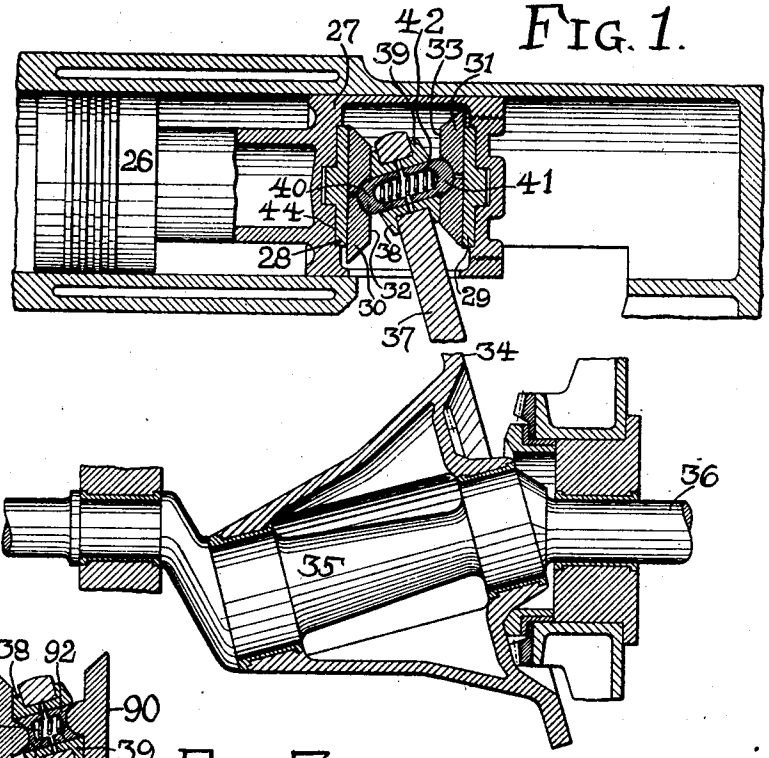
Feb. 4, 1941. W. HULSEBOS 2,230,839

SWASH PLATE AND WOBBLER MECHANISM

Filed Nov. 24, 1937 2 Sheets-Sheet 1

FIG. 1.



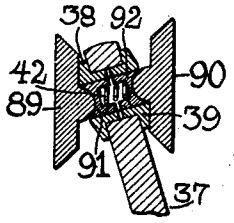


FIG. 7.

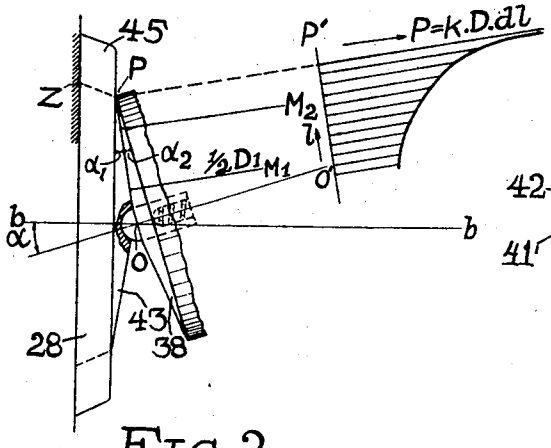


FIG. 2.

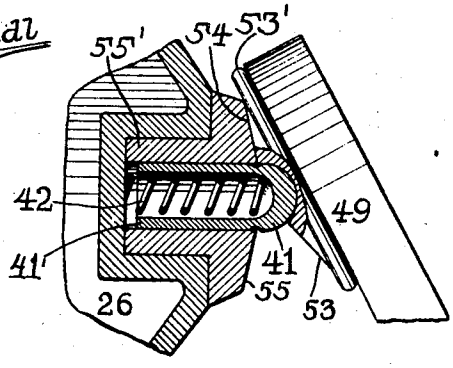


FIG. 3.

