March 15, 1949. F. BERRY 2,464,481

PLURAL STAGE ROTARY ABUTMENT FLUID POWER DEVICE

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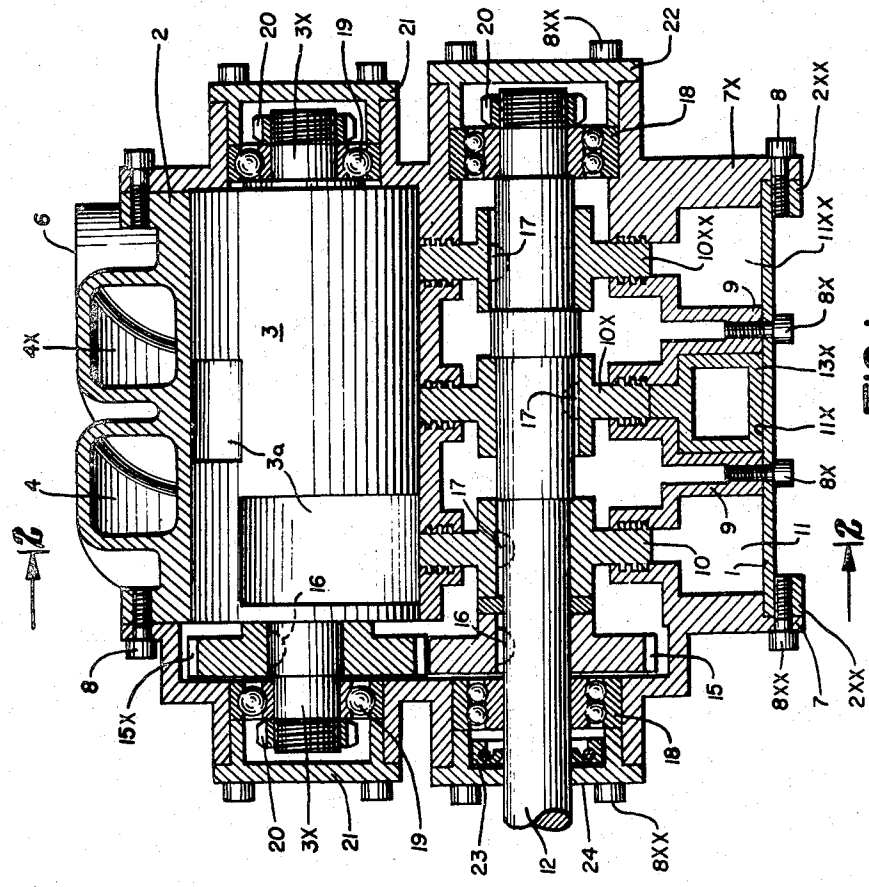


