the cylinder axes throughout the displacement stroke.

The invention produces a pump which is intended to be driven in one direction only, but which will not be damaged by a few backward turns.

In the preferred embodiment, the plungers are of simple cylindrical form having a long guiding contact with the cylinders. Each cylinder is offset a uniform distance from and parallel with a radial line. Each of the plungers carries a head which has an oblique bearing surface contacting the corresponding face of a polygonal prismatic sleeve journaled on the driving eccentric. The offset of the cylinders is opposed to the direction of rotation of the eccentric, and the amount of such offset and the degree of obliquity of the bearing surface on the thrust head are so chosen, that when working against the normal pressure head, and with normal friction between the eccentric and the sleeve, and between the sleeve and the thrust head on respective plungers, the resultant displacement thrust on each plunger is nearly in the direction of its axis. The effect is to minimize the side thrust on the plungers.

Another and related effect is that the tendency of the sleeve to rotate with the eccentric is so resisted that the unit pressure between the sleeve and the thrust head is, at least during the displacement stroke, approximately uniform over the area of engagement.

A successful embodiment of the invention in a multicylinder radial type pump will now be described by reference to the accompanying drawing, in which:

Fig. 1 is a section of the pump on the plane of the plunger axes.

Fig. 2 is a section on the line 2—2 of Fig. 1.

Fig. 3 is a perspective view of a plunger thrust-head.

Since the invention resides in the plunger actuating mechanism, a very simple inlet and discharge arrangement is chosen for illustration This involves side inlet ports in the cylinder bushings, controlled by the plungers, and spring pressed discharge valves sealing against the end of the cylinder bushings. This is a known construction and any known valve arrangement can be substituted.

The pump body 6 has an inlet connection 7 which leads to the arcuate passages 8, and a discharge connection 9 which leads from the arcuate passages 11. A series of eight cylinder bushings 12 are pressed into approximately radial bores formed in body 6. The arrangement is such that the axis of each cylinder bushing is parallel with but displaced from a true radial line, and the displacement is opposed to the direction of rotation of the drive shaft of the pump, as will be explained in detail.

Each bushing 12 has side inlet ports 13 in free communication with one of the passages 8, and is exposed at its outer end in one of the passages 11. Cup-shaped valves 14 seat against the ends of corresponding bushings 12. They are urged in a seating direction by coil compression springs 15 which react against combined closure and valve guiding plugs 16 screwed into body 6. Each valve is freely guided by the corresponding guide plug. A plain cylindrical plunger 17 works in each bushing. At its innermost limit of motion it slightly overtravels the ports 13 and at its outermost limit forces the corresponding valve 14 from its seat.

No novelty is here claimed for this valve arrangement, nor is the invention limited to use with any particular type of valve.

The pump shaft 18 which, as viewed in Fig. 1, turns counter-clockwise, is mounted in annular ball bearings, the main bearing 19 being mounted in body 6 and the outboard bearing 21 being mounted in the removable cap 22 which is accurately centered on body 6 by a flange 23, and is held in place by studs, as shown.

Between the two bearings, the shaft 18 carries an eccentric 24, and on this eccentric is swiveled an octagonal prismatic thrust block 25. Bearing rollers 26 (sometimes called needles) are interposed between the eccentric and the thrust block.

The thrust block is octagonal simply because the pump has eight cylinders 12 and plungers 17. Within reasonable limits any number of cylinders may be used, and there must be a thrust surface on the block to coact with the thrust head of each plunger 17.

The plungers 17 and the thrust block 25 are of hardened steel, but each plunger 17 carries at its inner end a thrust head 27, preferably of bronze. The inner end of each plunger 17 makes a press fit, and bottoms in a recess bored in the thrust head to receive it. Each block is also pinned to its plunger as indicated at 28. Each head is rectangular in cross section and has a plane thrust face which is not normal to the axis of its plunger 17, but at a slight angle to a

normal plane. In the example illustrated, the angle is 5°.

Each thrust head with its plunger 17 is urged inward toward the thrust block by a coil compression spring 29. These springs seat at one end on external shoulder 31 on the bushings 12 and at the other end on the shoulders 32 on the heads 27. As clearly indicated in the drawing, each spring is spaced from its plunger at all times, and so sustained that it has no tendency to bow laterally.

By a proper choice of dimensions of the thrust block and thrust heads, it is possible to cause the forward and rear edges of each thrust head to over-travel slightly the limits of the coacting surface on the thrust block. Fig. 1 illustrates this effect. This is desirable in the interests of uniform wear.

