

March 10, 1964

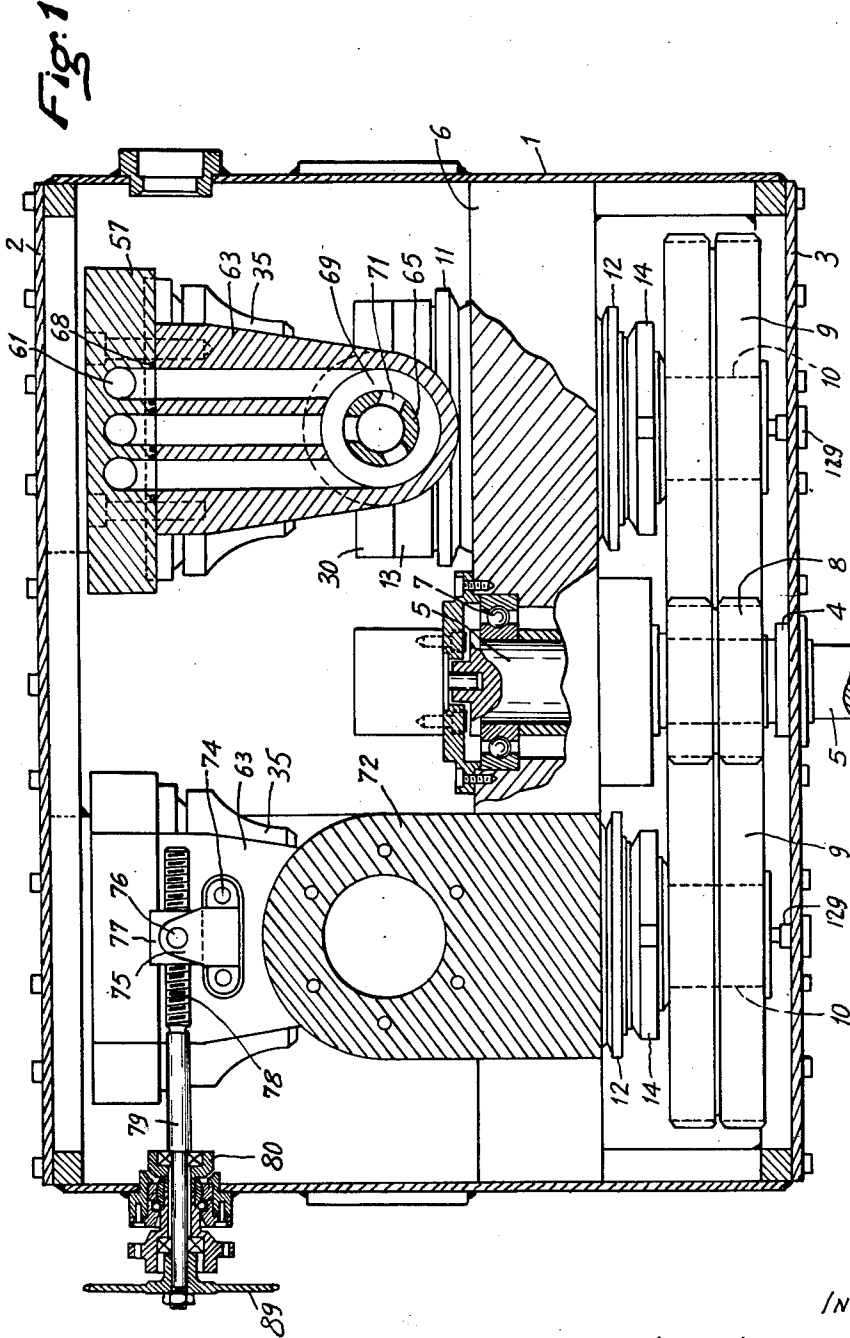
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3,124,079

ROTARY MACHINE OPERATED BY COMPRESSED FLUID

Filed March 30, 1962

6 Sheets-Sheet 1



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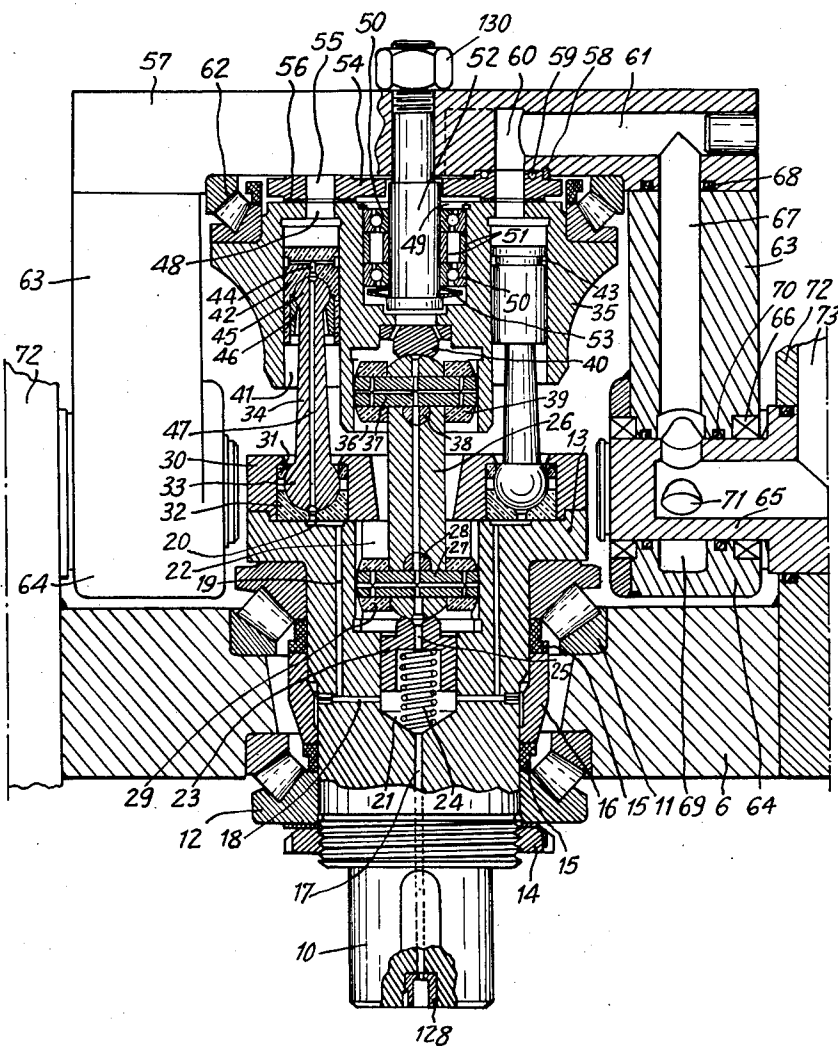
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*Fig. 2*