FIG. 1

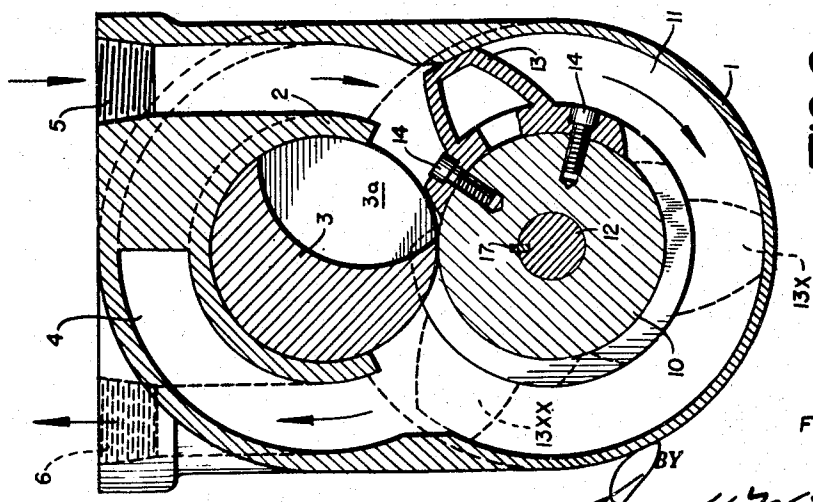


FIG. 2

INVENTOR.
FRANK BERRY

BY Donald W. Robertson

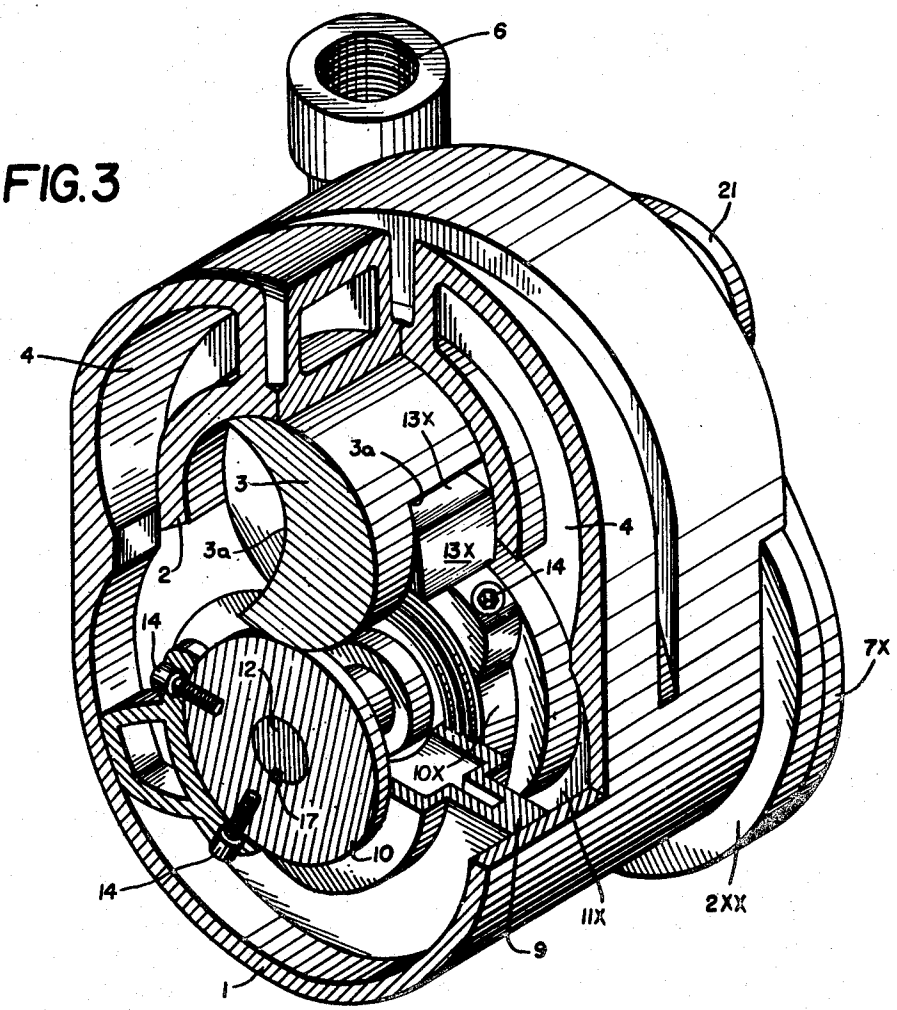
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FIG. 3



