No. 808,343. PATENTED DEC. 26, 1905.

J. W. CLOUD.

ELASTIC FLUID TURBINE.

APPLICATION FILED MAR. 7, 1905.

6 SHEETS—SHEET 1.

Fig. 1.

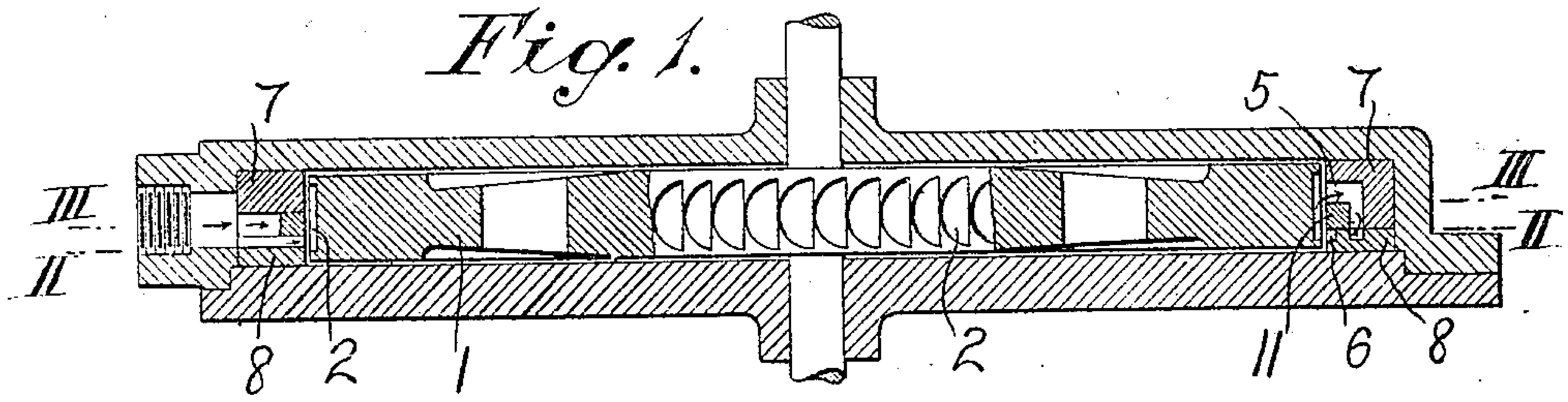
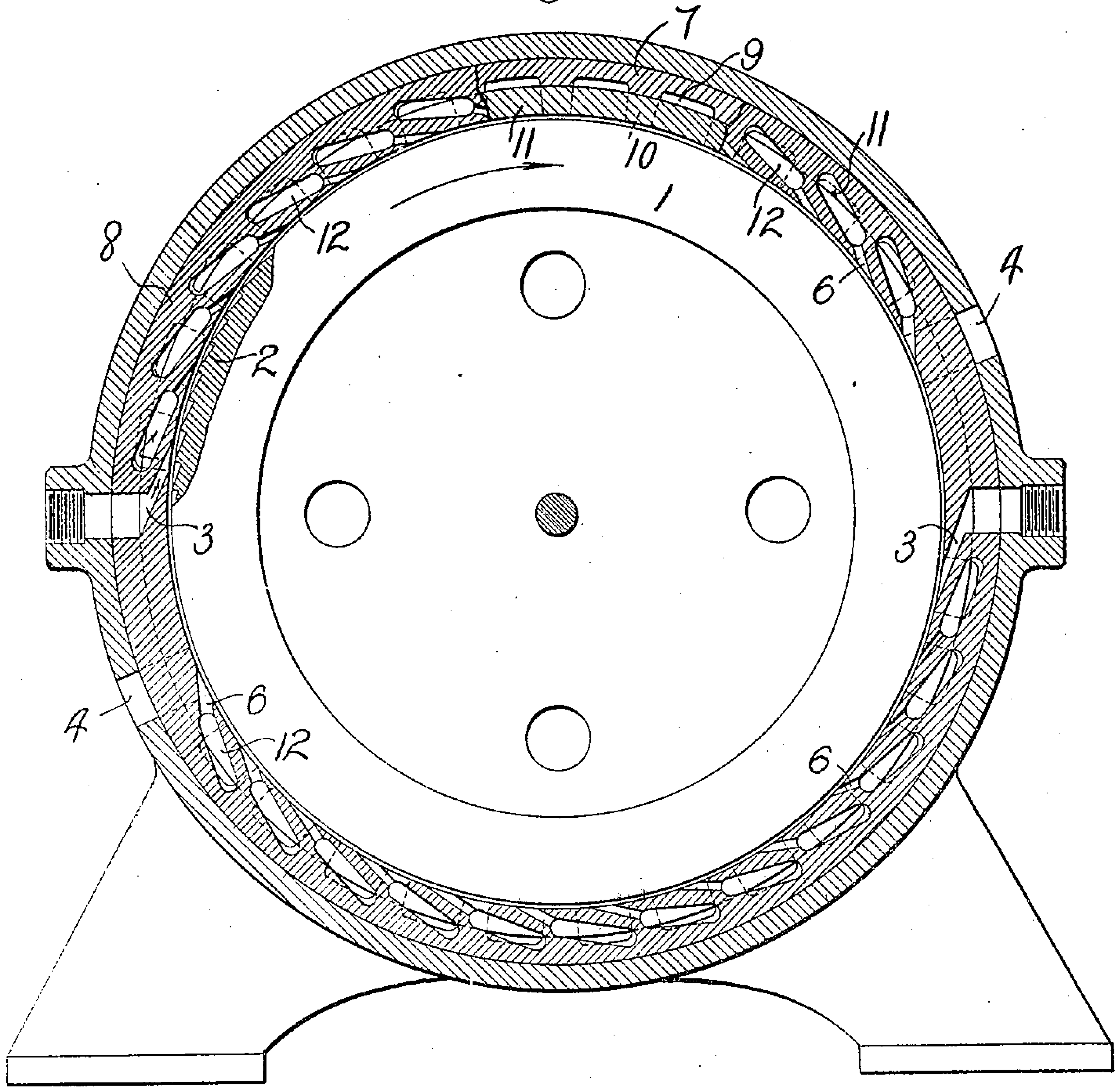


Fig. 2.



Witnesses
J. S. Custer
J. B. MacDonald

Inventor
John W. Cloud
by E. H. Wright Att'y.

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6 SHEETS—SHEET 2.

Fig. 3.

