July 5, 1949. J. MIKULASEK 2,475,247

PLANETARY PISTON FLUID DISPLACEMENT MECHANISM

Filed May 22, 1944 3 Sheets-Sheet 1

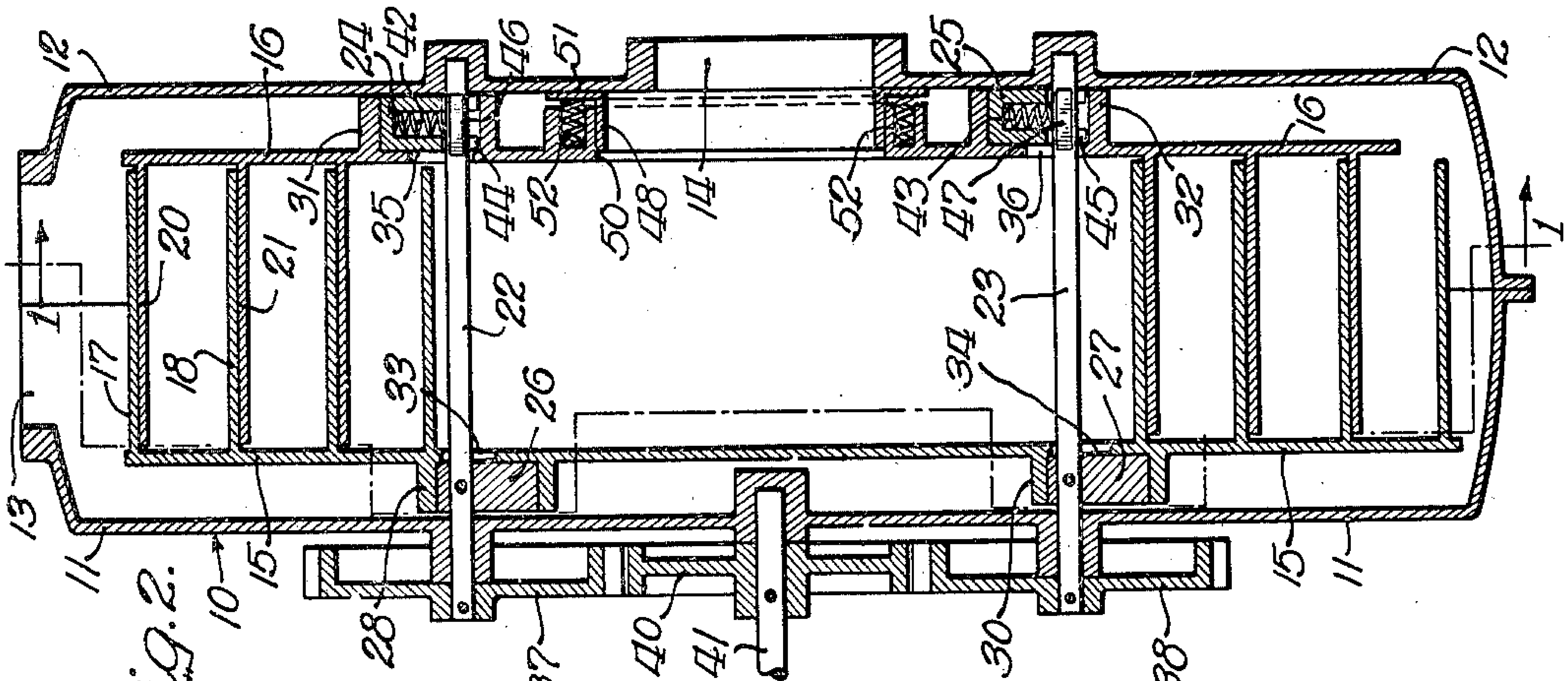

Fig. 2.

