(No Model.) 2 Sheets—Sheet 1.

M. W. HALL.

ROTARY PUMP.

No. 557,123. Patented Mar. 31, 1896.

FIG. 1.

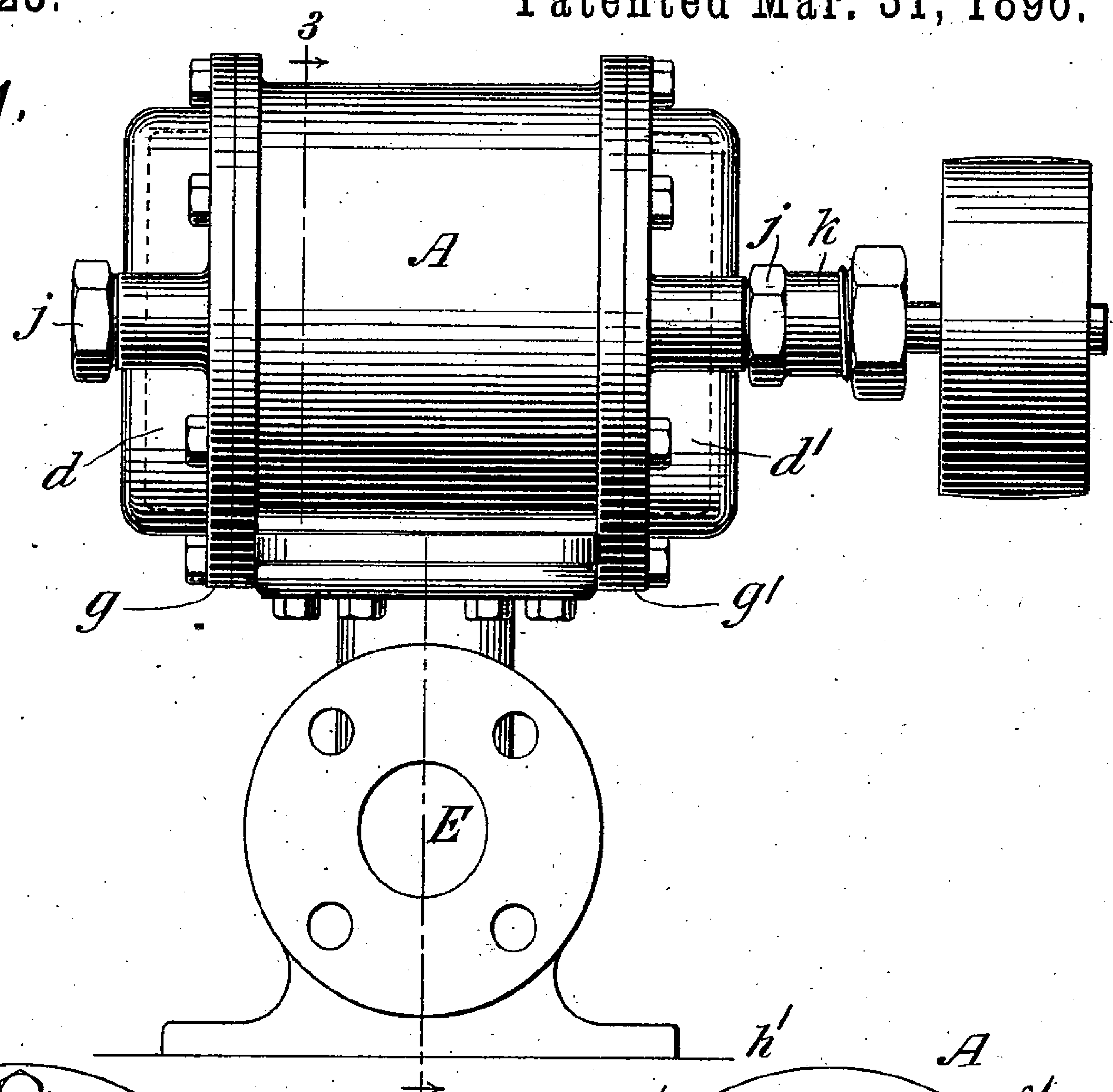


FIG. 2.

