May 21, 1935. H. CENTERVALL 2,001,706

VARIABLE CAPACITY PUMP

Filed April 28, 1932 2 Sheets-Sheet 1

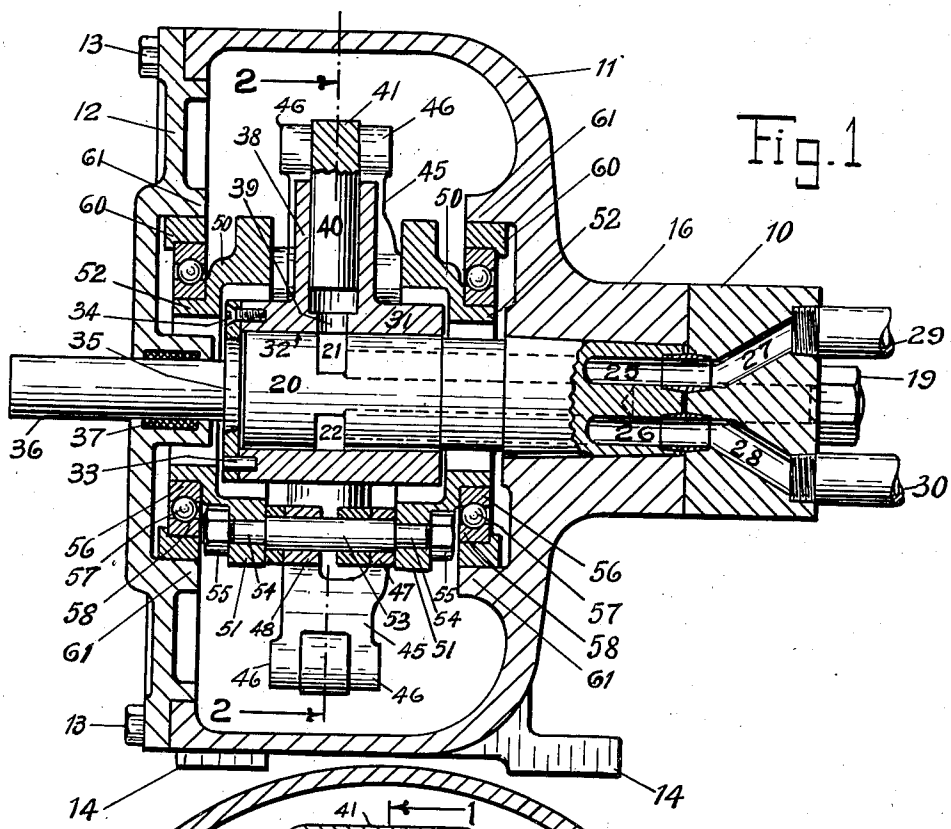


Fig. 1

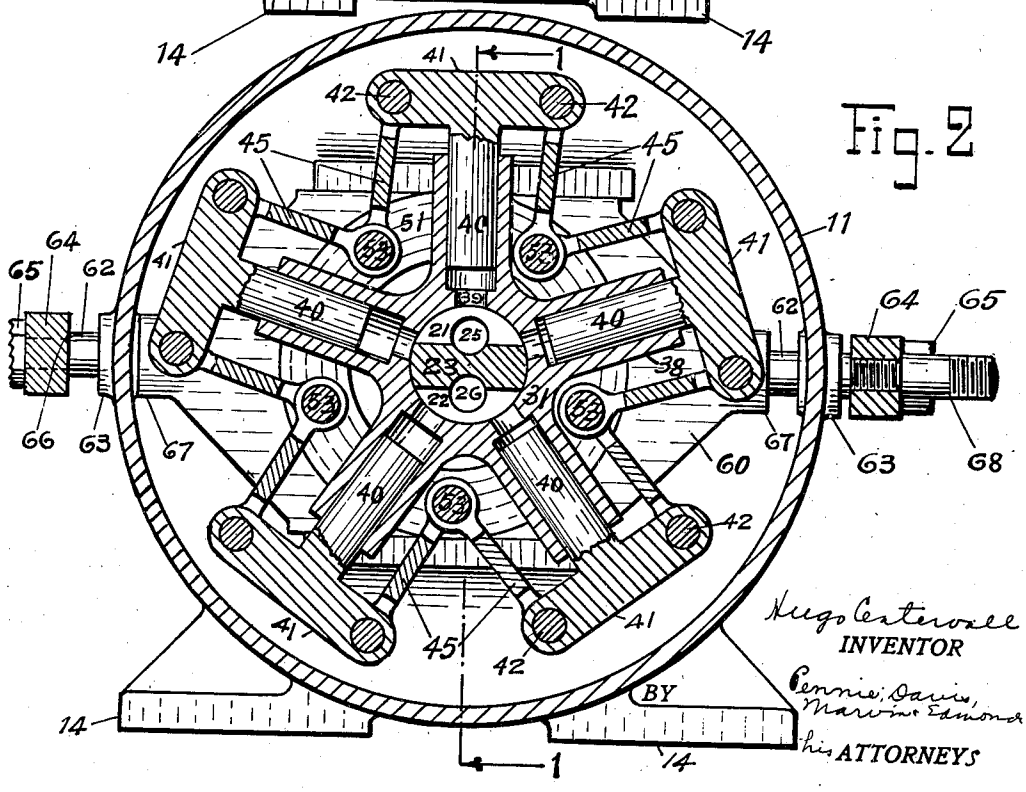


