

United States Patent

Thoma et al.

[15] 3,656,409

[45] Apr. 18, 1972

[54] **TILTING HEAD AXIAL PISTON
HYDRAULIC MACHINES**

[72] Inventors: **Jean Ulrich Thoma**, Bellevue 23, Zug, Switzerland; **Renzo Galdabini**, Via Ivrea 1, Gallarate, Italy

[22] Filed: **Mar. 5, 1970**

[21] Appl. No.: **16,860**

[30] **Foreign Application Priority Data**

Mar. 5, 1969 Switzerland3760/69

[52] U.S. Cl.**91/504**

[51] Int. Cl.**F01b 13/04**

[58] Field of Search91/504-506;
92/12.1

[56] **References Cited**

UNITED STATES PATENTS

3,026,814 3/1962 Binack91/499

3,426,686 2/1969 Anderson417/218

FOREIGN PATENTS OR APPLICATIONS

881,192 7/1958 Great Britain91/505

994,202 12/1963 Great Britain91/505

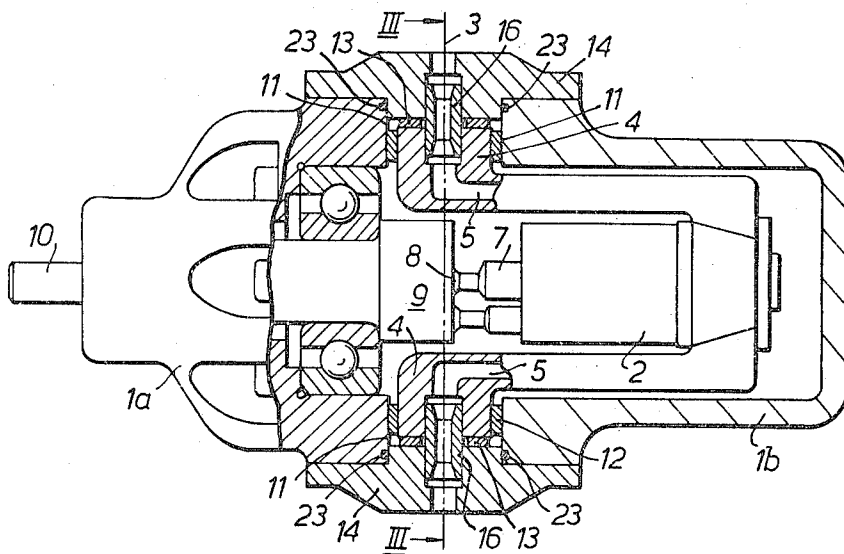
Primary Examiner—William L. Freeh

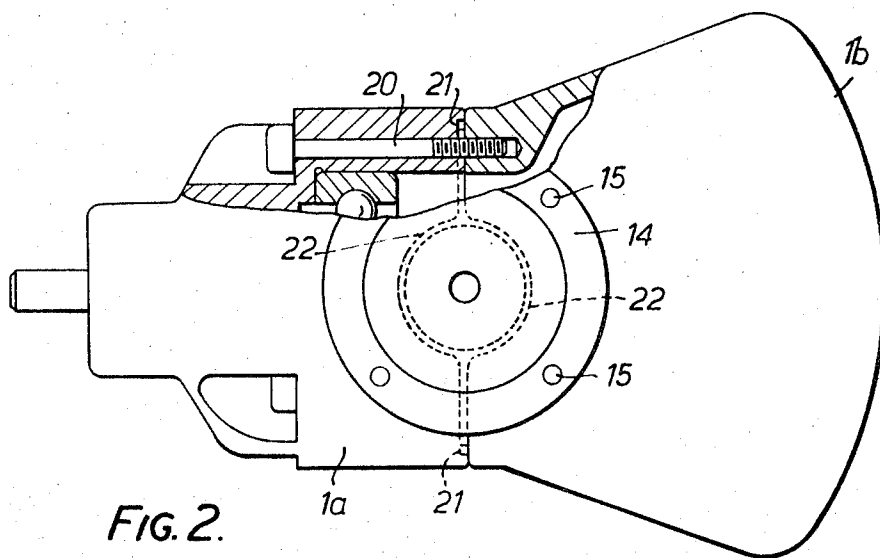
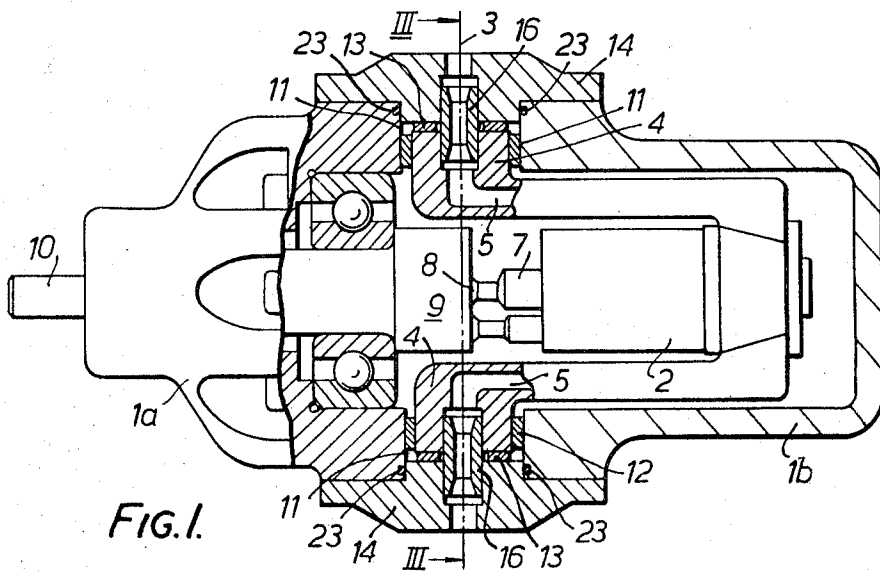
Attorney—Young & Tompson