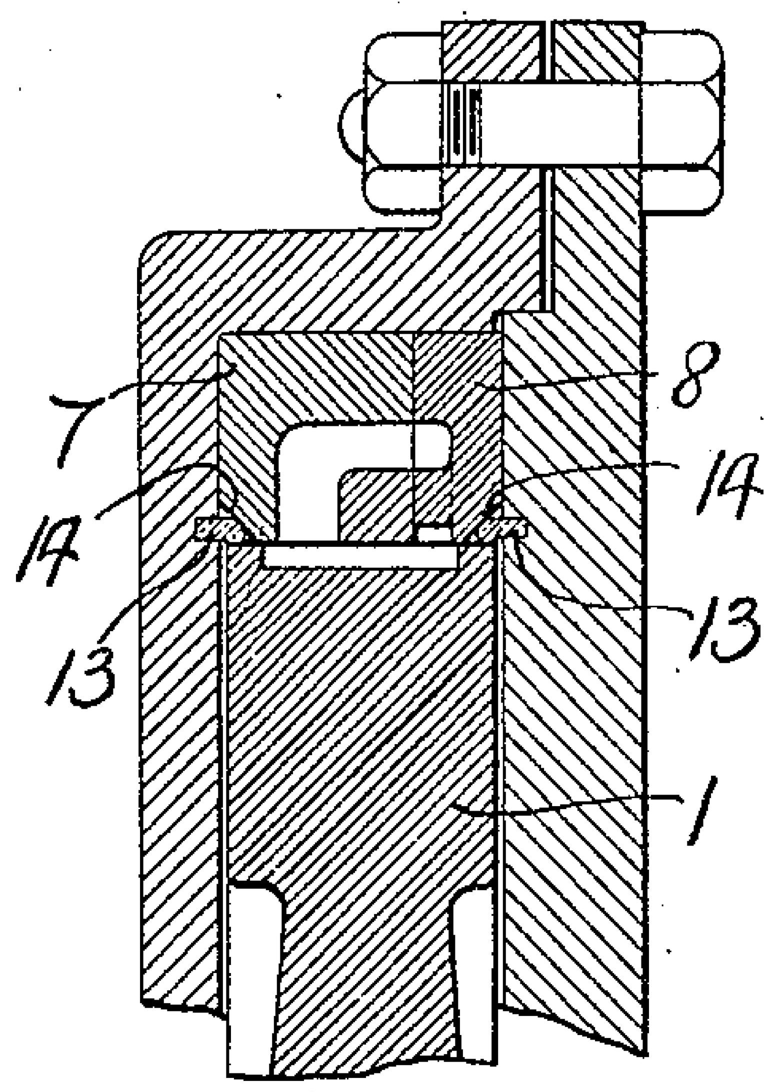
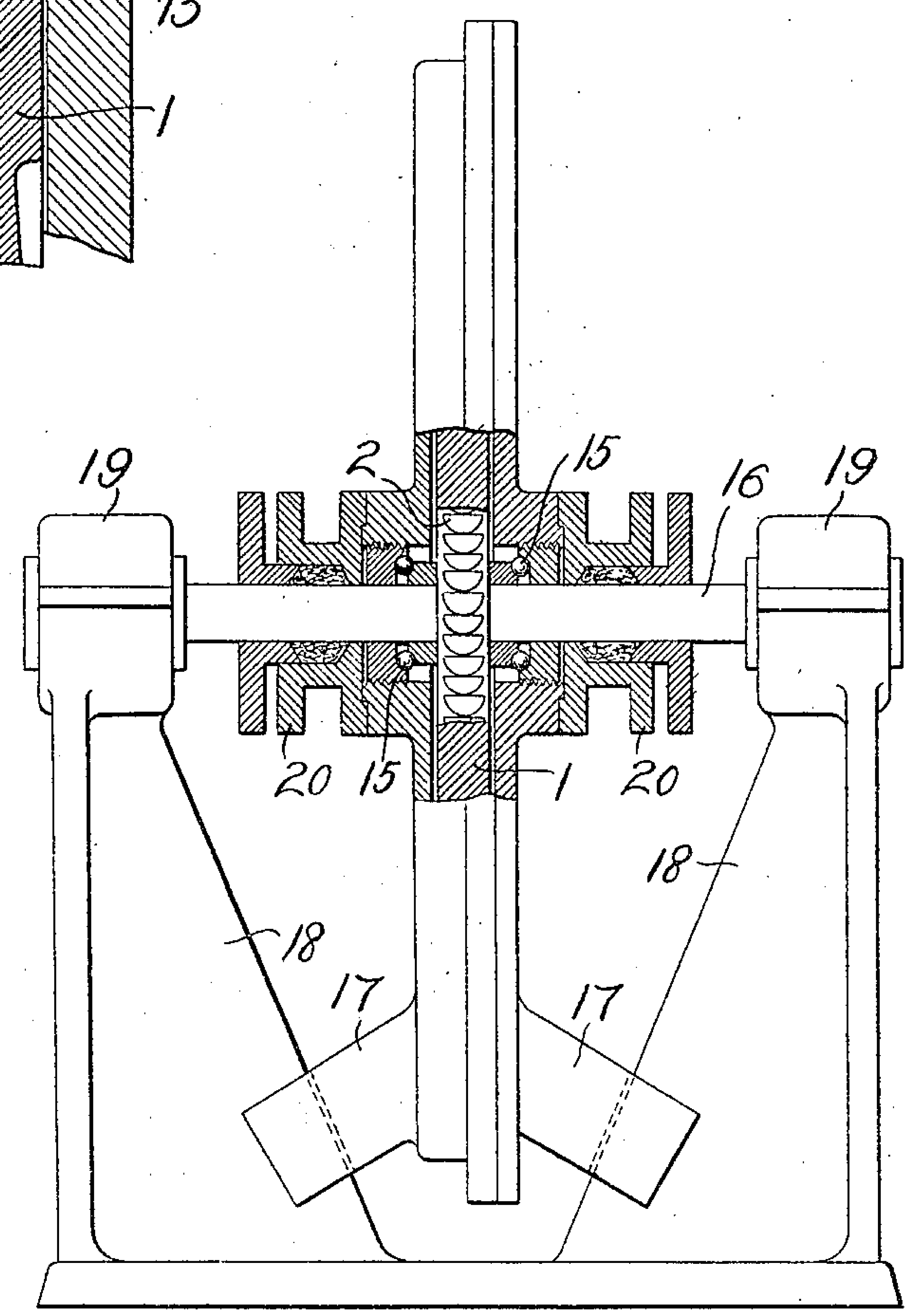


Fig. 4.



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6 SHEETS—SHEET 3.

Fig. 5.

