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Thoma

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[54] **HYDRAULIC PUMPS OR MOTORS**

[75] Inventor: **Oswald H. Thoma,** St. Clement, Jersey, Channel Islands, England

[73] Assignee: **Hydraulic-Drive A.G.,** Glarus, Switzerland

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[51] **Int. Cl.** **F04b 13/06**
[58] **Field of Search** 103/161; 184/27; 91/486–488

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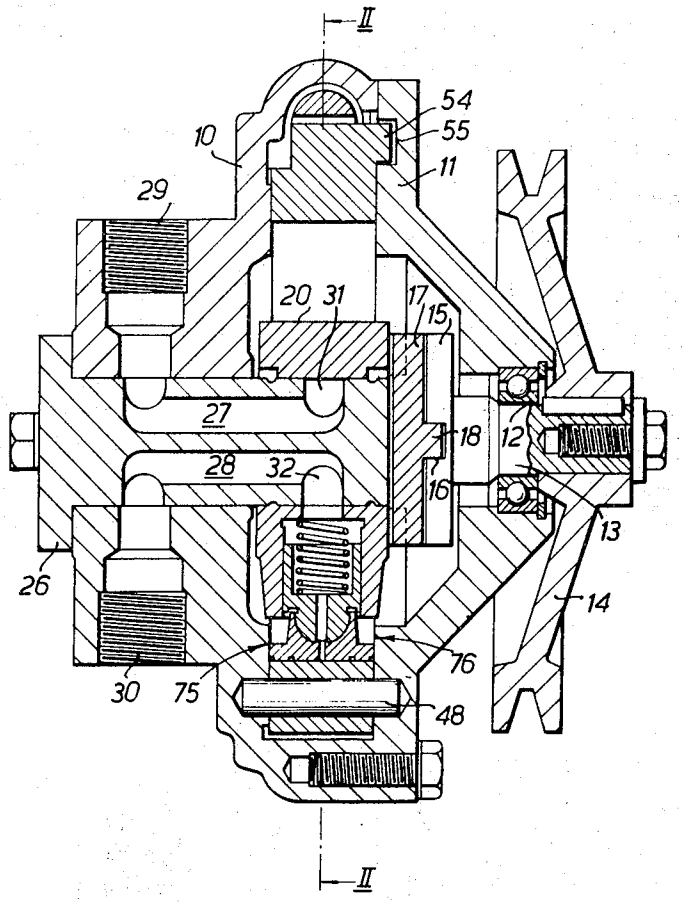
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Primary Examiner—William L. Freeh
Attorney—Young and Thompson

[57] **ABSTRACT**

A radial piston hydraulic pump or motor comprising a rotary cylinder block receiving a number of radial pistons whose outer ends are connected to bearing pads engaging the inner surface of an annular cam ring, the pads being rectangular in end view and located in an axial direction between inwardly facing shoulders of a surrounding casing, while the rotary cylinder block is free to move axially on a central supporting shaft and is located axially through the pistons and bearing pads.

