March 6, 1951

C. BANCROFT

2,544,481

ROTARY DISPLACEMENT DEVICE

Filed April 24, 1947

4 Sheets-Sheet 1

Fig. 1.

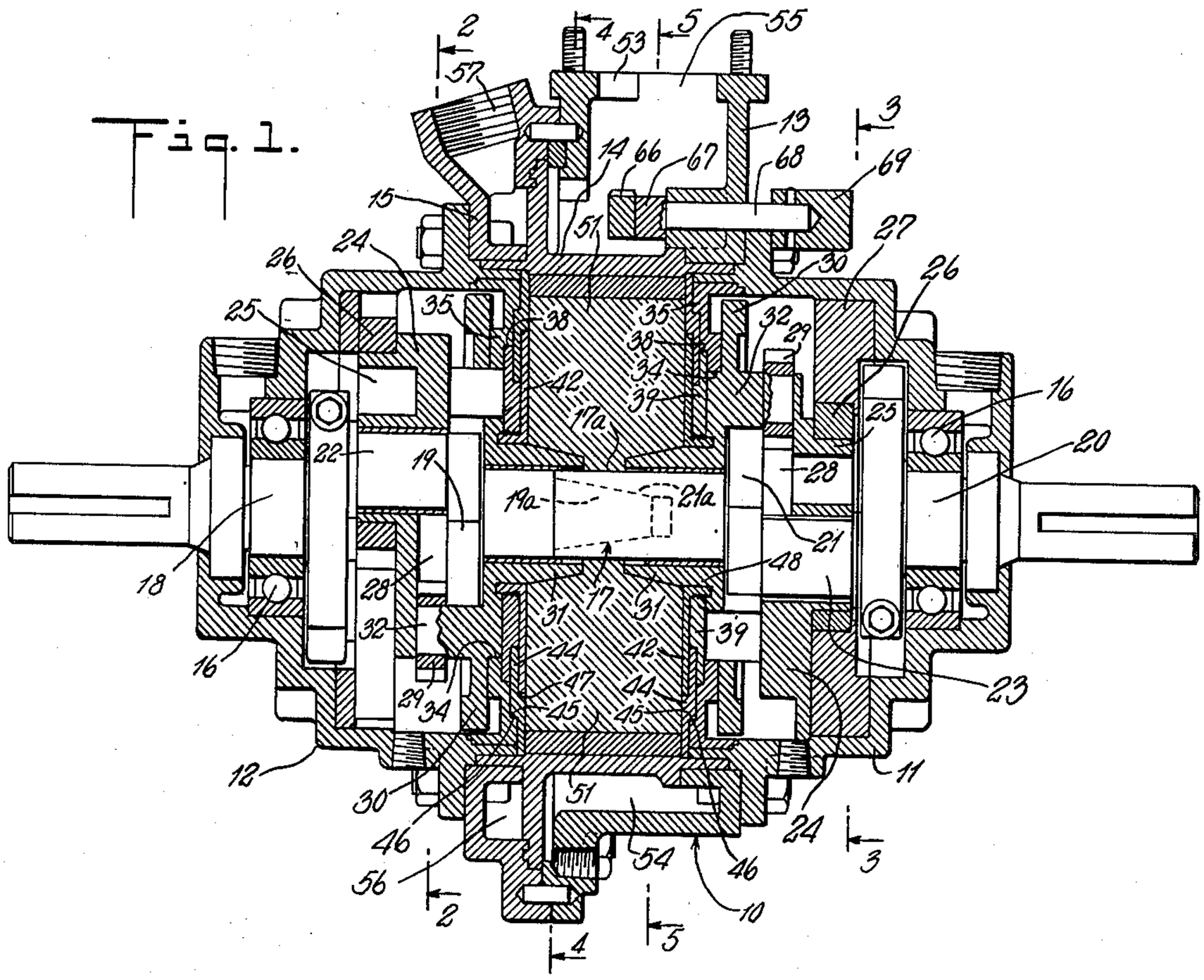
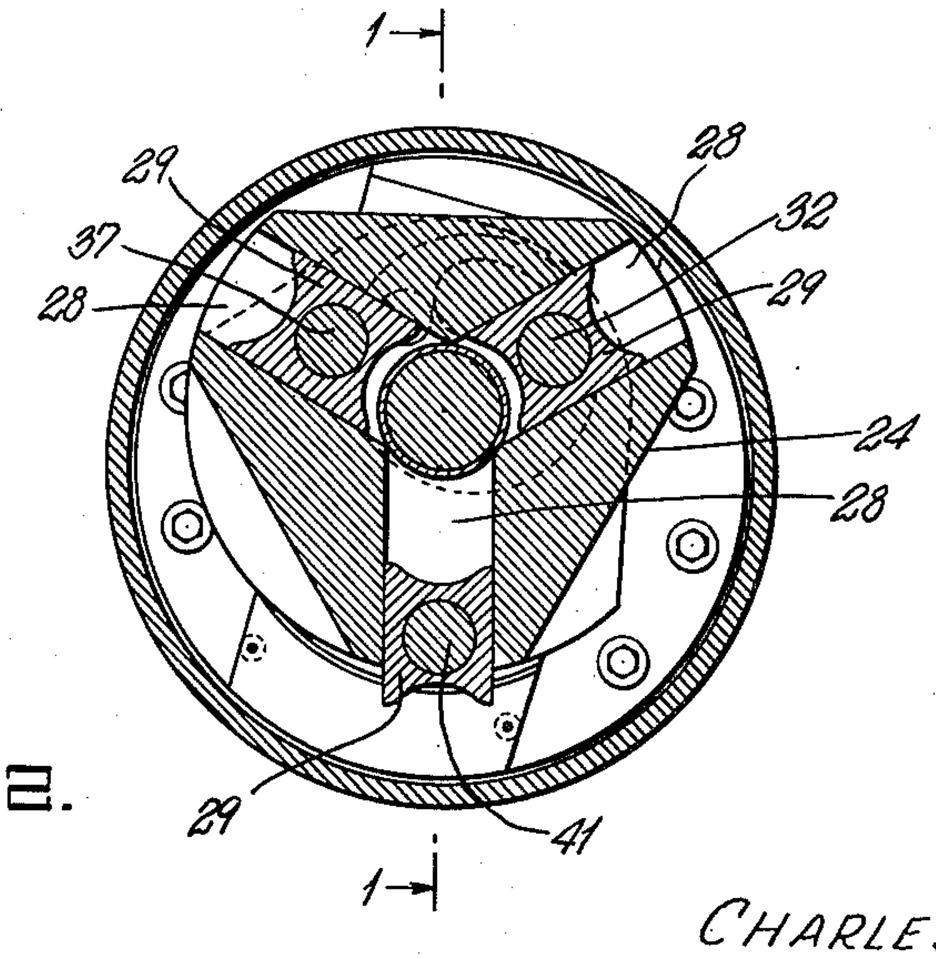


