June 28, 1966 M. DANGAUTHIER 3,257,855

MOTION CONVERTING MECHANISM FOR A MOTOR, PUMP OR COMPRESSOR OF THE BARREL TYPE

Filed May 1, 1964

Fig. 1

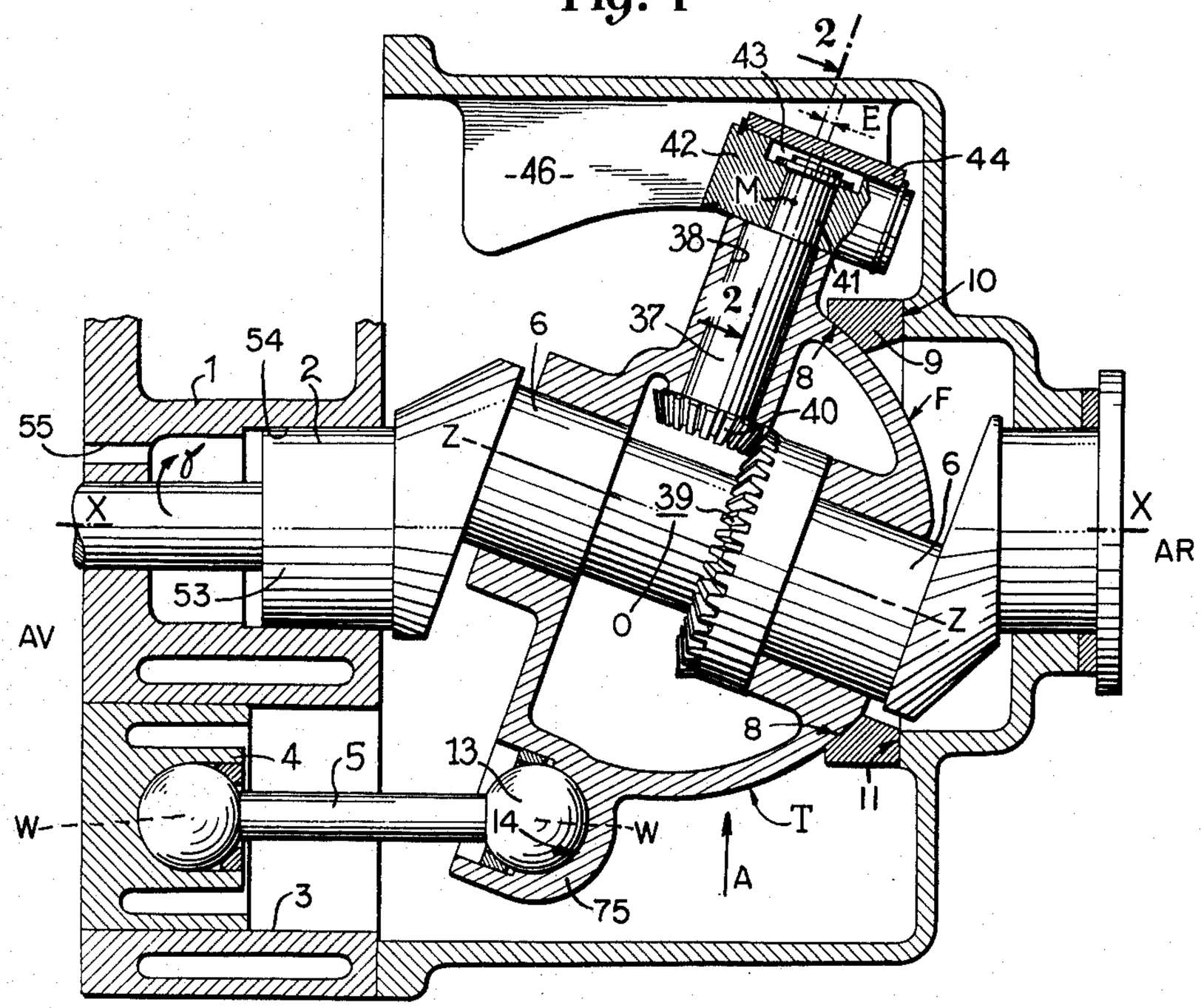


Fig. 2

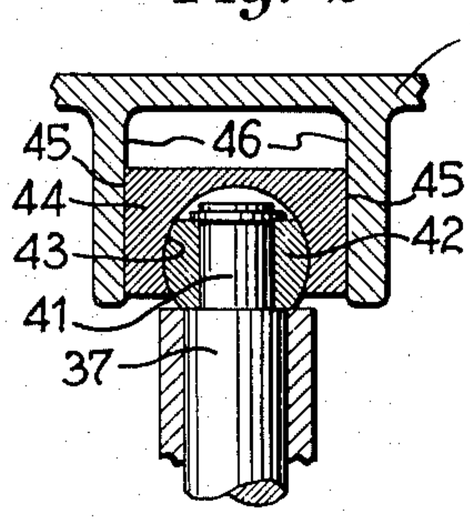
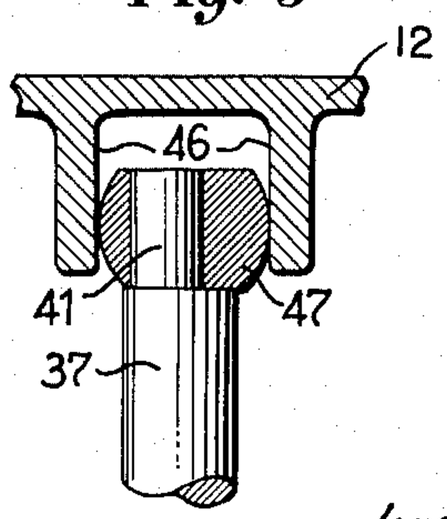


Fig. 3



INVENTOR
MARCEL DANGAUTHIER
BY LeBlanc & Shur
ATTORNEYS

United States Patent Office

3,257,855

Patented June 28, 1966

3,257,855

MOTION CONVERTING MECHANISM FOR A MOTOR, PUMP OR COMPRESSOR OF THE BARREL TYPE

Marcel Dangauthier, Paris, France, assignor to Societe d'Etudes et d'Applications Industrielles Commerciales et Immobilieres "Inter-Technique," Paris, France, a French corporation

Filed May 1, 1964, Ser. No. 364,073
5 Claims. (Cl. 74—60)

The present invention relates to motion converting mechanisms employed in motors, pumps or compressors of the barrel type and to these machines themselves.

It is known that such a motion converting mechanism includes a plate commonly termed a swashplate or converter which is interposed between the crankshaft and connecting rods connected to pistons sliding in cylinders which have their axes parallel with the axis of the crankshaft so as to convert thrust exerted on these pistons into a torque applied to the crankshaft or vice versa, said swashplate being prevented from rotating but undergoing, at least theoretically, a uniform motion of precession.

It is known that this uniform motion of precession corresponds to a uniform motion of rotation of the crankshaft in a given direction about the axis of its journals and to a uniform rotational velocity, equal to the preceding but in the opposite directions, of the swashplate about the axis of the crankpins, this axis being inclined relative to that of the journals.

It is also known that forces of inertia are created due both to this movement of precession of the swashplate and to the longitudinal and alternating motion of the connecting rods and pistons. Now, a mathematical study of these motions shows that the optimum conditions for the balancing of said forces of inertia are obtained when the swashplate describes a uniform motion of precession or at least when its real motion is as near as possible to this motion of precession.

Various solutions have been proposed to cause the swashplate to undergo a motion similar to the uniform motion of precession but the guide devices for this purpose which usually include parallel and rectilinear slideways, only provide a more or less approximate solution.

The object of the invention is to impart to the plate or swashplate of the motion converting mechanism of a barrel-type machine a motion corresponding to a motion of uniform precession or at least a motion very near to this motion of precession.