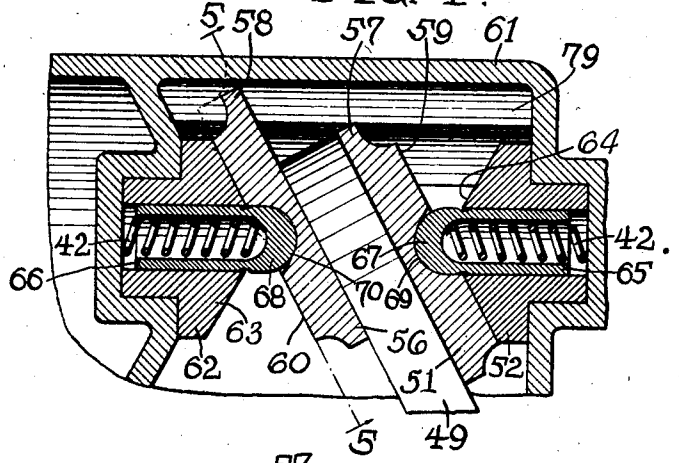
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Feb. 4, 1941. W. HULSEBOS 2,230,839

SWASH PLATE AND WOBBLER MECHANISM

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FIG. 4.



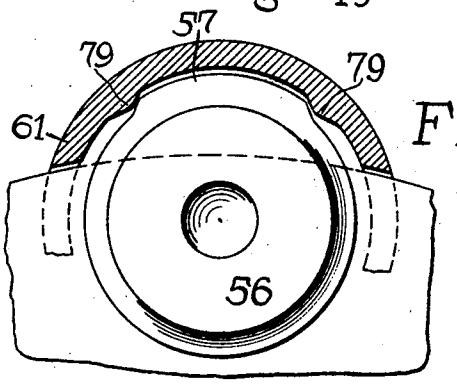


FIG. 5.

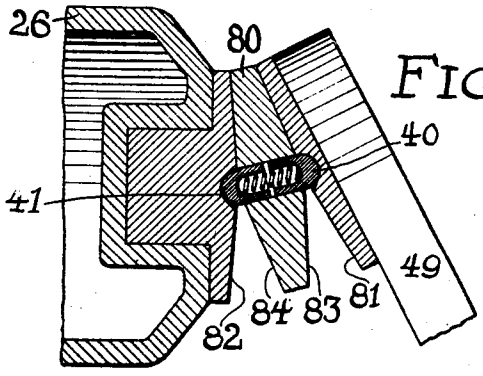


FIG. 6.

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Patented Feb. 4, 1941 2,230,839

UNITED STATES PATENT OFFICE

2,230,839

SWASH PLATE AND WOBBLER MECHANISM

Wichert Hulsebos, Province of Noord, Netherlands, assignor to Naamlooze Venootschap, Hulsemo, Utrecht, Netherlands

Application November 24, 1937, Serial No. 176,219
In the Netherlands November 24, 1936

8 Claims. (Cl. 308—1)

This invention relates to wobbler or swash plate mechanism applicable to engines or pumps having cylinders more or less parallel with the axis of the crankshaft for transmitting the movement of the piston to a wobble or swash plate, or vice versa, and refers particularly to efficient connections between the swash plate and the pistons working in said cylinders.

The main object of my invention is to provide connections in mechanism of the type indicated which will be free from excessive friction and also practically trouble free in operation.

Another most important object is to have such mechanism with efficient connections as indicated which can be designed according to Stribeck's rules so that the entire mechanism can, as a result be greatly reduced in size without loss of capacity or efficiency, so that the machine is compact and convenient.

A further object is to utilize several effective means which will serve to embody the features of the connections in this type of mechanism, and to render such parts simple in design and economical to manufacture.

Other objects and the many advantages inherent in and accruing from the construction, nature and practical application of my invention will appear more fully as this specification proceeds.

The structural features and principles will be more readily grasped by consulting the accompanying drawings which form part hereof, and in which,

Fig. 1 is a sectional side elevation of part of a wobbler engine or pump, similar to that shown and described in my Patent 1,842,322 granted January 19, 1932, the construction embodying certain features of my invention in practical form.

