Aug. 3, 1965 O. THOMA 3,198,130

HYDRAULIC APPARATUS

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FIG.1.

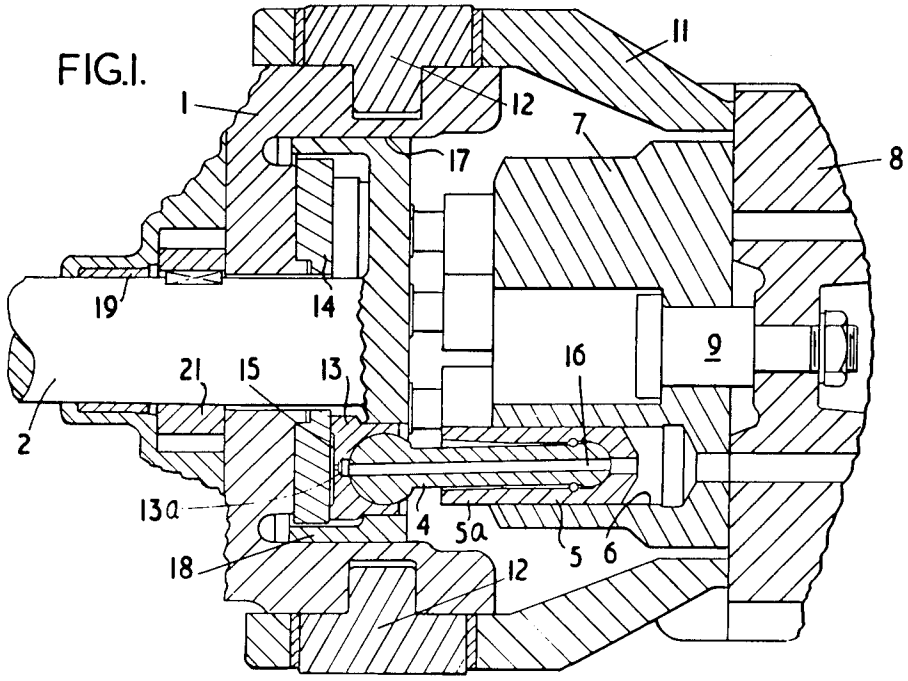
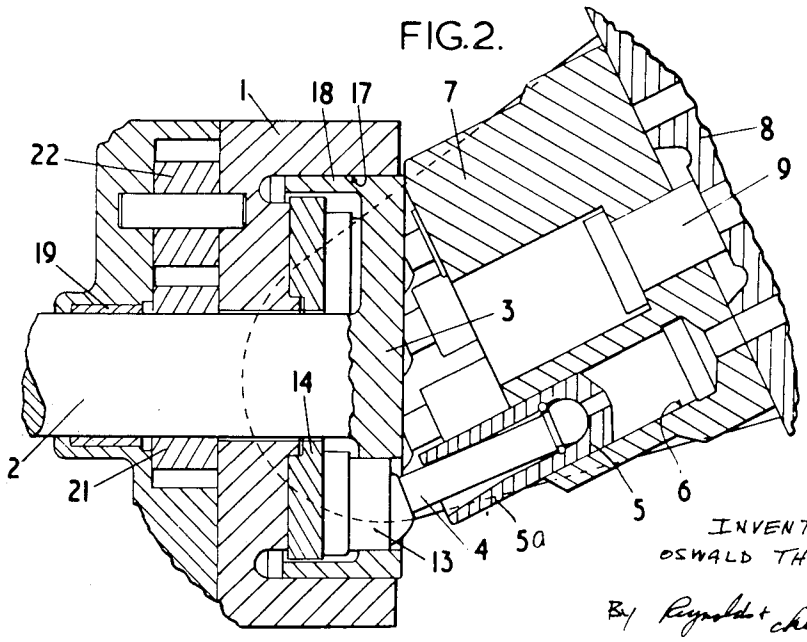


FIG.2.



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HYDRAULIC APPARATUS

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1 Claim. (Cl. 103—162)

This invention relates to hydraulic pumps or motors.

