Nov. 8, 1966 G. W. P. SCOTT ETAL 3,283,725

HYDRAULIC MACHINES

Filed Dec. 2, 1964 2 Sheets-Sheet 1

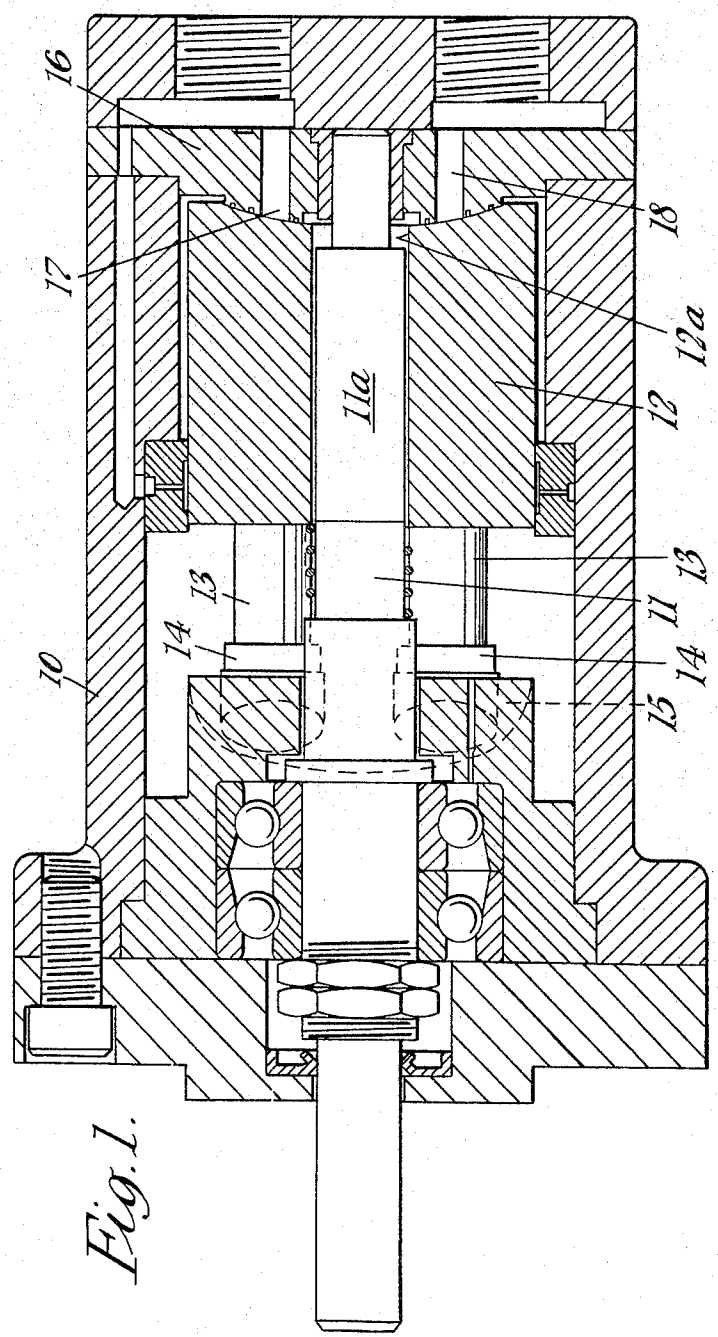


Fig. 1.

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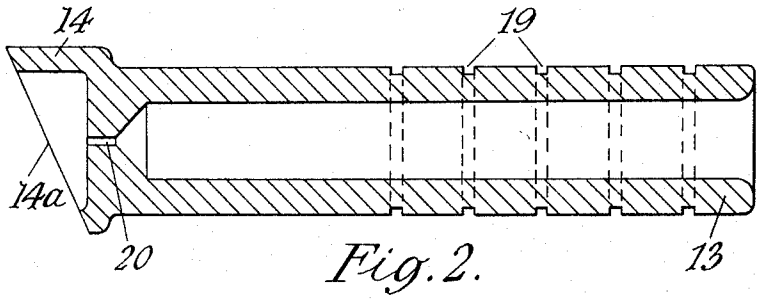


Fig. 2.