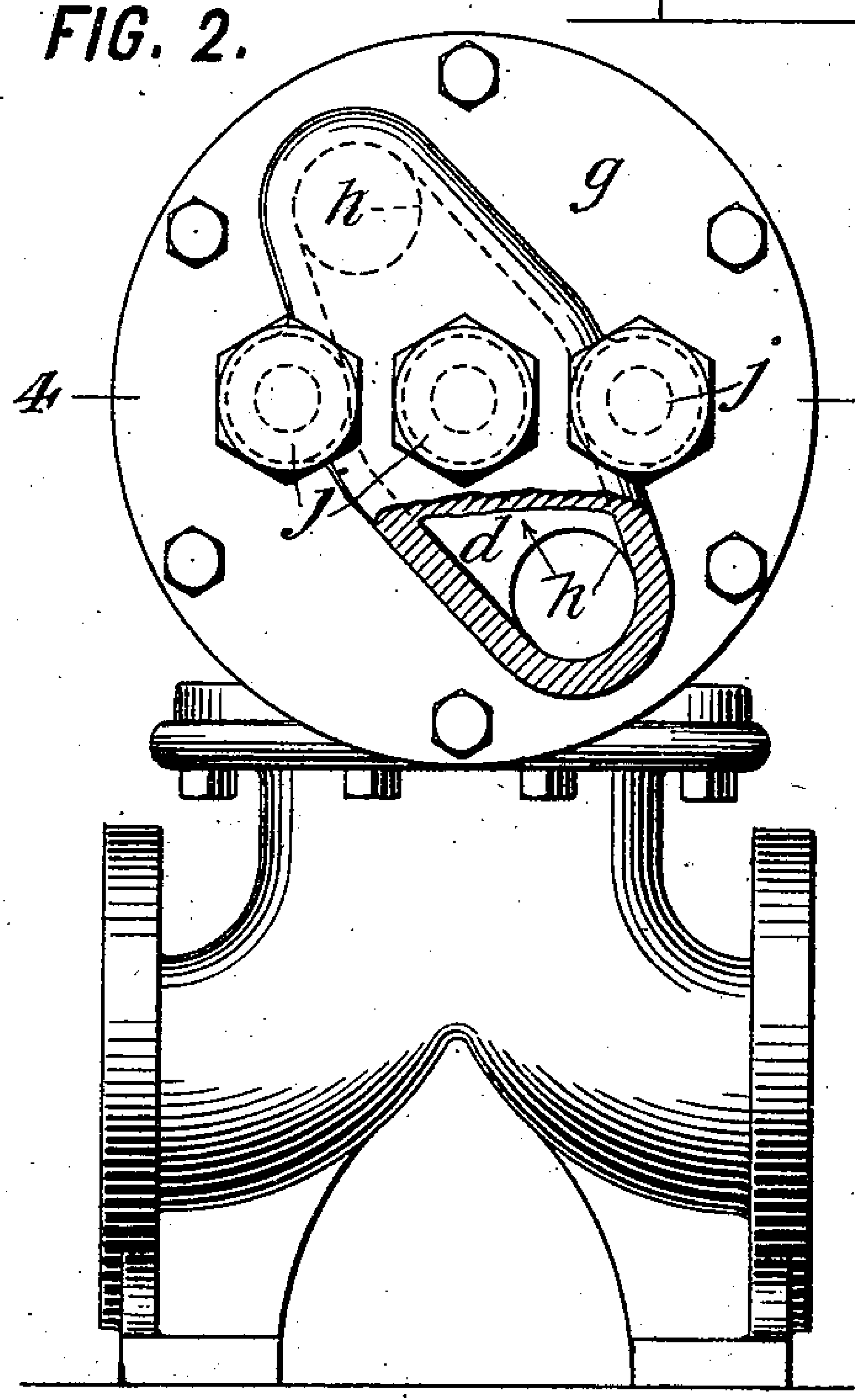
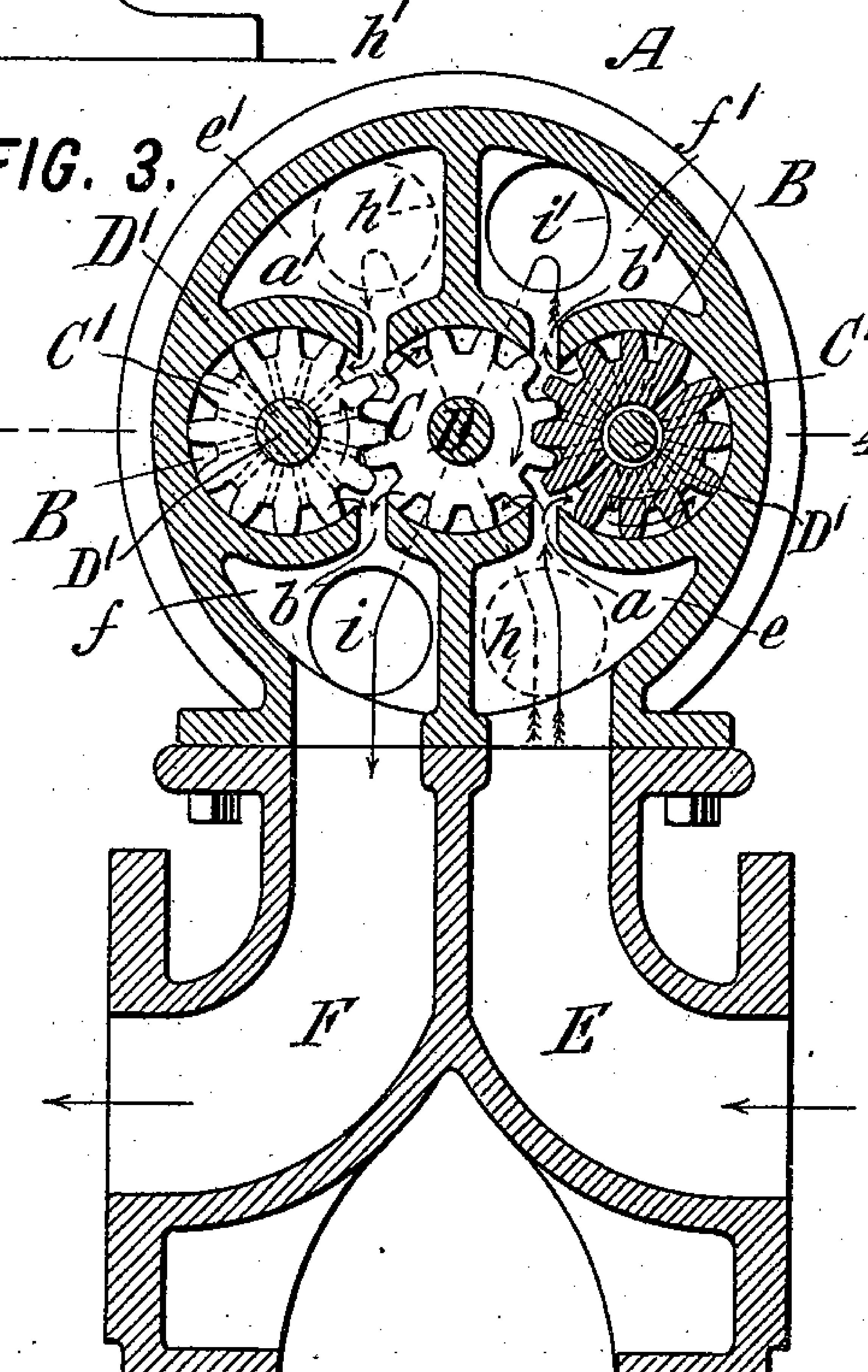