The present invention provides a hydraulic pump or motor including a rotatably-mounted drive shaft, a drive member connected for rotation with the drive shaft, as by being fast on the drive shaft, a radial thrust main bearing surrounding and acting on the drive member, a radial thrust pilot bearing surrounding and acting on the drive shaft, in the event that the drive member is fast upon the drive shaft, a cylinder block mounted for rotation with the drive member about an axis that in operation is inclined to the rotational axis of the drive member and drive shaft, the cylinder block having a series of cylinders extending in a direction substantially parallel to the rotational axis of the cylinder block, a series of assemblies including pistons each reciprocably mounted in a different one of the series of cylinders in the cylinder block, connecting rods each normally pivotally connected to a different one of the series of pistons, and slippers to which the respective connecting rods are pivotally connected. Liquid inlet means and liquid outlet means are associated with the cylinder block to deliver liquid to and to discharge it from the successive cylinders during rotation. The drive member is formed with axially directed holes, similar in number to the assemblies, wherein the slippers are reciprocative.

The line of action of the radial thrust main bearing surrounding and acting on the drive member may be located on the opposite side of a plane passing through the pivotal connections of the connecting rods to the shoes.

In other words, a plane passing through the several pivotal connections of the connecting rods to the shoes may also pass through the surface of the radial thrust bearing acting on the drive member.

Each slipper that is pivotally connected to its connecting rod is slidable over the axially facing bearing surface of a fixed track member.

Each slipper and the track member may co-operate to define a chamber to which liquid under pressure is fed from the respective cylinder through a passage in the piston, connecting rod and slipper assembly.

One of the gear wheels of a gear pump may be mounted on and driven by the drive shaft and located between the radial thrust bearing in which the drive shaft is mounted and the drive member.

The drive member may be integral with the drive shaft.

One embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawings of which,

FIGURE 1 is an axial sectional view of a hydraulic pump, at a plane that includes the axis of a cylinder, and,

FIGURE 2 is a similar view of the pump in a plane perpendicular to the plane of the view of FIGURE 1.

With reference to the accompanying drawing, a hydraulic pump includes a housing 1 in which a drive shaft 2 is rotatably mounted. A circular drive member 3 is connected for rotation with drive shaft 2, usually being fast on the drive shaft and, in this embodiment, the drive member 3 is integral with the drive shaft 2. A series of connecting rods 4 has one set of ends pivotally connected, although indirectly, to the drive member 3 and the other set of ends each is pivotally connected to a different one

of a series of pistons 5. Each piston 5 has a skirt 5a which surrounds the connecting rod 4 over a portion of its length. Each piston 5 is reciprocably mounted in a different one of a series of cylinders 6 in a rotatably mounted cylinder block 7. The cylinders 6 are spaced equally around the axis of rotation of the cylinder block 7 and extend in a direction substantially parallel to this axis of rotation.

The cylinder block 7 is radially located with respect to a fixed valve member 8 by a spindle 9. The cylinder block 7, spindle 9 and valve member 8 are carried by a yoke 11 pivotally connected by trunnions 12 to the housing 1. The cylinder block 7 during operation is mounted for rotation about an axis inclined to the axis of rotation of the drive member 3. Rotational movement of the drive shaft 2 and drive member 3 is transmitted to the cylinder block 7 by the connecting rods 4 by their engagement with the skirts 5a of the pistons 5. Pivotal movement of the yoke 11 relative to the housing 1 varies the angle of inclination between the axes of rotation of the cylinder block 7 and the drive member 3.

Rotation of the drive shaft 2, drive member 3 and cylinder block 7 causes liquid to be drawn into and pumped out of the successive cylinders 6 through ports in the valve member 8, which ports act as liquid inlet means and liquid outlet means.

The pivotal connection between each connecting rod 4 and the drive member 3 is formed by a ball-end of the connecting rod 4 and a slipper 13 having a recess in which the ball-end is mounted. Each slipper 13 is slidably mounted in a hole 23 in the drive member 3 and can slide relative to the drive member 3 in a direction parallel to the axis of rotation of the drive member 3. A track member 14 is mounted in the housing 1 and has a surface 14a perpendicular to the axis of rotation of the drive shaft, and the slipper 13 slides over that surface of the track member 14 as the drive member 3 rotates.