Fig. 2

Hugo Centervall
INVENTOR

Dennis, Davis, Marvin & Edmonds
his ATTORNEYS

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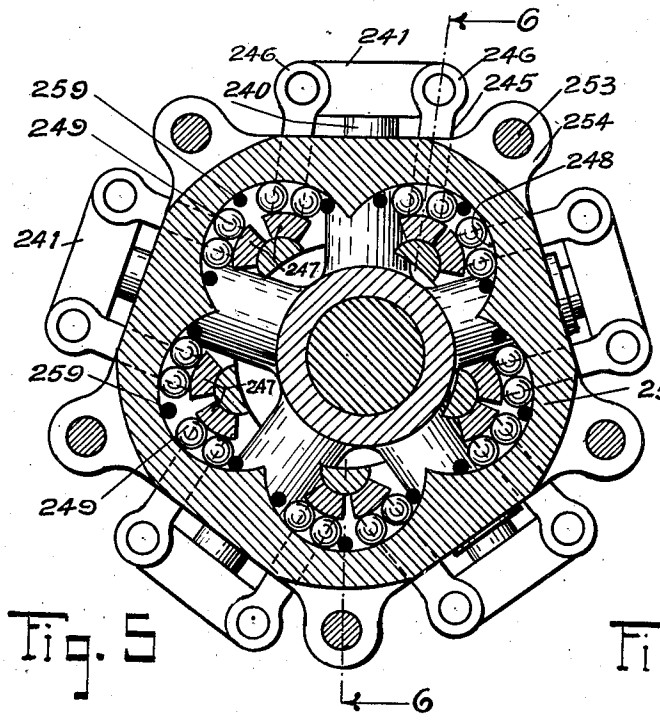