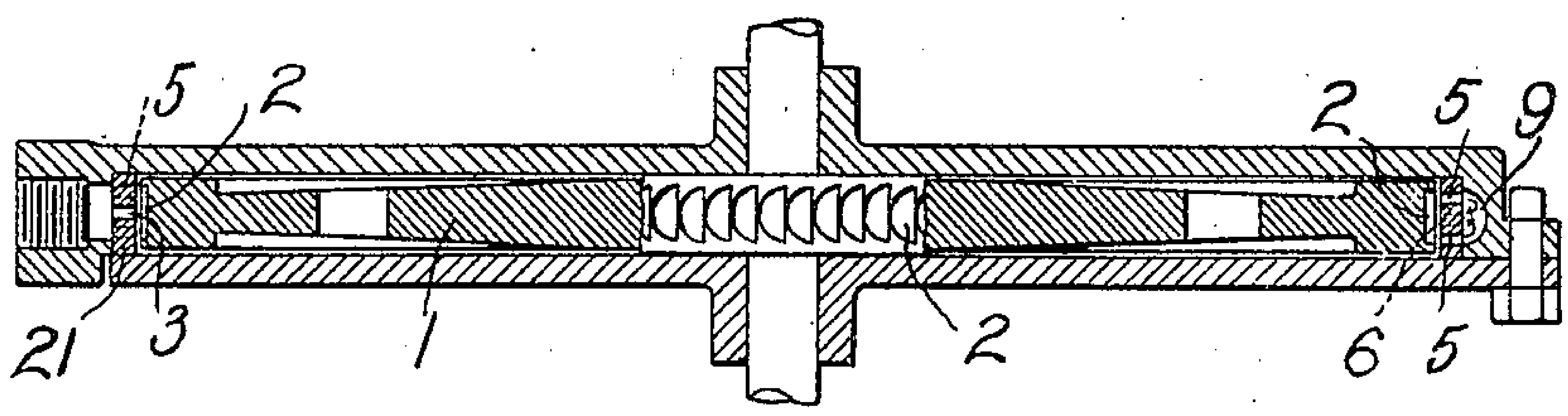
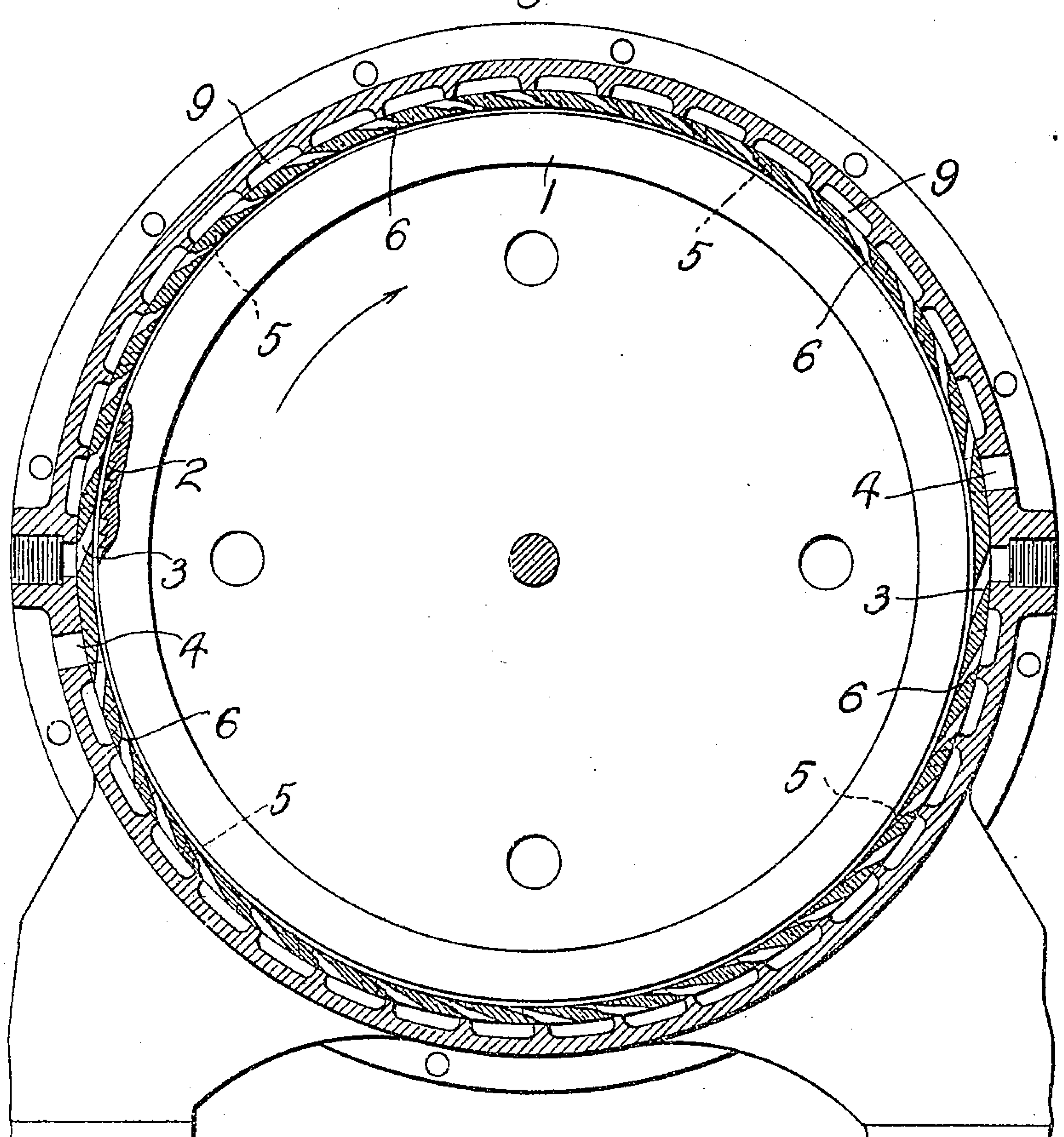


Fig. 6.



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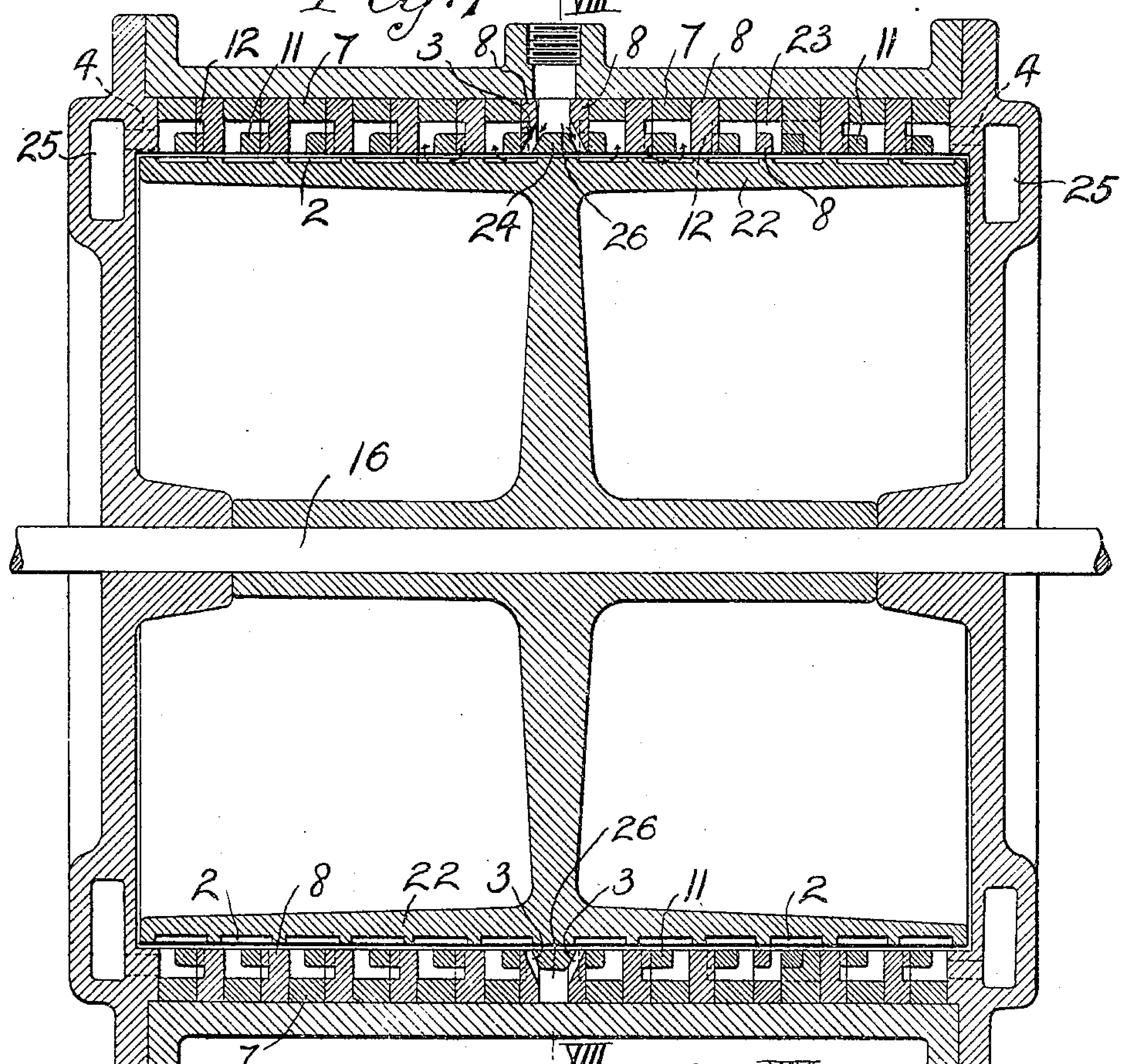
6 SHEETS—SHEET 4.