The surface of each slipper 13 engaging the track member 14 has a recess which co-operates with the surface 14a of the track member 14 to form a chamber 15. Each chamber 15 is fed with liquid under pressure from the bore 6 through a passage 16 passing through the piston 5, connecting rod 4 and slipper 13 and a restrictor 13a in the slipper 13. The liquid leaks away from each chamber 15 between the slipper 13 and the track member 14. The liquid under pressure in each chamber forms a hydrostatic bearing and provides a force which opposes the thrust exerted during operation of the pump by each connecting rod 4 on its slipper 13 in a direction parallel to the axis of rotation of the drive member 3 and drive shaft 2.

The thrust exerted, during operation of the pump, by each connecting rod 4 on its slipper 13 in a direction perpendicular to the axis of rotation of the drive member 3 and drive shaft 2, that is to say in a radial direction, is transmitted by the slipper 13 to the drive member 3. An interior surface of the housing 1 is formed as a radial thrust main bearing 17 which surrounds and acts upon the peripheral edge surface of the drive member 3 to oppose the radial thrust exerted on the drive member 3 by the connecting rods 4. The drive member 3 has a peripheral skirt 18 surrounding and spaced from the drive shaft 2 and the track member 14 in order to provide a larger area in contact with the bearing 17 than would otherwise be provided by the drive member 3 in the absence of the skirt 18.

The main bearing 17 balances at least a substantial proportion of the radial thrust exerted on the drive member 3 by the connecting rods 4. From FIGURE 1, it will be seen that a plane passing through the centres of the ball-ends of the connecting rods 4 housed in the slippers 13 also passes through the surface of the bearing 17 en-

gaging the drive member 3. The line of action of the force exerted by the bearing 17 on the drive member 3 does not lie in this plane, but is spaced from this plane on the opposite side of the plane to the cylinder block 7. A couple will therefore be exerted on the drive member 3 and transmitted to the drive shaft 2. In order to balance this couple, the housing 1 includes a radial thrust pilot bearing 19 which surrounds and acts upon the drive shaft 2 at a position axially spaced from the bearing 17 by a distance which is large compared to the distance between the said plane and the said line of action.

The housing 1 also includes a gear pump which has two externally meshing gear wheels 21, 22, the gear wheel 21 being mounted on and driven by the drive shaft 2 and being located between the radial thrust bearing 19 and the drive member 3. When the hydraulic pump is used in a hydrostatic transmission, the gear pump can be used as a make-up pump to maintain the transmission primed with liquid at low pressure. Radial thrusts generated in the gear pump are absorbed by the radial thrust bearings 17 and 19.

In this embodiment it will be obvious that the cylinder block may be brought closer to the drive member and the cross-sectional area of each connecting rod can be substantial compared with the cross-sectional area of a cylinder, thus affording a high system pressure.

I claim as my invention:

A hydraulic pump or motor including

(a) a rotatably mounted drive shaft

(b) a drive member fast on the drive shaft

(c) a radial thrust bearing surrounding and acting on the drive member

(d) a cylinder block mounted for rotation with said drive member about an axis that during operation intersects and is inclined relative to the rotational axis of the drive shaft and drive member

(e) said cylinder block having a series of sylinders directed generally parallel to the rotational axis of the cylinder block

(f) a series of connecting rod, slipper and piston assemblies interconnecting the cylinder block and the drive member

(g) the pistons being reciprocably mounted one in each cylinder of the cylinder block

(h) the drive member having a series of holes extending parallel to its rotative axis within the corresponding one of which holes the respective slippers are unrestrained against reciprocation in a direction parallel to the rotative axis of the drive member

(i) the connecting rod of each assembly being pivotally connected to the corresponding slipper and piston

(j) a track member separate from but adjacent the drive member having a surface against which the slippers bear in the axial direction and by reciprocation in their holes can bear evenly on the track member despite bending or inaccuracy in the drive member

(k) means including liquid inlet and outlet ports for delivering a liquid to and discharging it from the cylinders during rotation of the cylinder block

(l) a plane that includes the centers of the pivotal connection between the connecting rods and the slippers intersecting the surface of the radial thrust bearing for the drive member such that the greater part of the said surface lies on the side of the said plane remote from the cylinder block

(m) and a radial thrust pilot bearing surrounding and acting on the drive shaft at a position axially spaced from the drive member.

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