Fig. 5

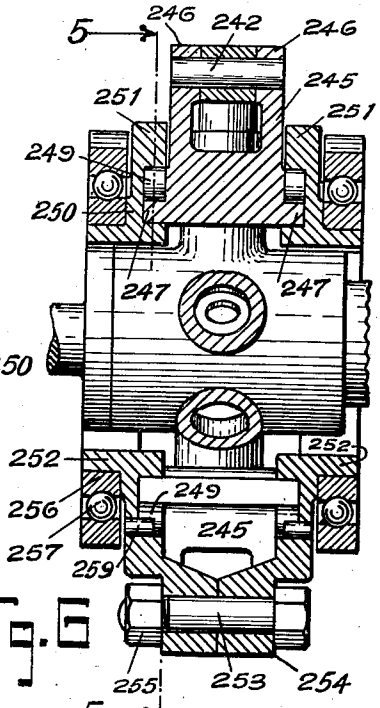



Fig. 6

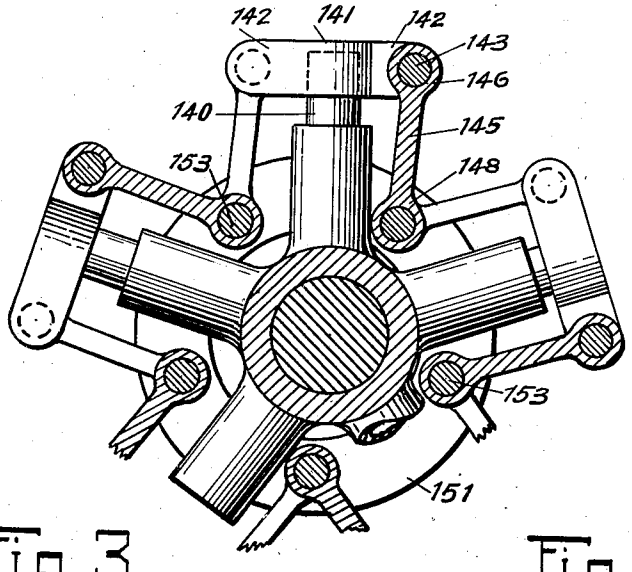



Fig. 3

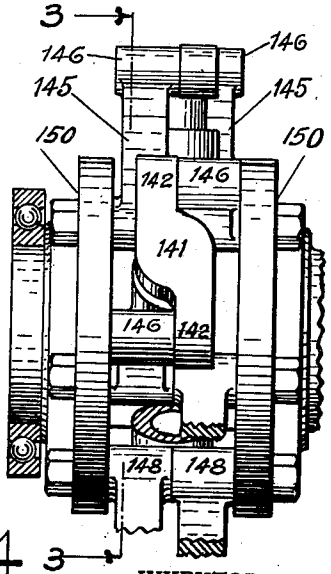



Fig. 4

INVENTOR
Hugo Centervall
BY
Pennie, Davis, Marvin & Edmonds
his ATTORNEYS

Patented May 21, 1935

2,001,706

# UNITED STATES PATENT OFFICE

2,001,706

## VARIABLE CAPACITY PUMP

Hugo Centervall, Brooklyn, N. Y., assignor to Manly Corporation, New York, N. Y., a corporation of Delaware

Application April 28, 1932, Serial No. 607,927

17 Claims. (Cl. 103—161)

This invention relates to improvements in pumps and fluid motors having rotating radial cylinders and a non-rotatable central cylindrical valve member.

One of the objects of the invention is to provide a pump or motor of this class that is simple, compact and relatively inexpensive to manufacture.

Another and more specific object is to provide a pump or motor of this class in which the pistons are at all times maintained substantially parallel with the bores of their corresponding cylinders.

The pump or motor selected for illustration is of the variable capacity type such as used in hydraulic transmissions for obtaining variable speeds and torques, but the structure may be used with like advantages in pumps and motors of fixed capacity.

In the drawings

Figure 1 is a central longitudinal view, partly in section, of a pump or motor constructed according to the present invention and taken along the line 1—1 of Fig. 2;

Fig. 2 is a cross sectional view of the device along the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary transverse view, partly in section, showing an alternative embodiment of the links and cross heads and taken along the line 3—3 of Fig. 4;

Fig. 4 is a corresponding longitudinal side view of the device shown in Fig. 3;

Fig. 5 is a transverse view, partly in section, of a second alternative embodiment of the links, cross heads and associated mechanism, taken along the line 5—5 of Fig. 6; and

Fig. 6 is a corresponding longitudinal view, partly in section, of the device as shown in Fig. 5 and taken along the line 6—6 of Fig. 5

Before explaining the present invention, it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts described herein and illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced and carried out in various ways. It is also to be understood that the phraseology or terminology used herein is for the purpose of description and not for limitation, and it is not intended to limit the invention beyond the terms of the several claims hereto appended as considered in view of the prior art and the requirements thereof.

Referring now to the drawings, the enclosing casing is preferably formed in two portions and as here shown comprises a rear member 11 to which is attached a front member 12, the two members being held rigidly together by bolts 13. The enclosing casing forms the support for the device and the member 11 is accordingly provided with feet 14.

The rear member 11 is formed with a hub 16 whose preferably tapered bore is adapted to receive the end of the stationary cylindrical valve member 20 which is keyed against rotation as by a cap screw, not shown, in said hub 16. The valve member 20 is held in place lengthwise of the hub 16 by nuts 19 on the threaded outer ends of studs, indicated in dotted lines, which pass through suitable openings in the rear cover plate 10 and whose inner ends are secured in the valve member 20.