Fig. 2 is a diagrammatic representation of the cooperating surfaces of the mechanism which play an important role in the invention.

Fig. 3 is an elevation, partly in section, of one portion of the construction provided with a plate or disk which is mounted in inclined fashion upon the crankshaft and rotates therewith, the pistons being connected to and cooperating with said disk.

Fig. 4 is a modification of the mechanism of Fig. 1.

Fig. 5 is an end elevation as seen in the direction of the arrows V—V in Fig. 4.

Figs. 6 and 7 are similar sections to that of Fig. 3, showing various modifications.

Throughout the views, the same or like parts are indicated by the same references.

In mechanisms of the present type, as represented, for example, by Patent Number 1,842,322, mechanical difficulties have been encountered which were particularly characterized by rather harsh wear of certain of the parts.

Two examples of such mechanism are also described in the British Letters Patent No. 350,308, in one of which the second of two rolling surfaces is spherical while in the other it is conical. In such constructions it is necessary to provide guiding means or locating means for maintaining the two rolling surfaces in the correct relationship and the means preferably employed for this purpose consists of a central ball-shaped knob co-operating with a socket or seating as described with reference to Figure 2 of said patent.

The surfaces of the knob and the socket rub upon one another and this rubbing friction may become excessive because it is difficult to ensure that the rubbing surfaces are not subjected to a considerable proportion of the load between the piston and the wobbler or swash plate.

It may also be pointed out that in such mechanisms heretofore known, the connection between the sliders and the pistons or plungers comprised ball and socket joints but it is found in practice that the surfaces of such joints give trouble owing to rapid and excessive wear. Such wear is particularly disadvantageous in mechanism of this kind because it increases the clearance between the sliders and the swash plate with the result that when reversal of load occurs the parts hammer against one another. Consequently, as soon as any wear takes place it continues at an increasing rate and breakdowns occur in a comparatively short time.

Modifications of these constructions have also shown in practice that unreasonable wear, noise and inefficient operation resulted, so that the parts were often made large in the attempt to compensate some of the wear, but in general these and other difficulties have militated against popular use of such machines for engines and pumps, etc.

In order to eliminate these disadvantages and also to embody the foregoing objects, it is now proposed to introduce certain new and highly meritorious features as embodied in several related practical forms.

Hence, in the practice of my invention, and referring now again to the drawings, in Figure 1, the piston 26 is formed with a guiding ex-

tension 27 within which are mounted two opposed discs 28, 29 having their exposed surfaces flat and parallel to one another. Two shoes or slippers 30, 31 slide upon the discs 28, 29 and their inner opposed surfaces 32, 33 respectively are flat or slightly convex. A spherical socket or recess is formed in the centre of each of the surfaces 32 and 33.

The wobbler 34 is mounted on the inclined portion 35 of a crankshaft 36 and consists of arms 37, only one of which is shown in the drawings and near the extremity of each arm is secured a pair of pressure members 38, 39, the external surfaces of which are conical, these surfaces having a common axis which is parallel to the axis of the inclined crankshaft on which the wobbler is mounted. These pressure members make line contact with the surfaces 32, 33 as clearly shown in the drawings, and as the piston reciprocates and the crankshaft rotates, the pressure members roll upon the surfaces 32, 33 of the shoes or slippers which themselves slide upon the surfaces of the discs 28, 29 and at the same time rotates slowly.