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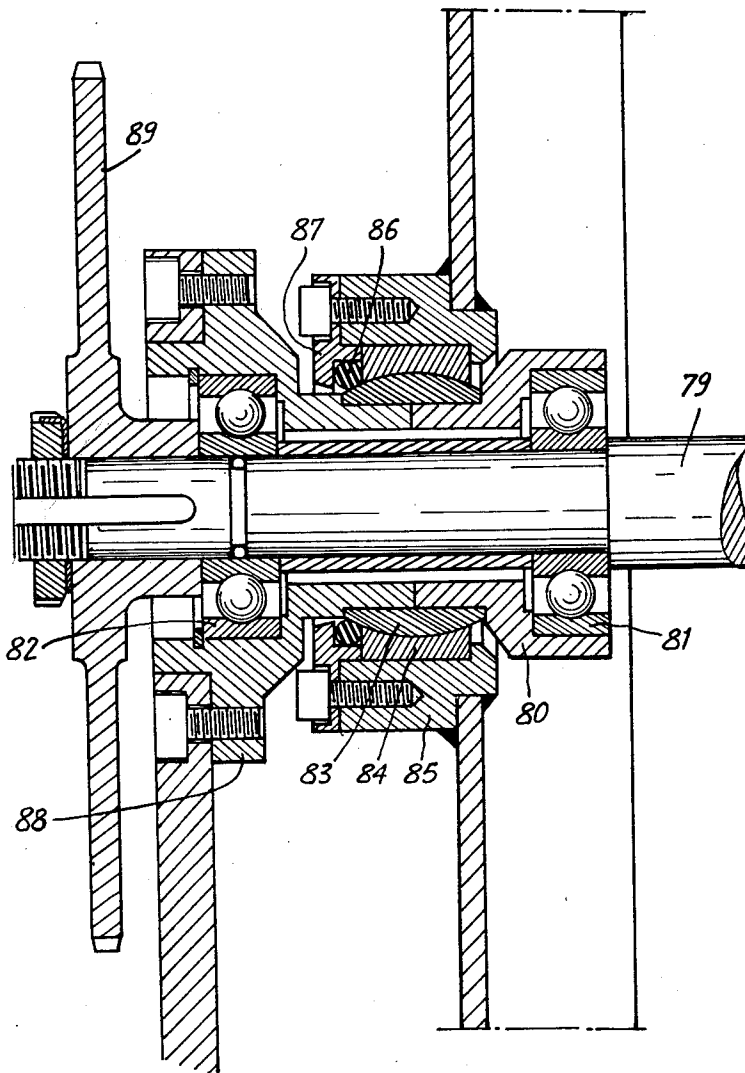
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6 Sheets-Sheet 3