[57] **ABSTRACT**

An axial piston hydraulic pump or motor of the tilting head type, including a tilting body supporting a rotary cylinder block containing the individual pistons, and mounted for tilting movements about a transverse tilting axis in order to vary the capacity of the machine. The tilting head is provided with hollow trunnions mounted in bearings in a split casing, each bearing being located partly in one casing section and partly in the other.

4 Claims, 4 Drawing Figures





INVENTORS
JEAN U. THOMA
RENZO GALDABINI
BY
Young & Thompson
ATTORNEYS

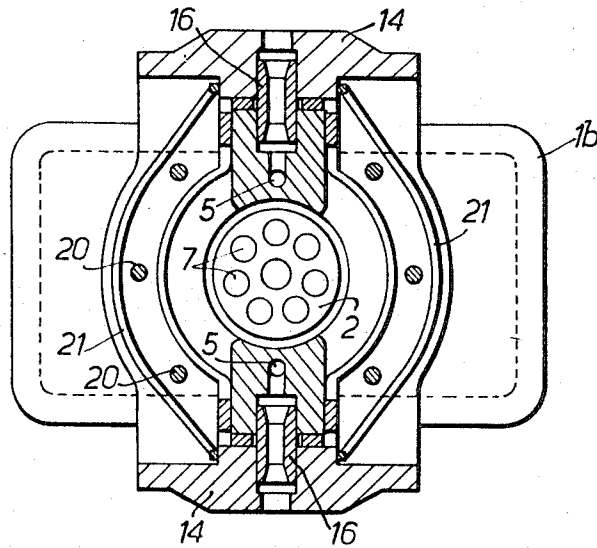


FIG. 3.

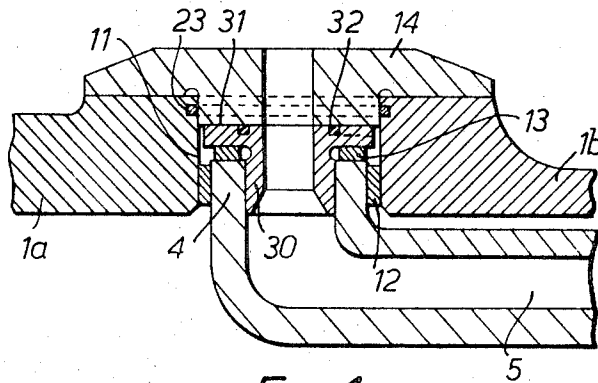


FIG. 4.