5 Claims, 4 Drawing Figures



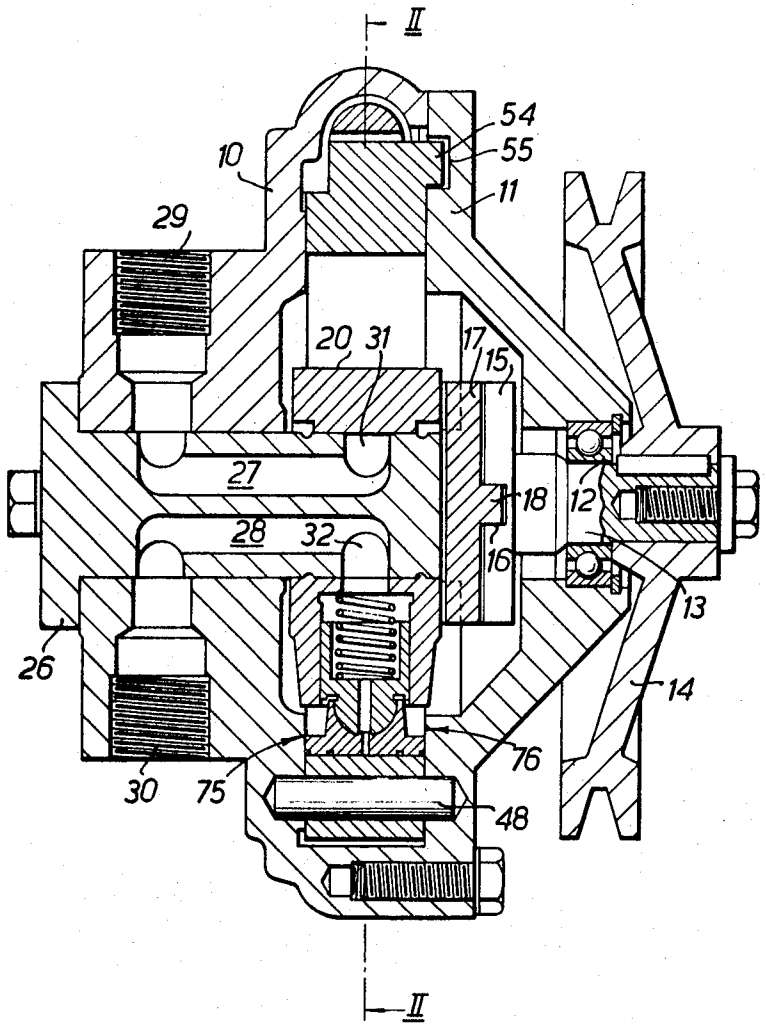


FIG. 1.

INVENTOR
OSWALD H. THOMA
BY
Young & Thompson
ATTORNEYS

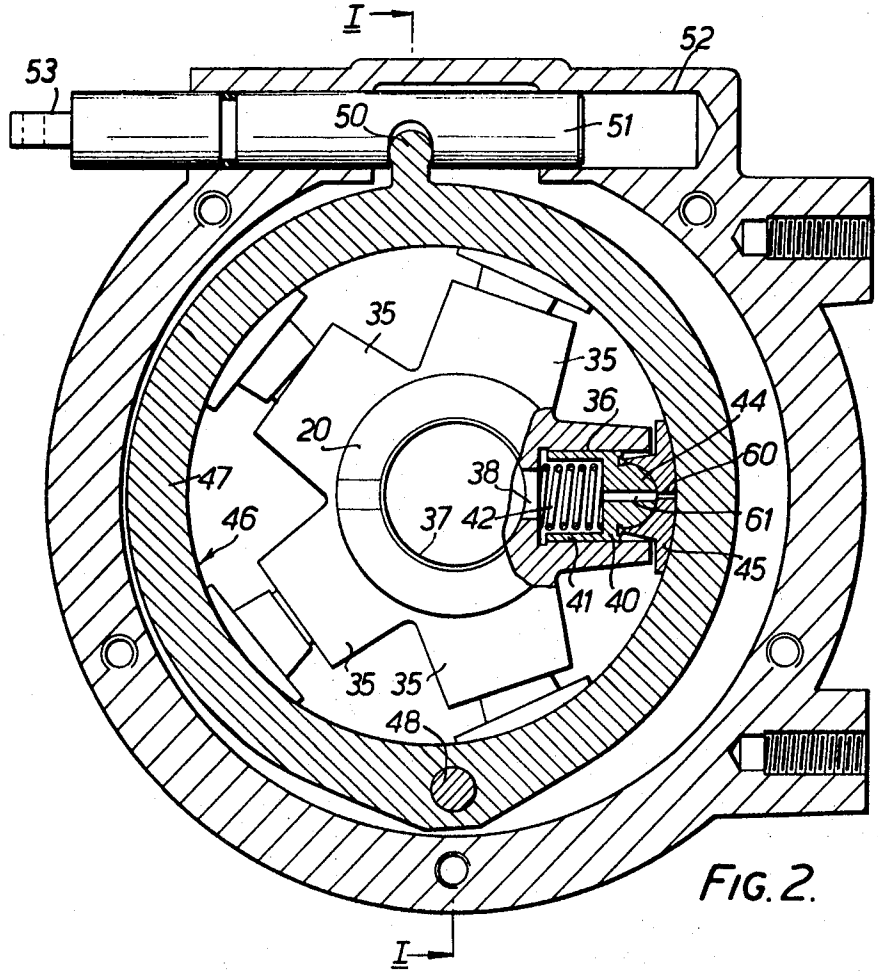


FIG. 2.

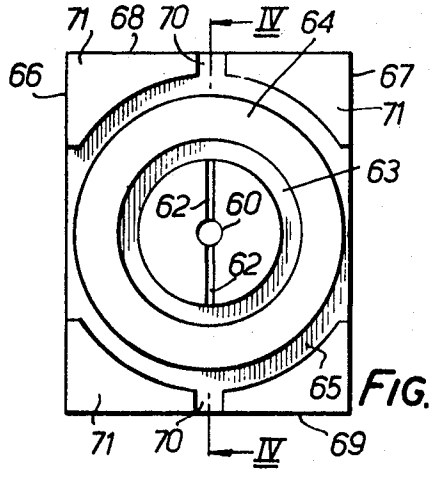


FIG. 3.