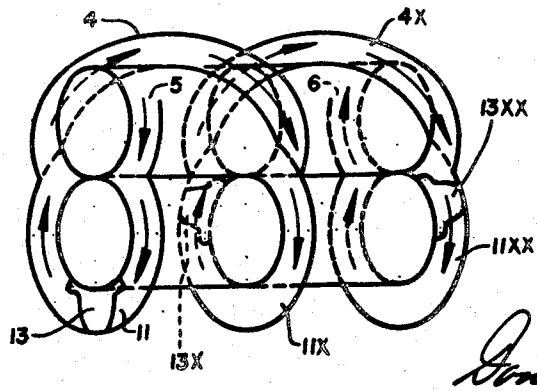


FIG. 1A

INVENTOR.
FRANK BERRY
BY Donald W. Robertson
ATTORNEY

March 15, 1949. F. BERRY 2,464,481

PLURAL STAGE ROTARY ABUTMENT FLUID POWER DEVICE

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FIG. 4

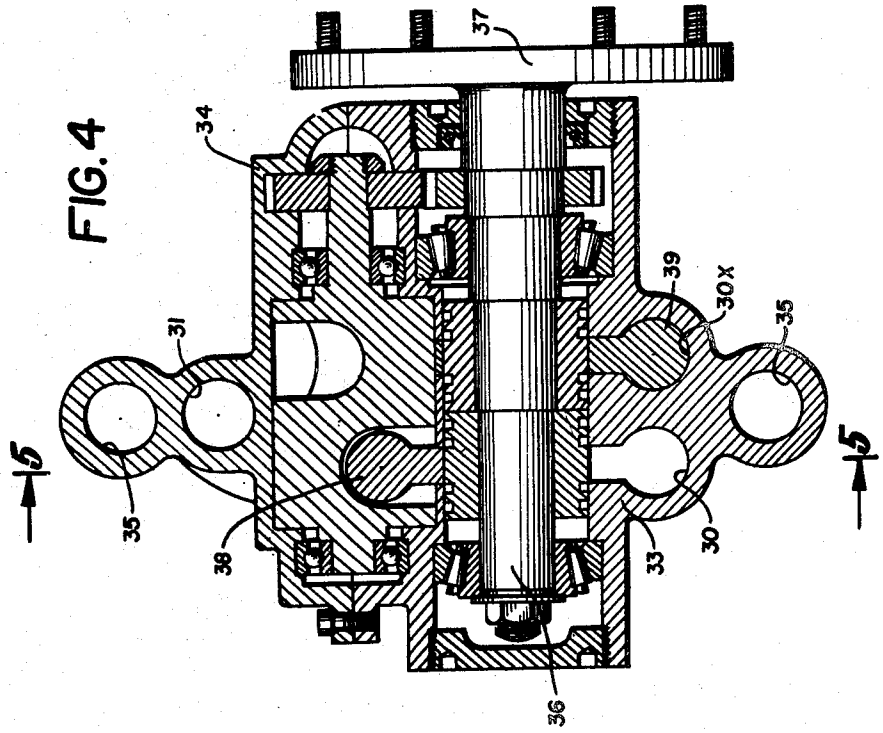
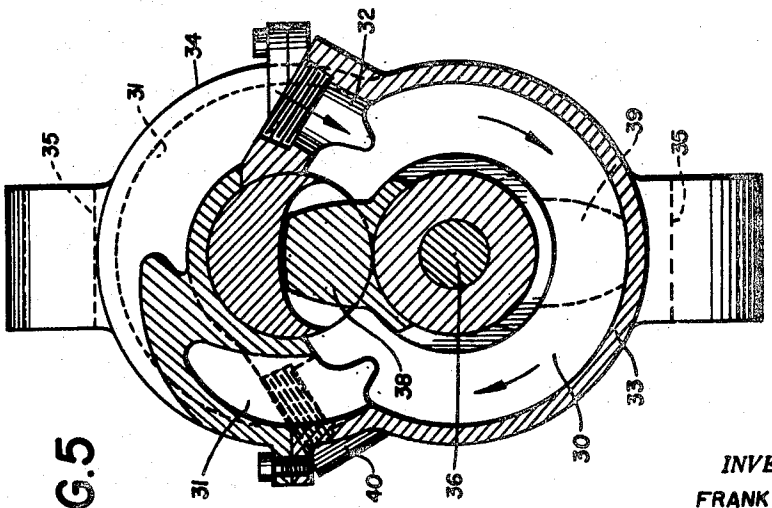


FIG. 5



INVENTOR
FRANK BERRY

BY Donald W. Peterson

ATTORNEY

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PLURAL STAGE ROTARY ABUTMENT FLUID POWER DEVICE

Frank Berry, Corinth, Miss.

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9 Claims. (Cl. 103—125)

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This invention relates to hydraulic power devices, such as hydraulic pumps, hydraulic motors and servo-motors, hydraulic transmissions, power connecters, and controls therefor.

One of the objects of my invention is to provide a hydraulic device serviceable either as a pump or motor having positive displacement action which will as a pump produce a constant fluid flow and will as a motor possess a smooth driving action having no perceptible periods or fluctuations of power delivery. In the case of the hydraulic pump continuous flow is assured by using two or more pistons and cylinders in series with each other and arranging them to coact with the abutment rotors so that a continuous stream of liquid is delivered at all times regardless of the position of pistons or abutment rotors. The operation depends upon the operating cycle wherein one piston is delivering a column of fluid to the discharge at all times.

The fluid motors or power converters are identical to the pumps with the exception of operating in the exact reverse, two or more pistons in combination being required in any case. Where the highest efficiency and smoothest operation are of prime importance and in the event of high operating pressures more cylinders are used. Due to the stream line path of the liquid within all the mechanisms high speeds and efficiencies are obtained. Due to the reversible inherent features of the design the motor will maintain mechanical equilibrium by rotary motion through a variation in pressures of the actuating liquid, thereby constituting a rotary servo-control.