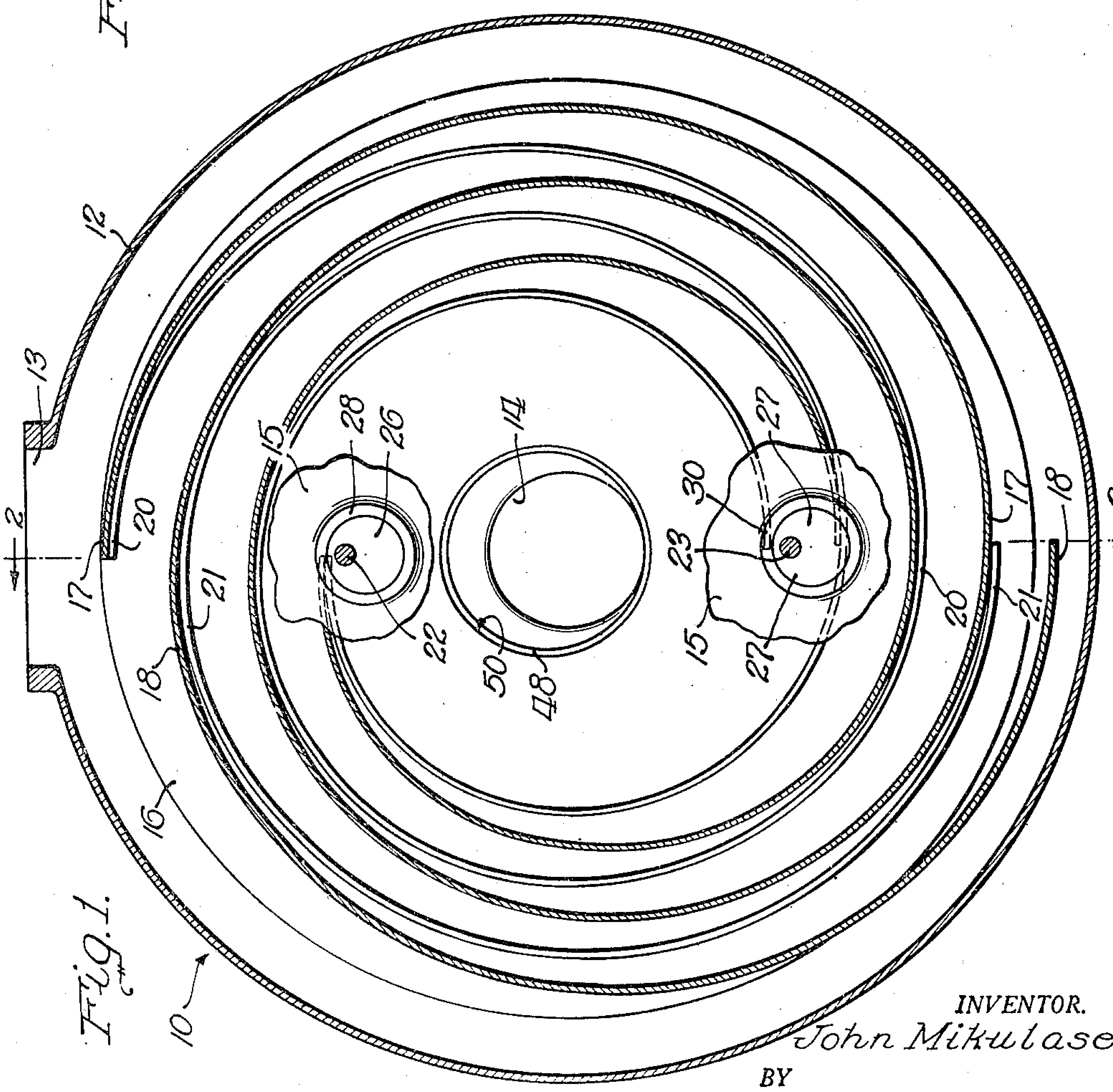

Fig. 1.

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Filed May 22, 1944 3 Sheets-Sheet 2

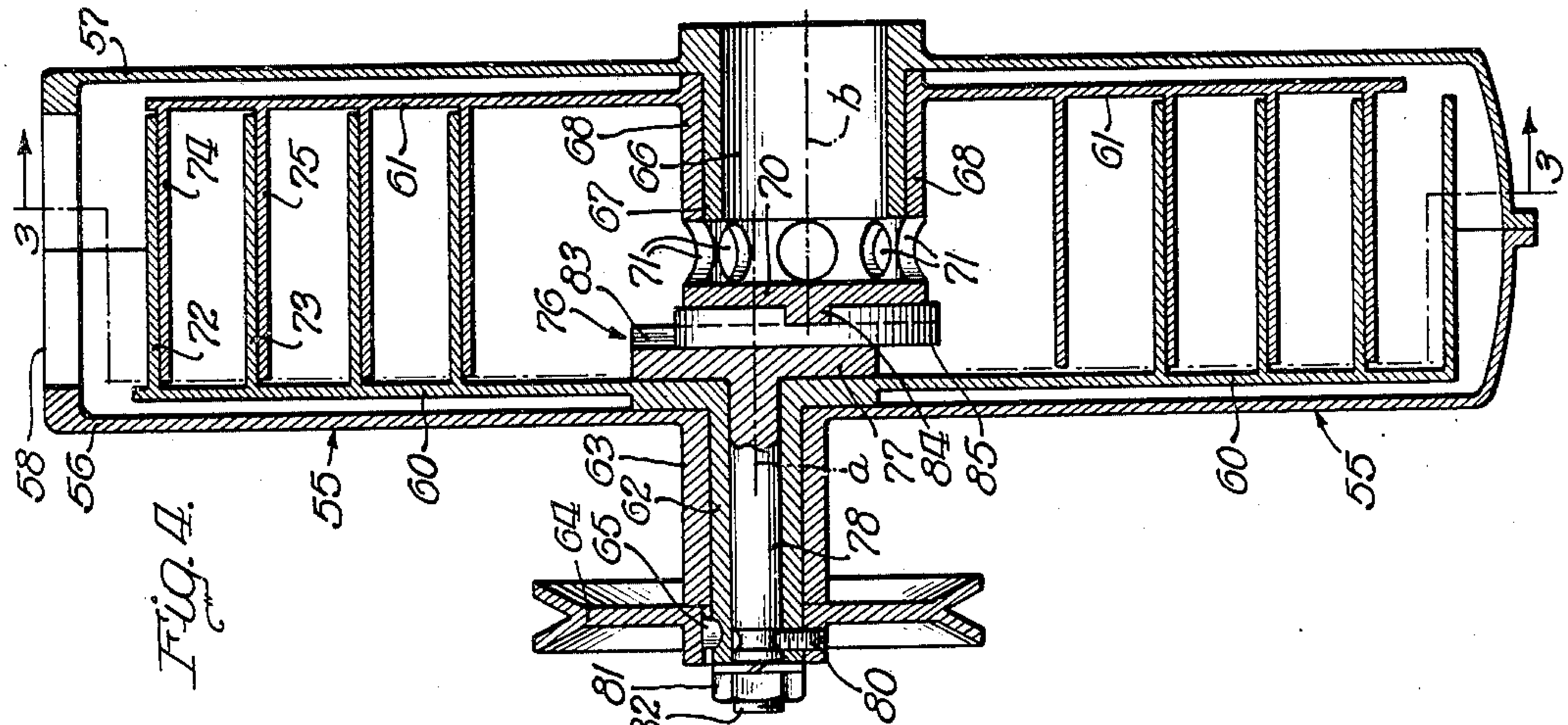

Fig. 4.