Fig. 2.



INVENTOR.
CHARLES BANCROFT
BY
Kenyon & Kenyon
ATTORNEYS

March 6, 1951

C. BANCROFT

2,544,481

ROTARY DISPLACEMENT DEVICE

Filed April 24, 1947

4 Sheets-Sheet 2

Fig. 3.

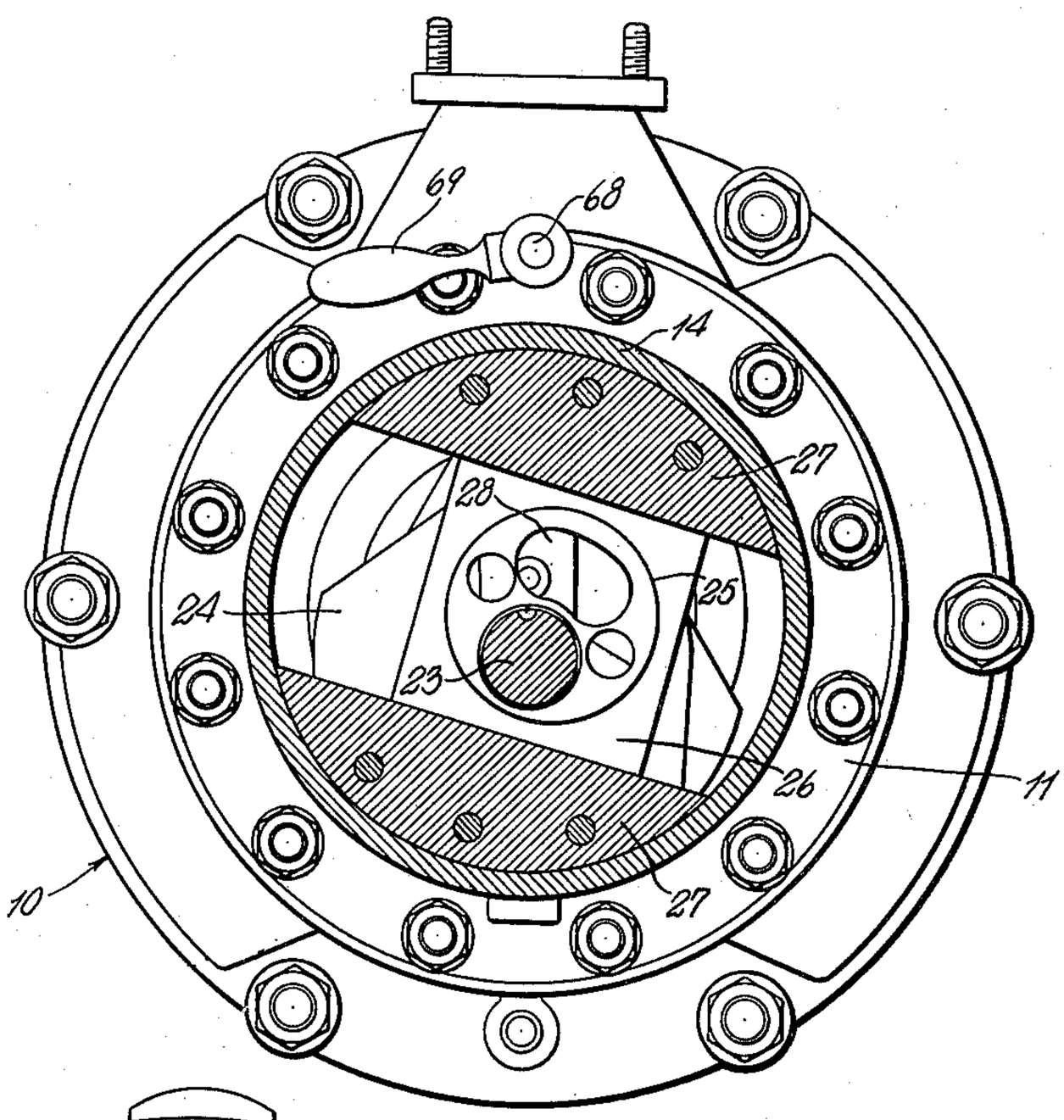
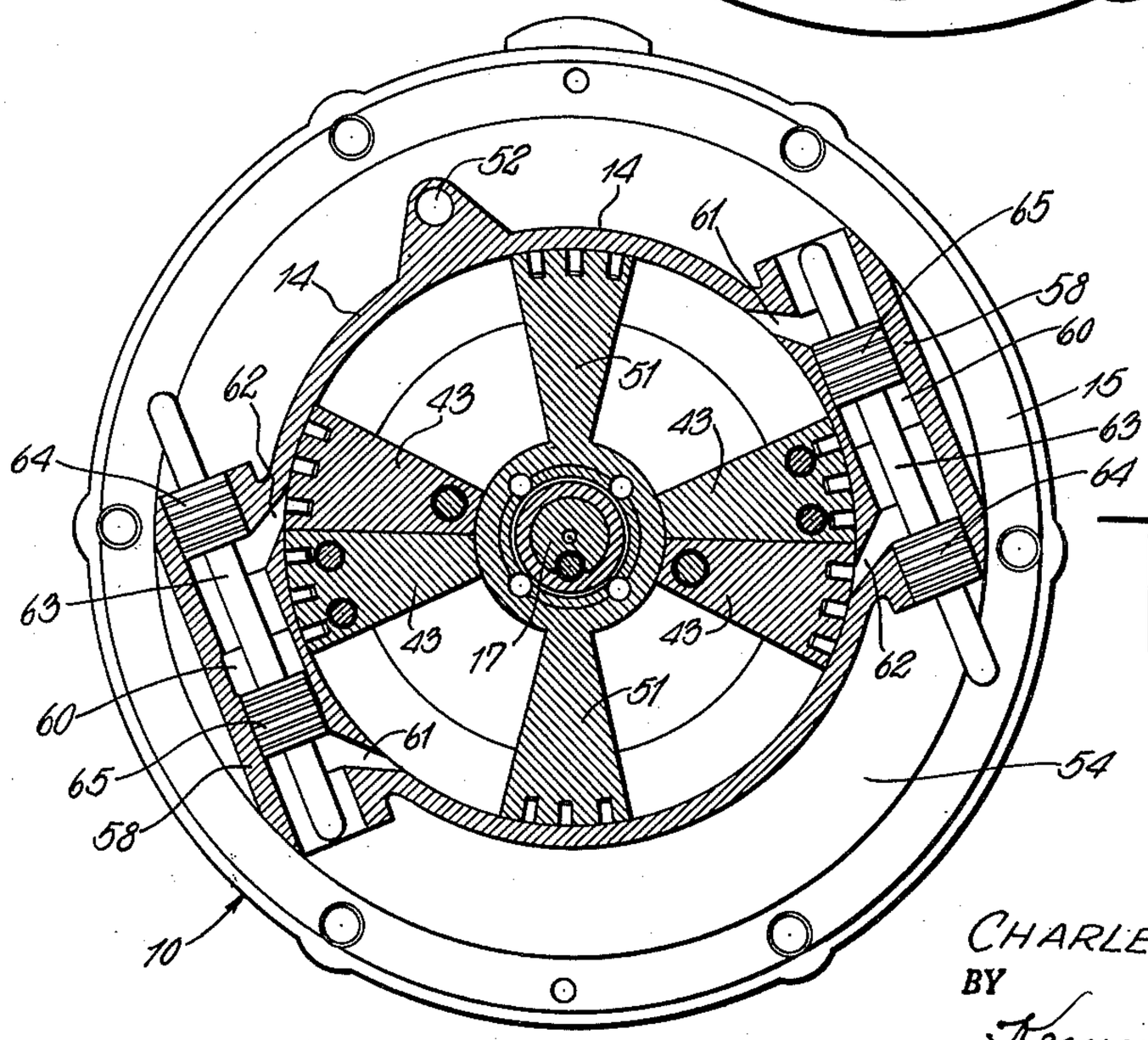


Fig. 4.



INVENTOR.
CHARLES BANCROFT
BY
Kenyon & Kenyon
ATTORNEYS

March 6, 1951 C. BANCROFT 2,544,481

ROTARY DISPLACEMENT DEVICE

Filed April 24, 1947 4 Sheets-Sheet 3

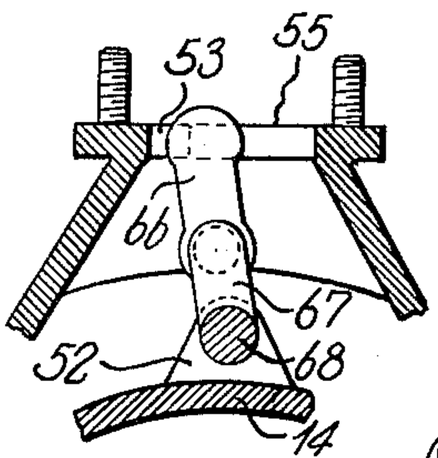


Fig. 5a.

Fig. 5.