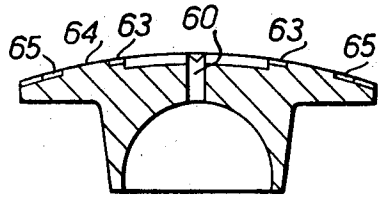


FIG. 4.

INVENTOR
OSWALD H. THOMA
BY Young & Thompson
ATTORNEYS

HYDRAULIC PUMPS OR MOTORS

This invention relates to radial piston hydraulic pumps or motors of the type comprising a cylinder member or assembly providing a number of angularly spaced generally radial cylinders, each containing a piston whose outer end is operatively connected to a bearing member arranged to engage a surrounding annular cam track.

In accordance with one aspect of the present invention the bearing members are located axially and the cylinder block is free to move axially so as to adopt its axial position automatically in relation to the bearing members.

The invention is particularly of advantage in arrangements where the bearing members have bearing surfaces in the form of sections of a surface of revolution, e.g., part-cylindrical, and two opposed parallel flat guide surfaces.

In such arrangements it is desirable that the bearing members should be prevented from pivotal movements about the axes of the respective pistons, since otherwise the external bearing surfaces of the members would not be properly aligned with the surface of the cam track. Thus conveniently the bearing members are located axially between two annular shoulders on opposite sides of the cam track.

By so locating the bearing members against pivotal movement about the axes of the respective pistons, the bearing members are also located axially. The freedom of movement of the cylinder block to move axially therefore allows the block to adopt an axial position corresponding automatically to the axial positions of the bearing members and pistons, thus avoiding stresses and possible wear or damage which would result from manufacturing tolerances and inaccuracies.

Preferably the cam track is adjustable between the annular shoulders in a direction transverse to the rotary axis of the machine, and conveniently the two shoulders are formed respectively on two separate parts of a casing for the machine.

The invention is particularly applicable to a pump or motor in which the cylinder block is mounted for rotation on a fixed shaft or pintle.

The bearing members may comprise bearing slippers or pads, pivotally connected to the respective pistons, and preferably the bearing face of each bearing member is formed with oil distribution and/or throttling grooves.

It will be appreciated that the invention is of particular merit in radial piston pumps or motors in which the bearing members are designed to rotate relative to the cam track about the main rotary axis so that sliding occurs between these parts at relatively high speed. This is to be contrasted with arrangements in which the actual surface of the cam track is itself capable of rotation about the main rotary axis, so that this relative movement can be eliminated, the latter type of construction being relatively expensive. In preferred embodiments of the present invention the bearing members have part-cylindrical bearing surfaces to engage the cam track and it is accordingly necessary to prevent the bearing members from pivoting or twisting about the axes of the respective pistons, since otherwise the bearing surfaces will not be properly aligned with the surface of the cam track.

From another aspect the invention consists in a bearing member for providing an operative connection between a piston and a surrounding cam track in a radial piston pump or motor, the bearing member having a part-cylindrical bearing surface to engage the cam track, and two opposed parallel flank surfaces to engage corresponding guide surfaces so as to locate the bearing member.

In a preferred construction the bearing surface is generally rectangular in development and includes a generally circular or ring-shaped oil groove, and four lands of generally triangular shape adjacent the four corners thereof.

In any case the bearing member is preferably formed on its reverse side with an integral ball or socket, to provide a universal connection with a corresponding part on a piston.

According to a particular preferred feature of the invention the bearing member is formed as an integral casting, or sintered product. Thus preferably the actual bearing surface is machined, at least some of the oil supply and distribution grooves being formed in the casting or sintering operation.

The invention also consists in a radial piston pump or motor including a cylinder block formed with a number of generally radial cylinders, each containing a piston which is operatively connected to a surrounding cam track by means of a bearing member as defined above.

The invention may be performed in various ways and one specific embodiment will now be described by way of example, with reference to the accompanying drawings, in which:

FIG. **1** is a sectional side elevation through a hydraulic rotary pump according to the invention, taken on the line I — I in FIG. **2**,

FIG. **2** is a part-sectional end elevation on the line II — II in FIG. **1**;

FIG. **3** is an end view as seen in a radial inward direction and on an enlarged scale, of the outer bearing surface of one of the bearing slippers, and

FIG. **4** is a sectional view through the bearing slipper of FIG. **3**, taken on the line IV — IV.