*Fig. 3*



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ROTARY MACHINE OPERATED BY COMPRESSED FLUID

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6 Sheets-Sheet 4

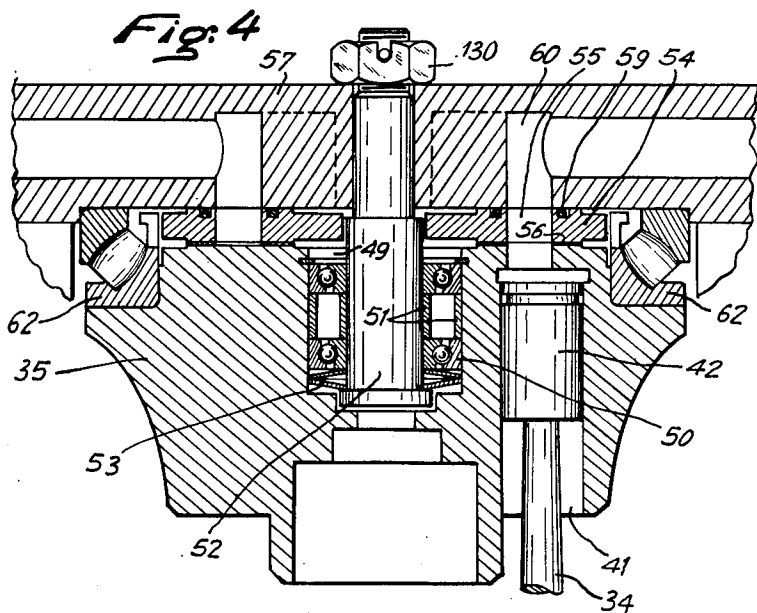


*Fig. 5*

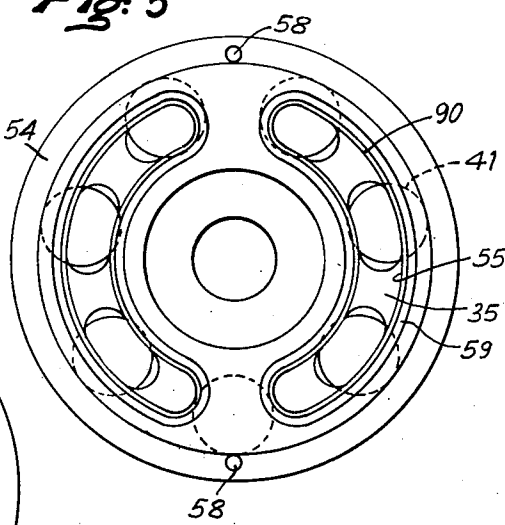
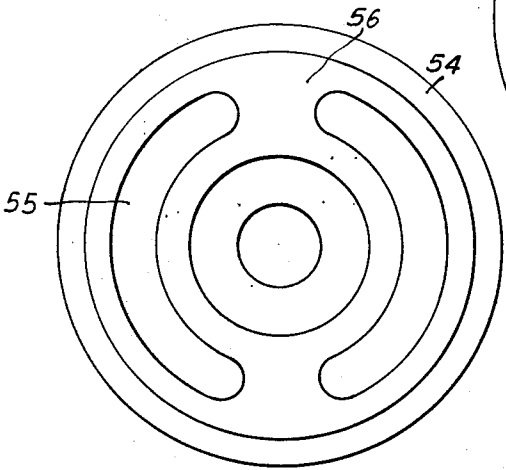


*Fig. 6*



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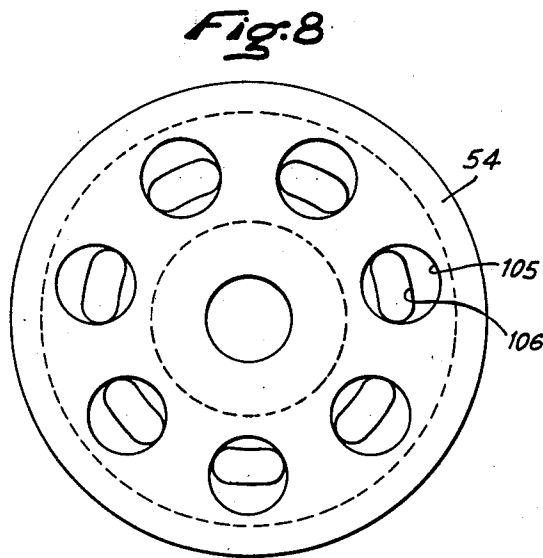
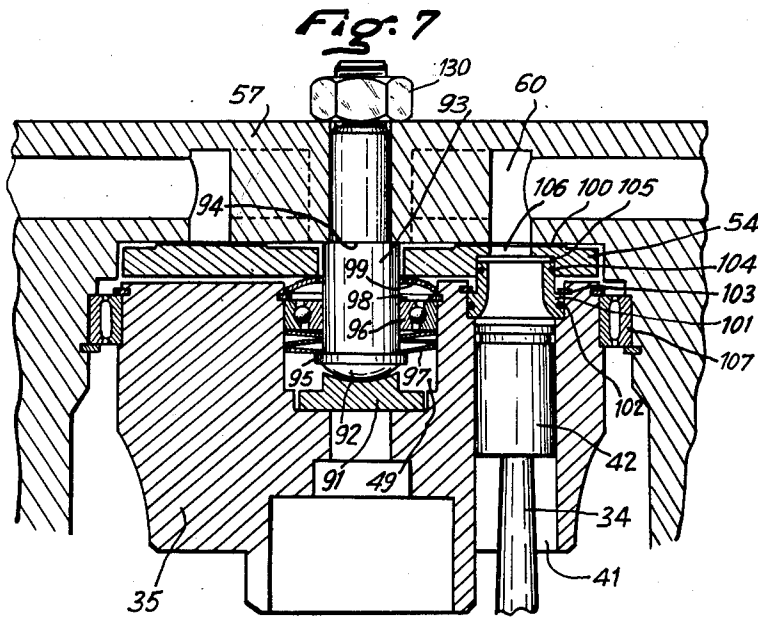
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6 Sheets-Sheet 5



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ROTARY MACHINE OPERATED BY COMPRESSED FLUID

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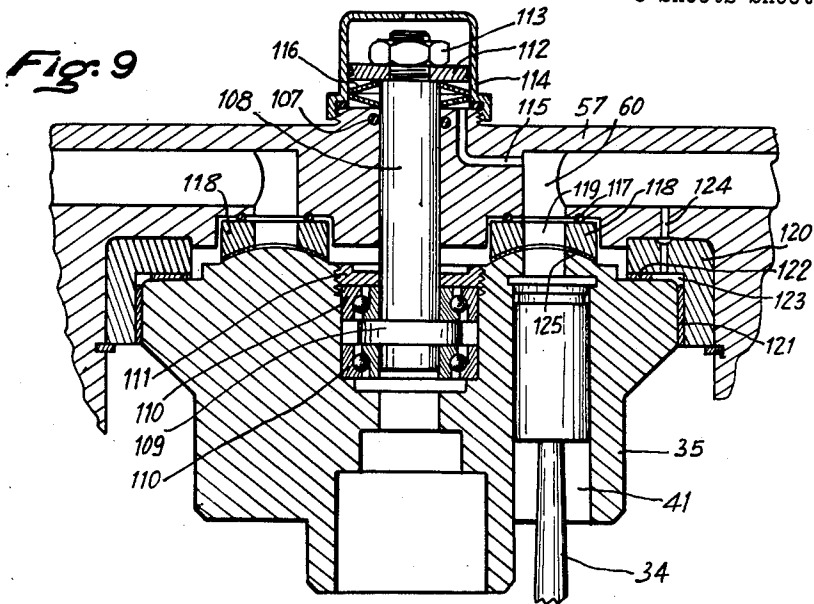
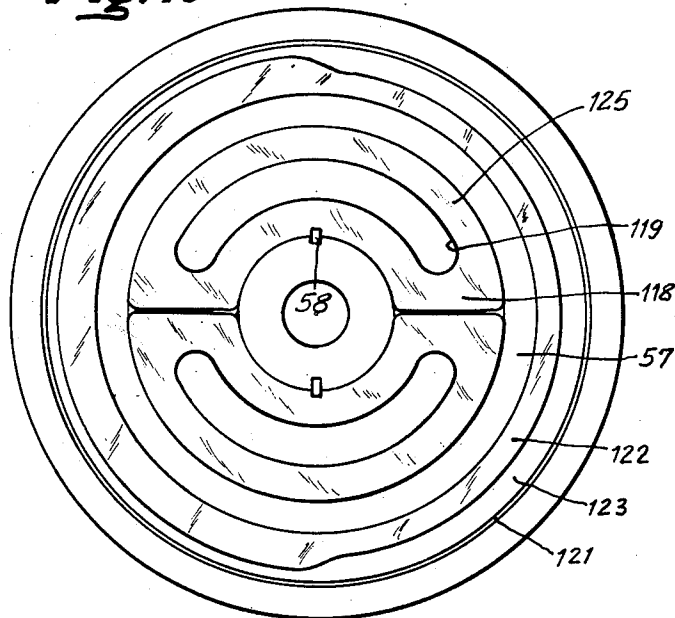


