April 19, 1966 R. LINDER 3,246,835

ROTARY FLUID DELIVERING MACHINE

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FIG. 1

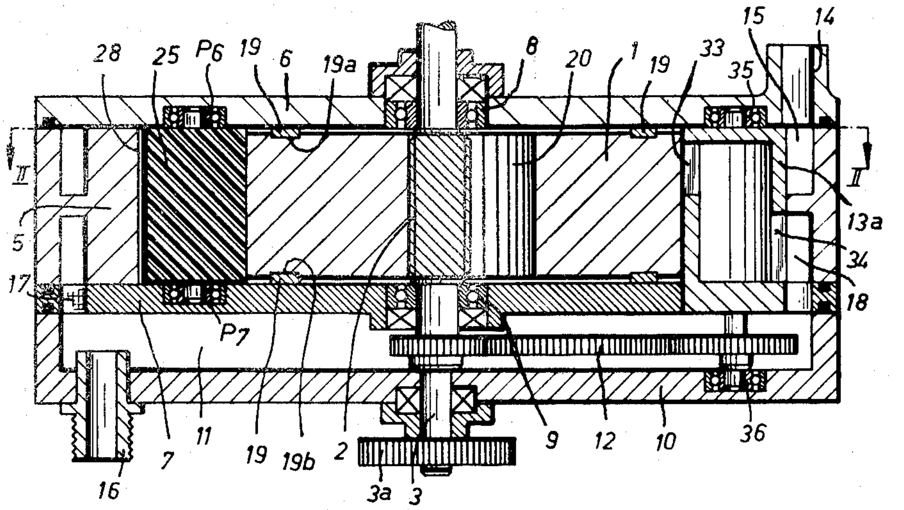

FIG. 3

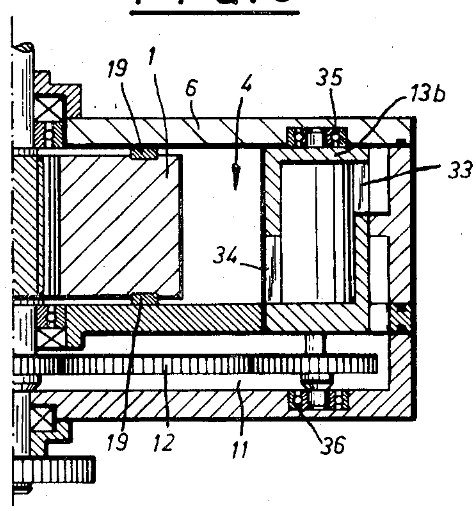

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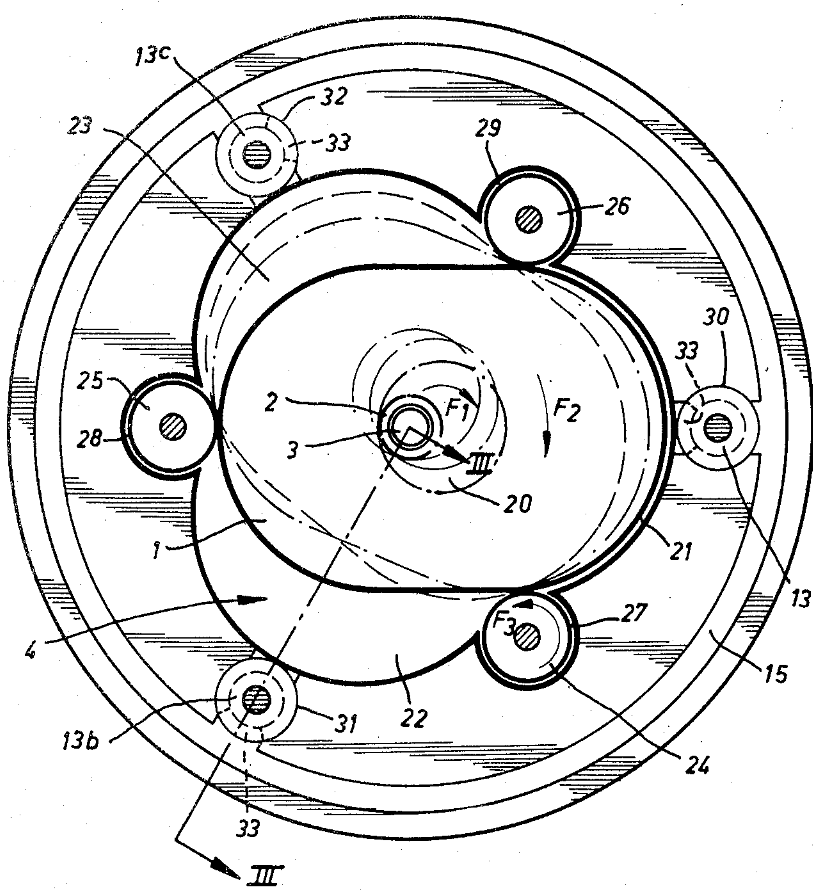
FIG. 2