The valve member 20 is provided with the usual valve ports 21 and 22 which are separated by a transverse land 23. Longitudinal passages 25 and 26 lead from the valve ports 21 and 22 respectively and extend through the rear end of the valve member 20. The rear cover plate 10 is likewise formed with two passages 27 and 28 adapted to register with the passages 25 and 26, respectively, and to the outer ends of said passages 27 and 28 are attached appropriate pipe connections 29 and 30, respectively.

The cylinder body 31 is rotatably mounted upon the valve member 20 and for this purpose is provided with a central bore 32, the fit of the parts being such as to permit the cylinder body 31 to rotate freely while forming a substantially fluid-tight running joint. To the cylinder body 31 is attached by pins 33 and cap screws 34 a flange 35 on one end of the revoluble shaft 36 which passes through a suitable opening in the front casing member 12, suitable packing 37 being used to prevent leakage. The cylinder body 31 is provided with a plurality of radially disposed cylinders 38 having ports 39 on their inner ends adapted to register with the valve ports 21 and 22, said ports 39 being preferably less in area than the area of the cylinders 38.

Slidable within the cylinders 38 are pistons 40, here shown as formed integrally with the cross heads 41. Each cross head 41 is bored on each of its ends to receive pins 42, held in place by any preferred means, not shown, by which said cross head is rockably attached to one end of link members 45. The link members 45 are here shown as having forked outer ends provided with hubs 46 positioned on each side of the cross head 41 and which are adapted to receive the pins 42.

The inner ends of the link members 45 are like-

wise forked and are formed with two hubs 47 and 48 of unequal width and slightly offset with respect to the hubs 46. The arrangement is such that when the links 45 on opposing ends of adjacent cross heads are turned at 180° to each other, the forked inner end of one of said links 45 will fit within the other, as clearly shown in Fig. 1. This construction permits the use of identical links throughout while allowing the inner ends of said links 45 on opposing ends of adjacent cross heads 41 to be journaled upon a common supporting pin 53 to be described later.

There is also provided a pair of oppositely positioned disks 50 formed with offset annular flanges 51 and with hollow hubs 52. The hubs 52 surround the shaft 36 and the valve member 20 respectively and are received within the inner races 56 of a pair of bearing assemblies 57. The disks 50 are rigidly connected by the pins 53 which, as already explained, also carry the inner ends of two adjacent links 45 which are located between the opposing faces of the flanges 51. Each pin 53 is formed near its outer ends with reduced portions 54 which pass through suitable holes in the flanges 51. The ends of the pins 53 are threaded to receive the nuts 55 which hold the inner faces of the flanges 51 against the shoulders formed by the reduced portions 54.

Each bearing assembly 57 is carried by a laterally movable slide 60 which is formed to receive the outer race 58. Each slide 60 is supported upon a pair of parallel transverse slideways 61, one such pair of slideways being formed in the inner side of the casing member 12 and another such pair being formed in the opposing inner side of the casing member 11. The slides 60 are fastened together in order to assure uniformity of their movement and position and for this purpose each slide 60 is provided on both its ends with guide studs 62 which project through suitable openings in bosses 63 formed on the side walls of the casing member 11. The outer ends of the guide studs 62 pass through holes in the cross heads 64 and are held in place with respect to said cross heads and with respect to each other by nuts 65 in cooperation with shoulders 66 formed on said guide studs 62. The inner surfaces of the bosses 63 form stops for the reduced ends 67 of the slides 60, as shown in Fig. 2. Lateral movement of the slides 60 may be effected by any preferred means, such as an appropriate screw and nut device, not shown, connected to cross head 64 by means of the stud 68.

The position of the disks 50 relative to the center of rotation of the cylinder body 31 determines the length of the stroke of the pistons 40 and the direction of flow of the fluid; hence, by movement of the slides 60 the stroke of the pistons 40 may be infinitely varied at will from zero (when the slides 60 are in their middle position and the centers of the disks 50 are coincident with the axis of rotation of the cylinder body 31) to maximum (when the slides 60 are in their extreme outward positions). The direction of flow of the fluid may obviously be reversed by moving the slides 60 from one side to the other of their middle or zero stroke position.