**Fig. 10**



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## ROTARY MACHINE OPERATED BY COMPRESSED FLUID

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Claims priority, application France Apr. 13, 1961

4 Claims. (Cl. 103—162)

The present invention has for its object hydraulic power units and pumps and generally speaking all rotary machines operated by a compressed fluid of the type including inside a fluidtight casing, a drum inside which are provided a plurality of cylinders having parallel axes and of which the pistons are connected by connecting rods provided with ball-and-socket joints at their ends with a plate, said drum and plate being driven into rotation with reference to a distributing cylinder head. Generally speaking, such pumps serve as variable throughput pumps, the throughput of which is adjusted through a modification of the slope of the common axis of the drum and of the cylinder head with reference to the axis of the plate.

For the sake of simplicity, the rotary machines of the type mentioned will be termed "pumps" hereinafter, the expression "pumps" being intended to cover all hydraulic power units and pumps in the following disclosure. Also, the various ball-and-socket joints employed in the pump according to this invention will be termed "rotulas" or "rotula joints" for convenience. Certain difficulties arise in the fabrication of such machines, especially when it is desired to obtain pumps operating under high and very high pressures. These difficulties are due to the important leaks which may appear, chiefly between the bearing surface of the drum and the port-face on the cylinder head. As a matter of fact, said two surfaces should engage each other under a high mechanical pressure and during operation, the hydraulic pressure is applied dissymmetrically, which has a tendency to deform said port-face.

Hitherto, leaks between the drum and the cylinder head were allowed and in such a case, the contacting surfaces were given a shape designed so as to produce a fluid bearing. It has also been proposed to transfer the axial thrusts directly through ball bearings or the like fitted between the drum and the cylinder head while a gap is left between the cooperating surfaces of said two parts in which gap a packing was positioned. However it is impossible to produce a packing of a sufficiently yielding material, for it to mate the clearance formed by said gap which is mechanically defined and which is sufficiently rigid for it to resist the highest operative pressures.

Furthermore, in the case of very high pressures, it is a difficult matter to ensure fluidtightness of the pistons in the cylinders and a lubrication of the rotula joints on the connecting rods, since the thrusts exerted on said rotula joints are very high. Lastly the adjustment of the slope of the drum axis and of the cylinder head with reference to the plate should be very accurate since any modification, even of a very reduced importance, leads by reason of the high pressures involved, to a substantial modification in power.

An object of the present invention is to provide a pump which avoids the aforementioned drawbacks and to provide a pump or power unit operating satisfactorily with compressed fluid under very high pressures with a high yield.

The arrangement controlled by compressed fluid, whether a hydraulic power unit or a pump, according to the invention, includes a thrust bearing between the

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drum and the cylinder head, packing-carrying elements fitted floatingly between the cylinder head and the drum, pistons having thin-walled piston skirts, means to urge the floating packing-carrying element against the surface with reference to which it moves, and the skirts of the pistons against the cylinder walls with a force which is governed by the high operative pressure of the arrangement, means ensuring the lubrication of the rotula joints of the connecting rods under a pressure which is also governed by said high pressure and means adjusting the relative slope between the axes of the drum and of the plate through the agency of a screw jack of which the threaded rod passes fluidtightly through the wall of the fluidtight casing as provided by a rotula joint.

According to a further feature of the invention, the fluidtightness between the drum and the cylinder head is ensured by floating packing-carrying elements inserted floatingly between these two parts and adapted to rotate in unison with and to be fitted fluidtightly on one of said parts while they are subjected to a thrust towards the other part, in a manner corresponding to the pressure required for the fluidtight packing, with a view to ensuring fluidtightness between the packing-carrying element or elements and said other part.

According to a still further feature of the invention, the unitary pressure exerted on the frictional packing is adjusted through action on the operative pressure acting on the differential cross-section formed between the surface defined on the packing-carrying element by the stationary fluidtight packing on the one hand and the surface of the port defined by the packing rubbing on the opposite side of the packing-carrying element.

The thrust bearing transmitting the thrusts between the drum and the cylinder head may be a smooth bearing, whether flat or frustoconical or else a tore-shaped or part-spherical sector coated with anti-friction material. It may also be constituted by a fluid bearing subjected to pressure. Said fluid may also be constituted by a fluidtight volume separating the two parts moving with reference to each other and of which the transverse cross-section depends on the difference between the cross-sections of the cylinders and the admission port. The thrust bearing may also be constituted by a peripheral or axial annulus provided with balls, rollers or cylinders. It may also be constituted by an axial ball or a bearing of the step bearing type. Lastly the thrust bearings may be of the hydraulic piston type, the drum or a part rigid with the drum operating as a piston inside a cylinder rigid with the cylinder head, whereas in said cylinder a pressure prevails, which may be the operative pressure or a pressure depending on said operative pressure.

Said different types of bearings may be associated and they may also be opposed by other thrust bearings preventing any axial spacing between the drum and the cylinder heads.