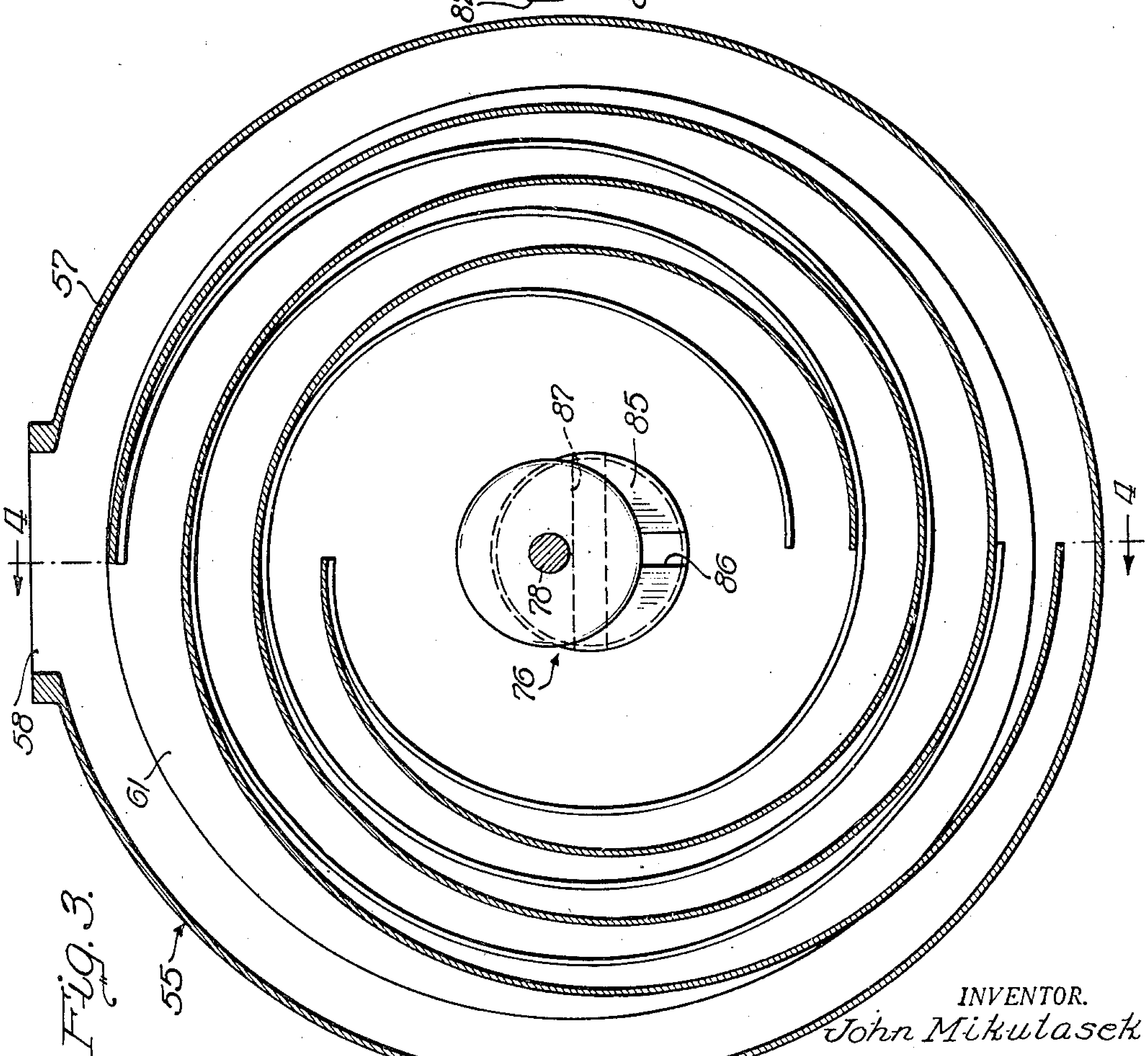

Fig. 3.