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ROTARY FLUID DELIVERING MACHINE

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4 Claims. (Cl. 230—145)

My invention has for its object a fluid delivering machine including a rotary piston adapted to move inside a chamber; according to my invention, said piston is elongated and its thickness in the direction of the rotary axis of said piston is uniform while the two ends of the piston considered longitudinally are given a semi-cylindrical shape, said piston being furthermore provided with an inwardly toothed cylindrical opening; the chamber carrying said piston is bounded by two parallel lateral walls extending fluidtightly over the transverse surfaces of the piston while a peripheral inner surface includes six cylindrical surfaces distributed uniformly around the axis of the chamber and, of these cylindrical surfaces, three are defined by concave arcuate lines of which the medial lines lie at 120° from each other and converge along the axis of the chamber, the radius of said three arcuate lines being equal to the radii of the semi-cylindrical ends of the piston and the geometrical intersection of two successive arcuate lines lying at a distance from the middle point of the diametrically opposed arcuate line which is equal to the length of the piston between the apices of its terminal cylindrical sections while on the other hand the three other intermediate cylindrical surfaces forming the periphery of the chamber, are convex and merge on either side into the adjacent concave cylindrical surfaces. Furthermore, the driving shaft for my improved machine passes through the central opening in the piston and carries eccentrically a pinion meshing with the above-mentioned inner teeth in said opening so that the piston is subjected, upon rotation of the shaft, both to a rotary movement and to a translational movement as a consequence of the eccentricity of said pinion, asid translational movement performed in the rotary plane of the piston being such that the periphery of said piston is in permanent contact with the three convex surfaces forming the periphery of the chamber while three independent elementary chambers are formed between the piston and each of the first mentioned concave surfaces.

I will now describe my invention with further detail with reference to the accompanying drawings illustrating my improved machine and operating as a compressor. In said drawings:

FIG. 1 is an axial cross-section through the machine,
FIG. 2 is a cross-section through line II—II of FIG. 1,
FIG. 3 is a cross-section through line II—II of FIG. 2.

The machine illustrated includes a rotary piston **1** provided with a central opening **20** the inner periphery of which is toothed. Said piston is carried inside a chamber **4** and is controlled by a driving shaft **3** carrying eccentrically a pinion **2** meshing with the inner teeth in the opening **20**. The chamber **4** enclosing the piston is bounded on one hand, by two parallel flat walls **6** and **7** extending perpendicularly to the axis of rotation of the piston to either side of the latter end, on the other hand, by a peripheral medial wall **5** extending between the two parallel walls. The above-mentioned shaft **3** extends centrally of the chamber **4** and is revolvably carried in the parallel tranverse walls thereof **6** and **7** by means of wall bearings **8** and **9** and its projects through the central opening **20** of the piston **1**. The diameter of the pinion **2** rigid with the shaft **4** is smaller than the diameter of the toothed periphery of the opening **20** whereby the piston, as disclosed hereinafter, is shifted in its rotary plane during its rotation.

An auxiliary transverse wall **10** extending in parallelism with the wall **7** and outside the latter, with reference to the chamber **4**, defines an auxiliary chamber **11** enclosing a gearing **12**. Said gearing **12** of which only a fraction is illustrated in FIGS. 1 and 3 serves for synchronizing the movements of the valves **13***a*, **13***b* and **13***c* with that of the piston.

The transverse wall **6** of the chamber is provided with an input pipe **14** connected with a pipe which is not illustrated through which the medium which is to be compressed is fed into the annular chamber **15** formed within the peripheral wall **5** throughout the length thereof. After the mediuum has been compressed, it enters an annular chamber **18** independent of the annular chamber **15** and also formed in the peripheral wall **5**. Beyond said chamber **18**, the compressed fluid enters the passageway **17** opening into the auxiliary chamber **11** through which the medium is removed out of the machine through the pipe element **16** carried by the auxiliary transverse wall **10**.