Fig. 7



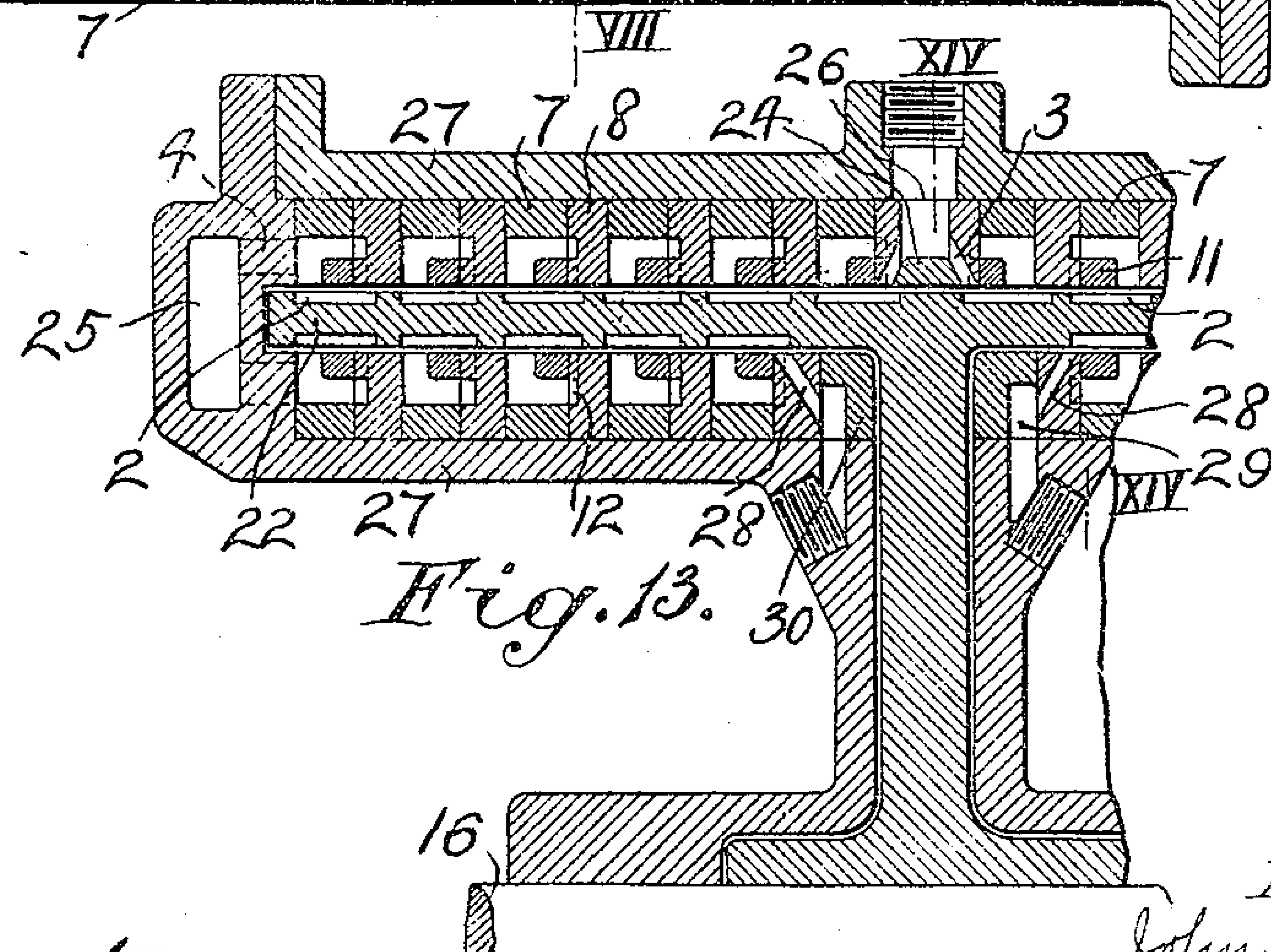


Fig. 13.

Witnesses
J. S. Custer
J. B. MacDonald

Inventor
John W. Cloud
by E. H. Wright Att'y.

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6 SHEETS—SHEET 5.

Fig. 8.