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PLANETARY PISTON FLUID DISPLACEMENT MECHANISM

Filed May 22, 1944 3 Sheets-Sheet 3

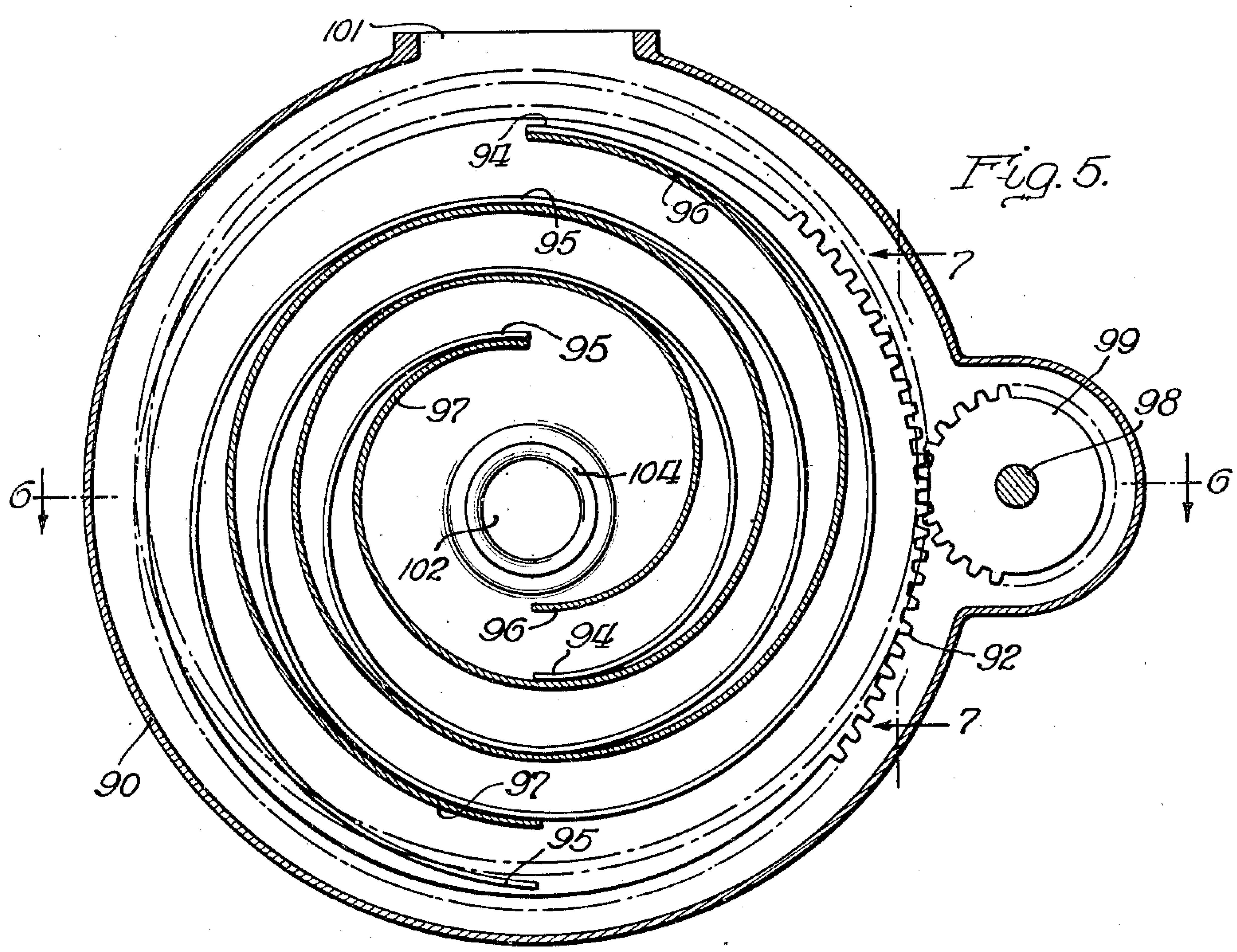

Fig. 5.

Fig. 6.

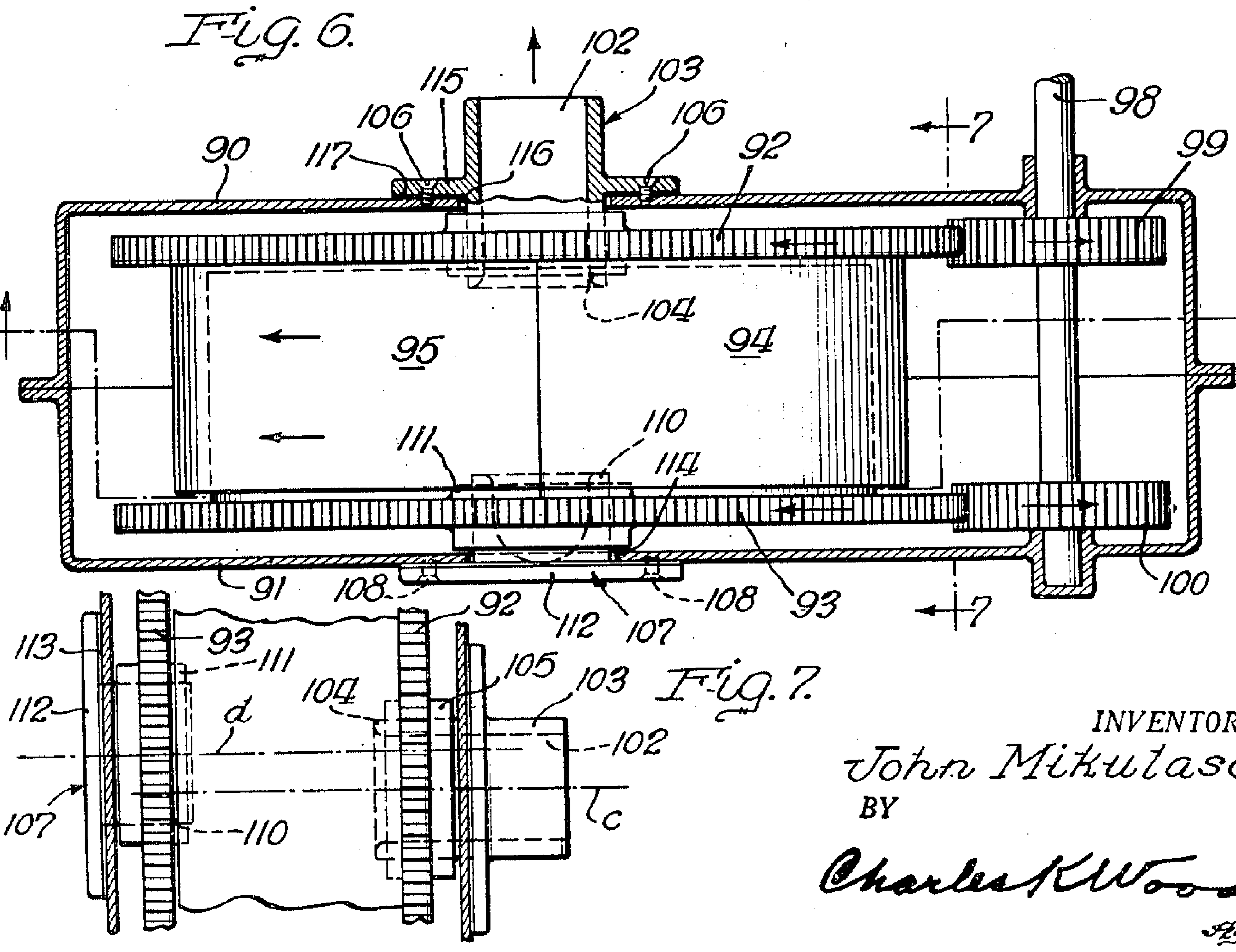

Fig. 7.