When fixed stroke of the pistons is desired, it will be obvious that the bearing assemblies 57 may be carried upon any suitable non-movable supports, such as annular recesses formed in the casing member 12 and in the rear wall of the casing member 11 and adapted to receive the outer races 58.

From the foregoing the operation of the device will be clear to those skilled in the art. It will be evident that as the pistons 40 reciprocate, the links 45 are free to rock on both their inner and outer ends. As the links 45 are of equal length, each cross head 41 will at all times be maintained parallel to the centers of the corresponding pins 53, thus producing a movement of each piston 40 parallel to its corresponding cylinder 38. There will be only a relatively small angular movement of the links 45 with respect to the pins 53 and the cross heads 41 (or the pins 42) and such angular movement is equivalent to a very small relative linear movement of the parts. It will further be evident that the motion of the disks 50 is constrained with respect to the movement of the cylinder body 31.

The above described construction presents several advantages over pumps and motors of this general type as previously constructed. Parallel link connections between the cross head of the pistons and the eccentrically supported disks 50 insure a radial reciprocation of the pistons in the cylinders without imposing on the pistons any tendency to bind in the cylinders, thereby relieving the pistons of any lateral wear. The rocking motion of the links is small and consequently the rate of angular motion about the bearings at the ends of the links is slow, thereby avoiding undue friction loss.

All of the parts are of simple design and are interchangeable. The pump is easy to assemble and when the bearings of the links have become worn the pump may be readily taken down and the worn parts replaced at small expense. As the cylinders are of tubular cross section throughout they may be readily made of sections of steel tubing threaded or otherwise secured in the central hub, no external machining being required. By connecting the pistons to the eccentric disk with the inwardly extending links the size of the disks, the bearing assembly is considerably reduced, the bore of the disk being just sufficiently larger than the hub of the cylinder member to afford the desired eccentricity.

Figs. 3 and 4 show an alternative embodiment of the links and cross heads. In this modification the links 145 are formed with a single hub 146 upon their outer ends and a single hub 148 upon their inner ends, the hubs 146 and 148 being substantially the same with and substantially in line with each other. The cross head 141 is likewise modified to comprise two oppositely offset ends 142, each having a face substantially in line with the center of the cross head member 141 as clearly shown in Fig. 4. The pistons 140, here shown as secured to the cross heads 141 by a pressed fit, are positioned centrally with respect to the center of the cross head 141. The hubs 146 on the outer ends of the links 145 are rockably attached to the cross heads 141 by pins 143 projecting from the faces of said cross heads that are substantially in line with their centers. As in the first embodiment, the hubs 148 on the inner ends of the links 145 depending from opposing ends of adjacent cross heads 141 are positioned between the opposing faces of the flanges 151 of the disks 150 and are rockably supported upon a common pin 153.

This modification of the pump presents the same advantages as the previously described structure, but is of somewhat cheaper design and simpler construction.

Figs. 5 and 6 show a second alternative embodiment of the link members and associated parts. In this instance the outer ends of the links 245

are forked and are formed with a pair of hubs **246** bored to receive the pins **242** by which they are rockably connected with the cross heads **241**. The pistons **240** are here shown as formed integrally with the cross heads **241**. The inner ends of the links **245** are formed with a pair of outwardly extending segmental feet **247** which are received within circular trackways **248** recessed within the opposing faces of the flanges **251** of the disks **250**. Rollers **249** are inserted between the outer faces of the feet **247** and the outer circumferential surfaces of the trackways **248**, the movement of said rollers **249** being limited by suitable stop pins **259** set in the flanges **251**. The flanges **251** of the disks **250** are also provided with offset projecting arms **254** positioned so as not to interfere with the movement of the links **245** and bored to receive the pins **253** upon whose threaded ends are nuts **255**. The two disks **250** are thus rigidly connected. The disks **250** are also formed with hubs **252** which are received within the inner races **256** of the bearing assemblies **257**, said bearing assemblies being movably supported as in the other embodiments.