INVENTORS
JEAN U. THOMA
RENZO GALDABINI

BY

Young & Thompson
ATTORNEYS

TILTING HEAD AXIAL PISTON HYDRAULIC MACHINES

The present invention relates to axial piston hydraulic machines of the so-called bent axis or tilting head type, in which the cylinder block and other parts are arranged to tilt about a transverse axis inside a casing, to generate or vary the effective piston stroke and thus adjust the volumetric capacity of the machine. The tilting body is usually supported by two lateral tilting trunnions mounted in the casing, and in order to avoid over-stressing or breakage of the connecting rods, it is important that the tilting axis, and the axis of the trunnions, should be situated accurately within a plane containing the centers of the spherical heads of the connecting rods.

The casing is usually provided with tilting bearings for supporting the trunnions, but it is difficult in practice to assemble the trunnions into these bearings. One known solution is to provide suitable slots or openings in the tilting bearings, through which the trunnions can be passed during assembly. However, this weakens the support for the bearings, and limits the maximum allowable piston forces, by reducing the tilting bearing area.

Another known solution is to provide relatively small trunnions that can be easily slipped into the casing. These small trunnions are connected, after assembly, with large bearing caps, having sufficient bearing area, but this construction involves a complicated assembly system, and is relatively bulky and expensive to manufacture.

It is an object of the present invention accordingly to maintain or improve the bearing area of the casing, and at the same time to allow easy assembly.

The invention consists broadly in an axial piston hydraulic machine comprising a tilting body supporting the cylinders of the machine and mounted in a casing, the casing being divided on a plane containing the tilting axis, with tilting bearings disposed partly in one and partly in the other section of the casing.

In a preferred construction each trunnion bearing is in the form of two half cylinders, one half being situated in each of both sections of the casing. Thus it is possible to place the tilting body with the trunnions in position, before assembly of the casing. It is also possible to provide adequate bearing area, or bearing races of sufficiently large diameter. Since the support for the trunnions in both half cylinders of the casing is very close, it is possible to make the bearings thin and deformable.

The interior of the casing is usually filled with oil under low pressure. It is therefore desirable that the interfaces of the two parts of the casing on the plane of the tilting axis should be accurate and smooth in order to avoid leakage of the oil. Alternatively a groove may be provided in one of these surfaces, and a sealing ring such as an O-ring. This sealing ring is preferably formed with two circular portions, arranged to surround the two tilting bearings.

The transmission of oil between the tilting body and the lateral covers on the trunnion bearings is normally achieved by a connecting sleeve having a cylindrical sealing surface. The sleeve may be relatively long and the sealing portions relatively short in order to accommodate certain errors in the alignment of the tilting axis. Instead, the sleeve may be replaced by a connecting member which has at one end a cylindrical portion located within a bore in a trunnion of the tilting body. The other end of the connecting member is plane and bears against a fixed plane surface on a cover for the bearing such that small radial compensating movements can occur. To obtain good contact between the plane surfaces, at least one of them is preferably provided with a circular draining groove, which may accommodate a small circular sealing ring.

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

FIG. 1 is a side elevation, partly in section, of a tilting head machine according to the invention,

FIG. 2 is a plan view of the machine of FIG. 1, partly in section,

FIG. 3 is a sectional end view as shown by the arrows III — III in FIG. 1, and

FIG. 4 is a detailed side elevation through a modified trunnion construction, on an enlarged scale.

The tilting head hydraulic pump or motor illustrated in FIGS. 1, 2 and 3, is basically of known type and the basic components thereof will not be described in detail. The machine has a rotary cylinder block 2, able to be tilted about a transverse tilting axis 3 passing through two hollow trunnions 4. The trunnions communicate respectively through passages 5 and ports (not shown) with the individual cylinders in the block 2. Pistons 7 in the cylinders each have a spherical head or ball-joint 8 which engages in a rotary driving flange 9 attached to a drive shaft 10, and the centers of these spherical heads lie on a plane containing the tilting axis 3. When the block 2 is tilted about this axis the volumetric capacity of the machine, i.e. the effective working stroke of each piston 7 is altered.

As illustrated in FIG. 1 the casing of the machine is divided on a plane containing the tilting axis 3 into two parts 1a and 1b. Each part is formed with a pair of semi-cylindrical bearing surfaces 11 which combine, when the two casing parts 1a and 1b are secured together, to form cylindrical bearing housings for the trunnions 4. Each trunnion is located by a bearing sleeve 12, and a bearing ring 13, the sleeve 12 providing radial location while the ring 13 provides axial location. The ring 13 is held in place by a cover plate 14, secured by bolts 15, each cover plate having a central passage through which fluid is supplied to or delivered from the machine, via a pair of inter-connecting sleeves 16.