FIG. 3.



WITNESSES:

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H. W. Lloyd.

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(No Model.) 2 Sheets—Sheet 2.

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FIG. 4

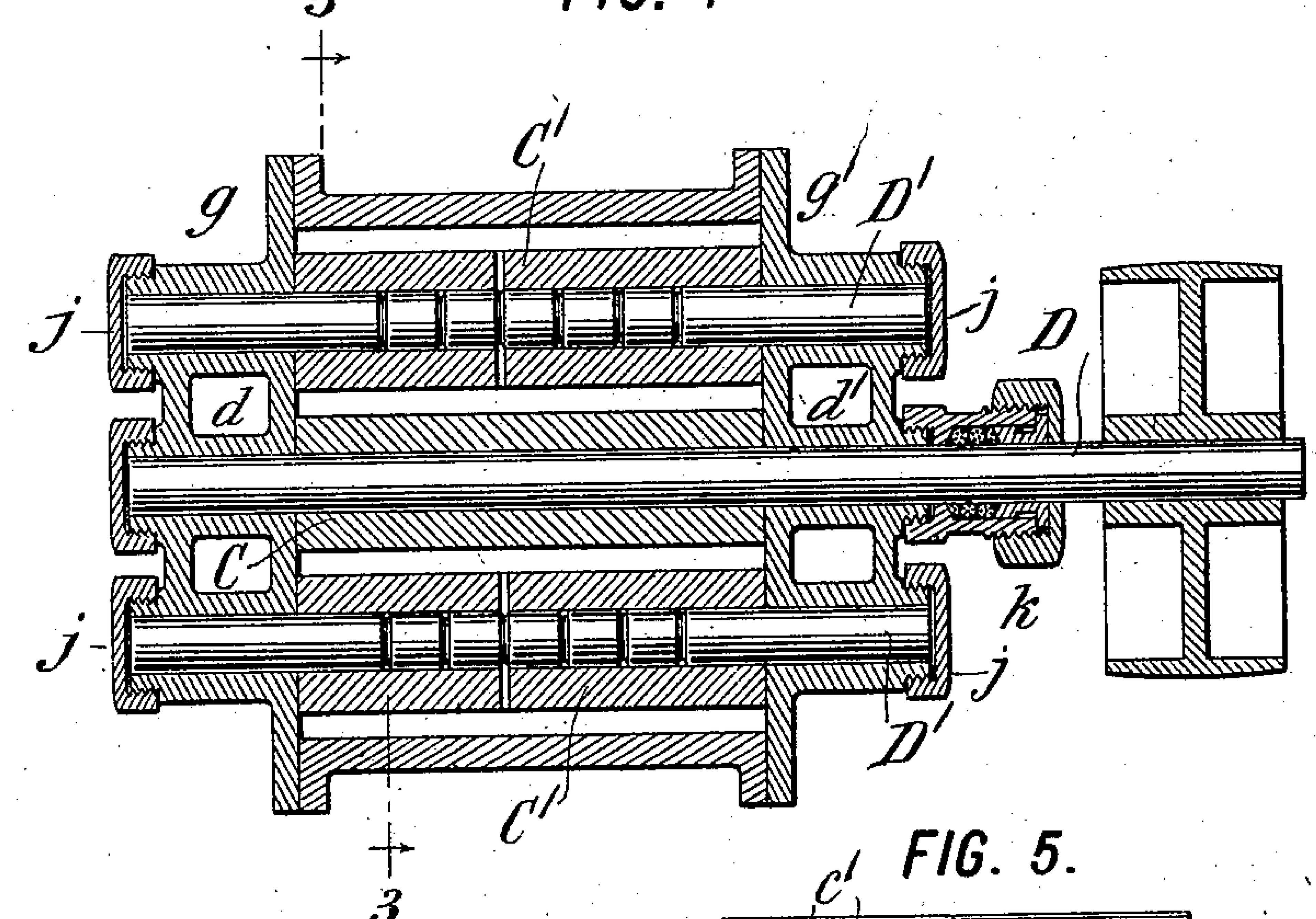


FIG. 5.

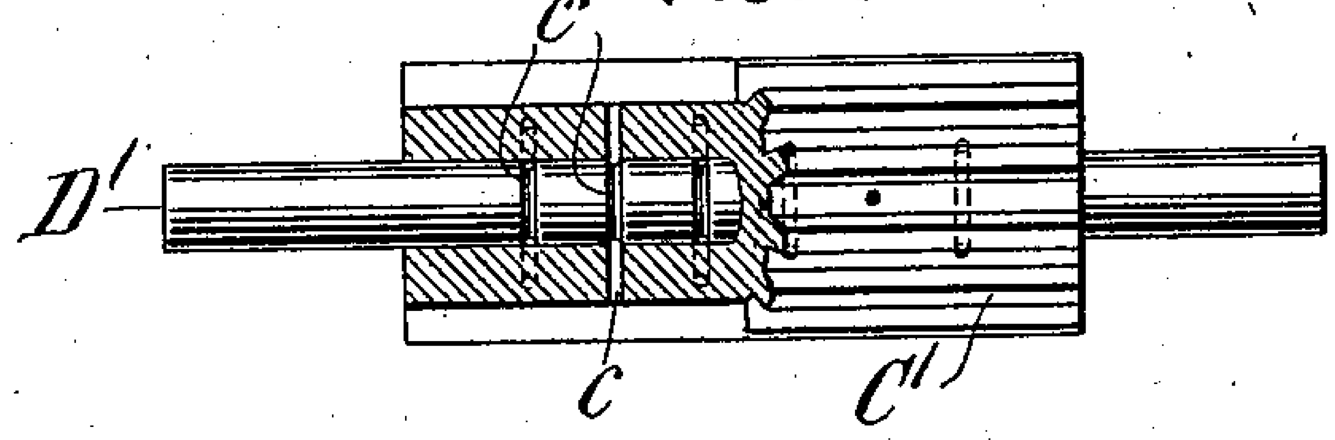


FIG. 6.