In operation, as the pistons **240** reciprocate, the hubs **246** on the outer ends of the links **245** will rock on the pins **242** as in the other embodiments and the segmental feet **247** will move within the trackways **248** to permit the links **245** to rock with respect to the disks **250**. It will be evident that whenever the pistons **240** and the cross heads **241** are under load, the pressure will come on the outer faces of the feet **247** and as rollers **249** are interposed between said outer faces of the feet **247** and the outer circumferential surfaces of the trackways **248**, movement of the feet **247** will be translated into rolling motion. The inner faces of the feet **247** and the inner circumferential surfaces of the trackways **248** prevent inward radial movement of the links **245** with respect to the disks **250** and hence the parts are at all times kept in proper relation to each other. Obviously rollers may also be placed between the inner faces of the feet **247** and the inner circumferential surfaces of the trackways **248** if desired, or all rollers may be omitted and plain bearings employed for either or both inner and outer faces of said feet **247**. It will also be evident that detachable hardened liners may be employed on the trackways **248**.

By this construction the inner ends of the links are brought closer to the center of rotation and anti-friction bearings may be substituted for the plain bearings at the free ends of the links. The entire pump construction is also more compact, the bearing centers being brought closer together and the two eccentric disks can be fastened directly together by the bolts extending between the cylinders, forming in effect a single rugged piece adapted to withstand heavy loads without distortion.

It is to be understood throughout that the usual fluid-tight packings are employed wherever required.

I claim:

1. In a structure of the class described, the combination of a rotary cylinder structure having radial cylinders, pistons in said cylinders, a rotary member supported on bearings eccentric to the cylinder structure, and articulated connections between the pistons and said rotary member, said connections comprising links extending inwardly from the outer ends of the pistons to said member, said links having their outer ends connected to their respective pistons at points offset from the axes of the pistons circumferentially of the cylinder structure and positioned exteriorly with respect to the bore of the corresponding cylinder.

2. In a structure of the class described, the combination of a rotary cylinder structure having radial cylinders, pistons in said cylinders, a rotary member supported on bearings eccentric to the cylinder structure, and articulated connections between the pistons and said rotary member, said connections comprising parallel links on each side of each of said pistons and between adjacent pistons, said links being pivotally connected to said pistons and said member.

3. In a structure of the class described, the combination of a rotary cylinder structure having radial cylinders, pistons in said cylinders, a rotary member supported on bearings eccentric to the cylinder structure, and articulated connections between the pistons and said rotary member, said connections comprising a cross head at the end of each piston and extending circumferentially of the cylinder structure, and links at the ends of each cross head extending inwardly to said rotary member.

4. In a structure of the class described, the combination of a rotary cylinder structure having radial cylinders, pistons in said cylinders, rotary members supported eccentrically to said cylinder structure on opposite sides of said radial cylinders, connections between said members extending axially between said cylinders, and articulated connections between said pistons and the connections between said members.

5. In a structure of the class described, the combination of a rotary cylinder structure having radial cylinders, pistons in said cylinders, rotary members supported eccentrically to said cylinder structure on opposite sides of said radial cylinders, bolts connecting said rotary members and extending axially between said cylinders, and links mounted at one end on said bolts and at the other end attached to said pistons.

6. In a structure of the class described, the combination of a rotary cylinder structure having radially extending cylinders, pistons in said cylinders, cross heads on the ends of said pistons, links at the ends of said cross heads extending inwardly, a rotary member on each side of said cylinders, said rotary members being supported eccentrically to said cylinder structure, bolts extending between said cylinders and connecting said rotary members, said bolts constituting pivotal bearings for the inner ends of said links.

7. In a structure of the class described, the combination of a rotary cylinder structure having radially extending cylinders, pistons in said cylinders, cross heads on the ends of said pistons extending in the plane of rotation, links at the ends of said cross heads extending inwardly, a rotary member on each side of said cylinders, said rotary members being supported eccentrically to said cylinder structure, said links having bearing shoulders formed on the inner ends, flanges on said rotary members overlying said bearing shoulders and with bearing surfaces formed thereon for co-action with the bearing shoulders on said links.

8. In a structure of the class described, the combination of a rotary cylinder structure having radical cylinders angularly disposed with respect to each other, pistons in said cylinders, a rotary member supported on bearings eccentric to the cylinder structure, and articulated connections between each piston and said rotary mem-

ber, said connections comprising links extending inwardly from the outer end of the piston to said member, said links having their outer ends connected to the piston at points offset from the piston axis in the plane of rotation of said cylinder structure and positioned exteriorly with respect to the bore of the corresponding cylinder.