The pressure members 38, 39 are bored to receive plungers 40, 41 between which is interposed a spring 42 which presses them outwards. The exposed ends of the plungers are curved to spherical shape and fit sockets or recesses previously referred to, in the shoes or slippers 30 and 31. These spherical curved ends of the plungers working in the sockets or recesses, maintain the pressure members, 38, 39 in correct central relationship with the shoes or slippers as described in the British Patent 350,308 referred to above, and also serve as rolling bearing means. The only tangential or lateral force on the plungers is that due to friction between the slippers and the discs 28, 29 together with the inertia of the slippers and owing to the fact that each of the sockets or recesses comprises nearly a hemisphere the wedging action of the surfaces of these sockets on the spherical curved knobs or ends of the plungers will be very slight and will be easily resisted by a stress in the spring 42 which is not enough to cause sufficient pressure between the spherical surfaces to bring about appreciable wear of these surfaces. Thus it is ensured that the pressure on the spherical surfaces of the knobs and the sockets or recesses can never exceed a predetermined small amount.

As may be particularly noted in Figure 2, if the angle of inclination of the conical surfaces of pressure members 38 and 39 is equal to the angle of inclination of the inclined crank 35, the plane surfaces 32 and 33 are perpendicular to the axis of the crankshaft 36.

However it is also possible, that the conical surfaces 38 and 39 of the pressure members cooperate with conical surfaces of the slippers.

The sum of the angles of inclination 1 and 2 of the cooperating conical surfaces 38 and 43 of the pressure members then equals the angle of inclination of the inclined crank respectively of the centerline of the cone 38.

As will appear in later views, the conical pressure members may also be replaced by other surfaces of revolution.

Now it may be stated that heretofore the plane surfaces 44 of the discs 28 and the surfaces of the slippers cooperating therewith wore out strongly to one side, so that these surfaces did not remain plane, due to which the whole construction gets out of order, and the wear and tear especially occurred in the ring-shaped zone *z*.

Now with respect to the axis O', P', which has been drawn parallel to OP, the load, which is allowable between the surfaces of contact of the member 38 and the surface 43, has been graphically indicated.

The invention starts from the idea that by using Stribeck's tests and formulas a notion of this may be obtained.

The contact of the cone or pressure member with the counter surface will take place upon a small area. (The cooperating surfaces are slightly impressed.)

When Stribeck says, that the permissible load on a roller, which bears on a surface, equals: $P=k.d.l$ (d=the diameter of the roller, l=the length of the roller and k=a constant factor, which depends on the material of the roller and the supporting surface and also of the shape of the supporting surface, e. g., whether this is concave or convex), therewith he also starts from the fact, that the roller at the periphery is slightly impressed and this the more so as the diameter of the roller is smaller.

The conical surface of 38 resting on the surface 43 may be considered a series of small rollers, each having a length dl. The diameters of these small rollers increase towards the point P (vide centers of curvature M_1 and M_2).

Then according to Stribeck each small roller can bear $P=k.d.dl$ (in which case and hence in this case d depends of l; thus $d=f(l)$.

The total cone can then bear

$$K=k.d.dl.$$

(the area of the diagram in Figure 2).

Now it is clear, why the zone *z* wore out so heavily.

If the cone or pressure member is too large, only the part thereof near P having the largest diameter) bears well. The flattening of the bearing surface here is slightest and near the apex of the cone the same does not even have an opportunity to be subjected to the full flattening along a generatrix, which is possible there on account of the maximum load which is allowable. In other words the cone will bear where it can take most load. But then the resulting force between the cone 38 and the plane 43 is rather remote from the centerline *b—b* of the slipper 28 and the latter therefore wears out at the peripheral zone *z*.

Now we should determine the forces to be taken (pressure of explosion forces of inertia). The maximum force is K_1. Then choose the cone or pressure member 38 so large, that the allowable load thereof, i. e. $K=k.d.dl$ at least equals that force K_1. Then the cone will bear nearer to the apex, because it will come out much smaller and thus the slipper 28 is less eccentrically loaded.

As a further improvement the slipper may also be extended as at 45 so that the surface pressure is still more decreased there. Stribeck's constant factor may be derived from handbooks.

The principles can be applied in constructions having an inclined plate fixed to the main shaft. (Figure 3.)