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PLANETARY PISTON FLUID DISPLACEMENT MECHANISM

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Application May 22, 1944, Serial No. 536,841

6 Claims. (Cl. 103—130)

1

The present invention is directed to a displacement mechanism embodying the use of spiral blades oppositely disposed and nested within a casing with suitable actuating means for causing such blades to movably cooperate and to trap fluid within cells formed between the blades and to cause such fluid to flow from one to the other of inlet and outlet openings that are located in the casing. The present structure set forth in the design of the displacement mechanism herein disclosed and described is very similar to the displacement mechanisms disclosed and described in my co-pending application S. N. 528,-304, filed March 27, 1944. The fundamental principles of the use of oppositely related spirals, with the spirals in each group being angularly displaced and also with the spiral blades of one group being offset radially with respect to the spiral blades of the other group are all generally and specifically described in connection with the above mentioned co-pending application.

More specifically, one of the main objects of the present invention is to provide a displacement mechanism having spiral blades wherein each blade or each of the sets of blades of each group are movably mounted to reduce the relative motion between the blades by reducing the eccentricity of such blades. In other words, the present device has each of the blades movably mounted in such fashion that the oscillation is accomplished between the blades by moving each blade or groups of blades one-half of the distance normally required by devices wherein one blade or set of blades is fixed while the other blade or set of blades are solely movable relative to the former.

This relative oscillatory movement between the oppositely related blades is advantageous in eliminating considerable counter-balancing problems which must be considered to reduce vibration in such a unit particularly when the same is being operated at relatively high speeds. This feature or advantage is particularly well disclosed in one form of the present device wherein groups of spirals or blades are driven by oppositely disposed eccentrics or cranks, and therefore it is apparent that under operation such blades will have equal masses acting in opposition to each other during the oscillation of such blades.

It is another object of the present invention to provide a means in the nature of a sealing ring that is adapted to move with one of the sets of blades during the oscillation thereof to provide proper communication between the interior of the spiral cellular chambers and the discharge port of the pump. Such a sealing ring also provides

2

a means through the resilient construction embodied therein for exerting axial pressure against one of the sets of spiral blades to maintain the same in snug operating contact with the other oppositely related spiral blades thereby holding such oppositely related blades in nested and leak-proof relation during the operation of the device.

Also in connection with the above resilient axial pressure, other additional resilient means is disclosed for the purpose of maintaining the respective convolutions of one of the sets of spiral blades in sealing or leak-proof contact with the convolutions of the other set of spiral blades as the blades are oscillated by the actuating means provided therefor.

Another object of the present invention is to provide a displacement mechanism wherein the blade supporting discs are both rotatably mounted in off-set relation for carrying their corresponding blade or sets of spiral blades in continuous rotative motion. However, in such construction, the generating centers of each of the blades or common thereto are offset with respect to the center of rotation of the adjacent disc supporting such blade or blades whereby a true oscillation is obtained of the blade during the continual rotation of the disc. Therefore, by offsetting each of the discs a predetermined amount, and by offsetting the blade or blades of each disc with the generating center common to such blades eccentrically disposed with respect to the center of rotation it is possible to obtain the rotational movement of the discs wherein each of the oppositely related blades or sets of blades are caused to oscillate one-half of the distance between the spaces of adjacent convolutions of the blades. Furthermore, by using more blades in each group it is posible to substantially reduce the vibration of the displacement mechanism to a very minimum inasmuch as the distances between adjacent convolutions will thereby also be reduced.

In displacement mechanisms using dual rotating discs for obtaining the necesary oscillation and pumping action of the coacting spiral blades of each disc it is important to drive both of the discs at constant and synchronized speeds inasmuch as any variation of one of the disc blade units with respect to the other disc blade units would cause binding between convolutions of the spiral blades and interfere with the operation of the pump. It is therefore another object of this invention to provide a driving means for actuating the discs to positively cause concerted movement of both discs and therefore of the nested blades of each disc in synchronized speed relation to obtain the highest efficiency possible in a device of this kind.

As will be understood by referring to the drawings and to the co-pending application hereinbefore designated, it will be obvious that as the blades are rotated the sizes of the plurality of cells between the coacting convolutions of the sets of blades will diminish from the radially outer periphery of such blades to the center thereof. However, as these cells are decreased, the action is successive in nature and the fluid trapped within the cells will be steadily compressed so that the relative pressure difference between each successive cell during the progress of this compression will be relatively small counteracting leakage of fluid from the higher pressure cell to the lower pressure cell.

Furthermore, when the displacement mechanism is being operated at higher speeds any such possible leakage of fluid from one of the higher pressured cells to the lower pressured cells will be substantially negligible.

The above mentioned theory augmented by the introduction of resilient means such as referred to for maintaining the blades in nested relation and also the additional means for convolutionally maintaining such blades in operative contact produces a device which is highly efficient and relatively simple in construction.

All other advantages and features not hereinbefore referred to shall be subsequently set forth in the following detailed description having reference to the several illustrations in the accompanying drawings.