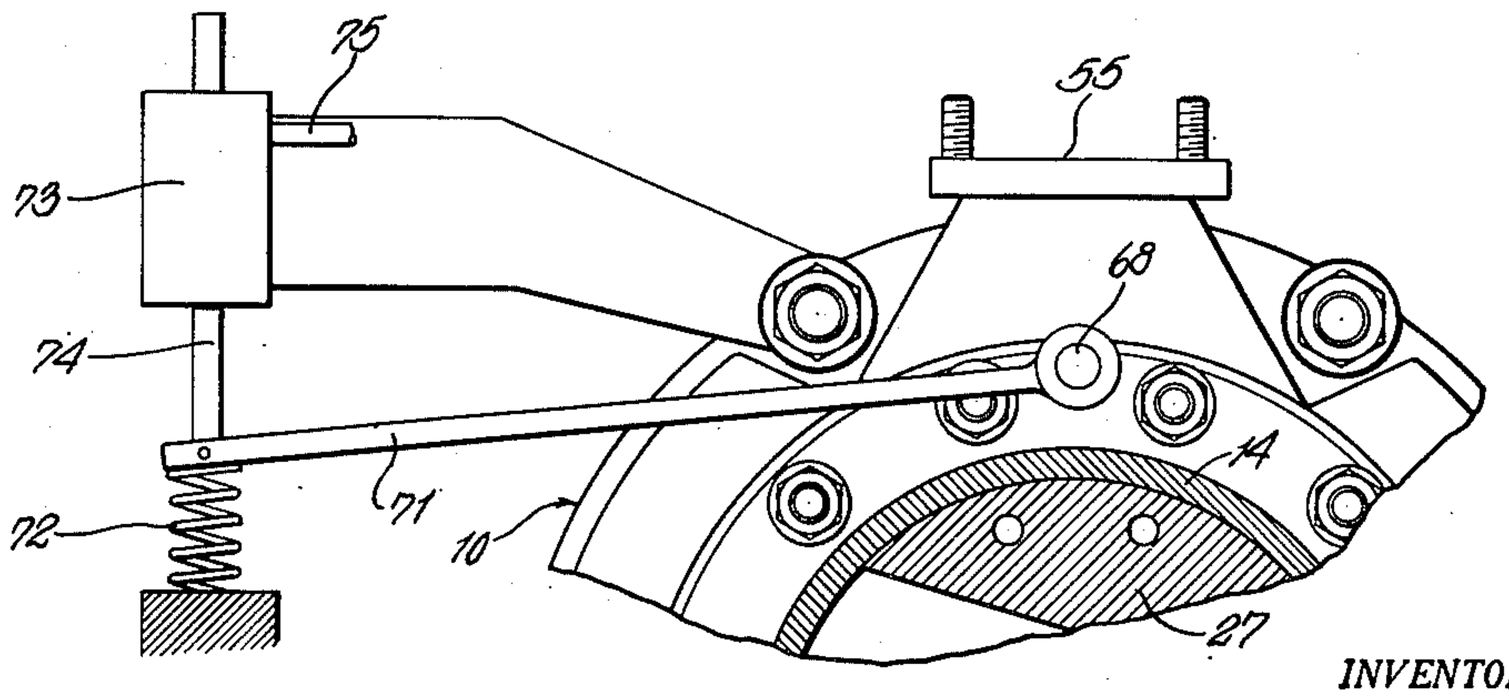


Fig. 6.

INVENTOR.
CHARLES BANCROFT
BY
Kenyon & Kenyon
ATTORNEYS

March 6, 1951 C. BANCROFT 2,544,481

ROTARY DISPLACEMENT DEVICE

Filed April 24, 1947 4 Sheets-Sheet 4

Fig. 7.

