T. S. KEMBLE.

TURBINE.

APPLICATION FILED FEB. 19, 1909.

951,373. Patented Mar. 8, 1910.

4 SHEETS—SHEET 1.

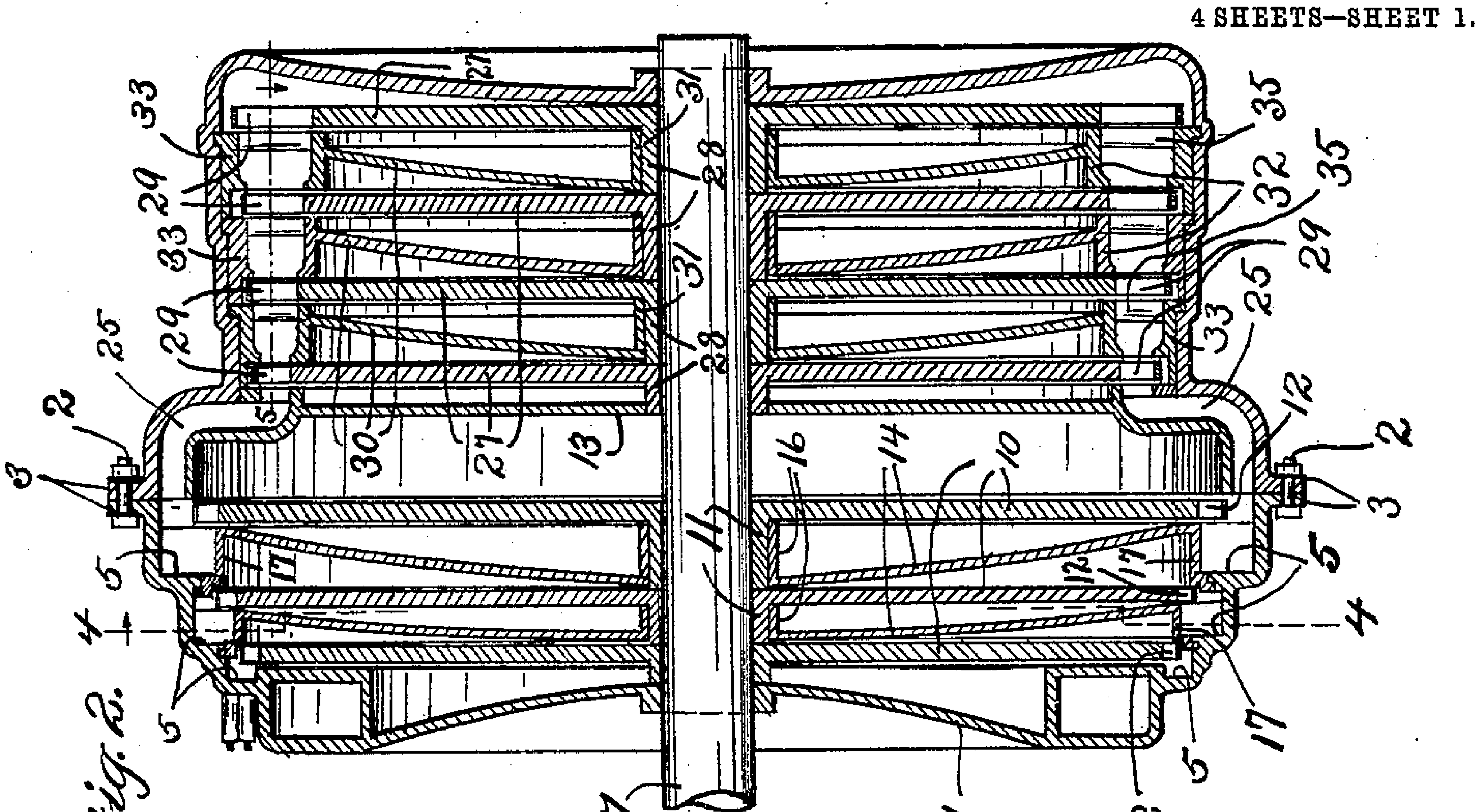

Fig. 2.