The invention provides an improved motion converting mechanism for a barrel-type machine, wherein the swashplate or motion converter is combined with guide means which are so arranged that a point of its periphery describes a gauche curve in the shape of an **8** whose projection on a plane parallel with the axis of said curve is at least very near to the lemniscate which would correspond, in respect of this point, to the projection of the theoretical curve pertaining to the uniform motion of precession.

Calculation shows that in fact the projection of the gauche curve described by such a point for the uniform motion of precession is such as lemniscate, and experience has shown that in approaching this curve as far as possible it is much easier to balance the forces created in operation.

In one embodiment, the guide means comprise a gear rigidly mounted on the crankshaft of the mechanism, said gear driving a gear rigidly mounted on an auxiliary shaft, rotatably mounted within the swashplate at a speed which is double the speed of said crankshaft, and being provided with an eccentric journal on which is mounted an element adapted to move between and along two parallel, plane and rectilinear surfaces provided on the housing.

Another object of the invention is to provide a barrel-type machine (motor, pump or compressor) including the aforementioned improved motion converting mechanism.

Further features and advantages of the invention will be apparent from the ensuing description with reference to the accompanying drawings to which the invention is in no way limited.

In the drawings:

FIG. 1 is a partial vertical sectional view of a motion converting mechanism for a barrel-type machine showing one embodiment of guide means which cause one of the points of the swashplate to describe the theoretical lemniscate;

FIG. 2 is a partial sectional view taken along line **2—2** of FIG. 1;

FIG. 3 is a view similar to FIG. 2 of a modification of the guide means.

In the embodiment shown in FIGS. 1 to 3, the motion converting mechanism A is applied to a barrel-type machine which could be a motor, pump or compressor.

Journalled in the housing **1** of this machine is the crankshaft **2** having an axis X—X. Located on a circle concentric with this axis X—X are the cylinders **3** whose axes W—W are at least roughly parallel with the axis X—X. Slidable in each of the cylinders is a piston **4** connected to the shaft **2** by a connecting rod **5** and a swashplate or motion converter T adapted to convert the alternating motion of the pistons **4** into a motion of rotation of the shaft **2** (in the case of a motor) or vice versa (in the case of a pump or compressor).

The swashplate T is mounted on crankpins **6** which are formed on the shaft **2** and have an axis Z—Z which is oblique relative to the axis X—X which it intersects at O. This swashplate can consist of a single piece but is preferably in the form of two half-shells interconnected in a diametral joint plane.

The swashplate has a spherical dome shape and bears by its outer spherical male portion **7** against a spherical female face **8** preferably provided on a support ring **9**.

This ring **9** bears through the medium of a plane machined face **10** against a corresponding plane machined face **11** which is perpendicular to the axis X—X of the journals of the crankshaft **2** mounted in the fixed housing **12** of the mechanism A. This housing **12** is connected to the housing **1** of the motor by screws (not shown).

Each connecting rod **5** terminates at the end adjacent the swashplate in a ball **13** which bears in a corresponding cavity or socket **14** in a peripheral boss **15** formed on the plate T which has a substantially star shape when viewed in the direction of the axis Z—Z.

The shaft **2** is rotatably mounted by its crankpins **6** in the swashplate which must be prevented from rotating relative to the case **12** while being left free to undergo a motion of precession, the foregoing definition of which will now be repeated.

The shaft **2** undergoes a uniform motion of rotation, for example in the direction of arrow *f* about the axis X—X of its journals; the swashplate T rotates about the axis Z—Z of the crankpins **6** relative to the shaft **1**, taken as a reference, at a speed of rotation near to the preceding speed and in the opposite direction.

All the foregoing is known and the present invention concerns the guide means for guiding the swashplate T in such manner that a point M thereon, located at a distance R from the centre O of the swashplate describes a gauche curve which is as near as possible to the theoretical curve that an analysis of the movement of precession permits determining for such a point.