In Figure 3 the knob 41 is relieved, on account of the fact that the inclination of the conical

surface 53 of the sliding shoe 53' has been chosen small. This conical surface 53 rolls against a corresponding conical surface 55 at a mutual line of surface contact 54. The conical surface 55 projects exteriorly from the member 55' inserted into the end of the piston 26, while the locating or centering knob 41 (which actually serves also as rolling bearing means) has its shank 41 slidably mounted in member 55' and is urged toward the sliding shoe 53' by the interior spring 42.

In Figures 4 and 5, as in Figure 3, the swash plate 49 has parallel flat surfaces and the force between it and the pistons is transmitted by means of sliders 57, 58. The outer surfaces 59, 60 of these sliders are flat and parallel to the inner surfaces which bear against the swash plate. It is not essential that these external surfaces should be exactly flat; they might be very slightly convex and either spherically curved or conical. The piston extension 61 is provided with two opposed pressure members 52, 62 having the conical surfaces 63, 64 co-axial with one another and with the piston. The angle of the conical surfaces 63, 64 is such that they make line contact with the surfaces 59, 60 as clearly shown in the drawings. The pressure members 52, 62 are bored axially to receive plungers 65, 66 urged outwardly by springs 42 and having spherically curved ends or knobs 67, 68 seated in spherical sockets or recesses 69, 70 formed in the outer sides of the sliders 51, 56. The force exerted between the piston and the sliders is taken by the rolling surfaces 59, 63 and 60, 64, but the pressure between the spherical surfaces 67, 69 and 68, 70 is limited by the stress of the springs 42.

Because the surfaces 59, 60 are parallel to the surfaces of the swash plate 49 there is no transverse load on the plungers 65, 66 due to the inclination of the swash plate; the only transverse load that can occur is that due to friction between the sliders and the swash plate and the inertia of the sliders.

Owing to the fact that the linear velocity of the relative movement between the swash plate and the sliders is greater at the outer edges of the sliders than at the inner edges, the sliders tend to be set in undesirable rotation because such rotation would tend to cause slip between the rolling surfaces of the pressure members and the outer surfaces of the sliders. In order to prevent this the sliders are formed with projections 57 (Figure 5) co-operating with guiding ribs 79 formed on the inner wall of the piston extension 61.

Figure 6 illustrates a construction, in which an auxiliary member 80 is arranged between a conical surface 81 of a sliding shoe and a conical surface 82 of the piston, said member presenting conical surfaces 83 and 84 having their bases facing each other.

The sum of the angles of inclination of all conical surfaces equals the angle of inclination of the inclined plate 80. Since the angles of inclination of the cones now come out very small, the radii of curvature of the conical surface (and the diameters of the small rollers, of which the cone is considered to be composed) are very large, so that the bearing capacity is very great. This construction is meant for heavy motors having high pressures on the pistons.

The auxiliary members are positioned as before by resilient knobs 40, 41.

Referring now to Figure 7, the construction illustrated in this figure is characteristic in that the spherical knobs are formed on the sliders 89, 90 and the plungers 91, 92 are formed at their outer ends with spherical sockets or recesses fitting these spherical knobs.

In the form of the invention last described above the angle between the convex surface of the ring on each side and the groove in which it rolls is less than the angle of obliquity of the wobbler or the swash plate, being in general half that angle. This is advantageous because the area of the contact surfaces (due to the elasticity of the material) is at maximum.

It is understood that the pressure members and their corresponding sliders, etc., may broadly be termed rolling bearing means.

Manifestly variations other than those described may be resorted to, and parts may be used without others.

Having now fully described my invention, I claim:

1. An antifriction joint adapted to transmit thrust loads between a reciprocating piston and a wobbling element comprising a pair of corresponding rolling bearing means having bearing surface portions in rolling contact during oscillation of the wobbling element comprising surfaces of revolution which are conical in form and disposed at an angle making mutual line contact between said surface portions in all positions of the wobbling element, one rolling bearing means being disposed on a slider mounted between the piston and the wobbling element, while resilient locating means are associated with the rolling bearing means, said locating means comprising a protruding part on one of the bearing means and a socket in the other bearing means and resilient means for ensuring resilient cooperation of said protruding part and said socket, and the protruding part of the locating means being shaped as a piston having its axis coinciding with the geometrical axis of one of the conical surfaces and said resilient means arranged according to the latter axis for urging said piston.