The important features of the invention are the oblique surfaces on the thrust heads, and the use of this type of thrust head in conjunction with offset cylinders. The Patent Office drawings, filed with the present application, show a pump whose bore and stroke are each 5/16 inch, the offset being about 9/64 inch and the thrust angle 5°. These dimensions are typical but not limiting, for the optimum offset is a function of the friction between the eccentric and the polygonal thrust block, and the optimum thrust angle is a function of the friction between the thrust block and the thrust head. Further these two variables seem to be interrelated in some degree which makes definition of precise values impossible.

However, satisfactory values for these two variables can readily be determined by trial and error if due consideration be given to the factors now about to be outlined.

At high speeds and operating against high head pressures, there is considerable friction between the eccentric 24 and the thrust block 25 so that the thrust block tends to rotate with the eccentric. This tendency is resisted solely by the plunger heads. Irrespective of any obliquity of thrust surfaces, if the plungers are radial to the axis of the shaft, the thrust block will be slightly displaced angularly when the pump runs, and the thrust faces on the thrust heads 27 will wear to a convex form. This results ultimately in high unit pressures because there is then practically only line contact. By offsetting the cylinders and consequently the plungers in the direction opposed to the direction of rotation of the shaft 18, the plungers are caused to develop a turning moment on the thrust block which opposes the rotary tendency. It is practically possible to neutralize the rotary tendency of the thrust block by properly offsetting the cylinders. Thus the amount of offset is primarily a function of the friction between the eccentric and the thrust block 25.

However, there are modifying factors such as the strength of the springs 29, the speed at which the pump is operated, and the head pressure against which the pump delivers. Experience has shown that for a given offset, there is a reasonable operating range as to the factors just mentioned.

The obliquity of the thrust face on the thrust head of each plunger is effective to neutralize a condition set up by friction between the thrust block 25 and each thrust head 27. In a radial pump with a polygonal thrust block and plungers with thrust surfaces which are normal to the plunger axis, there is side wear on the plungers which develops very rapidly. It will occur whether the cylinders are offset or not. The location and extent of the side wear show that the wear-producing side thrust occurs in the latter half of the discharge stroke and hence is unidirectional. This makes it possible to neutralize this side thrust by the adoption of an oblique thrust surface.

Obviously the thrust between the thrust block 25 and the thrust surface on the head 27 is normal to the plane of the contacting surfaces. However, the frictional drag between the block 25 and the head 27 near the end of the displacement stroke introduces a lateral component. By proper choice of the angle of thrust, the resultant of the thrust proper and of the frictional drag can be made to coincide approximately with the axis of the plunger so that the side wear is greatly reduced.

The thrust obliquity is useful even without any offset, but attains its best effect when coordinated with offset.

It will require only brief study to determine the fact that the motion of the plungers is harmonic. It is also obvious that the use of a spring returned plunger is not essential, the geometry of the movement being such that various other ways of causing the plunger head to follow the thrust surfaces on the thrust block may be used.

Thus while a preferred embodiment of the invention has been described in great detail, this is intended to be illustrative only, and implies no limitations beyond those expressed in the claims.

I claim:

1. In a pump, the combination of a rotary shaft with eccentric; a block swiveled on the eccentric and having a plane thrust face parallel with the axis of the shaft; a cylinder mounted with its axis approximately radial to said shaft but offset from a true radial line in a direction opposed to the direction of rotation of the shaft; a plunger working in said cylinder, and having a plane thrust surface on its end in contact with the plane face on the block, the plunger thrust surface being at an angle to a plane normal to the plunger axis; and means for maintaining the plunger and block in coactive relation.

2. A pump having a rotary shaft; a plurality of cylinders each arranged approximately radially with respect to the shaft but each similarly offset from a true radial line in a direction opposite to the direction of rotation of the shaft; an eccentric turning with said shaft; a prismatic block swiveled on said eccentric and having plane sides, one corresponding to each cylinder, such sides serving as thrust surfaces; plungers, one in each cylinder, each having a thrust surface at a moderate angle to a plane normal to the plunger axis, the thrust surface on each plunger engaging a corresponding thrust surface of the prismatic block; and means for maintaining each plunger in operative relation with said block, the cylinder offset and the angle of the plunger thrust surfaces being so chosen as to neutralize the lateral thrusts on the plungers otherwise caused by friction between eccentric and block and between the block and plungers.

MATTHEW W. HUBER.