According to mathematical calculation the projection of such a theoretical curve on the plane XOY is a lemniscate satisfying the following equations in parametric coordinates, Y being the axis which passes through O and which is perpendicular to the plane of FIG. 1:

$$x = R \cos a \sin b$$

$$y = \frac{R}{2}(1 - \cos b) \sin 2a$$

in which:

a is at a given instant the angle of rotation of the crankshaft relative to an original angular position;

R is the aforementioned distance between the points O and M;

b is the angle in correct magnitude that the axis Z—Z of the crankpins makes with the axis X—X of the crankshaft.

The invention resides in the guide means for the swashplate T that permit the point M to describe a gauche curve which, if not identical to the curve which has a projection in the form of the theoretical curve given by the aforementioned equations, is a curve at least very close thereto.

The embodiment according to the invention permits to obtain exactly the theoretical curve for the locus of the point M. A secondary shaft **37** within the swashplate or motion converter T is rotatable in a bearing **38** in the swashplate at a rational speed which is twice that of the rotational speed of the crankshaft **2** about the axis X—X owing to the provision of a pair of gears **39–40** whose gear ratio is equal to 2. The shaft **37** comprises at its end an eccentric **41** whose eccentricity

$$E = \frac{R}{2}(1 - \cos b)$$

or approximately this value.

This eccentric can be journalled in a cylindrical member **42** (FIGS. 1 and 2) having an axis which is perpendicular, or roughly perpendicular, to that of the eccentric and is disposed in a bore **43** formed within a block **44** whose flat faces **45** are slidable against corresponding flat faces **46** of a longitudinal slideway carried by the housing **12**.

In the embodiment shown in FIG. 3, the eccentric **41** is journalled in a part-spherical head **47** which is slidable and pivotable in the recess **46**.

In both solutions, the axis of the shaft **37**, which must be transversely inclined relative to the planes defining the recess (owing to the fact that the point M describes a lemniscate having a certain length) is thus able to assume such inclination.

In some portions of the crankshaft in which the plane of the crankshaft is parallel with the direction of the reaction of the groove **46** on the block **40** or the guide eccentric, this reaction creates, owing to the oblique condition of the crankpin on the axis X—X of the crankshaft **2**, an axial reaction which is alternately directed forwardly (AV) and rearwardly (AR).

Although the crankshaft **2** can be positioned in the longitudinal direction, this reciprocating motion could create operational noise. This can be remedied in arranging one end of the crankshaft in the form of a piston **53** which is annular in that only a part of the front surface of the journal of the crankshaft transmits a force and on which is exerted in a bore **54** of the housing a liquid pressure applied through a bore **55** in the housing **1** for example the pressure of lubricating oil. Thus, the resultant of the forces exerted on the crankshaft **2** can always maintain the same direction and permanently apply the crankshaft against a single axial abutment **56** without risk of tapping or noise.

Although specific embodiments of the invention have been described, many modifications and changes may be made therein without departing from the scope of the invention as defined in the appended claims.

Having now described my invention what I claim as new and desire to secure by Letters Patent is:

1. In a motion-converting mechanism for a barrel type machine: a housing, a crankshaft rotatably mounted in that housing for rotation about a general geometrical axis, a swashplate rotatably secured to said crankshaft at an angle to said general geometrical axis and guide means interposed between said swashplate and said housing; said guide means comprising: a shaft rotatably mounted within said swashplate, gear means solid with said crankshaft and said shaft, respectively, in mutual meshing relation for imposing to said shaft a rotational speed twice that of the rotational speed of said crankshaft, an eccentric journal solid with said shaft, a roller element rotatably mounted on said journal, a slideway rigid with said housing and having two plane parallel guiding surfaces facing each other and parallel with said general geometrical axis, said roller element being in operative relation with said slideway for rotating and sliding between said two guiding surfaces, whereby a point of said swashplate is caused to perform a lemniscate movement in the shape of an **8**.