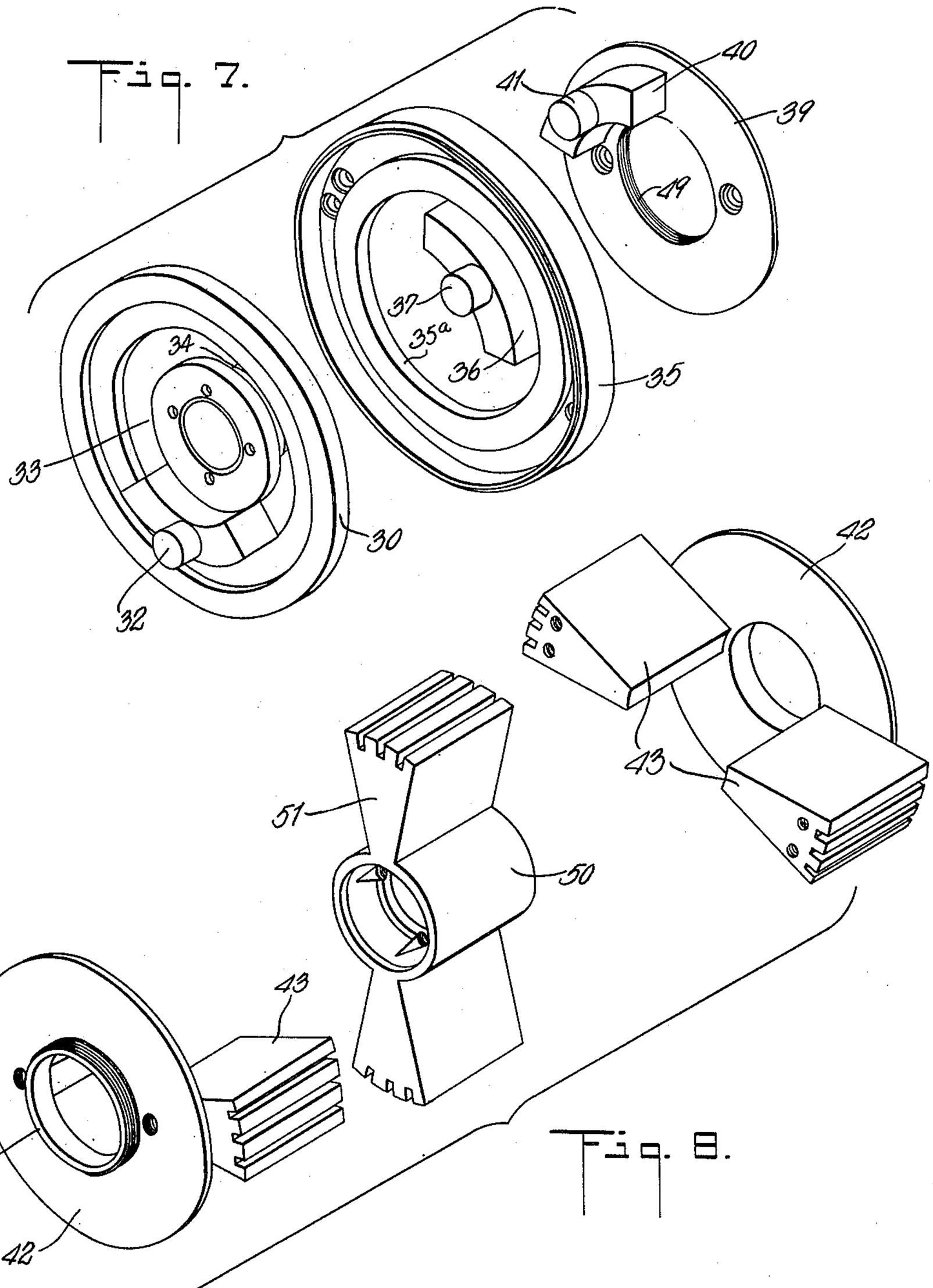


Fig. 8.

INVENTOR.
CHARLES BANCROFT
BY
Kenyon & Kenyon
ATTORNEYS

Patented Mar. 6, 1951

2,544,481

UNITED STATES PATENT OFFICE

2,544,481

ROTARY DISPLACEMENT DEVICE

Charles Bancroft, New Canaan, Conn.

Application April 24, 1947, Serial No. 743,517

7 Claims. (Cl. 103—129)

1

This invention relates to rotary displacement devices and more especially to rotary displacement devices of the alternately accelerating piston type.

An object of this invention is a rotary displacement device of the alternating accelerating piston type of such structure that the direction of flow of compressible fluid through the device may be easily and quickly reversed or that the most efficient valve setting for varying working pressures may be automatically obtained.

A further object of the invention is an alternately accelerating piston rotary displacement device which is of improved operational characteristics and of simplified construction.

Other objects, novel features and advantages of this invention will become apparent from the following specification and accompanying drawings, wherein:

Fig. 1 is a vertical section through a device embodying the invention;

Fig. 2 is a section on the line 2—2 of Fig. 1;

Fig. 3 is a section on the line 3—3 of Fig. 1;

Fig. 4 is a section on the line 4—4 of Fig. 1 with the pistons in one position;

Fig. 5 is a section on the line 5—5 of Fig. 1 with the pistons slightly changed from the position of Fig. 4;

Fig. 5*a* is a fragmentary view similar to Fig. 5 with certain parts in a different relation;

Fig. 6 is a fragmentary view partially in section of a form of control mechanism, and

Figs. 7 and 8 are exploded views of units of the device.

The enclosing casing for the moving parts consists of a center annular multiple-part section 10 and two end sections 11 and 12 suitably bolted to the center section. The section 10 is made up of three annular members 13, 14 and 15, of which the member 14 is rotatably mounted on the inner edges of the end sections 11 and 12 and is formed with shoulders against which the members 13 and 15 abut with the member 14 enclosed by the members 13 and 15 which are suitably interconnected. Each of the two end sections 11 and 12 supports an anti-friction bearing 16 in which is journalled one end of a crank shaft 17 made up of the parts 18, 19, 20 and 21. The part 19 is formed with a crank pin 22 which projects into and is keyed to the part 18 while the part 21 is formed with a crank pin 23 which projects into and is keyed to the part 20. The part 19 is separable from the part 18 and the part 21 is separable from the part 20 to facilitate assembly but when assembled, the parts 18 and 19,

2

as well as the parts 20 and 21 are in effect unitary. The inner end of the part 19 is reduced as shown at 19*a* and is received in a correspondingly shaped socket 21*a* formed in the inner end of the part 21 and the parts 19 and 21 are keyed together. The inner ends of the parts 19 and 21 cooperate to form a cylindrical pin 17*a* coaxial of the crank shaft 17.