The radial forces acting on the bearing sleeves 12 are produced by the fluid pressure exerted on the pistons 7, while the axial forces acting on the rings 13 are produced by the connecting sleeves 16 between the trunnions 4 and the end covers 14, particularly when working under high oil pressure.

The two parts 1a, 1b of the divided casing are connected together by longitudinal screws or bolts 20. These screws are required to transmit the piston forces and, therefore, must be of considerable strength and correspondingly well fastened during assembly.

The effective sealing between the parts 1a and 1b at the interface of the casing can be achieved simply by close contact between suitably well machined surfaces. Preferably, however, a sealing ring is provided within a machined groove 21 in one or other of the mating surfaces. In order to avoid the tilting bearings, the sealing ring has two auxiliary circular portions 22 lying respectively in grooves 23 formed in the bearing surfaces 11.

In this illustrated example the trunnions 4 are supported by plain bearing sleeves 12 and thrust bearing rings 13, but it will be understood that roller or needle type bearings may be used instead, in which case it is particularly important that the bearing races should be well supported in the half-cylindrical bearing seats 11.

FIG. 3 illustrates on an enlarged scale an alternative trunnion bearing construction. To accommodate for tolerance variations in the position of the tilting axis relative to the tilting body 2 and to the end covers 14 a special connecting sleeve is used. This sleeve has at its inner end a cylindrical portion 30 which seats in a cooperating bore in the trunnion 4 such that sealing is obtained in known manner. At its other end, the connecting sleeve is formed with a plane surface 31. This face cooperates with a plane face on the interior of the cover 14, such that small radial movements are possible to compensate for tolerance errors.

In order to obtain good contact and avoid an excessive oil pressure area between these plane faces, a draining groove 32 is provided in the face 31, this draining groove having the same or a slightly smaller diameter than the cylindrical portion 30 of the connecting sleeve in order to limit the oil pressure field. This draining groove 32 may contain a small sealing ring, in order to improve the limitation of the oil pressure field and avoid leakage at high pressure. Another sealing ring in the

groove 23 provides a seal around the cylindrical extension of the cover 14.

An important feature of the invention is the division of the casing in the plane of the tilting axis. Nevertheless, it is possible to provide further divisions of the casing, depending on the constructional requirements and the method of assembly.

The axial piston machine described provides the trunnion tilting bearings with very good support and is nevertheless extremely compact.

We claim:

1. An axial piston hydraulic machine of the tilting head type, comprising a two-part casing, one part of the casing having an aperture through which extends a rotary drive shaft, a tilting head assembly mounted within said casing and including a multiple-cylinder rotary member operatively connected to said drive shaft, said tilting head assembly being mounted for pivotal movement on a pair of trunnions lying on a transverse tilting axis, one trunnion on each side of the axis of said rotary drive shaft, said casing being divided into two parts on a plane containing said tilting axis, the said two sections of the casing being formed to provide between them a pair of cylindrical bearing seats respectively for said two trunnions, and means for supplying operating fluid to and from said cylinders of the machine when the rotary member rotates, including supply and discharge ducts passing through the wall of said casing and situated on said tilting axis one on each side of the axis of said rotary drive shaft, and corresponding internal passages formed within said two trunnions, and in which each

trunnion is provided with a thrust bearing to resist thrust exerted along said tilting axis, and including an annular seal extending uninterruptedly around each trunnion and forming a fluid seal with said two casing sections, and sealing means acting between said two casing sections, and extending around the axis of said rotary shaft in the plane of division of the casing, and cooperating with said annular trunnion seals to form a continuous seal around the casing, said sealing means being in two portions that are spaced apart by said annular seals and whose ends meet said annular seals.

2. A hydraulic machine according to claim 1, wherein each of said two bearing seats provided by said two casing sections surrounds the whole periphery of the respective trunnion and extends over substantially the whole axial length of the said trunnion.

3. A hydraulic machine according to claim 1, including a hollow connecting sleeve providing fluid communication between the internal passage of each trunnion and the respective supply or discharge duct, each said sleeve being arranged to permit small relative movements between the said trunnion and duct in directions transverse to said tilting axis.

4. A hydraulic machine according to claim 3, in which each sleeve is of appreciable length and has limited external annular contact areas at opposite ends, such that the sleeve can tilt to accommodate misalignment between the respective trunnion and the associated duct.

* * * * *

30

35

40

45

50

55

60

65

70

75