2. In a motion-converting mechanism for a barrel type machine: a housing, a crankshaft rotatably mounted in that housing for rotation about a general geometrical axis , a swashplate rotatably secured to said crankshaft at an angle to said general geometrical axis and guide means between said swashplate and said housing; said guide means comprising: a shaft rotatably mounted within said swashplate, gear means solid with said crankshaft and said shaft, respectively, in mutual meshing relation for imposing to said shaft a rotational speed twice that of the rotational speed of said crankshaft, an eccentric journal solid with said shaft, a slideway rigid with said houisng and having two plane parallel guiding surfaces facing each other and parallel with said general geometrical axis, a block having two plane parallel surfaces engaging said guiding surfaces to slide therebetween, said block further having a cylindrical recess; a cylindrical roller coaxial with said recess and rotatably engaged therein, said eccentric journal being rotatably mounted in a transverse bore of said roller; whereby a point of said swashplate is caused to perform a lemniscate movement in the shape of an **8**.

3. In a motion-converting mechanism for a barrel type machine: a housing, a crankshaft rotatably mounted in that housing for rotation about a general geometrical axis, a swashplate rotatably secured to said crankshaft at an angle to said general geometrical axis and guide means interposed between said swashplate and said housing; said guide means comprising: a shaft rotatably mounted within said swashplate, gear means solid with said crankshaft and said shaft, respectively, in mutual meshing relation for imposing to said shaft a rotational speed twice that of the rotational speed of said crankshaft, an eccentric journal solid with said shaft, a roller element rotatably mounted on said journal and having a spherical peripheral surface, a slideway rigid with said housing and having two plane parallel guiding surfaces facing each other and parallel with said general geometrical axis, said spherical peripheral surface of said roller element being in engagement with said guiding surfaces to rotate and slide therebetween, whereby a point of said swashplate is caused to perform a lemniscate movement in the shape of an **8**.

4. In a motion-converting mechanism for a barrel type machine: a housing, a crankshaft rotatably mounted in that housing for rotation about a general geometrical axis, a swashplate rotatably mounted on said crankshaft, guide means interposed between said swashplate and said housing for imposing a lemniscate movement to a point of the periphery of said swashplate, a piston coaxial with said general geometrical axis and rigidly mounted on said

crankshaft, said piston being slidably mounted in a cylinder solid with said housing; and a fluid under pressure interposed between said cylinder and said piston, whereby the axial thrusts on said crankshaft are balanced.

5. In a motion-converting mechanism for a barrel type machine: a housing, a crankshaft rotatably mounted in that housing for rotation about a general geometrical axis, a swashplate rotatably secured to said crankshaft at an angle to said general geometrical axis and guide means interposed between said swashplate and said housing; said guide means comprising: a shaft rotatably mounted within said swashplate, gear means solid with said crankshaft and said shaft, respectively, in mutual meshing relation for imposing to said shaft a rotational speed twice that of the rotational speed of said crankshaft, an eccentric journal solid with said shaft, a roller element rotatably mounted on said journal, a slideway rigid with said housing and having two plane parallel guiding surfaces facing each other and parallel with said general geometrical axis, said roller element being in operative relation with said slideway for rotating and sliding between said two guiding surfaces, whereby a point of said swashplate is caused to perform a lemniscate movement in the shape of an 8; a piston coaxial with said general geometrical axis and rigidly mounted on said crankshaft, said piston being slidably mounted in a cylinder solid with said housing; and a fluid under pressure interposed between said cylinder and said piston, whereby the axial thrusts on said crankshaft are balanced.

References Cited by the Examiner

UNITED STATES PATENTS

1,948,827	2/1934	Redrup	74—60
2,430,788	11/1947	Sherman	74—60
2,550,613	4/1951	Sparmann	74—60
3,069,913	12/1962	McCrory et al.	74—60
3,101,621	8/1963	Bunyan	74—60

FOREIGN PATENTS

371,069	4/1932	Great Britain.

MILTON KAUFMAN, *Primary Examiner.*

BROUGHTON G. DURHAM, *Examiner.*

D. H. THIEL, *Assistant Examiner.*