In this example the invention is applied to a small size radial piston rotary pump having an overall diameter of approximately 8 inches. This pump is intended to be coupled hydraulically to a similar hydraulic motor (not shown), at least one of the units being of adjustable capacity to provide a variable speed transmission between the drive shafts of the pump and motor. The complete transmission is designed to be incorporated in the drive between the engine and ground wheels of a low-power self-propelled lawn mower or tractor.

The hydraulic pump illustrated in FIGS. **1** and **2** comprises a main casing **10** formed with a separate cover **11**, the cover having a central aperture carrying a bearing **12**, in which is mounted a drive shaft **13** attached to an external pulley **14**. The inner end of the drive shaft is provided with a flange **15** formed with a transverse slot **16** forming part of a tongue-and-groove connection with a flexible coupling member **17**. The coupling member is in the form of a circular disc having a diametral rib **18** on both opposite faces, the ribs being perpendicular to one another with one rib designed to make a sliding fit in the slot **16** of the flange on the drive shaft, while the other rib is designed to make a similar sliding fit in two aligned radial slots in the annular end face of a rotary cylinder member **20**.

The main casing **10** is provided with a central aperture in the end wall opposite from the cover **11** and in this aperture is fixedly mounted a stationary pintle **25** whose inner end projects into the chamber within the casing and whose outer end has a flange **26** arranged to abut and seal against the external surface of this end wall. The part of the pintle which extends into the casing provides a bearing mounting for the rotary cylinder member **20** and the pintle is also formed with two internal hydraulic fluid flow passages **27,28** extending parallel to the length of the pintle and each passage having a port at one end to cooperate with one of two hydraulic inlet/outlet flow passages **28,30** in the end wall of the casing, and a further port **31,32** at the other end designed to cooperate with ports in the rotary cylinder member **20** to act as timing control ports.

The rotary cylinder member **20** has five angularly spaced projecting bosses **35** each formed with a cylinder **36** extending inwardly from the outer end thereof, and a central bearing aperture **37** designed to fit over the projecting inner end of the pintle **25.** Radial passages **38** extend from the inner ends of each of the cylinders into the central bearing aperture and cooperate with the timing ports **31,32** on the pintle to control the supply and discharge of hydraulic fluid to and from the individual cylinders. Each cylinder contains a piston **40** formed with a hollow skirt **41** extending radially inwardly and a compression spring **42** is seated within the skirt and bears against the inner end of each cylinder to urge each piston radially outwards. The outer end of each piston is formed with a part-spherical ball element **44** designed to fit in a corresponding part-spherical socket in a bearing slipper **45** so as to act as a universal joint.

The external surfaces of the slippers **45** all engage a cylindrical annular cam track **46** formed on a cam ring **47** surrounding the rotary cylinder member **20** and adjustably located in the casing on a pivot pin **48** at one side of the cam ring. The other side of the cam ring is provided with a projecting pin **50** engaging a slot in an adjusting rod **51** which is slidable transversely to the main rotary axis in a locating bore **52** in the casing, the external projecting end **53** of this rod being attached to a control element (not shown) for varying the speed ratio of the transmission. In order to limit the pivotal adjusting movements of the cam ring the adjusting pin **50** is extended at **54** parallel to the rotary axis on the other end of the ring and engages in an arcuate slot **55** formed in an adjacent part of the casing wall, the length of the slot **55** determining the limits of movement of the cam ring. It will be understood that by tilting the cam ring about its pivot pin **48** the eccentricity of the ring in relation to the fixed pintle **25** and the rotary cylinder member **20** can be varied, thus varying the effective volumetric capacity of the pump.