The floating element carrying the packing may be stationary and held against rotation with reference to the cylinder head, but it may also be driven into rotation by the drum. According to a modified embodiment, said element is constituted by a plurality of independent elements and include for instance an independent packing element, that is a sector-shaped element carrying a packing for each cylinder or else for each of the admission and delivery ports.

The movable fluidtight packing inserted frictionally between the floating element and the cooperating surface, whether on the drum or on the cylinder head, is preferably flat, but it may also be given any desired shape of revolution round the axis, say that of a tore, ball or conical-shaped sector.

The fluidtight packing fitted between the floating element and the part cooperating therewith, whether the

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drum or the cylinder head, with which it is driven into rotation, may be fitted between the cooperating surfaces of said floating element and of the cooperating part or again at the periphery of a piston rigid with one of the parts and sliding inside a cylinder rigid with the other part.

The movable packing is subjected to a preliminary stressing by mechanical or hydraulic members subjecting it to pressure and which are pre-stressed and this pre-stressing is associated with the pressure exerted on the differential surface between the axial cross-sections of the areas defined by the stationary packing and the movable packing.

According to a further feature, the frictional packing is constituted by a metallo-organic compound having as a base a metal and polytetrafluorethylene.

According to a still further feature, the lubrication of the connecting rods is ensured during operation under pressure, by the peripheral leak round the piston head which is separated from its skirt by a peripheral groove providing a release in pressure and communicating with the spherical recesses housing the two terminal rotulas of the connecting rod through bores formed in the piston and in the connecting rod itself. The rotula forming the foot of the connecting rod has a diameter larger than that forming the head of the connecting rod, so that the larger surface obtained may compensate for the losses of head in the lubricating circuit.

With such an arrangement, the pressure of the lubricating oil surrounding the rotulas increases when the delivery pressure itself is made higher, the leaks collecting in the oil circuit which is provided with a non return valve.

According to a further feature of the pump according to the invention, the drum and consequently the cylinders are made of steel of a grade having the same expansion coefficient as the bronze forming the pistons.

Furthermore, each rotula forming the head of a connecting rod is held in a hemispherical recess by an annular thrust bearing engaging the comparatively thin sleeve of the piston and held fast by an elastic ring. The oil pressure ensuring the lubrication exerted on the connecting rod head, urges the ring into position and expands the skirt so as to ensure a better fluidtightness for the piston under high pressures.

Lastly the accuracy in the adjustment of the throughput is obtained by adjusting the slope of the drum and of the cylinder head through the agency of a screw jack of which the threaded rod passes through the pump casing, as provided by a rotula, said threaded rod cooperating with a nut pivotally secured to the cylinder head. This eliminates any clearance which would otherwise arise in the case of jacks including a rod stationary with reference to the casing so as to drive the cylinder head through studs sliding in grooves formed in the cylinder head.

Further features of the variable throughput pump according to the invention will appear from the reading of the following description of three embodiments disclosed hereinafter, reference being made to the accompanying drawings wherein:

FIG. 1 is an elevational lateral partially sectional view of the two units forming a double pump,

FIG. 2 is a partial sectional view passing through the pivotal axis of the cylinder head of one of the pump units,

FIG. 3 is a detail cross-section on a larger scale of the fluidtight rotula in the controlling screw jack,

FIG. 4 is an axial cross-sectional view of the portion of the pump, including the drum and the cylinder head in a first embodiment thereof,

FIG. 5 is a front view of the packing-carrying element seen from the cylinder head,

FIG. 6 is a rear view thereof as seen from the drum,

FIG. 7 is a sectional view, corresponding to FIG. 4, of a second embodiment,

FIG. 8 is a view from underneath of the packing-carrying element of FIG. 7,

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FIG. 9 is a sectional view corresponding to FIG. 4 of a third embodiment,

FIG. 10 is a view from underneath of the cylinder head in said third modification, after removal of the drum.

The double pump illustrated in FIG. 1 is enclosed inside a fluidtight casing 1 closed by a cover 2 bolted thereto and by a bottom 3 through which passes the pump driving shaft 5 inside a fluidtight packing 4. A cross-member 6 forming a carrier member for the pumps is housed inside the casing, and the shaft 5 is fitted revolvably within cross-member 6 with the interposition of ball bearing 7. A pinion 8 is keyed to the shaft 5 at a point between the bottom 3 and the cross-member 6, the pinion 8 engaging two pinions 9 driving the two pumps, so as to form a speed reducing gear.

Each pinion 9 is keyed to a stub shaft 10 revolvably carried in the cross-member 6 with the interposition of frustoconical roller bearings 11 and 12. The bearing 11 is urged against a shoulder formed by a plate 13 on the stub shaft while the bearing 12 is urged against a threaded ring 14 screwed over said stub shaft 10. Between said bearings 11 and 12, assembling rings 15 and a sleeve 16 (FIG. 2) ensure the proper positioning of the bearings 11 and 12 with reference to the stub shaft. The lubricating circuit includes an axial bore 17 in the shaft 10, radial bores 18 and further longitudinal bores 19 opening into distributing grooves 20 in the terminal surface of the plate 13. The bore 17 opens into a connection 128 passing through the bottom 3 of the casing inside a rotary connection 129, said connection being provided with a non-return valve and allowing the lubricating pressure to reach, at the start, the desired value. The stub shaft 10 is also provided with a larger axial bore 21 and with a bore 22 having a cross-shaped cross-section. Inside the bore 21, is fitted a piston 23 urged upwardly by a spring 24 while its end forms a thrust member in the shape of a concave spherical cap. Said piston 23 is provided in its turn with an axial bore 25 forming an extension of the above-described lubricating circuit opening into the bore 21 and thus reaching the spherical cap at the end of the piston. Said concave spherical cap engages the spherical end of a shaft 26 carrying two orthogonal spindles 27 and 28, the ends of which carry rollers 29 fitted in the grooves formed by the cross-shaped bore 22, and the whole system forms thus a cardan type assembly.