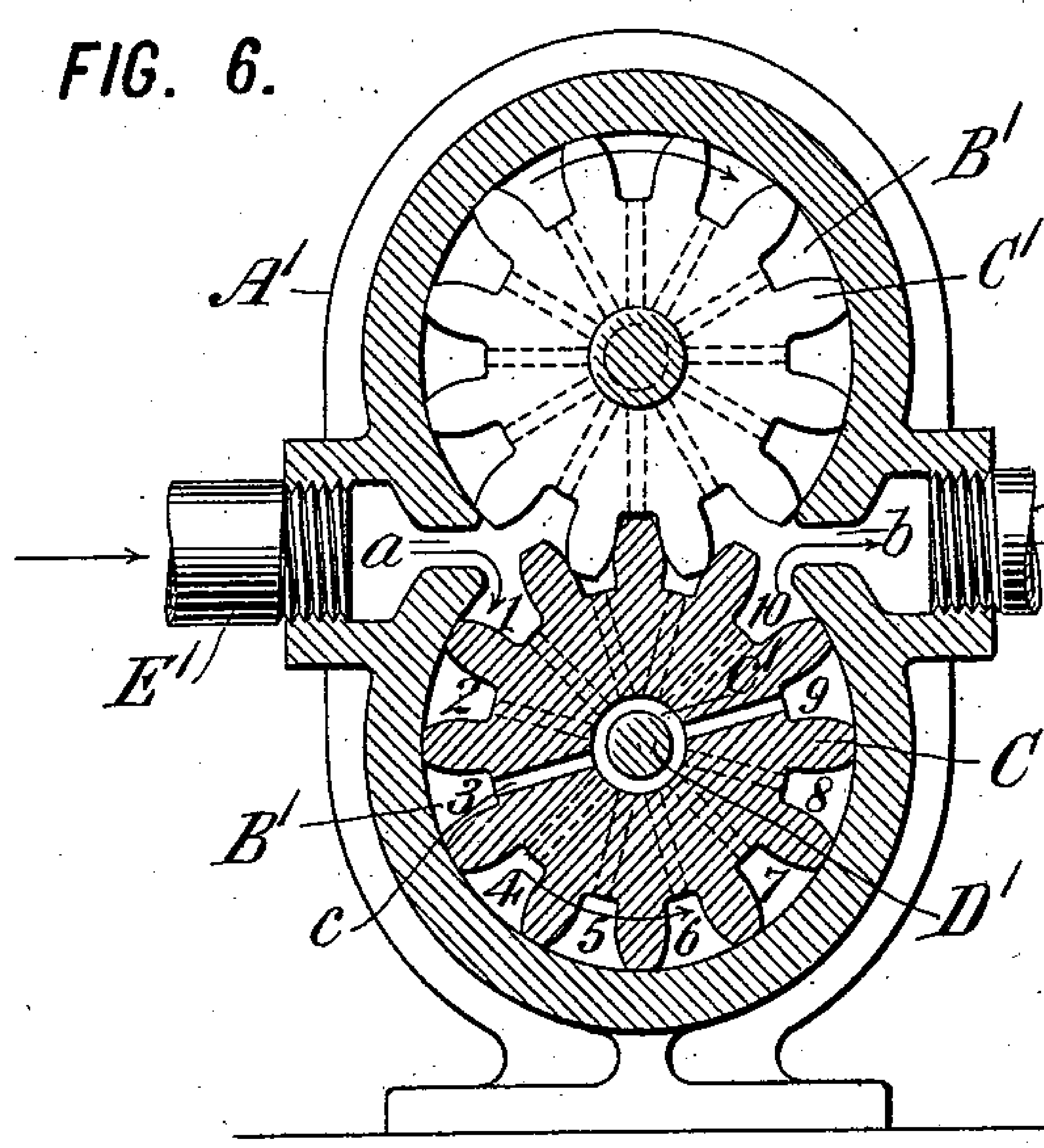