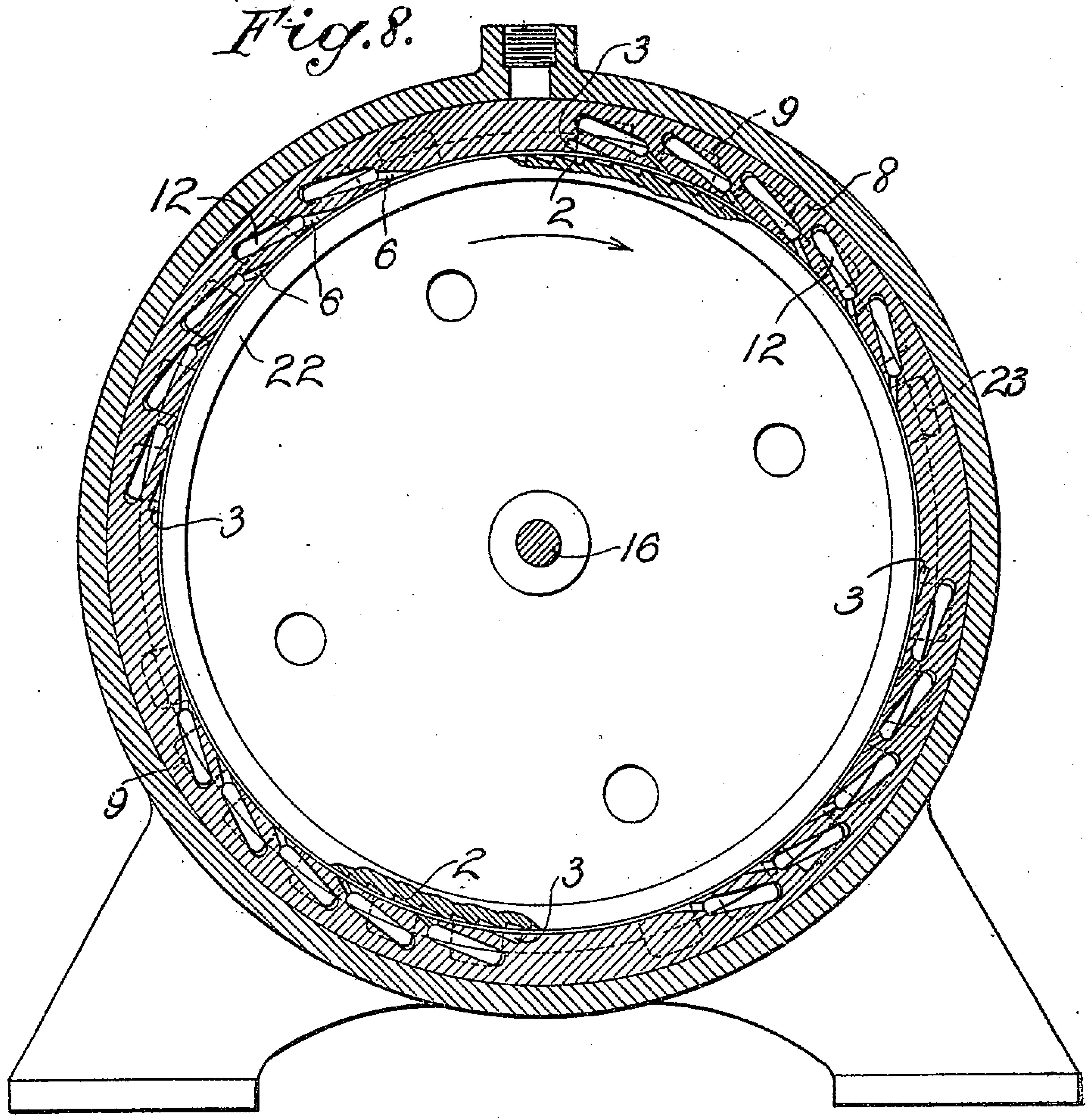
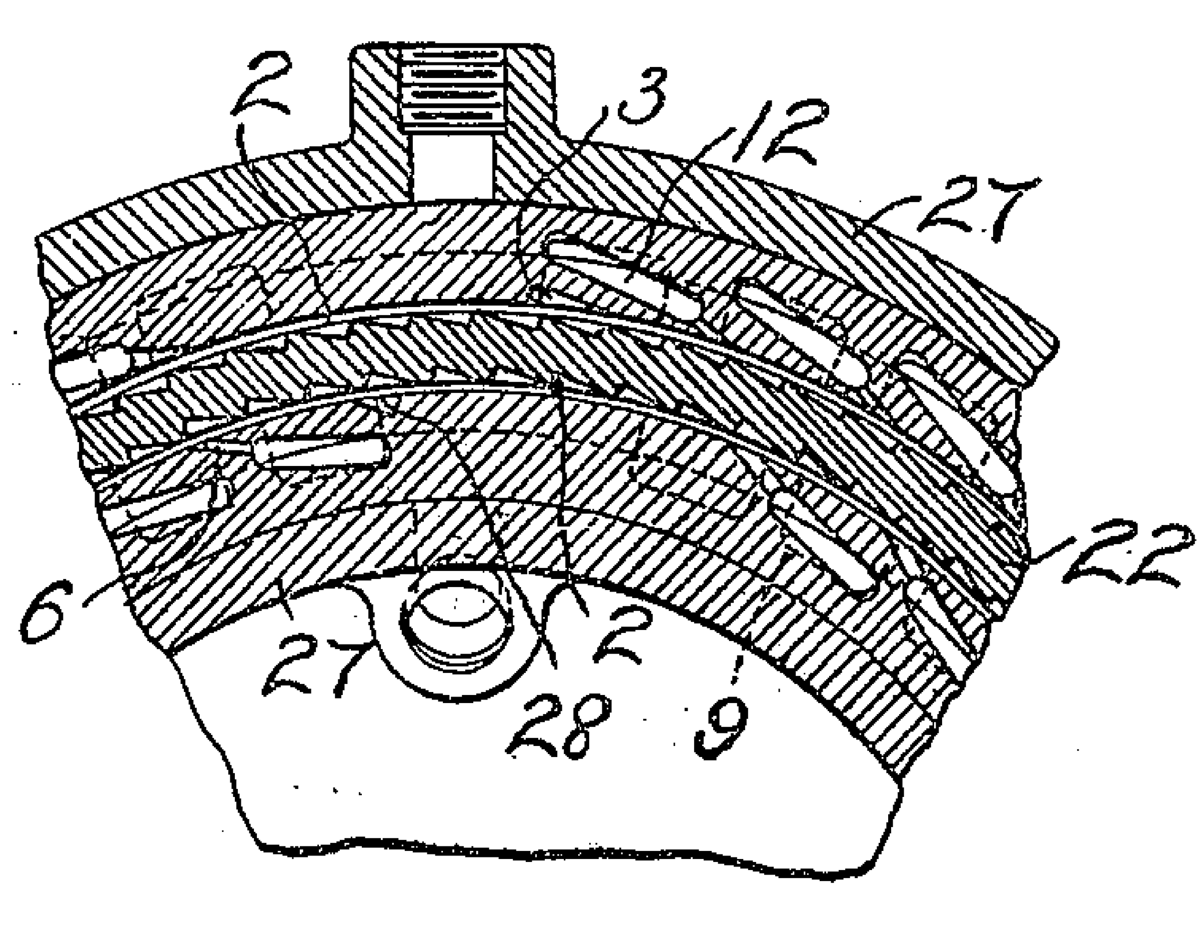


Fig. 14.



Witnesses
J. S. Custer
J. B. MacDonald

Inventor
John W. Cloud
by E. Wright
Att'y.