For the attainment of the foregoing and such other objects of invention as may appear or be pointed out herein I have shown several embodiments of my invention in the accompanying drawings, wherein—

Figure 1 is a longitudinal section through a multiple cylinder hydraulic pump or motor in which the cylinders are arranged in series;

Figure 1A is a schematic view of the device of Figure 1 showing the path of the fluid flow therethrough;

Figure 2 is a transverse section taken through one of the cylinders, on the line 2—2, Figure 1;

Figure 3 is a perspective view of the device of Figures 1–2 with one end and a portion of the front casing removed to expose the interior;

Figure 4 is a longitudinal section through a modified form of the invention for driving an automobile wheel, and

Figure 5 is a vertical section on the line 5—5, Figure 4.

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It is understood that the machine will be precisely the same whether used as a fluid pump or as a motor; for convenience, it will be referred to herein as a "fluid motor." Referring especially to Figures 1, 2 and 3, it will be seen that the fluid motor is contained within an outer casing 1 having an interior portion 2. As best shown in Figure 2, interior portion 2 of the casing is provided with a long circular bore within which is rotatively mounted a cylindrical abutment rotor 3. Within interior casing 2 is also provided fluid passageways 4 and 4*x* and inlet 5 and outlet 6, each on opposite sides of the motor, Figure 2. Flanges 2*xx* are provided at the ends of casing 1, Figure 1 for bolting end bearing housings 7 and 7*x*, as by bolts 8.

Secured to the outer casing 1, as by means of bolts 8*x*, Figure 1, and extending radially inwardly are two annularly shaped members 9 which separate the interior of outer casing 1 into three annular cylinders designated from left to right in Figure 1 as 11, 11*x* and 11*xx*. Cylinder separators 9 are irregular cross-section, see Figure 1, having oppositely facing portions between which are disposed the piston rotors 10, 10*x* and 10*xx*, respectively. Also, the left housing 7 has a rightwardly facing portion between which and the leftwardly facing portion of separator 9 is disposed the left piston rotor 10; similarly, the right housing 7*x* has a leftwardly facing portion between which and the rightwardly facing portion of separator 9 is disposed the right piston rotor 10*xx*. The central piston rotor 10*x* is disposed between the oppositely facing portions of the two separators 9. The piston rotors 10, etc., are secured, as by keys 17, to a drive shaft 12 rotatively mounted in anti-friction bearings 18. The right end of drive shaft 12 is provided with a threaded reduced portion and provided with a nut 20 which holds the inner race of the anti-friction bearing 18 securely on drive shaft 12. The outer race is held by an annular flange inwardly projecting from a cover plate 22 which is secured to right bearing housing 7*x* by bolts 8*xx*.

Pistons 13, 13*x* and 13*xx*, which are slidably received in the annular cylinders, respectively 11, 11*x*, and 11*xx*, are fastened to their rotors, respectively, 10, 10*x* and 10*xx* by bolts 14. As clearly shown in Figure 2, the three pistons 13, 13*x* and 13*xx* are spaced 120° apart so that they are equidistant from one another for the purpose of balancing their weight and power distribution.

Piston drive shaft 12 rotates in synchronism with abutment rotor 3 which is common to all

three pistons 13, 13x and 13xx. For this purpose spur gear 15x, Figure 1, is secured, as by key 16, to the left spindle 3x of abutment rotor 3, and meshes with a gear 15 secured, as by key 16, on drive shaft 12. Spindles 3x of abutment rotor 3 are mounted on anti-friction bearings 19, the inner races of which are held in place in the threaded spindles by nuts 20, the outer races being held in place by annular flanges inwardly projecting from cover plates 21 which are bolted to end bearing housings 7 and 7x. The left end of piston drive shaft 12 extends beyond left housing 7 and is provided with an oil seal packing 23 held in place by retainer plate 24.

The common abutment rotor 3 is provided with three arcuate cut-outs or recesses 3a, each of which provides a space in which respective ones of the three pistons 13, 13x, and 13xx clears. The width of the cut-outs 3a is somewhat greater than the width of the pistons 13, etc. The cut-outs 3a are spaced around the abutment rotor at 120° intervals similar to the equidistant spacing of the pistons 13, etc. around the piston rotors 10, etc.