The external bearing surface of each bearing slipper is of part-cylindrical form, as best seen in FIGS. **3** and **4,** to cooperate with the internal cylindrical cam surface **46** of the cam ring **45.** To ensure adequate lubrication this bearing surface of each slipper is provided with oil distribution and throttling passages associated with a central oil supply passage **60** which opens into the part-spherical socket at the inner face of the slipper and cooperates with a corresponding supply passage **61** formed in the outer ball end **44** of each piston, and opening into the external surface of the ball element thereof. From the central supply passage **60** in the slipper two radial throttling grooves **62** of relatively small section extend outwards to an inner circular oil distribution groove **63** of approximately 0.60 inch diameter. Each throttling groove **62** is of generally V-section and has a width at its upper part of approximately 0.010 inch and a depth of approximately 0.018 inch. Around the inner circular oil distribution groove **63** is provided an annular land **64** having an external diameter of approximately 0.94 inch. Around this land extends a further generally circular oil relief groove **65** having an external diameter of approximately 1.10 inch. The developed surface of the slipper is rectangular, as seen in FIG. **3,** and has a dimension measured in the direction of the circumference of the cam ring of approximately 1.25 inch and a transverse dimension of approximately 1.0 inch. The outer oil relief groove **65** thus breaks into the two longer sides **66,67** of the bearing surface of the slipper and this groove is connected to the two shorter sides **68,69** of the slipper by short radial grooves **70** positioned centrally in these two ends. At the four corners of the bearing surface of the slipper four generally triangular bearing lands **71** are thus formed. Lubricating oil supplied through the central oil passage **60** is throttled as it passes radially outwards through the two throttling grooves **62** into the first circular oil distribution groove **63,** the pressure of the oil being thus reduced to the desired value so that an oil film at suitable pressure is maintained over the central circular land areas surrounding the oil supply passage **60** and over the annular land **64** between the inner and outer oil ring grooves **63,65.**

Each bearing slipper must be restrained against pivotal movement about the axis of the respective piston, since otherwise its part-cylindrical bearing surface will move out of alignment with the cylindrical annular cam surface **46.** This is attained by positioning the annular cam ring **47** between two facing annular shoulders **75,76** provided respectively on the main casing **10** and on the cover **11,** the cam ring being capable of pivotal movement about its hinge pin **48** between these facing shoulders. The corresponding axial dimension of each slipper is such that its longer side surfaces **66,67** engage the two facing shoulders **75,76** so as to maintain each slipper in the appropriate attitude.

Since each slipper is thus located axially in relation to the casing, and by means of the respective ball and socket joints provides corresponding axial positioning of the individual pistons **40,** the rotary cylinder member **20** is arranged to have freedom of axial movement within limits on the stationary pintle **25,** the rotary cylinder member being in effect axially located by way of the pistons **40** and the slippers **45.**

Each piston **40** is preferably formed by sintering a ferrous alloy and machining can be reduced to centreless grinding of the external cylindrical surface, the ball surface being left in the as-cast condition. Each slipper **45** is formed by sintering phosphor bronze, the external bearing surface and the internal part-spherical socket being formed in the casting process. Machining is then reduced to little more than grinding or otherwise surfacing the main part-cylindrical external surface, most of the oil distribution and throttling grooves and passages being formed in the sintering operation. The internal socket surface is left in the as-cast condition. This method of manufacture thus eliminates many highly complex machining operations and greatly reduces the cost of each slipper. Moreover the inherent

porosity of the sintered slipper further contributes to efficient lubrication.

I claim:

1. A radial piston pump or motor having a central fixed cylindrical pintle, a cylinder member or assembly mounted for rotation on said pintle and providing a number of angularly spaced generally radial cylinders, each containing a piston whose outer end is operatively connected to a bearing member, a surrounding annular cam track engaged by said bearing members, said cam track having a pair of spaced shoulders or guide surfaces at opposite axial sides thereof, and in which said cylinder member is free to move axially on said pintle, and each bearing member has a bearing surface of part-cylindrical shape coaxial with and engaging said cam track and two opposed parallel flank surfaces engaged between said pair of guide surfaces on opposite axial sides of said annular cam track, whereby each bearing member is axially located by said guide surfaces in relation to said cam track, and said cylinder member is thereby axially located from said bearing members by means of said pistons.

2. A pump or motor as claimed in claim 1, in which the cam track is adjustable in a direction transverse to the rotary axis of the machine to vary the volumetric capacity of the machine, but is prevented from movement in an axial direction.

3. A pump or motor as claimed in claim 1, in which the two shoulders are formed respectively on two separate parts of a casing for the machine.

4. A pump or motor as claimed in claim 1, in which each bearing member comprises a bearing slipper pivotally connected by a universal joint to the respective piston, the joint being capable of transmitting axial forces for location purposes.

5. A pump or motor according to claim 1, in which each bearing member is a sintered product, and is formed on its reverse side with an integral ball or socket, to provide a universal connection with a corresponding part on a piston, and the bearing surface is generally rectangular in development and includes a generally circular or ring-shaped oil groove, and four lands of generally triangular shape adjacent the four corners thereof.

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