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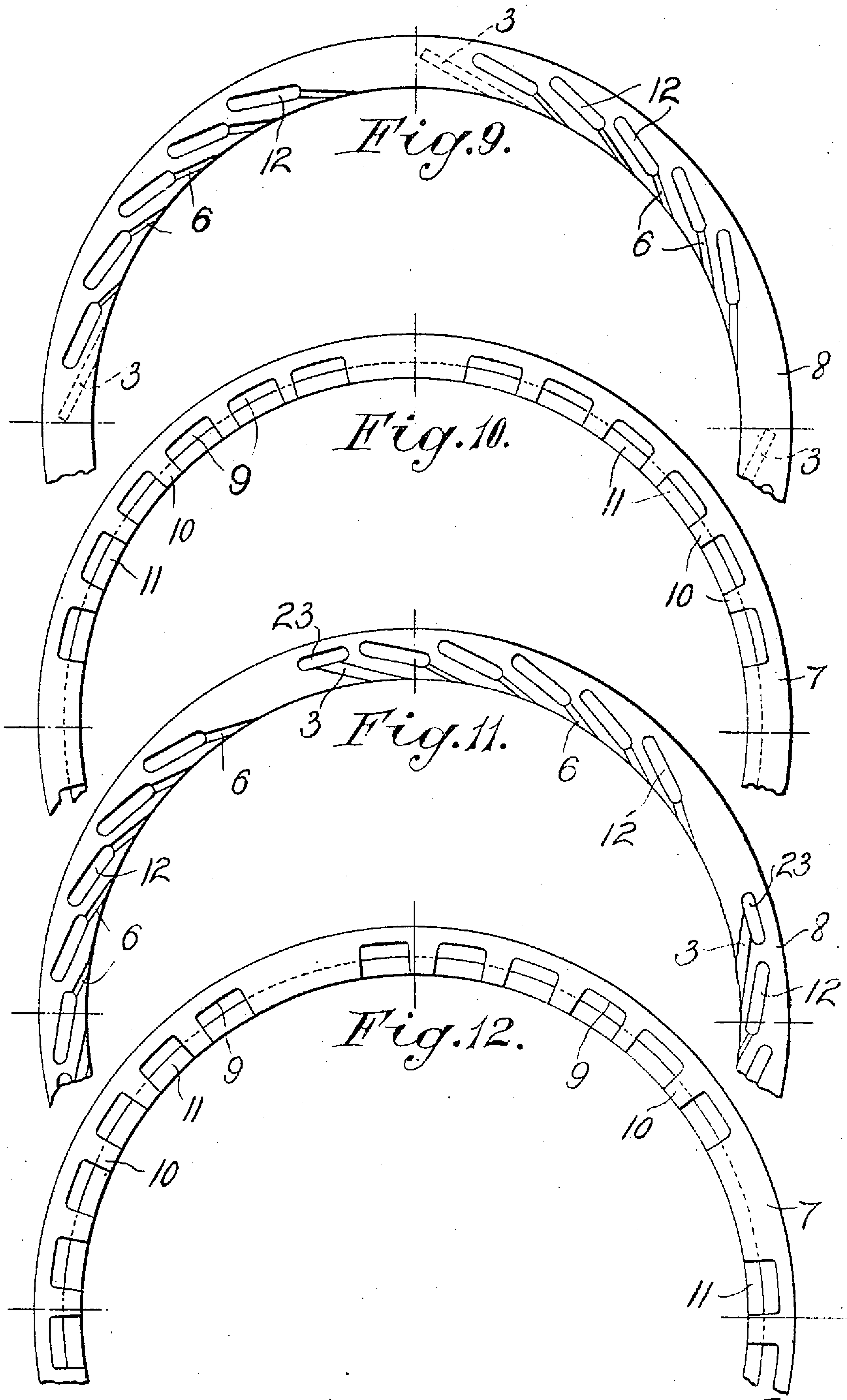
6 SHEETS—SHEET 6.



Witnesses
J. S. Custer
J. B. MacDonald

Inventor
John W. Cloud
by E. H. Wright
Att'y.

UNITED STATES PATENT OFFICE.

JOHN WILLS CLOUD, OF LONDON, ENGLAND.

ELASTIC-FLUID TURBINE.

No. 808,343. Specification of Letters Patent. Patented Dec. 26, 1905.

Application filed March 7, 1905. Serial No. 248,831.

To all whom it may concern:

Be it known that I, JOHN WILLS CLOUD, a citizen of the United States of America, residing at 82 York road, King's Cross, London, England, have invented a new and useful Improvement in Elastic-Fluid-Pressure Turbines, of which the following is a specification.

This invention relates to elastic-fluid-pressure turbines of the type in which the velocity energy of the motive fluid is utilized by impact.

According to this invention the velocity energy of the motive fluid is utilized by impact in a circumferential series of stages on a portion of the rotary member or wheel, the flow of fluid from the buckets being in each stage circumferentially advanced and reversed in the casing.

This invention is illustrated in the accompanying drawings, in which—

Figure 1 is a longitudinal section through the casing and partly through the wheel, illustrating the application of this invention in its simplest form to a single turbine-wheel. Fig. 2 is a cross-section, partly on line II II and partly on line III III of Fig. 1. Fig. 3 is a detail view showing means for packing the periphery of the wheel. Fig. 4 is a side elevation, partly in section, showing an arrangement for supporting the casing of the turbine on the shaft. Figs. 5 and 6 are respectively a longitudinal section and cross-section of a modified form of the turbine shown in Figs. 1 and 2. Fig. 7 is a longitudinal section of a turbine constructed in accordance with this invention and in which the velocity energy is utilized on a plurality of wheels and in a circumferential series of stages on a portion of each wheel. Fig. 8 is a cross-section on the line VIII VIII of Fig. 7. Figs. 9, 10, 11, and 12 are face views of a portion of the successive cylinders or rings forming the chambers in the casing of the turbine shown in Figs. 7 and 8. Fig. 13 is a portion of a longitudinal section of a turbine similar to that shown in Figs. 7 and 8, showing an arrangement of the passages and buckets by means of which the turbine may be operated in either direction as required. Fig. 14 is a broken cross-section on lines XIV XIV of Fig. 13.

Referring to Figs. 1 and 2, the wheel 1 is provided with a circumferential series of suitable notches, buckets, or blades 2. The buckets 2 may conveniently be formed in a known manner by means of a rotary cutter, so that the outline of the buckets corresponds with an arc of a circle, as shown in the center of Fig. 1, whereby the course of the fluid after impact is diverted in a direction which is, as a whole, more or less parallel to the axis of the turbine and finally reversed. The casing is provided with a suitable number of inlet-nozzles 3 for the motive fluid, the number of such inlet-nozzles being such as to balance the pressure upon the wheel, which number may, for example, be two, as shown in Fig. 2, each nozzle being arranged at an angle of one hundred and eighty degrees with the other. A number of outlets 4 corresponding to the number of inlet-nozzles are provided. The inlet-nozzles 3 are arranged so that the motive fluid impinges on one side of the buckets 2. Between each inlet-nozzle 3 and corresponding outlet 4 a circumferential series of isolated chambers are provided in the casing, each chamber having an inlet 5 on one side and an outlet-nozzle 6 on the other side. These chambers are so formed as to divert the flow of fluid from the inlet 5 of the chamber toward the outlet-nozzle 6 of the same. The chambers are formed in two separate rings 7 and 8. In the ring 7 a suitable number of recesses 9 are first milled out, the intermediate portions 10 being then partially turned down, so as to provide a shoulder for the insertion of a ring 11. By the insertion of the ring 11 a number of isolated chambers are formed, which divert the flow of the fluid from the radial direction into a direction parallel to the axis of the turbine. In the joint-face of the ring 8 a corresponding number of recesses 12 and communicating outlet-nozzles 6 are milled out on lines more or less tangential to the inner circumference of the ring and located so that the outer end of the recesses 12 form an extension of the chambers in the ring 7, the inner end of the recesses 12 terminating in the outlet-nozzles 6, whereby the motive fluid is again directed onto the buckets 2 of the wheel.

The action is as follows: The motive fluid after entering the casing passes through the inlet-nozzles 3 and strikes one or more of the buckets 2 of the wheel. After impact the course of the motive fluid is diverted, so that it may escape through an inlet 5 of the succeeding isolated chamber. In passing through this chamber the course of the fluid is again diverted in a direction opposite to that in which the fluid was previously diverted by the buckets 2 of the wheel. After this deflection the fluid escapes from the chamber by the outlet-nozzle 6 and again strikes one or more buckets of the wheel. The fluid then passes to a second isolated chamber, whence it again escapes to further act by impact upon one or more buckets on the wheel. This action is repeated until the fluid arrives at one of the exhaust-outlets 4 in the casing. In this manner the motive fluid is utilized by impact in a circumferential series of stages on a portion of the rotary member or wheel.