To the plate 13 is secured a counter-plate 30 provided with an axial passageway for the shaft 26 and with cylindrical recesses arranged radially and distributed angularly, the number of recesses being equal to the number of cylinders of the pump. In each recess of the counter-plate 30 is arranged a thrust ring 31 and a hemispherical bearing 32 enclosing the rotula forming the foot 33 of a connecting rod 34. The hemispherical bearing 32 is provided with a bore opening into the lubricating groove 20 so as to ensure its own lubrication.

The drum of the pump includes a steel body 35 provided with an axial recess 36 the cross-section of which is cross-shaped and is engaged by the upper end of the shaft 26 opposed to the first mentioned end, said upper end carrying two orthogonal spindles 37 and 38 provided with rollers 39 so as to form a second cardan joint ensuring the rotational drive of the barrel 35 starting from the stub shaft 10. The upper end of the shaft 26, having the shape of a spherical cap, engages a correspondingly shaped concave stop 40. The lubrication of these different bearings for the shaft 26 and the rollers is ensured by a system of bores illustrated in FIG. 2, it not being necessary to describe the latter lubricating system in further detail.

In the pump drum 35 there are also formed a suitable number of cylindrical bores 41 inside which slide the bronze pistons 42. The latter are provided with a pressure-releasing groove 43 communicating through radial and longitudinal bores 44 with the hemispherical bearing formed for the rotula 45 on the connecting rod 34. The connecting rod head is held in position by a sleeve 46 en-

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gaging an elastic ring which is not illustrated and which is fitted in a groove of the piston skirt. The hemispherical bearing of the rotula 45 communicates through a longitudinal bore 47 formed in the connecting rod 34 with the hemispherical bearing on the rotula 33 forming the foot of the connecting rod. Each cylinder is provided in its cover with a channel 48 the cross-section of which is substantially in the shape of a flat bean and opens radially into the terminal surface of the drum.

The terminal surface of the drum is bored axially at 49 and, inside said bore, a spindle 52 is revolvably carried with the interposition of ball bearings 50 spaced by rings 51, said spindle 52 being adapted to slide axially inside the races of said ball bearings which are longitudinally locked against movement inside the body of the barrel 35 so as to ensure the compression of the spring washers 53.

The terminal surface of the drum 35 engages a port-face formed on the floating element 54 provided with two annular channels or ports 55 (the shape of ports 55 is best seen in FIGURES 5 and 6) ensuring, in a conventional manner, the distribution of the fluid. According to the invention, a packing 56 made of a compound material having as a base polytetrafluorethylene is fitted between the element 54 and the terminal surface of the drum 35, said packing being rigidly secured to the element 54.

The rear surface of the element 54 is fitted inside the cylinder head 57 and it is held fast against rotation by studs 58. Stationary packings 59 surround the ports in the element 54 and are urged under pressure against the cylinder head. The cylinder head is provided with symmetrical chambers forming a part annular sector 60 registering with the ports in the floating element, said chambers communicating with radial channels 61 opening into diametrically opposed points of the cylinder head.

Between the cylinder head 57 and the drum 35, there is also fitted an annular thrust bearing of a frusto-conical shape provided with rollers 62. The whole arrangement is assembled by a nut 130 screwed over the threaded end of the spindle 52 extending through the cylinder head.

The cylinder head 57 is held fast by two diametrically opposed flanges 63 which are bolted to its lower surface. These two flanges are provided with cylindrical bearings 64 extending substantially in the plane of the rotulas 33 and they are revolvably fitted over trunnions 65 with the interposition of roller bearings 66. Inside said flanges, are provided channels 67 fluidtightly connected through packings 68 with the channels 61 of the cylinder head and round the trunnions 65, the flange 63 is provided with an annular chamber 69 fitted fluidtightly over said trunnion with the interposition of packings 70, inside which open the channels 67 formed in the flanges. The trunnion 65 which is hollow communicates with chamber 69 through radial bores 71. The trunnion 65 is in its turn fitted in and bolted on a flange 72 rigid with the cross-member 6 inside which are formed the suction and delivery ducts 73.

The cylinder head, the floating element and the drum may thus revolve round an axial line defined by the two trunnions 65, and their slope defines the volumetric stroke executed by the pistons, and consequently their throughput. To ensure a slope of a predetermined accurate value, one of the flanges 63 is provided with a plate 74 (FIG. 1) bolted thereon which forms a bracket 75. A tapped core 77 is revolvably carried, between flange 63 and bracket 75, upon the trunnions 76 fitted in the flange and in the bracket. Said tapped core cooperates with a threaded rod 78 formed on a shaft 79 extending through the casing 1 with the interposition of a bearing member 80 inside which said shaft 79 is revolvably carried with the interposition of two ball bearings 81 and 82 (FIG. 3). The bearing member 80 is made of two parts fitted inside a ring 83 forming an annulus, the outer spherical surface of which is fitted in its turn in an associated ring 84 so as to form a rotula for said shaft 79. The ring 84 is fitted

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inside a race 85 welded to the casing inside which it is held by a packing 86 compressed by a bolted flange 87. The bearing member 80 forms outwardly a flange 88 to which is secured another flange carrying an adjusting pump (not illustrated). This adjusting pump drives the toothed plate 89 keyed to the stub shaft 79 through a chain transmission.

The operation of the variable throughout pump described hereinabove is identical with that of conventional pumps of the same type, the slope assumed by the cylinder head 57 and by the drum 35 provided by the rotation round the axis of the trunnions 65 defining the length of stroke of the pistons 42 inside their cylinders 41 and this stroke on the one hand provides a suction through the pipes 73—67 and 61 and the distributing port 55 and on the other hand, a delivery through the port and pipes arranged symmetrically with the first mentioned port and pipes.