A disk 24 is journalled on each of the crank pins 22 and 23 and is formed with a hub 25 rotatably fitting an aperture in a block 26 slidable in a groove in a non-rotatable plate 27 mounted in the end casing 11 or 12. Each disk 24 has three radial grooves 28 in each of which is slidably mounted a block 29. Each of two spaced disks 30 has a hub 31 journalled on the crank shaft pin 17*a* and has a stud 32 fitting into one block 29. Each disk 30 also has an arcuate slot 33 (see Fig. 7) of approximately 300° and an annular shoulder 34. Each of two disks 35 is journalled on the shoulder 34 of one disk 30 and has an arcuate extension 36 projecting into the slot 33 of a disk 30 which extension carries a stud 37 fitting into a second block 29. In one face of each disk 35 there is provided a circular recess 38 in which is journalled a third disk 39 which has an arcuate extension 40 also projecting into the arcuate slot 33 of a disk 30 through the central aperture 35*a* of the disk 35. The extension 40 carries a stud 41 which fits into a third block 29. The three disks 30, 35 and 39 are capable of limited relative rotary movement.

A disk 42 journalled on the hub 31 of each disk 30 carries two diametrically opposed pistons 43. Each of the two disks 44 is formed with an annular shoulder 45 which is journalled in a recess 46 in a disk 35 and is formed with a circular recess 47 in which is received a disk 42, the threaded flange 48 of which surrounds the hub 31 and is screwed into the thread 49 of the disk 39. A sleeve 50 receives the hubs 31 and is fixed to the hubs for rotation therewith. The sleeve is formed with a pair of diametrically opposed pistons 51. The piston 43 of each plate 42 extends between the pistons 51 of the sleeve 50 into contact with the opposite disk 42 and the opposite disk 44 to which the pistons 43 and a disk 35 are suitably attached. Thus, one piston set 43 connects with one of the disks 39 on one side of the assembly and with the disk 44 and hence the disk 35 on the opposite side, and the other piston set 43 connects with the disk 44 and hence the disk 35 on said one side and with the disk 39 on said opposite side. The disks 42 and 44 together with the sleeve 50 and

member 14 form a ring cylinder in which are located the pistons 43 and 51.

Rotation of the crank shaft 17 produces oppositely directed rotation of the three pairs of pistons with the piston assembly making one complete rotation relative to the casing for each complete rotation of the crankshaft. During each complete rotation of the piston assembly, the different pairs of pistons rotate at varying relative speeds so that the adjacent pistons move relative to each other as they rotate about the crankshaft axis to form between adjacent pistons chambers of varying volume.

The member 13 cooperates with the member 14 to form an annular chamber 54 having a port 55. The member 14 is provided with a lug 52 and a slot 53 is formed in the periphery of the port 55. The member 15 cooperates with the member 14 to form an annular chamber 56 having a port 57. The members 13 and 15 are rigidly connected to the end sections 11 and 12 and to each other while the member 14 is supported by said other two members for limited rotation about the crankshaft axis. The member 14 supports two diametrically related tubular sleeves 58 each of which is received in a recess 59 in the member 13, the recess being of somewhat greater extent or lengths than the sleeves 58. A port 60 provides communication between the interior of each sleeve and the chamber 56. A pair of ports 61 and 62 lead from each sleeve 58 through the member 14 into the ring cylinder. A plunger 63 having heads 64 and 65 is slidably mounted in each housing 58 and the arrangement is such that in one position of the plunger the port 61 is connected to the annular chamber 54 with the port 62 connected to the annular chamber 56 and in another position of the plunger the port 61 is connected to the annular chamber 56 with the port 62 connected to the annular chamber 54. The position of the plunger is changed by rotating the member 14 from the position shown in Fig. 4 in which one end of the sleeve 58 engages one end wall of the recess 59, to a position in which the opposite end of the sleeve 58 engages the opposite end of the recess 59, thereby sliding the plunger 63 into a position opposite to that shown in Fig. 4. Such rotation of the member 51 is accomplished by means of a link 66 pivotally connected at one end to the lug 52 and pivotally connected at approximately its midpoint to an arm 67 carried by a shaft 68 journalled in the member 13 and provided with an operating handle 69 exterior of the casing. Upon 90° rotation of the shaft 68 from its Fig. 5 position by the handle 69, the member 14 is moved clockwise half-way from its Fig. 4 position to its other position and the free end of the link 66 moves up into the slot 53 which slot acts as a fulcrum for the free end of the link 66 upon additional 90° rotation of the shaft 68 to continue clockwise movement of the member 14 to its other position as the shaft 68 is rotated beyond its position in which the arm 67 is vertical.

In the member 14 are provided two diametrically opposed arcuate slots 70 offset axially from the ports 61 and 62. The length of each slot is less than the distance between the ports 61 and 62 and each slot is so arranged that its ends are equally spaced circumferentially from the two ports. These slots provide ports between the annular chamber 54 and the ring cylinder.

Assume that the device is being operated as a motor with the member 14 in the position shown in Figs. 4 and 5 with the port 55 open to atmosphere and the port 57 connected to a supply of compressed air. Flow of air through the device rotates the piston at varying speeds to cause variation in the spacing between adjacent faces of successive pistons, thereby forming varying size chambers for expanding the compressed air and scavenging the expanded air. As the pistons rotate clockwise from their Fig. 5 position to their Fig. 4 position and beyond, compressed air admitted through the annular chamber 56 and the port 62 forces the leading piston 51 away from the trailing piston 43 until the trailing piston 43 closes the port 62. Further clockwise rotation of the pistons causes the trailing piston 43 to approach the leading piston 51 to scavenge the air from between the pistons through the ports 70 and 61 into the annular chamber 54 until the trailing piston 43 covers the ports 61 and 70 and the same cycle is repeated by each pair of pistons. Rotation of the pistons as above described effects counterclockwise rotation of the crankshaft as previously described. The overlapping arrangement of the disks 42 and 44 in conjunction with the arrangement of the disks 35 and 39 effectively prevents the loss of pressure from the ring cylinder through the circular walls thereof.