The piston **1** is constituted by an elongated metal member provided with its uniform thickness in the direction of a rotary axis while its longer lateral sides are parallel and are interconnected by shorter terminal semi-cylindrical surfaces. The thickness of the piston **1** illustrated in FIG. 1 is somewhat smaller than the height of the chamber **4**. The piston is fluidtightly carried inside the lateral walls **6** and **7** by means of packings **19** engaging corresponding grooves **19***a* and **19***b* in the two piston surfaces facing said walls. These packing elements **19** extend throughout the periphery of the piston and are urged by springs, which are not illustrated and are carried at the bottom of said grooves **19***a* and **19***b*, against the transverse walls **6** and **7**. These packings may be made of metal or preferably of a self-lubricating synthetic material such as that sold under the registered tradename "Teflon." It is also possible to cut out the compression springs and to resort to packings made of an elastically compressible synthettic material, the deformation of which produces a sufficient pressure for obtaining the desired fluidtightness without the aid of any spring.

The inner periphery of the peripheral wall **5** of the chamber **4** is constituted as shown in FIG. 2, by three concave semi-cylindrical surfaces distributed symmetrically with reference to the center of the chamber and the generating lines of which are arcuate lines defining the elementary chambers **21**, **22** and **23**. The lines passing medially through said arcuate lines cut one another at the center of the chamber and form with one another, angles of 120°. The radius of these arcuate lines is that of the semi-cylindrical rounded ends of the piston **1** and the distance between the geometrical intersections of any two successive arcuate lines and the apex of the diametrically opposed third arcuate line, is equal to the length of the piston **1** between the apices of its rounded ends.

Between any two successive concave cylindrical surfaces of the peripheral wall **5**, is provided a cylindrical depression **27**, **28** or **29** opening into the inside of the chamber **4**.

Said depressions carry cylindrical rollers **24**, **25** and **26** which are pivotally carried in the transverse walls **6** and **7** through the agency of ball-bearings P6 and P7. Said rollers project into the chamber **4** through a fraction of their periphery, so as to engage permanently the periphery of the piston **1** during the rotation of the latter. The piston **1** is driven by the pinion **2** carried eccentrically by the shaft **3** and meshing with the teeth on the inside of the central opening **20** of the piston. This drive produces in addition to the simple rotation of the piston **1**, a translational movement holding said piston permanently in contact with the three rollers 24, 25, 26. When the pinion 2 moves in the direction of the arrow F1 (FIG. 2), the piston moves in its plane in the direction of the arrow F2 while the rollers 24, 25, 26 revolve in the direction of the arrow F3. Two further positions of the piston are illustrated in FIG. 2, respectively in interrupted and in dot and dash lines.

The rollers 24, 25 and 26 may be made of metal for instance of bronze or else of a self-lubricating synthetic material such as the above-mentioned Teflon.

The points of contact between the rollers 24, 25 and 26 and the periphery of the piston form thus on the one hand, the bearing points for the piston rolling on said rollers and on the other hand, a linear sealing separation of the chamber 4 into the three elementary chambers 21, 22 and 23, said sealing preventing any fraction of the medium to be compressed, from passing out one elementary chamber into the other.

To obtain an optimum service with my improved machine, the following relationship should be taken into account in its execution: the eccentricity e of the pinion with reference to the shaft 3 should be equal to:

$$e=D/125$$

D being the diameter of the pitch circle of the pinion 2. Furthermore, the distance A between the axis of the shaft 3 and the axes of the rollers 24, 25 and 26 should be:

$$A=3.9722D$$

Between the radius R of the rollers 24, 25 and 26 and the radius r of the semi-cylindrical rounded ends of the piston 1, the following relationship should be observed:

$$R+r=3.4722D$$

If the rollers 24 to 26 are made of an elastically deformable synthetic material, obviously their diameter may be somewhat larger than that which is theoretically necessary and this improves the fluidtightness between the piston and the rollers which are thus compressed.