The fluid passageway 4 connects the left annular cylinder 11 with the central annular cylinder 11x, as schematically shown in Figure 1A, while fluid passageway 4x connects central annular cylinder 11x with right annular cylinder 11xx. The piston rotors 10, 10x and 10xx are rotated as a unit by drive shaft 12 in a clockwise direction, as viewed in Figure 1A and shown by the arrows. That is, the pistons move downwardly in the front portion of the annular cylinders, as shown by the three downward arrows, and upwardly in the rear portion of the annular cylinders, as shown by the three upward arrows. The fluid enters, through inlet 5, at the upper end of the front portion of the left annular cylinder 11 and leaves at the upper end of its rear portion, being conducted by fluid passageway 4 to the upper end of the front portion of the central annular cylinder 11x, and from the upper end of its rear portion the other fluid passageway 4x leads to the front portion of the right annular cylinder 11xx. At the upper end of the rear portion of right annular cylinder 11xx is the outlet 6.

Considering first the device used as a fluid motor, the in-flowing fluid drives the first or leftmost piston 13, Figure 1A around in its annular cylinder 11 until the piston reaches and passes through the abutment valve at which time the pressure of the fluid, being blocked by the abutment valve, is transmitted through the first fluid passageway 4 to exert itself against the second or central piston 13x, which is 120° in advance, in a clockwise direction, from first piston 13 and thus in position in advance of the exit point of fluid passageway 4 to be impelled by the fluid flow from the first cylinder 11. Similarly, the second piston 13x is driven by the fluid pressure until it reaches and passes through the abutment valve, at which time the pressure of the fluid is transmitted through the second fluid passageway 4x to exert itself against the third or rightmost piston 13xx, which is 120° in advance of the second piston 13x. The only time a piston is not subjected to the turning pressure of the fluid is when it clears through the abutment valve. Since the three pistons are spaced 120° around the circle, only one piston is passing through the abutment valve at a time; hence there are at all times two pistons exposed to the fluid pressure, thus assuring an even development of power at the shaft. Since the pistons are subjected to a

continuous stream or flow of fluid from the inlet, through the successive annular cylinders and the interconnecting fluid passageways to the outlet, there is a minimum of slippage. If there should be some slippage in the first cylinder, this will be taken up, successively, at the second and third cylinders.

The device acts similarly as a pump, but in reverse. Fluid is drawn in, at inlet 5, by the downward movement of first piston 13 in the front portion of its annular cylinder 11 and at the same time, first piston 13 forces the fluid in the rear portion of annular cylinder upwardly and through first fluid passageway 4 to the second cylinder 11x. Concurrently, second piston 13x acts to draw the fluid through passageway 4 and to force it through the second passageway 4x. At all times a continuous flow of fluid is maintained, regardless of speed of rotation or piston position.

It will be seen that the connecting passages for the terminal openings of adjacent cylinders are formed each by a continuous tubular portion of the casing and which partially encircles the abutment. Each passage extends in a continuous curve of uniform cross sectional area, and the passage connecting the discharge opening of one cylinder with the receiving opening of a succeeding cylinder is so related to the rotor and piston of the latter cylinder that fluid is discharged into the cylinder in a substantially straight line which intersects the piston when the latter lies at its initial fluid-impulse receiving position.

Figures 4 and 5 illustrate an embodiment of my invention as adapted for automotive wheel drives. As there shown, the device has two annular piston cylinders 30 and 30x connected by a circular passageway 31 connecting the discharge of first cylinder 11 to the intake of second cylinder 30x. Inlet 32 has a manifold connection to the two cylinders 30 and 30x so that the first cylinder 30 is in constant communication with inlet 32 and the second cylinder 30x is also in communication therewith except for such times as the first piston is in position to block communication to the second cylinder 30x.

Casing 33, which is split by a bolted cap 34, is supported by the provision of two fastening holes 35 by which the unit is mounted. To one end of its shaft 36 is provided a disc or coupling 37 for mounting one of the automobile wheels, as by bolts, shown.