The improvement provided by the pump described resides in the load transmitting annulus 62 transferring between the cylinder head 57 and the drum 35, the major fraction of the load to which the washers 53 are subjected, which washers balance the pressure exerted in said chamber 60. The pressure of the floating element 54 on the terminal surface of the barrel 35 is limited to the compression of the packings 59 to which is added the thrust exerted by the delivery pressure on the surface between the edge of the port 55 and the fluid tight line defined by said packings 59. In the case of rotary pumps or power units operating under high pressure, it is necessary to resort for the packing 56, to a special compound material, having as a base anti-friction products such as polytetrafluorethylene. With said packings which provide at the start, a high frictional torque, it is necessary to provide upon stoppage, a sufficiently reduced pressure on the packing. Such packings allow, on the other hand, with unitary pressures on the packing of the magnitude of 35 kgs. per sq. cm., ensuring a fluid tightness under operative pressures reaching up to 1,000 kgs. per sq. cm. and they resist unitary pressures under operation which are of a magnitude of 80 kgs. per sq. cm. and above.

With a packing-carrying element 54 which is rigid and common to the two admission and exhaust ports, and which is subjected to dissymmetrical loads, the total load can be considered as distributed over the two thirds of the total area of the frictional packing. If, for instance, the surface of the frictional packing 56 is equal to 180 sq. cm. in a pump operating under a maximum pressure of 750 kgs. per sq. cm. and with a maximum unitary pressure on the packing 56 equal to 35 kgs. per sq. cm., and a pressure at the start of 5 kgs. per sq. cm., the differential cross-section between the edge of the port and the packing 59 will be equal to

$$\frac{180 \times 2 \times (35 - 5)}{3 \times 750} = 4.8 \text{ sq. cm.}$$

Said differential cross-section 90 (FIG. 5) is estimated with a stationary packing 59 deformed by a maximum operative pressure.

The leaks being thus reduced to zero between the drum and the cylinder head, those leaks which might occur along the piston, are reduced by reason of the lubricating counter-pressure prevailing in the groove 43 and said counter-pressure is, by reason of the collection of the leaks, substantially equal to the delivery pressure. The high lubricating pressure urges an oil film under high pressure into the bearings of the rotulas 45 and 33 and by reason of the areas of said bearings, the rotulas revolve over an oil film and furthermore the rotula 45 engaging under said pressure against the ring 46 expands the comparatively thin skirt of the piston, which leads to a reduction in the leaks when the delivery pressure increases. Lastly, an accurate adjustment of the throughput is obtained by reason of the presence of the rocking screw jack 77—78.

In the embodiment illustrated in FIGS. 7 and 8, the pump includes, as precedingly, a drum 35, a cylinder head 57 and a floating element 54 carrying the packings. The axial thrusts exerted between the drum 35 and the cylinder head 57 are transmitted by a step bearing 91 housed in the axial bore 49 of the drum and cooperating with a spherical cap 92 provided at the end of the assembling spindle 93 carrying a stop 94 engaging the lower surface of the cylinder head and a threaded end is provided thereon for the screwing of an assembling nut 130. In the vicinity of the end shaped as a spherical cap, the spindle 93 is provided with a collar 95 engaged by a stack of spring washers 97 which, through the agency of a centering ball-bearing 96 slidably fitted on said spindle 93, exerts an axial thrust at the start which urges the drum towards the cylinder head. The elastic ring 98 which holds in position the roller bearing 96 engages a spring washer 99 which urges the floating element 54 towards the cylinder head 57, said floating element engaging said cylinder head through the movable frictional packing 100.

The bottom of the cylinders 41 is constituted by an inserted member 101 of which the cylindrical base is fitted inside a bore of an increased diameter with the interposition of a fluid tight packing 102 and a stop ring 103. The upper end of said member 101 is cylindrical and engages with the interposition of a fluid tight packing 104, a bore 105 formed in the floating element 54 and closing the cylinder; the bore 105 opens into the surface of said floating element 54, carrying the packing 100, through the shaped distributing ports 106.

The drum 35 is lastly held in its centered position inside the cylinder head through the agency of a needle bearing 107.

In such an assembly, the axial thrusts are as follows:

The drum 35 and the cylinder head 57 are urged towards each other by the spring washers 97, but the drum is furthermore subjected to an axial thrust equal to the difference between the cross-sections of the cylinder 41 and of the cylinder 105 and to a thrust exerted by the spring washer 99, which produces generally an increased axial thrust towards the cylinder head. Said thrusts are absorbed by the step bearing 91 and its pivot 92—93.

The floating element 54 is urged towards the cylinder head by the thrust exerted by the spring washer 99 and by the operative pressure exerted in the cylinders 105, but it is urged back by the operative pressure exerted on the surface of the port through the chamber 60 in the cylinder head. The resultant constitutes a force providing the unitary pressure exerted on the frictional packing. The different shapes and cross-sections are selected so as to exert on the packing 100, a unitary pressure which increases with the operative pressure so as to ensure, under maximum pressure, the desired unitary pressure on the packing 100.

In the embodiment illustrated in FIGS. 9 and 10, the cylinder head 57 is provided with a bore inside which slides fluidtightly, through the agency of a packing 107, a piston rod 108. The end of said rod which engages the bore in the drum is provided with a collar 109 held fast between two thrust bearings 110 locked in the recess 49 by a threaded ring 111. The other end of the rod 108 carries a piston 112 held fast by a nut 113 and said piston moves inside a cylinder 114 of which the lower chamber is connected through a channel 115 with the chamber 60 subjected to high pressure. A stack of spring washers 116 is also fitted in said chamber round the rod 108 so as to urge the drum towards the cylinder head. The latter is provided with a circular chamber connected with the chambers 60 inside which are housed, with the fluid-tight packings 117, two floating half-elements 118 in which are provided the ports 119. Lastly, at the periphery of the lower surface of the cylinder head, is fitted a bearing ring 120 the cross-section of which is in the shape of an L of which the two inner surfaces are provided with an antifriction lining constituted by the same organo-

metallic material as the frictional packings referred to hereinabove. Between the surfaces of the two linings 121—122 is provided a chamber 123 connected through a channel 124, with the high pressure chamber 60.