The fluidtightness between the periphery of the rollers 24 to 26 and the cylindrical depressions 27 to 29 in which they revolve, is ensured by strips, which are not illustrated, of a self-lubricating material secured to the inner periphery of the depressions. Further packings which are not illustrated provide for the fluidtightness between the chamber 4 and the cooperating annular chambers 15 and 18 as well as between the peripheral wall 5 and the transverse walls 6 and 7 so as to seal the elementary chambers with reference to one another.

At the apex of each elementary chamber are formed openings 30 to 32 carrying the valves 13*a*, 13*b* and 13*c*. Said valves are fitted in the peripheral wall 5 and are constituted by a hollow cylindrical member of which the wall includes (FIGS. 1 and 3) two diametrically opposed ports 33 and 34 of which the port 33 lies at the level of the annular chamber 15 and the other port 34 is in registry with the annular chamber 18. The valve bodies are pivotally secured between the transverse wall 6 and the auxiliary wall 10 through the agency of ball-bearings 35 and 36 and they are controlled during the operation of the machine, by the above-mentioned gearing 12. During said rotation of the valves, the annular chamber 15 is connected through the port 33 with the inside of the hollow valve and through the port 34 with the chamber 4 or else the annular chamber 18 is connected through the port 34 with the inside of the valve which communicates in its turn through the port 33 with the chamber 4. The speed reduction between the rotary movement of the piston and that of the valves, is selected so that, for the position of the piston illustrated, the valve 13*a* has just opened so as to connect the elementary chamber 21 with the annular chamber 18 (FIG. 1) whereby, during said stage, the medium compressed in said elementary chamber 21 is exhausted through said valve 13*a*. At the same moment, the valve 13*b* enters a position such that the elementary chamber 22 is connected with the annular chamber 15 (FIG. 3) so that the medium to be compressed is then sucked in through the valve 13*b* into said elementary chamber 22. The third valve 13*c* is then closed so that the compression may be performed inside the elementary chamber 23. The different positions of the valve are illustrated in FIG. 2 by an interrupted line defining the port 33 of each valve.

As the piston moves, the three valves have their positions changed periodically so that a cyclic operation including a suction, a compression and an exhaust stage, is performed in each of the elementary chambers 21, 22 and 23.

The shaft 3 driving the piston 1 is driven by the outer pinion 3*a* (FIG. 1) and a suitable associated gearing controlled by a motor or a turbine of a conventional type. The speed of rotation of the piston 1 is selected obviously according as to whether a liquid or a gas is to be compressed. In the case of a liquid, a maximum speed of rotation is selected for the shaft, which is equal to 300 to 400 r.p.m. whereas in the case of the compression of air or another gas, a speed of about 1,000 r.p.m. may be considered. The operative speed may be increased provided the diameter of the valves is correspondingly increased.

The fluid delivering machine, according to my invention, is not limited to the embodiment illustrated operating as a compressor. For instance, it is possible to make the machine serve as a generator of compressed gas or air adapted to feed a compressed air engine or else arrangements working through the expansion of gases.

When the machine is to feed gas engines or turbines, it should be modified through the incorporation of explosion chambers and corresponding valves. For instance, there is formed in the wall of each elementary chamber 21, 22 and 23, a suitable auxiliary opening in the wall 5, inside which opening is fitted a tubular sleeve acting as an explosion chamber provided with a conventional igniting device. Said sleeve is connected with the corresponding elementary chamber by a slot carrying an admission valve. Said admission valve is designed and fitted in a manner such that it allows the passage of the medium compressed in the elementary chamber into the explosion chamber only when the pressure of said medium has risen above a predetermined pressure. The compressed medium is ignited so as to explode in the explosion chamber and the combustion gases are fed through a suitable output valve to a gas engine or turbine adapted to produce electric or mechanical energy and also to drive the shaft 3 of the fluid-delivering machine.

In this modification, the valves other than those controlling the explosion chambers and controlling the passage of the medium to be compressed into the elementary chambers, differ from the valves 13*a* to 13*c* described for the compressor through the fact that, during the suction stage only, they open the passage between the corresponding elementary chamber and the annular admission chamber, said valves remaining closed throughout the remainder of the cycle.

According to a further application, my improved machine may serve as an ordinary gas or liquid pump or else as a vacuum pump. In the latter case, the annular chamber 15 is connected with the container in which vacuum is to be produced.