Shaft 36 carries two pistons 38, 39, in the respective cylinders 30 and 30x. In the operation of the device fluid pressure from any suitable source will be led to the inlet 32 and into cylinder 30. In the position of the parts shown in Figure 5 the fluid will flow in the direction of the arrow and will pass through the curved passageway 31 to throw its impulse upon piston 39. The movement of the latter in clockwise direction will bring piston 38 below the inlet 32 whereupon the full pressure of the incoming fluid will be brought upon said piston 38 until it passes the passageway 31 and reaches the position of Figure 5. From cylinder 30x the fluid passes through discharge 40 for flow back to the source of fluid pressure.

I claim:

1. In a device of the class described, a casing provided with a series of annular cylinders, a shaft disposed centrally of the annular cylinders having a rotor at each cylinder, a piston secured to each said rotor slidably received in the respective annular cylinders, a cylindrical abutment, ex-

tending parallel to the said pistol shaft and rotatively mounted in tangential contact with the said plurality of piston rotors, the said abument having recesses at the annular cylinders wherein the respective pistons clear, the terminal portions of the said annular cylinders on each side of the said abutment being provided with an opening, a fluid inlet connected to one of the said terminal openings of one annular cylinder, a passage wholly exterior the periphery of the cylindrical abutment and of substantially uniform cross-sectional area and extending in a continuous curve, said passage connecting the other of the said terminal openings of said one cylinder with the terminal opening of an adjacent cylinder corresponding positionally with the said inlet opening of the first cylinder, further fluid passages connecting successive cylinders in the manner of the said first fluid passage, a fluid outlet connected to the terminal opening of the last annular cylinder of the series positionally opposite to the said inlet opening of said one cylinder, the said pistons of the plurality of cylinders being secured to their respective rotors in an arrangement with a predetermined constant angle separating pistons of adjoining rotors, and the said piston recesses of the abutment being similarly disposed.

2. A device of the class described, constructed in accordance with claim 1, in which a wall area of each cylinder-connecting passage forms a bearing wall area for the periphery of the abutment.

3. In a device of the class described, a casing provided with a plurality of annular cylinders, a shaft disposed centrally of the annular cylinders having a rotor at each cylinder, a piston secured to each said rotor slidably received in the respective annular cylinders, a cylindrical abutment extending parallel to the said piston shaft and rotatively mounted in tangential contact with the said plurality of piston rotors, the said abutment having recesses at the annular cylinders wherein the respective pistons clear, the terminal portions of each of the said annular cylinders on each side of the said abutment being provided with an opening, a fluid inlet and outlet connected to the terminal openings of the first and last annular cylinders respectively on opposite sides of the said abutment, passages connecting adjacent cylinders to provide a fluid path therethrough, said connecting passages lying exterior the periphery of the abutment and of substantially uniform cross-sectional area and each extending in a continuous curve, the said pistons of the plurality of cylinders being secured to their respective rotors in an arrangement with a predetermined constant angle separating pistons of adjoining rotors, and the said piston recesses of the abutment being similarly disposed.

4. In a device of the class described, a casing provided with a plurality of annular cylinders, a shaft disposed centrally of the annular cylinders having a rotor at each cylinder, a piston secured to each said rotor slidably received in the respective annular cylinders, a cylindrical abutment extending parallel to the said piston shaft and rotatively mounted in tangential contact with the said plurality of piston rotors, the said abutment having recesses at the annular cylinders wherein the respective pistons clear, the terminal portions of each of the said annular cylinders on each side of the said abutment being provided with an opening, a fluid inlet and outlet connected to the terminal openings of the first and last

annular cylinders respectively on opposite sides of the said abutment, passages connecting adjacent cylinders to provide a fluid path therethrough, said connecting passages lying exterior the periphery of the abutment and each extending in a continuous curve, said passages being formed wholly by continuous tubular portions of the casing, the said pistons of the plurality of cylinders being secured to their respective rotors in an arrangement with a predetermined constant angle separating pistons of adjoining rotors, and the said piston recesses of the abutment being similarly disposed.