The lower surface of the floating half-elements 118 is in the shape of a concave tore-shaped sector and it is fitted with a packing 125 of an organo-metallic compound material. The upper surface of the drum has a corresponding convex shape round the admission ports of the cylinders. The periphery of the upper surface of the drum and its lateral surface are polished so as to cooperate with the linings 121 and 122 and to ensure a perfect guiding of the drum.

Such a pump is designed by reason of the drum engaging the cylinder head under the action of the pressure exerted in the high pressure chamber 60, so as to operate under a pressure applied always on the same side. The thrusts due to a dissymmetrical action of the cylinders subjected to pressure are thus always located on the same side and increase with pressure, and it may be therefore desired to balance their average value by giving the chamber 123 a larger cross-section in the part located on the half circumference corresponding to the part subjected to pressure, by reducing in said area, the breadth of the lining 122.

The embodiments described hereinabove by way of examples may be subjected to various modifications, without widening the scope of the invention as defined in the accompanying claims. Thus in particular the packing 125 shown in FIG. 9 may be in the shape of a spherical cap, the piston and cylinder system 112—114 may operate no longer under tractional efforts, but exert a thrust and bearings of the organo-metallic lining type 121 and 122 may be used with any other type of means urging the drum under pressure against the cylinder head.

What I claim is:

1. A hydraulic rotary machine of the type comprising a cylinder head provided with passageways for an operative fluid, said passageways opening in ports on a flat surface of said cylinder head, a drum adapted to rotate around its axis perpendicular to said flat surface of said cylinder head and provided with a number of cylinders with parallel axes, said cylinders being distributed uniformly around the drum axis and opening in ports provided in a flat surface facing and parallel to the flat surface of the cylinder head, a piston in each cylinder and means to rotate the drum and means to reciprocate said pistons in said cylinders during rotation of the drum, means to urge said drum towards said cylinder head; a thrust bearing inserted between the drum and the cylinder head and spacing the facing flat surfaces provided with ports of said drum and of said cylinder head, a valve plate inserted in the space between the drum and the cylinder head, said valve plate being provided with ports opening on both its opposite surfaces for communication between the ports in the cylinder head and the ports in the drum, a number of ring packing means surrounding the ports in one of the surfaces of said valve plate, a frictional packing on the opposite surface of said valve plate, and means rotatably securing the valve plate with the element cooperating with the ring packing means.

2. A hydraulic rotary machine of the type comprising a cylinder head provided with passageways for an operative fluid, said passageways opening in ports on a flat surface of said cylinder head, a drum adapted to rotate around its axis perpendicular to said flat surface of said cylinder head and provided with a number of cylinders with parallel axes, said cylinders being distributed uniformly around the drum axis and opening in ports provided in a flat surface facing and parallel to the flat surface of the cylinder head, a piston in each cylinder and means to rotate the drum and means to reciprocate said pistons in said cylinders during rotation of the drum, means to urge said drum towards said cylinder head, a thrust bearing inserted between the drum and the cylinder head and spacing the

facing flat surfaces provided with ports of said drum and of said cylinder head, a valve plate inserted in the space between the drum and the cylinder head, said valve plate being provided with ports opening on both its opposite surfaces for communication between the ports in the cylinder head and the ports in the drum, a number of ring packing means surrounding the ports in one of the surfaces of said valve plate, a frictional packing on the opposite surface of said valve plate, and means rotatably securing the valve plate with the element cooperating with the ring packing means, the area defined by the ring packing means being larger than the area defined by the frictional packing on the opposite surface of the valve plate.

3. A hydraulic rotary machine of the type comprising a cylinder head provided with passageways for an operative fluid, said passageways opening in ports on a flat surface of said cylinder head, a drum adapted to rotate around its axis perpendicular to said flat surface of said cylinder head and provided with a number of cylinders with parallel axes, said cylinders being distributed uniformly around the drum axis and opening in ports provided in a flat surface facing and parallel to the flat surface of the cylinder head, a piston in each cylinder and means to rotate the drum and means to reciprocate said pistons in said cylinders during rotation of the drum, means to urge said drum towards said cylinder head, a thrust bearing inserted between the drum and the cylinder head and spacing the facing flat surfaces provided with ports of said drum and of said cylinder head, a valve plate inserted in the space between the drum and the cylinder head, said valve plate being provided with ports opening on both its opposite surfaces for communication between the ports in the cylinder head and the ports in the drum, a number of ring packing means surrounding the ports in the surface of said valve plate facing the cylinder head, a frictional packing on the surface of said valve plate facing the drum, and means for securing the valve plate, against rotation, to the cylinder head.

4. A hydraulic rotary machine of the type comprising a cylinder head member provided with passageways for an operative fluid, said passageways opening in ports on a flat surface of said cylinder head member, a drum member arranged to rotate around its axis perpendicular to said flat surface of said cylinder head member and provided

with a number of cylinders with parallel axes, said cylinders being distributed uniformly around the axis of the drum member and opening in ports provided in a flat surface facing and parallel to the flat surface of the cylinder head member, a piston in each cylinder and means to rotate the drum member and means to reciprocate said pistons in said cylinders during rotation of the drum member, means to urge said drum member towards said cylinder head member; a thrust bearing inserted between the drum member and the cylinder head member and spacing the facing flat surfaces provided with ports of said members, a valve plate inserted in the space between the drum member and the cylinder head member, said valve plate being provided with ports opening on both its opposite surfaces for communication between the ports in the cylinder head member and the ports in the drum member, a number of ring packing means surrounding the ports in one of the surfaces of said valve plate, a frictional packing on the opposite surface of said valve plate, and means for coupling the valve plate with the member disposed adjacent to said one surface of the valve plate.

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