When the machine is to serve as a pump, and when a corrosion-opposing synthetic material is incorporated in the structure, the pressures on the suction side may reach 0.4 atmosphere and on the delivery side, up to 2 atmospheres. When the pumps are made of steel, the corresponding values may reach respectively 0.9 and 30 atmospheres. My improved machine, operating as a pump, provides a constant throughput which is proportional to pressure and to increase in pressure. Suitable auxiliary channels may serve for reversing the direction of flow of the medium through the machine.

In accordance with a modification which is not illustrated, the fluid delivering machine can be provided with annular channels conveying a coolant such as water or oil. Said channels are preferably arranged in parallelism with the rotary axis of the machine through the peripheral wall **5** in the vicinity of the valves or of the explosion chambers.

In a still further modification which is not illustrated, the cylindrical rollers designated by **24**, **25**, and **26** in the embodiment illustrated, can be cut out, and instead of said rollers, the peripheral wall **5** includes rounded convex sections facing the chamber **4** and extending between the successive elementary chambers **21**, **22** and **23** so that the periphery of the piston **1** rests permanently on the rounded sections thus projecting inside the chamber **4**. This simpler embodiment is however submitted of course to a higher wear of the piston surface.

What I claim is:

1. A rotary fluid-delivering machine comprising a chamber defined peripherally by three auxiliary equidistant concave arcuate wall sections the medial lines of which converge at a central point, by three equal intermediate angularly equidistant convex arcuate wall sections extending between the first-mentioned sections and by two plane transverse walls engaging either side of the arcuate wall sections, an elongated piston having transverse surfaces extending between the plane walls of said chamber, the thickness of which is uniform and the peripheral outline of which is defined by two parallel planes interconnected by two cylindrical sections the radii of which are equal to those of the first-mentioned wall sections of the chamber, said piston being provided with a central cylindrical inwardly toothed opening having its axis parallel with the axes of the cylindrical sections of said piston, the total length of the piston between the outermost points of its cylindrical sections being equal to the spacing between the outermost point of one of the first-mentioned concave arcuate wall sections of the chamber and the geometrical intersection of the two other first-mentioned wall sections, a driving shaft extending through the central point of the chamber revolvably carried by the transverse walls of said chamber and engaging the central opening of the piston, a slightly eccentric gear rigid with said shaft and meshing with the inner series of teeth in the opening of the piston to impart to the latter simultaneously a rotary movement and a translational movement in a plane perpendicular to the shaft axis, the peripheral wall of the piston being in permanent contacting relationship with the three convex chamber walls, and means feeding in succession fluid into and out of the elementary chambers formed between the piston and each of the first-mentioned concave walls.

2. A rotary fluid-delivering machine comprising a chamber defined peripherally by three auxiliary equidistant concave arcuate wall sections the axes of which converge at a central point, by three equal intermediate angularly equidistant concave arcuate wall sections extending between the first-mentioned sections and by two plane transverse walls engaging either side of the arcuate wall sections, an elongated piston having transverse surfaces extending between the plane walls of said chamber, the thickness of which is uniform and the peripheral outline of which is defined by two parallel planes interconnected by two cylindrical sections the radii of which are equal to those of the first-mentioned wall sections of the chamber, said piston being provided with a central cylindrical inwardly toothed opening having its axis parallel with the axes of the cylindrical sections of said piston, the total length of the piston between the outermost points of its cylindrical sections being equal to the spacing between the outermost point of one of the first-mentioned concave arcuate wall sections of the chamber and the geometrical intersection of the two other first-mentioned wall sections, a driving shaft extending through the central point of the chamber revolvably carried by the transverse walls of said chamber and engaging the central opening of the piston, a slightly eccentric gear rigid with said shaft and meshing with the inner series of teeth in the opening of the piston to impart to the latter simultaneously a rotary movement and a translational movement in a plane perpendicular to the shaft axis, a roller fitted in each of the three wall sections extending between the first-mentioned sections of the chamber and engaging permanently the peripheral outline of the piston and means feeding in succession fluid into and out of the elementary chambers formed between the piston and each of the first-mentioned concave walls.

3. In a machine as claimed in claim **1**, an eccentricity of the pinion which is equal to the quotient of the pitch circle of said pinion divided by 125.

4. In a machine as claimed in claim **1**, a spacing between the axis of the driving shaft and the axes of the convex wall sections which is equal to the product by 3.9722 of the pitch diameter of the pinion.

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