2. An antifriction joint according to claim 1, wherein the slider having one of the rolling bearing means is provided with a socket and the other rolling bearing means carries the locating means in a position in which it retractably projects from the same and fits or seats with its projecting end in said socket in all positions of the wobbling element.

3. An antifriction joint adapted to transmit thrust loads between a reciprocating piston and a wobbling element comprising a pair of corresponding rolling bearing means having bearing surface portions in rolling contact during oscillation of the wobbling element, comprising surfaces of revolution which in the case of at least one of the bearing surface portions is conical in form, while the bearing surface portions in rolling contact are disposed at an angle making mutual line contact between said surface portions in all positions of the wobbling element, one rolling bearing means being disposed on a slider mounted between the piston and the wobbling element, while resilient locating means are associated with the rolling bearing means, said locating means comprising a protruding part on one of the bearing means and a socket in the other bearing means and resilient means for ensuring resilient cooperation of said protruding part and said socket, the protruding part of the locating means being shaped as a piston having its axis coinciding with the geometrical axis of one of the conical surfaces and said resilient

means arranged according to the latter axis for urging said piston.

4. An antifriction joint according to claim 3, wherein the slider having one of the rolling bearing means is provided with a socket and the other rolling bearing means carries the locating means in a position in which it retractably projects from the same and fits or seats with its projecting end in said socket in all positions of the wobbling element.

5. An antifriction joint according to claim 1 including two sliders each having a rolling bearing means thereon and including two other rolling bearing means individually cooperating with said two rolling bearing means upon the sliders, each of said two rolling bearing means upon the sliders being provided with the socket portion and the other two rolling bearing means cooperating therewith each carrying the corresponding locating means in a position in which it retractably projects from the same and fits or seats with its projecting end in the socket of the rolling bearing means with which it cooperates in all positions of the wobbling element.

6. An antifriction joint according to claim 3, including two sliders each having a rolling bearing means thereon and including two other rolling bearing means individually cooperating with said two rolling bearing means upon the sliders, each of said two rolling bearing means upon the sliders being provided with the socket portion and the other two rolling bearing means cooperating therewith, each carrying the corresponding locating means in a position in which it retractably projects from the same and fits or seats with its projecting end in the socket of the rolling bearing means with which it cooperates in all positions of the wobbling element.

7. An antifriction joint according to claim 1 including two sliders each having a rolling bearing means thereon and including two other rolling bearing means individually cooperating with said two rolling bearing means upon the sliders, each of said two rolling bearing means upon the sliders each having the locating means provided with a protruding part, and the other rolling bearing means cooperating therewith being provided with the socket in each, in which the corresponding projecting part of the locating means fits or seats in all positions of the wobbling element.

8. An antifriction joint according to claim 3, including two sliders each having a rolling bearing means thereon and including two other rolling bearing means individually cooperating with said two rolling bearing means upon the sliders, each of said two rolling bearing means upon the sliders each having a locating means provided with a protruding part and the other rolling bearing means cooperating therewith, being provided with a socket in each, in which the corresponding projecting part of the locating means fits or seats in all positions of the wobbling element.

WICHERT HULSEBOS.

CERTIFICATE OF CORRECTION.

Patent No. 2,230,839. February 4, 1941.

WICHERT HULSEBOS.

It is hereby certified that the name and address of the assignee in the above numbered patent was erroneously written and printed as "Naamlooze Venootschap, of Hulsemo, Utrecht, Netherlands" whereas said name should have been written and printed as --Naamlooze Venootschap, Hulsemo, of Utrecht, Netherlands--, as shown by the record of assignments in this office; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 8th day of July, A. D. 1941.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.