Reversal of the position of the member 14 as above described results in reverse rotation of the pistons as well as reverse rotation of the crankshaft. Upon movement of the member 14 to engage the opposite ends of the sleeves 58 with the opposite ends of the recesses 59, the plunger 63 is moved into position to connect the port 61 to the port 60 and to connect the port 62 through the sleeve 58 to the chamber 54, whereupon flow of compressed air through the device effects counterclockwise rotation of the pistons and clockwise rotation of the crankshaft.

As shown in Fig. 6, additional means may be provided for varying the angular position of the member 14 responsive to pressure changes in the chamber 56 so that compressed fluids trapped between the approaching piston may be admitted to or discharged from the chamber 56 in a manner to give the highest efficiency of operation of the device for any given operating pressure. Thus, for a given input pressure, if the displacement of the rotary piston is too large or small during the time the pressure is introduced for expansion to drive the advancing piston ahead, the potential power output of the device may be reduced. With the optimum displacement, the full power potential is realized. An arm 71 is fixed to the shaft 68 and is biased by a spring 72 tending to move the member 14 out of its Fig. 4 position. An air cylinder 73 contains a piston having an extension 74 connected to the free end of the arm 71 to swing the arm against the action of the spring 72. A pipe 75 leads from the chamber 56 to the cylinder 73 to apply to the piston the pressure existing in the chamber 56 in opposition to the spring 72. Considering Figs. 4 and 5 in conjunction with Fig. 6, an increase in the pressure in the chamber 56 above a set value causes movement of the arm 71 in a direction to effect counterclockwise movement of the member 14 thereby resulting in quicker closing off of port 62 by the trailing piston 43 and thus reducing the volume of the chamber formed between the leading and trailing piston at the time of closing of the port.

The device may also be used as a pump by suitably connecting the ports 55 and 57 one to atmosphere and the other to a compressed air storage tank and positively driving the crankshaft. When the device is used as a pump, reversal of the

member 14 results either in reversal of fluid flow through the device for a given direction of rotation of the crankshaft or results in fluid flow through the device in the same direction upon reversal of the direction of rotation of the crankshaft.

It is of course understood that various modifications may be made in the displacement device above described, without in any way departing from the spirit of the invention as defined in the appended claims.

I claim:

1. A device of the character described comprising a ring cylinder including two spaced circular wall members and an annulus enclosing said wall members, a crank shaft having a pin coaxial therewith and extending between said wall members, a casing rotatably supporting said annulus and said crank shaft and formed with a pair of annular chambers respectively having an inlet and an outlet, two or more pairs of piston members rotatably supported in said cylinder, means interconnecting said crank shaft and piston members for effecting rotation of said piston members at varying speeds upon rotation of said crank shaft, two sleeves fixed to said annulus in diametrically opposed relation, each sleeve having two spaced ports communicating with said ring cylinder and a third port intermediate said two ports communicating with one of said annular chambers, an elongated slot in said annulus intermediate the ports of each sleeve and of less extent than the spacing between said ports and communicating with the other of said chambers, means movable in each sleeve between two alternate positions to place alternately one or the other of said two sleeve ports in communication with said third intermediate sleeve port, and means effective upon rotation of said annulus in said casing to move said movable means in said sleeves from one to the other of its two alternate positions.

2. A device of the character described comprising a ring cylinder including two spaced circular wall members and an annulus enclosing said wall members, a crank shaft having a pin coaxial therewith and extending between said wall members, a casing rotatably supporting said annulus and said crank shaft and formed with a pair of annular chambers respectively having an inlet and an outlet, two or more pairs of piston members rotatably supported in said cylinder, means interconnecting said crank shaft and piston members for effecting rotation of said piston members at varying speeds upon rotation of said crank shaft, two sleeves fixed to said annulus in diametrically opposed relation, each sleeve having two spaced ports communicating with said ring cylinder and a third port intermediate said two ports communicating with one of said annular chambers, an elongated slot in said annulus intermediate the ports of each sleeve and of less extent than the spacing between said ports and communicating with the other of said chambers, a plunger movable in each sleeve between two alternate positions and provided with two pistons adapted in alternate plunger positions to place alternately one or the other of the two sleeve ports in communication with the third intermediate sleeve port, a recess in said casing receiving each sleeve and being of greater length than the sleeve, said plunger being of greater length than the sleeve for engagement with the ends of said recess to locate said plunger in either of its two alternate positions upon rotation of said annulus, and means for effecting rotation of said annulus.