In the drawings:

Fig. 1 is a cross-sectional view taken transversely to the axis of a displacement mechanism of the present construction and substantially as viewed along the line **1—1** in Fig. 2;

Fig. 2 is a vertical cross sectional view as taken substantially along the diameter of the pump as viewed on line **2—2** in Fig. 1;

Fig. 3 is another cross-sectional view of a modified construction of displacement mechanism also taken transversely to the axis of the device and substantially as viewed along the line **3—3** in Fig. 4;

Fig. 4 is a vertical cross-sectional view taken approximately along the line **4—4** in Fig. 3;

Fig. 5 is another transverse sectional view of still another modified construction as viewed substantially along the line **5—5** in Fig. 6;

Fig. 6 is a horizontal cross-sectional view through the device illustrated in Fig. 5 and as taken substantially along the line **6—6** therein; and

Fig. 7 is a fragmentary sectional view taken substantially along the lines **7—7** in Figs. 5 and 6 to illustrate certain details of construction.

It is to be understood that the displacement mechanism of the present invention may have many uses. Although the device has hereinbefore been referred to as a pump, it is also possible to use the displacement mechanism as a blower, compressor, booster pump, vacuum pump, aspirator or in other similar capacities. Furthermore, the fluids being used may vary in nature. For example, if the device is being used as a motor it is possible to supply the same with fluid under pressure that may be air, vapor, thermally heated fluid or expansive gases such as can be supplied by internal combustion means, etc.

To simplify the explanation of the device herein disclosed it shall be referred to as a pump but not necessarily so by way of any limitation. Therefore, referring to Figs. 1 and 2, the pump is generally indicated by the reference numeral **10** and is enclosed by a casing made in two separable sections **11** and **12** respectively, for purposes of assembly. A fluid opening **13** extends from the upper periphery of the pump while a substantially axially disposed opening **14** is provided in the wall of the section **12** of the casing. Disposed within the confines of the casing are the discs **15** and **16**, disc **15** being adapted to carry the spiral blades **17** and **18** while the disc **16** carries the spiral blades **20** and **21**. The discs **15** and **16** are disposed in parallel spaced relation as best shown in Fig. 2 with the blades of one disc oppositely disposed and nested within the convolutions of the blades of the other disc. Furthermore, as illustrated in Fig. 1 it will be noted that the blades **17** and **18** of the disc **15** are disposed in 180 degree angular displacement with respect to each other while the blades **20** and **21** of disc **16** are also similarly located in relation to their supporting disc. The number of blades in each group may be increased in which case the angular displacement will be equal to 360 degrees divided by the number of blades. Therefore, by using four blades the relative angular displacement therebetween will be 90 degrees.

The mounting means and the mechanism for oscillating the discs **15** and **16** is best illustrated in Fig. 2. A pair of shafts **22** and **23** are mounted in the casing walls and extend therebetween for driving the eccentrics **24** and **25** adjacent the wall of section **12** of the casing and also the eccentrics **26** and **27** disposed adjacent the wall of section **11** of the casing. The disc **15** is provided with a pair of bosses **28** and **30** which act as followers, such bosses having the eccentrics **26** and **27** nested therein. Similarly, the disc **16** is provided with bosses such as **31** and **32** for cooperating with the eccentrics **24** and **25** in a similar manner. Obviously rotation of shafts **22** and **23** will cause the eccentrics connected with each shaft in 180 degree offset relationship to move the discs **15** and **16** toward and away from each other in oscillatory fashion to produce the pumping action within the cooperating spiral blades of each of said discs. Inasmuch as shafts **22** and **23** rotate on fixed axes, each disc is provided with openings to permit oscillation of the discs relative to the shafts. Disc **15** has openings **33** and **34** while disc **16** has similar openings **35** and **36** for such clearance purposes.

Gears such as **37** and **38** are conveniently secured to shafts **22** and **23** in any suitable manner, and such gears are driven by a common gear **40** secured to and driven by a shaft **41** that may be connected in any desirable fashion to a source of power.

Each of the eccentrics such as **24** and **25** are provided to carry springs **42** and **43** which react between the eccentrics **24** and **25** and their respective shafts **22** and **23** to force the disc **16** radially in a direction to maintain contact between the abutting portions of the convolutions of the coacting spiral blades. It will be seen that each eccentric **24** and **25** is slotted as at **44** and **45** for straddling the flat portions **46** and **47** on each of the shafts **22** and **23** respectively. Since the contact points between the respective blades will always be in the direction of the high points of the cams **24** and **25**, it is seen that the springs **42** and **43** will always act in the same direction as the radially aligned points of line contact between the convolutions of the respective blades. By the same principle it is obvious that the cam members 26 and 27 may also be provided with similar resilient means to urge the blades 17 and 18 of the disc 15 into operative contact with their mating blade convolutions of the opposite disc 16.

Inasmuch as the disc 16 oscillates during the operation of the pump, it is necessary to provide some form of sealing means between such disc and the wall of section 12 of the casing to provide suitable communicating means between the interior of the pump blades and the ports 14 for conveying fluids. Therefore a sleeve such as 48 is snugly fitted within the opening 50 provided in the disc 16 and is flanged as at 51 to provide an annular leg which is acted upon by two or more springs 52 which are carried by the disc 16 in the manner best illustrated in Fig. 2. Not only does this sealing means described form a gap between the interior of the pump and the opening 14, but the same also provides a reactionary means which causes the disc 16 to be urged axially of the pump for maintaining the spiral blades in operative end to end nested relation during the operation of the pump.