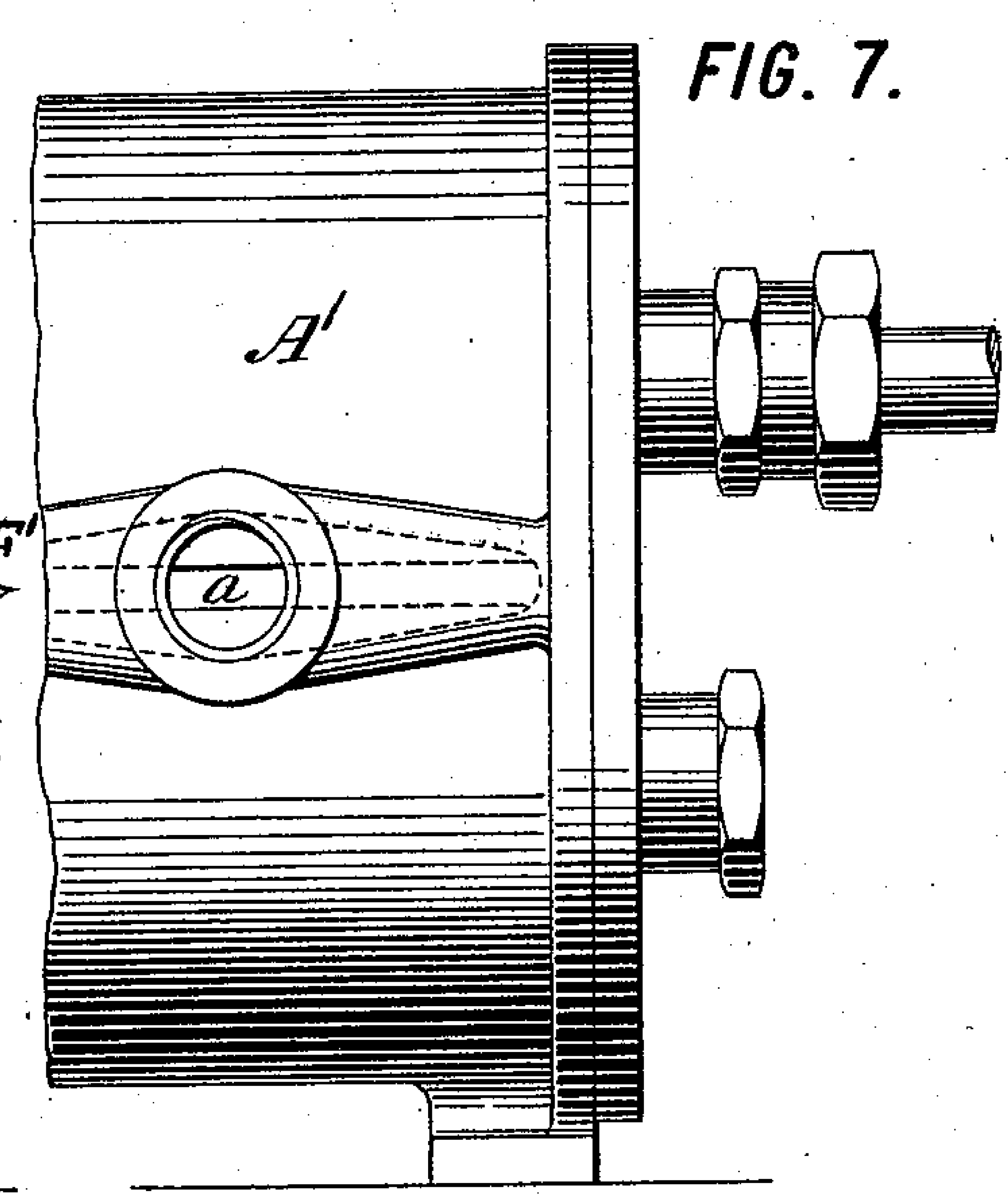