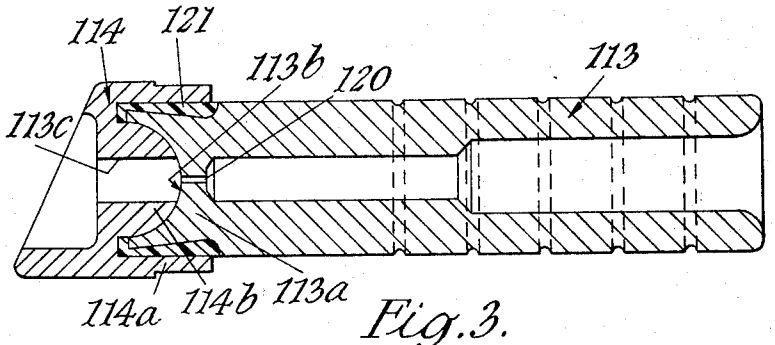


Fig. 3.

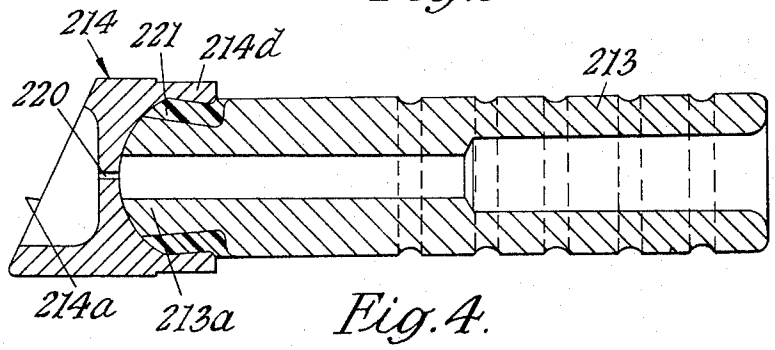


Fig. 4.

United States Patent Office

3,283,725

Patented Nov. 8, 1966

3,283,725

HYDRAULIC MACHINES

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Filed Dec. 2, 1964, Ser. No. 415,278
Claims priority, application Great Britain, Dec. 10, 1963, 48,666/63
3 Claims. (Cl. 103—162)

This invention relates to hydraulic machines of the kind comprising a housing, a rotatable shaft mounted in the housing, a rotor drivingly connected to said shaft, said rotor being formed with a plurality of passages, a pair of ports in one end of the housing arranged so that during rotation of the rotor said passages are brought successively into communication with ports, a plurality of pistons slideable respectively in the passages, and an inclined cam surface, at the end of the housing remote from the ports, against which the pistons bear so that rotary movement of the rotor is accompanied by axial movement of the pistons.

It is an object of the invention to provide an hydraulic machine of the kind specified in a convenient form.

According to the invention, in an hydraulic machine of the kind specified, each piston is hollow and is provided at its cam-engaging end with a slipper of cup-shaped form, the interior of the piston communicating with the interior of the slipper through a restricted bore and the slipper having and end face which is inclined to the axis of the slipper at an angle substantially corresponding to the inclination of the cam surface.

Reference will now be made to the accompanying drawings in which FIGURE 1 is a longitudinal section of one example of a motor according to the invention and FIGURES 2, 3 and 4 are enlarged sections showing three different forms of piston for the motor shown in FIGURE 1.

As shown in FIGURE 1 the motor includes a housing **10** in which a shaft **11** is rotatably mounted. Also rotatably supported by hydrostatic bearings in the housing **10** is a rotor **12**, which is drivingly connected to the shaft, by virtue of the non-circular section of its central passage **12***a* and the non-circular section of the associated part **11***a* of the shaft.

Formed in the rotor **12** are a series of axially extending passages in which pistons **13** are reciprocably mounted. These pistons project from one end of the rotor **12** and have slippers **14** bearing against an inclined cam surface **15** formed on a cylindrical block secured to the housing **10**. It will thus be seen that rotation of the rotor **12** causes the pistons **13** to be reciprocated in their respective passages.

Formed in the port plate **16** which provides an end wall of the housing, are a pair of ports **17**, **18** through which liquid enters and leaves the motor respectively. These ports are so disposed that the end of the passages in the rotor are brought successively into communication with the ports as the rotor is turned.

Referring now to FIGURE 2 the piston **13** shown therein has the slipper **14** formed integrally thereon. As shown the piston is formed at various positions along its length with circumferential oil retaining grooves **19**. It will also be seen that the slipper **14** is of generally cup shaped form with its axis aligned with the axis of the piston **13**. The end face **14***a* of the slipper is, however, inclined to the common axis of the piston and slipper at an angle corresponding to the inclination of the cam surface **15**.

The interiors of the slipper **14** and piston **13** are interconnected by a fine bore **20**.