Both the inlets and the outlet-nozzles in the isolated chambers may be somewhat inclined, so as to follow as near as possible the general course of deflection both in the buckets and the isolated chambers, or, as shown, the outlet-nozzles 6 may alone be thus inclined.

In some cases means are provided for preventing leakage on either side of the buckets on the wheel. According to the present invention the casing is so constructed as to permit of two rings of soft metal being compressed against the wheel. The casing, for example, may be made in three parts, consisting of a cylinder, in which the chambers are formed, and two end covers or heads, the whole being held together by bolts, the rings of soft metal being so arranged between the end covers and the cylinder that upon tightening up the bolts the rings are compressed inwardly upon the circumference of the wheel. This arrangement of packing is shown in Fig. 3 as applied to the construction described with reference to Figs. 1 and 2, the inner edges of the rings 7 and 8 being each chamfered at 14, so that when the bolts uniting the two parts of the casing are tightened up to form a fluid-tight joint as between each of these rings and the corresponding face of the casing the soft-metal rings 13 will be compressed inwardly on the circumference of the wheel 1.

In some cases in order to keep the casing and the wheel concentric in the event of the center of gravity of the wheel not coinciding with its axis the casing, as shown in Fig. 4, may be carried by suitable bearings—as, for example, by ball-bearings 15 upon the shaft 16 of the wheel. In this case the casing may be prevented from rotating in any suitable manner which will permit of a slight eccentric motion—as, for instance, by the lugs or jaws 17, which bear against brackets 18, forming part of the pedestals of the bearings 19. The bearings 19 may be of any well-known type provided, if necessary, with forced lubrication. In order to prevent any leakage of fluid which may flow past the bearings 15 of the casing, glands 20 are provided of any suitable or well-known type.

Instead of arranging the nozzles so that the fluid impinges on one side of the buckets 2 of the wheel the nozzles 3 and 6 may, as shown in Figs. 5 and 6, be centrally arranged with respect to the buckets, so that the stream of motive fluid on striking the center of the buckets is divided and diverted to both right and left in a direction as a whole more or less parallel to the axis of the turbine, each stream then passing through separate inlets 5 into one of the isolated chambers, where the two streams are then deflected to the common central outlet-nozzle 6. According to the construction shown in these figures the isolated chambers are formed by a series of recesses 9 in the casing, which are inclosed by a ring 21, in which the inlets 5 and outlet-nozzles 6 are formed. With this construction both the inlets 5 and the outlet-nozzles 6 are inclined, so as to follow as nearly as possible the general course of deflection both in the buckets and the isolated chambers, as shown in Fig. 6. The motive fluid after passing the exhaust-outlets 4 may be conveyed either direct to a condenser or may be further utilized in one or more additional wheels before passing to a condenser.

A suitable construction of turbine for utilizing the velocity energy of the motive fluid by impact in a circumferential series of stages on a portion of each of a plurality of wheels is shown in Figs. 7 to 12. The circumferential series of buckets 2 may be formed on separate wheels or, as shown in Fig. 7, upon a single drum 22, mounted upon a shaft 16. Each circumferential series of buckets 2 is provided with a set of inlet-nozzles 3, a set of circumferential series of isolated chambers formed, as already described with reference to Figs. 1 and 2, by a recess 12 in a ring 8 and a recess 9 in a ring 7, and the ring 11, the number of series in each set of chambers corresponding to the number of inlet-nozzles 3 in a set, each of said chambers having an inlet 5 on one side and an outlet-nozzle 6 on the other side. A passage 23 is provided in each ring 8, with the exception of the first, forming a communication between the last chamber of each series in one set with the inlet-nozzle 3, corresponding to the succeeding series of chambers with respect to the direction of rotation of the wheel in the next set. The recess 12 and outlet-nozzle 6, corresponding to the position of each of the communicating passages 23, is omitted in each ring 8. The communicating passages 23 are formed in each of the rings 8 with the exception of the first ring, as shown in Figs. 7 and 11. In this manner communication is provided from each of the first set of inlet-nozzles 3 through a series in the first set of chambers extending over an arc something less than ninety degrees, thence through a communicating passage 23 and corresponding inlet-nozzle 3 through a circumferential series of chambers forming a portion of the second set and extending through a succeeding arc of less than ninety degrees, and so on from series to series through succeeding arcs each less than ninety degrees until reaching the final series of chambers, when after passing through the corresponding arc the fluid escapes through an outlet 4 in the casing to a common exhaust-chamber 25, which communicates directly with the atmosphere or with a condenser. It will be observed that the first two rings 8 are arranged so as to form an annular admission-chamber 26, which is closed on the inner circumference by a ring 24, which also serves to form one wall of each of the first set of inlet-nozzles 3. While all the rings 7 and 8, with the exception of the first ring 8, are respectively similar in every respect, it will be observed from the arrangement of the rings, as shown in Figs. 9 to 12, which represent, respectively, the first ring 8, forming one wall of the annular chamber 26, the first ring 7, the second ring 8, and the second ring 7, that the recesses in the second rings 8 and 7, Figs. 11 and 12, are not in alinement with the corresponding recesses in the first rings 8 and 7, Figs. 9 and 10, this arrangement being necessary in order that the communicating passages 23 may register with the corresponding recesses 9 of the last chambers of each series and the recesses 9 with the recesses 12 of the first chamber ot each series.

In Figs. 13 and 14 the turbine-drum 22 is provided with both an inner and outer casing 27 and with a series of brackets arranged on the inner and outer circumference. The chambers in the inner and outer casing and the buckets on the inner and outer circumference of the drum are inversely arranged, so that the turbine may be driven in either direction at will. The chambers in the casing and the buckets on the drum are formed in the manner already described with reference to Figs. 1 and 2 and 7 to 12. In the inner casing 27 annular admission-chambers 29 are formed by rings 30 of angle-section. The inlet-nozzles 3 for driving the turbine in one direction and inlet-nozzles 28 for driving the turbine in the other direction are both preferably connected through the annular chambers 26 and 29, respectively, by branch pipes and a reversing-valve to the main source of supply. All the outlets 4 communicate with the common exhaust-chamber 25.

In all the constructions above described the inlet-nozzles 3 are preferably made larger than the nozzles 6, while the latter gradually increase in cross-sectional area, so as to suitably meet the conditions of expansion of an elastic fluid.

It will be observed that in all the constructions shown in the drawings, the isolated chambers with their inlets and outlet-nozzles are so arranged as to be readily an accurately machined, and all constructions whereby such chambers with their inlets and outlet-nozzles are formed in and by means of one or more separate rings must be considered as within the scope of this invention.

I claim as my invention—

1. In an elastic-fluid-pressure turbine the combination with a wheel, having a ring of buckets, and a casing, provided with a plurality of symmetrically-arranged inlet-nozzles and a corresponding number of outlets, of a corresponding number of circumferential series of isolated chambers arranged in said casing, each series of said chambers being arranged between an inlet-nozzle and a corresponding outlet, an inlet on one side of each chamber, and a contracted outlet-nozzle on the other side of said chamber.

2. In an elastic-fluid-pressure turbine the combination with a wheel, having a ring of buckets, and a casing, of a plurality of inlet-nozzles symmetrically arranged in said casing so as to direct the motive fluid to one side of said buckets, a corresponding number of outlets, a corresponding number of circumferential series of isolated chambers, arranged in said casing for circumferentially advancing and reversing the flow of fluid from one side of said buckets to the other, each series of said chambers being arranged between an inlet-nozzle and a corresponding outlet, and a contracted outlet-nozzle from each chamber.