FIG. 7.



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UNITED STATES PATENT OFFICE.

MILAN W. HALL, OF YONKERS, NEW YORK.

ROTARY PUMP.

SPECIFICATION forming part of Letters Patent No. 557,123, dated March 31, 1896.

Application filed March 23, 1894. Serial No. 504,767. (No model.)

To all whom it may concern:

Be it known that I, MILAN W. HALL, a citizen of the United States, residing at Yonkers, in the county of Westchester and State of New York, have invented certain new and useful Improvements in Rotary Pumps, of which the following is a specification.

This invention relates to rotary pumps of the class known as "gear-pumps," wherein two or more closely-fitting gear-wheels turn in mesh with one another within a casing having chambers closely inclosing them and with inlet and outlet openings on opposite sides, so that as the gears revolve the water is carried around in the interdental spaces. As heretofore constructed such gear-pumps have proved inefficient in practice by reason, as I believe, of the pressure on the revolving gears being unbalanced and tending to thrust them to one side, so that much of the power is consumed in friction.

The principal feature of my invention consists in remedying this difficulty by constructing the gears with ducts communicating between the interdental spaces on opposite sides of the gears, in order that whatever hydraulic pressure exists on one side the same pressure is necessarily communicated to the opposite side, thereby balancing the gear. By adopting this construction it is found that the efficiency of the pump is greatly increased.

My invention further consists in certain other features of construction, as will be hereinafter indicated.

Figure 1 of the accompanying drawings is a side elevation of the preferred construction of my improved rotary pump having three gears. Fig. 2 is an end elevation thereof, looking from the left in Fig. 1. Fig. 3 is a vertical transverse mid-section thereof, the upper portion being cut in the planes indicated by the line 3 3 in Fig. 4 and the lower portion being a mid-section, as denoted by the line 3 3 in Fig. 1. Fig. 4 is a horizontal section on the line 4 4 in Figs. 2 and 3. Fig. 5 is a sectional elevation of one of the gears and its shaft removed. Figs. 6 and 7 show a modification wherein my invention is reduced to its simplest form, Fig. 6 being a vertical transverse mid-section and Fig. 7 a fragmentary side elevation.

I will first describe the simpler construction shown in Figs. 6 and 7, where A′ designates the inclosing case formed with two cylindrical chambers B′ B′, in which the intermeshing gears C′ C′ turn. These gear-wheels are constructed as elongated pinions, the teeth of which are accurately finished to make a close mesh with each other and which make a close but free working fit within the chambers B′. They are mounted on shafts D′ D′ in the manner shown in Fig. 5, which illustrates one of the gears and its shaft removed. The water enters through a suction-pipe E′ and emerges by a discharge-pipe F′ connected in any suitable way with the case. From the suction-pipe E′ the water passes through a port *a* extending longitudinally of the gears and adjacent to their intermeshing teeth, and by reason of the rotation of the gears in the direction shown by the arrow the water is turned into the interdental spaces of the two gears in alternation, first entering the space of one gear and then, as the tooth closes that space, being drawn into the corresponding space of the other gear and being carried around within the chambers in the interdental spaces and delivered at the opposite side, where it passes out through a similar port *b* to the discharge-pipe F′.