Thus, in use, when high pressure liquid is supplied to port **17** the interiors of the slippers will fill with pressurized liquid and will form an hydrostatic bearing between the slippers **14** and the cam surface **15**. The spacing of face **14***a* from the surface **15** will regulate the rate at which liquid leaves the interior of the slipper and variation of flow through bore **20** will cause changes of pressure within the slipper as is known in hydrostatic bearings.

Turning now to FIGURE 3 (in which all reference numerals have been increased by 100) the piston **113** and the slipper **114** are formed separately and are sealingly joined together. The end of piston **113** is closed by wall **113***a* in which bore **120** is formed. Also formed in the end wall **113***a* is a substantially hemispherical recess **113***b*. The periphery of the end of the piston is of somewhat reduced diameter and, in fact, may be of frusto-conical form as shown.

The slipper **114** is formed with a central hemispherical projection **114***b* which fits into the recess **113***b*, a large bore **113***c* being formed in this projection and communicating with the interior of the slipper **114**. The slipper also has a cylindrical skirt portion **114***d* surrounding the reduced end of the piston. The end face **114***a* of the slipper is inclined as before.

The slipper **114** and piston **113** are joined together by means of a ring **121** of rubber or other elastomeric material. This ring is formed by treating the piston and slipper to form suitable keying surfaces, locating them together in the required relative position, injecting the raw elastomer into the space between the piston **113** and the skirt portion **114***d* and then curing the elastomer. Alternatively where the elastomer cannot be injected, a preformed ring of the raw elastomer may be inserted in the space during assembly. In either case when the elastomer is cured it becomes firmly bonded to the metal surfaces and forms a flexible but fully liquid-tight joint.

This flexible joint enables the slipper **114** to move slightly relative to the piston **113**. Such movement is, however, restricted to turning of the slipper about the centre of the mating spherical surfaces. Thrust and journal loads on the slippers are transmitted directly to the piston without much effect on the ring **121**. The movement of the slipper enables it to follow any irregularities in the cam surface and to allow for the bending of the pistons that occurs under load without any undue loss of pressure within the slippers.

Referring now to FIG. 4 (in which reference numerals have again been increased by 100) the piston **213** is formed with a convex part spherical end **213***a* which fits against a complementary surface within the skirt portion **214***d* of slipper **214**. The bore **220** is, in this case, formed in the slipper **214**. The piston **213** and the slipper **214** are again bonded together by a ring **221**.

In this case the piston receives directly any thrust on the inclined slipper face **214***a*, but journal loads are taken by the ring **221**.

In the embodiments shown in FIGURES 3 and 4 the ring **121** or **221** cured in situ may be replaced by a ring already cured and bonded in position using any suitable adhesive. Moreover (although not shown) a flexible metal bellows may be employed to form the flexible and sealed connection between the piston and the slipper. Once again the piston and the slipper would preferably be interengaged so that the bellows do not have to transmit thrust and journal loads.

The invention may be applied in like manner to hydraulic pumps and couplings.

Having thus described our invention what we claim as new and desire to secure by Letters Patent is:

1. An hydraulic machine comprising the combination of a rigid housing, a shaft rotatable within the housing,

a rigid cam block rigidly secured within the housing and providing a cam face extending in a plane inclined to the shaft axis, a rotor enclosed within the housing and drivingly coupled to the shaft, said rotor being formed with a plurality of passages, a pair of ports in one end of the housing arranged so that during rotation of the rotor the passages therein are brought successively into communication with the ports, a plurality of pistons slidable respectively in the passages and projecting from one end of the rotor towards the cam face, a plurality of cup-shaped slippers mounted respectively on the pistons where these project from the rotor, each slipper including a skirt portion encircling the piston, a cupped end face remote from the skirt portion and inclined to the axis of the skirt portion at an angle equal to the inclination of the cam face to the shaft axis and a portion engaged directly against the end of the associated piston, and a plurality of elastomeric rings coupling the respective slippers to the pistons, each ring being sealingly bonded to the interior of the associated skirt portion and to the piston and each piston/slipper combination having a restricted bore connecting the interior of the associated passage to the interior of the slipper to form between each slipper and the cam face, a hydrostatic bearing.

2. An hydraulic machine as claimed in claim 1 in which the portion of the slipper directly engaged with the end of the piston is in the form of a part-spherical projection which extends into a complementary part-spherical recess in the end of the piston.

3. An hydraulic machine as claimed in claim 1 in which the portion of the slipper which directly engages the end of the piston is of concave part-spherical form and the end of the piston is formed to a complementary convex part-spherical form.

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