3. In an elastic-fluid-pressure turbine the combination with a wheel, having a ring of buckets, and a casing, of a plurality of inlet-nozzles symmetrically arranged in said casing so as to direct the motive fluid to one side of said buckets, a corresponding number of outlets, a corresponding number of circumferential series of isolated passages, arranged in said casing for diverting the flow of motive fluid from said buckets into an axial direction, a ring provided, on the face adjacent to said passages, with a number of recesses coacting with said passages and an outlet-nozzle from each recess.

4. In an elastic-fluid-pressure turbine the combination with a wheel, having a ring of buckets, and a casing, of a plurality of inlet-nozzles symmetrically arranged in said casing and so as to direct the motive fluid to one side of said buckets, a corresponding number of outlets, a ring arranged in said casing and having a corresponding number of circumferential series of recesses on one side face, each recess extending outwardly from the inner periphery of the ring, a second ring in contact with the recessed face of the first-named ring and having a corresponding number of circumferential series of nozzles, affording communication between each recess in the first-named ring and the inner periphery of the second ring, and means for completely closing circumferentially a portion of each recess of the first-named ring.

5. In an elastic-fluid-pressure turbine the combination with a wheel, having a ring of

buckets, and a casing, of a plurality of inlet-nozzles symmetrically arranged in said casing and so as to direct the motive fluid to one side of said buckets, a corresponding number of outlets, a ring arranged in said casing and having a corresponding number of circumferential series of recesses on one side face, each recess extending outwardly from the inner periphery of the ring, a second series of recesses in the spaces between the first-named recesses extending outwardly from the inner periphery of said ring for a portion only of the radial length of the first-named recesses, and axially for a portion only of the depth of the same, a second ring inserted in said second series of recesses, a third ring of the same internal diameter as the first-named ring arranged in contact with both the said first and second rings and having circumferential series of recesses on the side face adjacent to said first and second rings, each recess being adapted to communicate with the corresponding recess in the first-named ring and terminating in an outlet-nozzle.

6. In an elastic-fluid-pressure turbine the combination with a wheel, having a ring of buckets, of a casing provided with a plurality of symmetrically-arranged inlet-nozzles and outlets and an annular wedge-shaped recess on either side of said wheel a soft-metal ring in each recess and means for compressing the said rings upon said wheel.

7. In an elastic-fluid-pressure turbine the combination with a wheel keyed on a shaft and bearings for said shaft of a casing mounted freely on said shaft, lugs projecting from the sides of the casing for preventing said casing from turning and means for preventing the escape of the fluid between the casing and the shaft.

8. In an elastic-fluid-pressure turbine the combination with a wheel, having a plurality of rings of buckets, a casing provided with a plurality of symmetrically-arranged inlet-nozzles for each ring of buckets, each inlet being adapted to direct the motive fluid to one side of the corresponding ring of buckets, and a corresponding number of outlets, of a passage connecting each outlet from one ring of buckets with an adjacent inlet-nozzle to the next succeeding ring of buckets, a series of nozzles arranged between each inlet-nozzle and corresponding outlet for directing the motive fluid to the same side of said bucket as the first-named nozzles, and means for circumferentially advancing and reversing the flow of fluid from the other side of said buckets to the next succeeding nozzle of said series.

9. In an elastic-fluid-pressure turbine the combination with a wheel, having a plurality of rings of buckets, and a casing provided with a plurality of symmetrically-arranged inlet-nozzles for each ring of buckets and a corresponding number of outlets, of a passage connecting each outlet from one ring of buckets with an adjacent inlet-nozzle to the next succeeding ring, circumferential series of isolated chambers arranged in said casing, each series being arranged between an inlet-nozzle and a corresponding outlet, an inlet on one side of each chamber and an outlet-nozzle on the other side of said chamber.

10. In an elastic-fluid-pressure turbine the combination with a wheel, having a plurality of rings of buckets, and a casing provided with a plurality of symmetrically-arranged inlet-nozzles for each ring of buckets and a corresponding number of outlets, of a passage connecting each outlet from one ring of buckets with an adjacent inlet-nozzle to the next succeeding ring, circumferential series of isolated passages arranged in the said casing, each series being arranged between an inlet-nozzle and a corresponding outlet, for diverting the flow of motive fluid into an axial direction, and a ring provided, from said buckets on the face adjacent to said passages, with a number of recesses coacting with said passages, each recess terminating in an outlet-nozzle.

11. In an elastic-fluid-pressure turbine the combination with a wheel, having a plurality of rings of buckets, and a casing provided with a plurality of symmetrically-arranged outlets, of a series of rings arranged in said casing each ring having a number, corresponding to the number of outlets, of symmetrically-arranged series of recesses extending outwardly from the inner periphery on one side face and registering with one side of a corresponding ring of buckets, a second series of rings, coöperating with the first-named series, each ring having a number, corresponding to the number of series of recesses in the first-named rings, of symmetrically-arranged inlet-nozzles, a corresponding number of series of outlet-nozzles, each affording communication between a recess in a ring of the first-named series and the inner periphery of the ring and, with the exception of the first ring in the series, provided with passages each affording communication between an inlet-nozzle and the last recess of a series in an adjacent ring of the first-named series, and means for completely closing circumferentially a portion of each recess in the first-named series of rings.

12. In an elastic-fluid-pressure turbine the combination with a wheel, having a plurality of rings of buckets, and a casing provided with a plurality of symmetrically-arranged outlets, of a series of rings arranged in said casing, each ring having a number corresponding to the number of outlets, of symmetrically-arranged series of recesses extending outwardly from the inner periphery on one side face and registering with one side of a corresponding ring of buckets, a second se-

ries of recesses in the spaces between the first-named recesses extending outwardly from the inner periphery of the ring for a portion only of the radial length of the first-named recesses and axially for a portion only of the depth of the same, a second series of rings inserted in said second series of recesses, a third series of rings of the same internal diameter as the first series of rings, each in contact with one of each of the first and second named series of rings and having firstly a circumferential series of recesses in the side face adjacent to said first and second named rings, each recess being adapted to communicate with a corresponding recess in an adjacent ring of the first-named series and terminating in an outlet-nozzle and secondly a number, corresponding to the number of series of recesses in the first-named rings, of symmetrically-arranged inlet-nozzles and means of communication between each inlet-nozzle with the exception of the first set, and the last recess of a series in the adjacent ring in the first-named series of rings.

13. In an elastic-fluid-pressure turbine the combination with a shaft, a drum provided on its inner circumference with buckets, means for securing said drum on said shaft, and a casing surrounding the outer circumference of said drum, of buckets arranged on the inner circumference of said drum, an inner casing surrounding the inner circumference of said drum, a plurality of inlet-nozzles symmetrically arranged in said inner and outer casing, a corresponding number of outlets in each casing, series of nozzles arranged between each inlet-nozzle and corresponding outlet and means for circumferentially advancing and reversing the flow of fluid from said buckets to the next succeeding nozzle of each of said series.

In testimony whereof I have hereunto subscribed my name this 20th day of February, 1905.

JOHN WILLS CLOUD.

Witnesses:

A. H. BERGIN,

W. J. SKERTEN.