5. In a device of the class described, a casing provided with a plurality of annular cylinders, a shaft disposed centrally of the annular cylinders, pistons secured to said shaft, each piston being slidably received in one of the respective annular cylinders, a cylindrical abutment extending parallel to the said piston shaft, the said abutment having recesses at the annular cylinders wherein the respective pistons clear, the terminal portions of the said annular cylinders on each side of the said abutment being provided with an opening, a fluid inlet connected to one of the said terminal openings of the first annular cylinder, a passage wholly exterior the periphery of the cylindrical abutment and of substantially uniform cross-sectional area and extending in a continuous curve, said passage connecting the other of the said terminal openings of the first cylinder with the terminal opening of the second cylinder corresponding positionally with the said inlet opening of the first cylinder, further fluid passages connecting successive cylinders in the manner of the said first fluid passage, and a fluid outlet connected to the terminal opening of the last annular cylinder positionally opposite to the said inlet opening of the first cylinder, the terminal portion of the passageway connecting the discharge opening of one cylinder with the receiving opening of a succeeding cylinder being so related to the last named cylinder as to direct fluid therein in substantially a straight line transversely intersecting the piston in said succeeding cylinder when said piston lies adjacent and in fluid pressure receiving relation to the said receiving opening.

6. In a device of the class described, a casing provided with a plurality of annular cylinders, a shaft disposed centrally of the annular cylinders, pistons secured to said shaft, each piston being slidably received in one of the respective annular cylinders, a cylindrical abutment extending parallel to the said piston shaft, the said abutment having recesses at the annular cylinders wherein the respective pistons clear, the terminal portions of the said annular cylinders on each side of the said abutment being provided with an opening, a fluid inlet connected to one of the said terminal openings of the first annular cylinder, a passageway wholly exterior the periphery of the cylindrical abutment and of substantially uniform cross-sectional area and extending in a continuous curve, said passage connecting the other of the said terminal openings of the first cylinder with the terminal opening of the second cylinder corresponding positionally with the said inlet opening of the first cylinder, said curved passage virtually constituting a continuation of the cylinder and being substantially equal thereto in cross-sectional area, and varying therefrom in radius only by its angularity to bridge the cylinders which it connects, further fluid passages connecting successive cylinders in

the manner of the said first fluid passage, and a fluid outlet connected to the terminal opening of the last annular cylinder positionally opposite to the said inlet opening of the first cylinder.

7. In a device of the class described, a casing having a plurality of annular cylinders each of said cylinders having an inlet and an outlet therefor, a shaft disposed centrally of the annular cylinders, pistons fixed for rotation with the shaft and slidably received in the respective annular cylinders, and a cylindrical abutment extending parallel to the piston shaft and having recesses at the annular cylinders to clear the pistons, adjacent annular cylinders being of substantially equal cross-sectional area and having the outlet of the one cylinder connected to the inlet of the other by a passage extending around the abutment, said passage having a uniform cross-sectional area substantially equal to that of the adjacent connected cylinders.

8. In a device of the class described, a casing having a plurality of annular cylinders each of said cylinders having an inlet and an outlet therefor, a shaft disposed centrally of the annular cylinders, pistons fixed for rotation with the shaft and slidably received in the respective annular cylinders, and a cylindrical abutment extending parallel to the piston shaft and having recesses at the annular cylinders to clear the pistons, adjacent annular cylinders being of substantially equal cross-sectional area and having the outlet of the one cylinder connected to the inlet of the other by a passage extending around the abutment, said passage having a uniform cross-sectional area substantially equal to that of the adjacent connected cylinders, the pistons being so arranged relative to one another that the piston of one cylinder is in operation in said cylinder while the piston of the adjacent cylinder

is passing through its abutment recess so that a continuous stream of liquid is in motion at all times regardless of the position of the pistons.

9. In an hydraulic device of the class described, a casing having a plurality of annular cylinders each of said cylinders having an inlet and an outlet therefor, a shaft disposed centrally with respect to each of the annular cylinders, a piston slidably received in each of said annular cylinders and fixed to the shaft disposed centrally thereof, and a cylindrical abutment with a recess to clear each of said pistons, adjacent annular cylinders being of substantially equal cross-sectional area and having the outlet of the one cylinder connected to the inlet of the other by a passage extending around the abutment, said passage having a uniform cross-sectional area substantially equal to that of the adjacent connected cylinders, the pistons being so arranged relative to one another and to said inlets and outlets that the piston of one cylinder is in operation in said cylinder while the piston of the adjacent cylinder is passing through an abutment recess so that one piston is in operation in its cylinder at all times and a continuous stream of liquid is constantly in motion in the cylinders and said passage regardless of the position of the pistons.

FRANK BERRY.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
646,151	Le Rond	Mar. 27, 1900
655,609	Cooper	Aug. 7, 1900
785,408	Cooper	Mar. 21, 1905