The construction thus far described is that of an ordinary gear-pump. Pumps of this character have not gone largely into use because of their low efficiency. This defect it is the purpose of my present invention to overcome. In an ordinary gear-pump it is obvious that the interdental spaces on the suction side of each gear contain liquid under a much lower pressure than that of the liquid in the spaces on the discharge or eduction side. For example, in pumping water from a lower level, such as will create a suction of ten pounds per square inch, and elevating it to a higher level, such as corresponds to a pressure of twenty pounds per square inch, there is a difference in pressure between the first interdental space on the suction side (marked 1) and the last or discharge interdental space on the discharge side, (marked 10 in Fig. 6,) this difference amounting to thirty pounds per square inch. In the second space (marked 2) there will be substantially the same degree of suction, and in the next to the last space (marked 9) there is, by reason of leakage due to the loose fit of the teeth, a pressure somewhat less than that in the space 10, but still considerably greater than the pressure in space 2. The pressures may thus be traced around the gear in the spaces 2 3 4, &c., the mean of the pressures on the suction side or left half of the gear being less than the mean of the pressures on the discharge or right half by an amount which, for example, I may represent at twenty-five pounds per square inch. It is obvious that this pressure tends to force each of the gears toward the left or suction side, and thereby presses the journals of the gear-shafts so strongly to one side in their bearings as to introduce a considerable degree of friction, the loss from this source becoming a high percentage of the power expended in accomplishing the lifting of the water. To overcome this unbalanced pressure my invention introduces a new construction in pumps of this character—namely, the provision of ducts or passages communicating between the interdental spaces on opposite sides of the gears. I prefer to connect the diametrically-opposite spaces by such ducts—as, for example, the spaces 3 and 9 in Fig. 6, which are connected by the duct or passage c. The effect of this connection is that sufficient liquid may flow from the space 9 of higher pressure back to the space 3 of lower pressure to equalize their pressures, and thereby, since the same equalization occurs in all the diametrically-opposite pairs of interdental spaces to balance the gear, so that it shall turn with perfect freedom, encountering only the direct resistance due to the lifting of the column of water and the indirect resistance due to the slight degree of friction of a balanced shaft turning in its bearings. The practical use of gear-pumps embodying my invention has demonstrated not only that their efficiency is greatly increased as compared with other gear-pumps, but that the increase in efficiency is such as to enable a pump of this character to compare favorably with any other construction of positive-acting rotary pump.

The preferred means of constructing the communicating ducts is by boring diametrical holes through the gears C′ in different positions, so as to connect together the interdental spaces 1 and 7, 2 and 8, 3 and 9, &c., on diametrically opposite sides. To prevent the interception of these bores by the shaft, the bores on opposite sides are connected together by means of a circular groove c', Fig. 6, these grooves being preferably formed in the shaft in the manner shown in Fig. 5. The successive diametrical bores c are spaced apart longitudinally sufficiently to coincide with the successive grooves c' in the shaft. Other means of effecting the communication between opposite interdental spaces may be substituted for the particular construction shown, although this is considered the most simple and convenient. While it is preferable to connect diametrically opposite interdental spaces, as 3 and 9, yet this is not essential—as, for example, space 2 might be connected with space 9, or space 3 might be connected with space 8.

It will be understood that by the provision of the ducts c the algebraic sum of the pressures in the interdental spaces on one side of the gear is rendered equal to the algebraic sum of such pressures on the opposite side. Thus the suction or negative pressure in space 1 on the left side is communicated to the space 7 on the right side, and the maximum pressure at the discharge which exists in space 10 on the right is transmitted across to space 4 on the left. Thus the transition from the extreme negative pressure to the extreme positive pressure, instead of being effected only between interdental spaces 1 and 10, occurs between spaces 1 and 4, and is followed by a corresponding decrease of pressure between spaces 4 and 7, and again by an increase between spaces 7 and 10. Practically the fit of the parts is so close that the actual passage or flow through the communicating ducts of but a very minute quantity of liquid is sufficient to instantly accomplish the requisite or balancing of pressures, so that very minute ducts are sufficient for the purpose, even at an exceedingly high speed of rotation.