9. In a structure of the class described, the combination of a rotary cylinder structure having radial cylinders provided with inlet and outlet ports on their ends nearest the center of rotation, pistons in said cylinders, a rotary member supported on bearings eccentric to the cylinder structure, and articulated connections between each piston and said rotary member, said connections comprising links extending inwardly from the outer end of the piston to said member, said links having their outer ends connected to the piston at points offset from the piston axis in the plane of rotation of said cylinder structure.

10. In a structure of the class described, the combination of a rotary cylinder structure having radial cylinders, pistons in said cylinders, cross-heads on the outer ends of said pistons, a rotary member supported on bearings eccentric to the cylinder structure, and articulated connections between each piston and said rotary member, said connections comprising links at the ends of each cross head extending inwardly to said rotary member and positioned with respect to each other in a plane substantially transverse the axis of rotation of said cylinder structure.

11. In a structure of the class described, the combination of a rotary cylinder structure having three or more radial cylinders, a piston in each cylinder, a rotary member supported on bearings eccentric to the axis of rotation of said cylinder structure, and articulated connections between each of said pistons and said rotary member, said connections comprising for each piston member a parallelogram formation, movement of said parallelogram formation relative to said rotary member being limited to movement of the members of said parallelogram formation with respect to each other.

12. In a structure of the class described, the combination of a rotary cylinder structure having three or more radial cylinders, a piston in each cylinder, a rotary member supported on bearings eccentric to the axis of rotation of said cylinder structure, and articulated connections between each of said pistons and said rotary member, said connections comprising for each piston member a parallelogram formation positioned substantially transverse the axis of rotation, movement of said parallelogram formation relative to said rotary member being limited to movement of the members of said parallelogram formation with respect to each other.

13. In a structure of the class described, the combination of a rotary cylinder structure having three or more radial cylinders, a piston in each cylinder, a rotary member supported on bearings eccentric to the axis of rotation of said cylinder structure, and articulated connections between each of said pistons and said rotary member, said connections comprising for each piston member a parallelogram formation one of which members has a constant angular relationship with respect to the axis of its corresponding cylinder, movement of said parallelogram formation relative to said rotary member being limited to movement of the members of said parallelogram formation with respect to each other.

14. In a structure of the class described, the combination of a rotary cylinder structure having three or more radial cylinders, a piston in each cylinder, a rotary member supported on bearings eccentric to the axis of rotation of said cylinder structure, and articulated connections between each of said pistons and said rotary members, said connections comprising for each piston member a parallelogram formation one of which members is continuously maintained at substantially right angles to the axis of its corresponding cylinder, movement of said parallelogram formation relative to said rotary member being limited to movement of the members of said parallelogram formation with respect to each other.

15. In a structure of the class described, the combination of a rotary cylinder structure having radial cylinders, a piston in each cylinder, a rotary member supported on bearings eccentric to the axis of rotation of said cylinder structure, a cross-head on each piston extending with its greatest dimensions in a plane substantially transverse the axis of rotation of said cylinder structure and having its ends positioned in a line substantially at right angles to said piston, and articulated connections between said cross head and said rotary member comprising parallel links connected with each end of said cross-head and with said rotary member at points equidistant from said cross head.

16. In a structure of the class described the combination of a rotary cylinder structure having radial cylinders, a piston in each cylinder, a rotary member supported on bearings eccentric to the axis of rotation of said cylinder structure, and articulated connections between each of said pistons and said rotary member, said connections comprising for each piston a pair of links extending inwardly from the outer end of said piston to said rotary member said links being arranged in parallelogram formation in the plane of rotation so as to maintain said piston parallel with the bore of its coacting cylinder.

17. In a structure of the class described the combination of a rotary cylinder structure having radial cylinders, a piston in each cylinder, a rotary member supported on bearings eccentric to the axis of rotation of said cylinder structure, and articulated connections between each of said pistons and said rotary member, said connections comprising for each piston and its coacting cylinder a pair of links of equal length extending inwardly from the outer end of said piston to said rotary member, said links being arranged in parallel relation one on each side of said cylinder and in the common plane passing through the radial center lines of said cylinders thereby maintaining said piston parallel with the bore of its coacting cylinder.

HUGO CENTERVALL.