With the construction of pump above described and disclosed in Figs. 1 and 2, it will be seen that upon operation of this pump and due to the oppositely related positions of the eccentrics thereof that the two discs and their respective blades will at all times be operated in radially opposite directions thereby neutralizing vibratory action due to this motion.

In the modified construction of pump illustrated in Figs. 3 and 4 the casing is generally indicated at 55 and comprises the two sections 56 and 57 that are conveniently connected and have a port at the upper periphery of the pump as indicated at 58. A pair of discs 60 and 61 are parallelly disposed within the casing similarly to the discs 15 and 16 in the previously described pump but in the latter case referring to Figs. 3 and 4, the disc 60 is mounted for rotation about an axis *a* while the disc 61 is mounted for rotation upon an axis *b*, said axes being offset in the manner shown in Fig. 4. As seen in Fig. 4 the disc 60 terminates axially in a sleeve such as 62 which is journaled in a bearing boss 63 connected with the wall of section 56 of the pump casing 55. A pulley wheel such as 64 is keyed at 65 to the sleeve 62 for rotatably driving disc 60 upon its axis *a*.

The axial portion of the wall casing section 57 terminates in a tubular port 66 determined by the bearing sleeve 67 which supports the disc 61 by means of sleeve 68 for rotation about the axis *b*. The inner end of the sleeve 68 is closed as at 70 and a plurality of peripherally located holes such as 71 provide communicating ports between the interior of the pump blade chamber and the port 66.

In this construction, each disc carries two or more spiral blades in cooperative engagement as described in connection with Figs. 1 and 2 and the blades carried by the disc 60 are designated by 72 and 73 while the blades carried by the disc 61 are designated as 74 and 75. However, in the construction in Figs. 3 and 4 it is seen that the discs 60 and 61 are continuously rotated about individually fixed axes. In this construction, however, the spiral blades are offset with their respective generic centers eccentrically displaced with respect to the centers of rotation of the respective discs 60 and 61 which carry such blades. The same action is obtained as in the form described in connection with Figs. 1 and 2 but the pump in Figs. 3 and 4 obtains this action by a continuous revolution of the working parts of the pump. This being the case it is necessary that both the discs 60 and 61 are driven at the same speeds. Such synchronization of speed may be obtained with various forms of mechanisms but in the present case universal means such as indicated generally at 76 is incorporated to establish such a drive. A disc 77 has a stem 78 located within the sleeve 62 and a set screw 80 is adapted to position the stem 78 within the sleeve 62 while the nut 81 threaded upon the end 82 of the stem 78 provides a means for locking such stem and its attached disc 77 in fixed angular relation with respect to the sleeve 62 and also the disc 60.

The face of disc 77 is provided with a slideway 83 while the closed end 70 of the sleeve 68 is provided with a similar slideway 84 disposed at right angles to the slideway 83. A circular disc 85 is interposed between the face of the disc 77 and the closed end 70 of the sleeve 68 and disc 85 has slots 86 and 87 in the opposite faces thereof for coacting with the slideways 83 and 84 to provide a universal drive between the blade carrying discs 60 and 61 respectively.

Therefore, as the pulley-wheel 64 is rotated by suitable belt means each of the discs 60 and 61 will be rotated in angular synchronism causing the blades of each disc to cooperate and move in eccentric paths due to their offset relation of their resepctive generic centers with respect to the axes of rotation thereby obtaining fluid compression as desired. Any angular adjustment necessary between the oppositely disposed spiral blades to obtain the correct contact between the respective convolutions of such blades may easily be had by adjusting the set-screw 80 and by locking the disc 60 and its corresponding blades by means of the nut 81 to maintain such contacting relation between the blades.

Referring now to Figs. 5, 6 and 7 another modified construction of displacement mechanism is shown having a separable casing consisting of sections 90 and 91 suitably fastened together by any desirable means. In this case, the discs hereinbefore refered to in connection with the other constructions are supplanted by a pair of gears 92 and 93 for carrying the spiral blades 94—95 and 96—97 respectively. An offset shaft 98 carries gears 99 and 100 for driving the gears 92 and 93 respectively. This produces a drive which synchronizes the motion of the gears 92 and 93 which here act in the capacity of the discs formerly explained. Such gears will obviously move the blades of each oppositely related set in the desired manner. In this construction the blades will also be offset as in the form described in connection with Figs. 3 and 4, such blades being eccentrically disposed with respect to the axes of rotation of the gears whereas the actual motion of each of the blade sets will be eccentric relatively to each other to obtain the pumping action. In this design as well as that illustrated in Figs. 3 and 4 the offset of each set of blades is such that the actual eccentricity of the blades in one set will be one-half the radial distances between adjacent convolutions of the blades.

It is through this rotary motion that the oscillatory motion of the blades is obtained, and it will also be seen that in the same instance as in the first construction wherein the blades move radially toward each other and radially away from each other during operation, reducing vibration, the same mechanical equivalents exist in this latter construction of Figs. 5 to 7 inclusive inasmuch as the blades act in the same manner although the bodily rotation thereof is continuous. This also applies to the construction in Figs. 3 and 4.

Referring again to Figs. 5 and 7 inclusive, it will be seen that a peripheral port 101 is provided for fluid passage into the casing whereas another port 102 is provided as shown in Figs. 6 and 7 for fluid discharge purposes. A sleeve member 103 provides the walls of the port 102 and extends inwardly into the casing to form a bearing 104 for rotatably supporting the hub 105 of the gear 92. Suitable screws or other fastening means such as 106 may be used for securing the sleeve 103 to the side wall of the casing section 90.