Having now elucidated the principle of my invention as applied to the simplest construction shown, I will proceed to describe my complete invention with reference to Figs. 1 to 4. This construction differs from that already described chiefly in the employment of three gears in place of two, whereby the capacity of the pump is doubled with the addition of only one moving part, and whereby a further degree of balancing is effected, since in the first construction one of the gears, B′, is necessarily employed as the driving-gear, and hence is subject to an unbalanced thrust by reason of driving the other or driven gear only at one side, whereas in the three-gear pump, by employing the middle gear as the driver, it exerts an equal thrust on opposite sides and in opposite directions upon the outer or driven gears, so that the middle gear is thereby completely balanced.

The middle gear is lettered C and is fixed on a shaft D which passes outside the casing of the machine and receives a pulley or other means for driving it, as shown. The two outer gears C′ C′ and their shafts D′ are identical in construction with the gears and shafts first described. The outer case is lettered A, its gear-chambers are B B, and its suction and discharge passages are, respectively, E and F. Within the casing A the suction-passage E communicates directly with a suction-chamber e, and this in turn communicates with a secondary suction-chamber e' on the diametrically opposite side, the communication between chamber e and chamber e' being effected by means of a passage d formed obliquely through the head g forming part of the case A and affording a cross-communication between the holes h opening into the chamber e and h' opening into the chamber e'. In like manner the discharge-passage F opens out of a discharge-chamber f in the lower part of the casing A, and this chamber communicates with a diametrically opposite discharge-chamber f', these communications being effected by a port or passage d' formed in the opposite head g', as shown in Fig. 1, and communicating with the respective chambers through holes i and i', Fig. 3.

It results from this construction that the water entering the pump through the suction E is divided into two portions, the one remaining in the suction-chamber e and the other crossing over to the suction-chamber e'. The water flowing from the chamber e enters the interdental spaces of the gears through the port a, while that from the opposite chamber passes to the gears through the port a'. The water is carried around in the interdental spaces of the respective gears and emerges through two opposite ports b and b' respectively into the discharge-chambers f and f'. From the latter it crosses over through the port d', whereby the two streams of water are reunited and pass out at the discharge F.

From the port a the water is carried alternately to the right by the gear C' and to the left by the gear C, being discharged into the port b' at the right and from the port b at the left, and the same action occurs at the opposite port a', the water passing partly to the port b and partly to b', so that each of the two streams into which the entering water is first divided is again divided into two other streams.

The gears C' C' are balanced by the provision of cross-ducts c in exactly the manner first described. The gear C, however, is unprovided with any such cross-ducts and its shaft D is not grooved, since this gear does not require balancing.

By examining Fig. 3 it will be seen that the algebraic sum of the pressures on diametrically opposite sides of the gear C must be the same, since the suction at a and a' presenting equal negative pressures are diametrically opposite, and the discharge at $b\ b'$ presenting equal positive pressures are diametrically opposite. The hydraulic thrust on gear C is therefore balanced, and by reason of its imparting equal mechanical propulsion to the gears C' C' on opposite sides, its mechanical thrust is likewise balanced, so that it turns with the minimum degree of friction.

The projecting ends of the shafts D D' D' are journaled in bearing-hubs formed in the heads $g\ g'$, as shown in Fig. 4. The ends of these hubs are closed by caps $j\ j$ screwed over these hubs, as shown, except in the case of one end of the shaft D, which passes out through a stuffing-box k screwed on the end of the bearing-hub, as shown. The two heads $g\ g'$ are duplicates.

The construction may be greatly varied without departing from my invention—as, for example, by adopting some different arrangement of the water-passages, or by employing a greater number of intermeshing gears in order to increase the capacity of the pump. It is not essential that the gears shall be of equal size.

I claim as my invention the following-defined novel features, substantially as hereinbefore specified, namely:

1. The combination of a casing having suction and discharge ports, and a plurality of intermeshing gear-wheels revolving in chambers therein, with ducts in one or more such gear-wheels communicating between opposite interdental spaces thereof, whereby the hydraulic pressures on opposite sides of the gear-wheels are balanced.

2. The combination of a casing having three chambers and suction and discharge ports entering said chambers at their intersections with one another, with three intermeshing gear-wheels revolving in said chambers, the two outer wheels being balanced hydraulically by having in them ducts communicating between their opposite interdental spaces.

3. The combination of a casing A, formed with three intersecting gear-chambers B B, and with a pair of suction-chambers and a pair of discharge-chambers, and two suction and two discharge ports communicating between said chambers respectively, and the gear-chambers at the intersections of the latter, and heads $g\ g'$ having cross-passages formed in them, the one passage affording communication between the two exhaust-chambers and the other passage affording communication between the two discharge-chambers, and three intermeshing gear-wheels revolving in said gear-chambers.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

MILAN W. HALL.

Witnesses:
GEORGE H. FRASER,
CHARLES K. FRASER.