3. A device of the character described comprising a ring cylinder including two spaced circular wall members and an annulus enclosing said wall members, a crank shaft having a pin coaxial therewith and extending between said wall members, a casing rotatably supporting said annulus and said crank shaft and formed with a pair of annular chambers respectively having an inlet and an outlet, two or more pairs of piston members rotatably supported in said cylinder, means interconnecting said crank shaft and piston members for effecting rotation of said piston members at varying speeds upon rotation of said crank shaft, two sleeves fixed to said annulus in diametrically opposed relation, each sleeve having two spaced ports communicating with said ring cylinder and a third port intermediate said two ports communicating with one of said annular chambers, an elongated slot in said annulus intermediate the ports of each sleeve and of less extent than the spacing between said ports and communicating with the other of said chambers, a plunger movable in each sleeve between two alternate positions and provided with two pistons adapted in alternate plunger positions to place alternately one or the other of the two sleeve ports in communication with the third intermediate sleeve port, a recess in said casing receiving each sleeve and being of greater length than the sleeve, said plunger being of greater length than the sleeve for engagement with the ends of said recess to locate said plunger in either of its two alternate positions upon rotation of said annulus, a control shaft rotatably supported by said casing, an arm carried by said control shaft within said first annular chamber, a link interconnecting said annulus and the free end of said arm, and a handle exterior of said casing for rotating said control shaft.

4. A device of the character described comprising a ring cylinder including two spaced circular wall members and an annulus enclosing said wall members, a crank shaft having a pin coaxial therewith and extending between said wall members, a casing rotatably supporting said annulus and said crank shaft and formed with a pair of annular chambers respectively having an inlet and an outlet, two or more pairs of piston members rotatably supported in said cylinder, means interconnecting said crank shaft and piston members for effecting rotation of said piston members at varying speeds upon constant speed rotation of said crank shaft, two sleeves fixed to said annulus in diametrically opposed relation, each sleeve having two spaced ports communicating with said ring cylinder and a third port intermediate said two ports communicating with one of said annular chambers, an elongated slot in said annulus intermediate the ports of each sleeve and of less extent than the spacing between said ports and communicating with the other of said chambers, a plunger movable in each sleeve between two alternate positions and provided with two pistons adapted in alternate plunger positions to place alternately one or the other of the two sleeve ports in communication with the third sleeve port, and means effective upon rotation of said annulus in said casing to move said plunger from one to the other of its two positions.

5. A device of the character described comprising a casing, a crank shaft journalled in said casing and having a pin coaxial with said shaft, a pair of disks rotatably mounted on said pin, a collar rotatably mounted on said pin, a pair of

pistons supported by each disk in contact with the remaining disk, a third pair of pistons supported by said collar between said disks, a second pair of disks each individually supported by one of said first pair of disks and connected to the pistons supported by the other of said first pair of disks, a third pair of disks rotatably supported by said casing and having inner sections overlapping the outer sections of said first pair of disks, an annulus enclosing said second pair of disks, and means interconnecting said first pair of disks, said second pair of disks and said collar to said crank shaft for effecting rotation of said pistons at varying speeds upon rotation of said crank shaft.

6. A device of the character described comprising a casing, a crank shaft journalled in said casing and having a pin coaxial with said shaft, a pair of disks rotatably mounted on said pin, a collar rotatably mounted on said pin, a pair of pistons supported by each disk in contact with the remaining disk, a third pair of pistons supported by said collar between said disks, a second pair of disks each individually supported by one of said first pair of disks and connected to the pistons supported by the other of said first pair of disks, a third pair of disks rotatably supported by said casing and having circular recesses receiving the peripheries of said first pair of disks, an annulus enclosing said second pair of disks, and means interconnecting said first pair of disks, said second pair of disks and said collar to said crank shaft for effecting rotation of said pistons at varying speeds upon rotation of said crank shaft.

7. A device of the character described comprising a casing, a crank shaft journalled in said casing and having a pin coaxial with said shaft, a pair of disks rotatably mounted on said pin, a collar rotatably mounted on said pin, a pair of pistons supported by each disk in contact with the remaining disk, a third pair of pistons supported by said collar between said disks, a second pair of disks each individually supported by one of said first pair of disks and connected to the pistons supported by the other of said first pair of disks, a third pair of disks rotatably supported by said casing and having inner sections overlapping the outer sections of said first pair of disks, an annulus enclosing said second pair of disks rotatably supported by said casing, a pair of annular chambers formed in said casing, said chambers respectively having an inlet and an outlet, two sleeves fixed to said annulus in diametrically opposed relation, each sleeve having two spaced ports communicating with said ring cylinder and a third port intermediate said two ports communicating with one of said annular chambers, an elongated slot in said annulus intermediate the ports of each sleeve and of less extent than the spacing between said ports and communicating with the other of said chambers, means movable in each sleeve between two alternate positions to place alternately one or the other of the two ports of each sleeve in communication with the third port of said sleeve, means effective upon rotation of said annulus in said casing to move said last-named means from one to the other of its two alternate positions, and means interconnecting said first pair of disks, said second pair of disks and said collar to said crank shaft for effecting rotation of said pistons at varying speeds upon rotation of said crank shaft.

CHARLES BANCROFT.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
1,838,252	Coppage	Dec. 29, 1931
1,843,155	Gronemeyer	Feb. 2, 1932
1,921,747	Greve	Aug. 8, 1933
1,997,233	Rodaway	Apr. 9, 1935
2,096,074	Stevens	Oct. 19, 1937
2,132,596	Bancroft	Oct. 11, 1938
2,222,706	English	Nov. 26, 1940
2,243,653	Rodaway	Nov. 27, 1941
2,270,493	Bancroft	Jan. 20, 1942

FOREIGN PATENTS

Number	Country	Date
444,706	Great Britain	Mar. 25, 1936