A plug such as 107 is secured to the wall of casing section 91 as by means of screws 108 and has an inwardly extending sleeve member 110 providing the bearing means for the hub 111 of the gear 93. The flanged portion 112 of the plug 107 has an annular gasket 113 for sealing the opening 114 in the wall of casing section 91. Similarly, the flange 115 of the port sleeve 103 is also adapted to seal the opening 116 in the wall of casing section 90 by means of a suitable gasket such as 117. Furthermore, it is to be noted that these sections consisting of the sleeve port 103 and the plug member 107 are made to be interchangeable so that the discharge port may be located at either side of the pump casing as needed by conditions of operation. It is also possible to use two ports such as defined by the sleeve 103 in the event that the pressures are great enough to deliver fluid from both sides of the casing under certain conditions of operation.

By referring to Fig. 7, it will be seen that the gear 92 is adapted to rotate about the axis C while the gear 93 is adapted to rotate about the axis *d* to obtain the eccentricity relation somewhat as shown in Figs. 3 and 4. It will also be noted as best illustrated in Fig. 5 that the gears 99 and 100 are located at a point where the pitch circles of the large gears 92 and 93 coincide producing a proper driving relationship between such eccentrically located gears. It is also possible to locate the offset shaft 98 at 180 degrees to the position indicated in Fig. 5 for driving the gears 92 and 93. Or, if desired, it is also within the purview of the present invention to locate two units such as the shaft 98 and gears 99 and 100 at both sides of the pump illustrated in Fig. 5 to obtain a dual driving relationship.

It is to be understood that the foregoing description and disclosures are all more or less specifically directed to exemplary constructions of the present displacement mechanism and that various changes and modifications are contemplated which will produce equivalent mechanisms or mechanical structures that shall function or produce the same operative requirements in a like manner as will the mechanisms described. It is therefore obvious that the present form, construction, or combination of parts described and illustrated are not to be limited to the exact disclosures excepting insofar as such structures shall be defined and determined by the breadth and scope of the appended claims.

I claim:

1. In a fluid displacement device having a casing with a pair of openings therein, a pair of movable discs in said casing and disposed in parallel spaced relation with respect to each other, a plurality of spiral blades of equal thickness

throughout their lengths carried by each disc in equal angular spaced relation, the blades of one disc being radially offset with respect to the blades of said other disc, said blades being nested between said discs with the convolutions of the blades on one disc substantially in contact with the convolutions of the blades on the other disc to provide cells between said blades, reactionary means interposed between a wall of said casing and one of said discs to urge the latter and its connected blades axially toward the other of said discs and its connected blades to maintain said blades of each disc in nested leakproof relation, and further reactionary means connected with one of said discs to maintain the contacting portions of said convolutions of the blades on said one disc in leakproof contact with the convolutions of the blades of the other of said discs, said latter reactionary means being adapted to follow the plurality of aligned contacted points of the respective convolutions of said groups of blades during the movement of said discs, and actuating means for moving said discs to progressively trap fluid within said cells and to conduct said fluid from one to the other of said casing openings.

2. In a fluid displacement device, a casing having a pair of openings, two sets of coacting spiral blades having the blades of each set displaced in equal angular relation with respect to each other, said blade sets each being offset radially with the convolutions of one set of blades in contact with the convolutions of the other set of blades to provide cells between said blades sets, oscillatory supporting means for each set of blades respectively, and actuating means to cause said supporting means to oscillate the blade sets and thereby trap fluid within said cells to conduct the fluid from one to the other of said openings through said casing, said actuating means comprising drive means including spaced eccentrics for each blade set, the eccentrics for one blade set being oppositely positioned from the eccentrics of the other blade set, and follower means connected with each set of blades and operatively connected with the eccentrics for each set of blades respectively to cause said blades to oscillate whenever said drive means functions.

3. In a fluid displacement apparatus, a casing having an inlet and an outlet, a pair of spaced parallel and rotary disks in said casing, said disks having spiral blades extending in overlapping relation, the blades of one disk being radially offset with respect to the blades of the other disk, each disk having a pair of spaced cup-like bearings upon its outer surface, the bearings on one disk being radially offset with respect to the bearings on the other disk, cams rotatably mounted in said bearings, the cams on one disk being oppositely disposed with respect to the cams on the other disk, a pair of driving shafts, each connecting a cam on one disk with the cam more directly opposite on the other disk and means for rotating said shafts in opposite directions.

4. In a fluid displacement apparatus, a casing having an inlet and an outlet, a pair of spaced parallel and rotary disks in said casing, said disks having spiral blades extending toward each other in overlapping relation, the blades of one disk being radially offset with respect to the blades of the other, a pair of spaced shafts journalled in said casing and extending through said disks, driving connections between said shafts and one disk for moving said disk in one direction and driving means between said shafts and

the other disk for forcing such other disk in the opposite direction.

5. In a fluid displacement apparatus, a casing having an inlet and an outlet, a pair of spaced parallel and rotary disks supported in said casing, yielding means between one disk and the adjacent wall of the casing to allow lateral movement of such disk, said disks having spiral blades extending in overlapping relation, a pair of spaced driving shafts journalled in said casing and extending through said disks, yielding driving means between said shafts and one of said disks and effective for shifting such disk in one direction, and driving connections between said shafts and the other disk effective for shifting such disk in the opposite direction.

6. In a fluid displacement apparatus, a casing having an inlet and an outlet, a pair of spaced parallel and rotary disks mounted in said casing, spaced parallel shafts journalled in said casing and extending through said disks, cams secured to said shafts in operative relation to said disks, the cams engaging one disk being oppositely directed with respect to those engaging the other disk and yielding means between one of said disks and the adjacent wall of said casing.

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