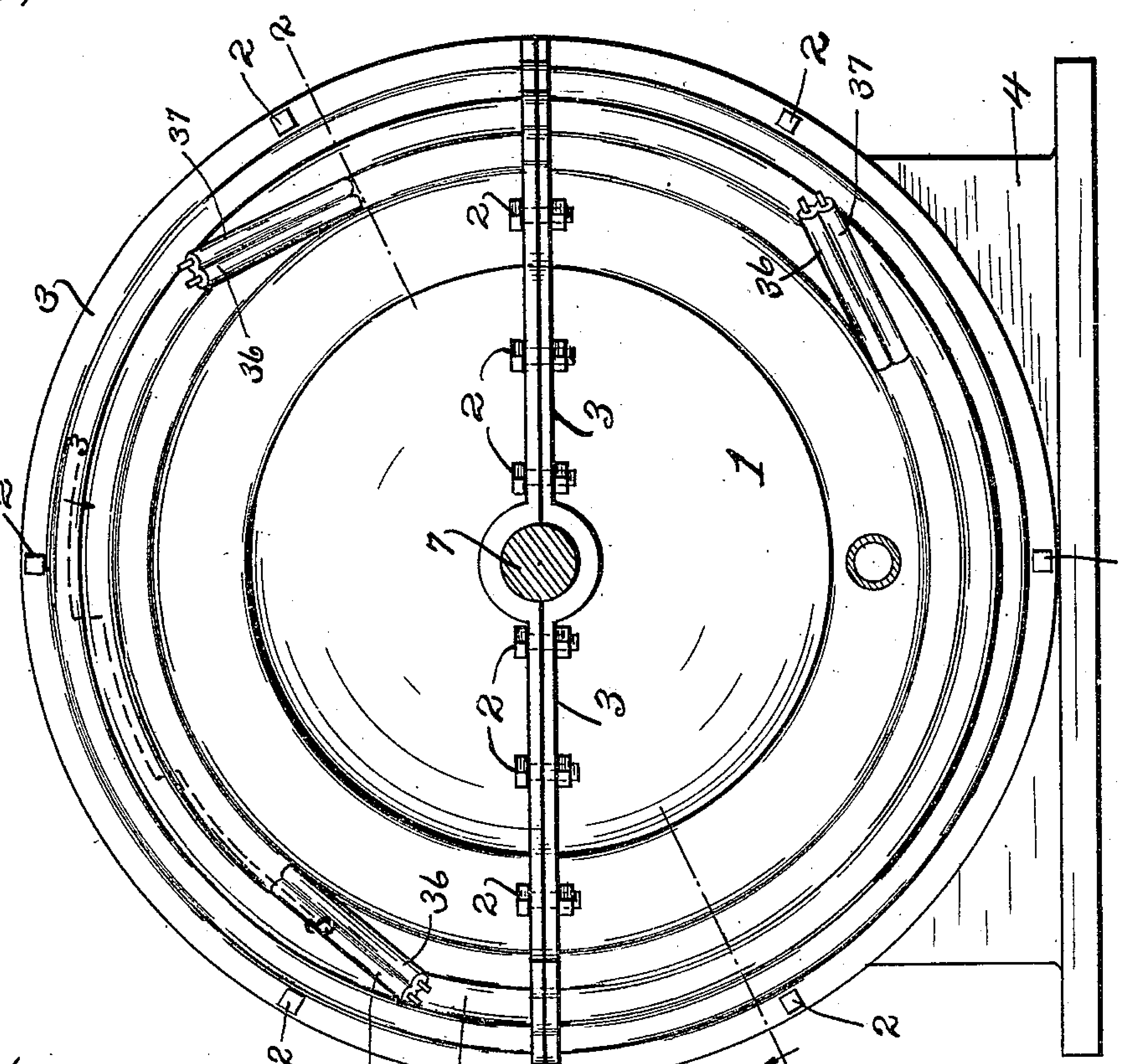

Fig. 1.

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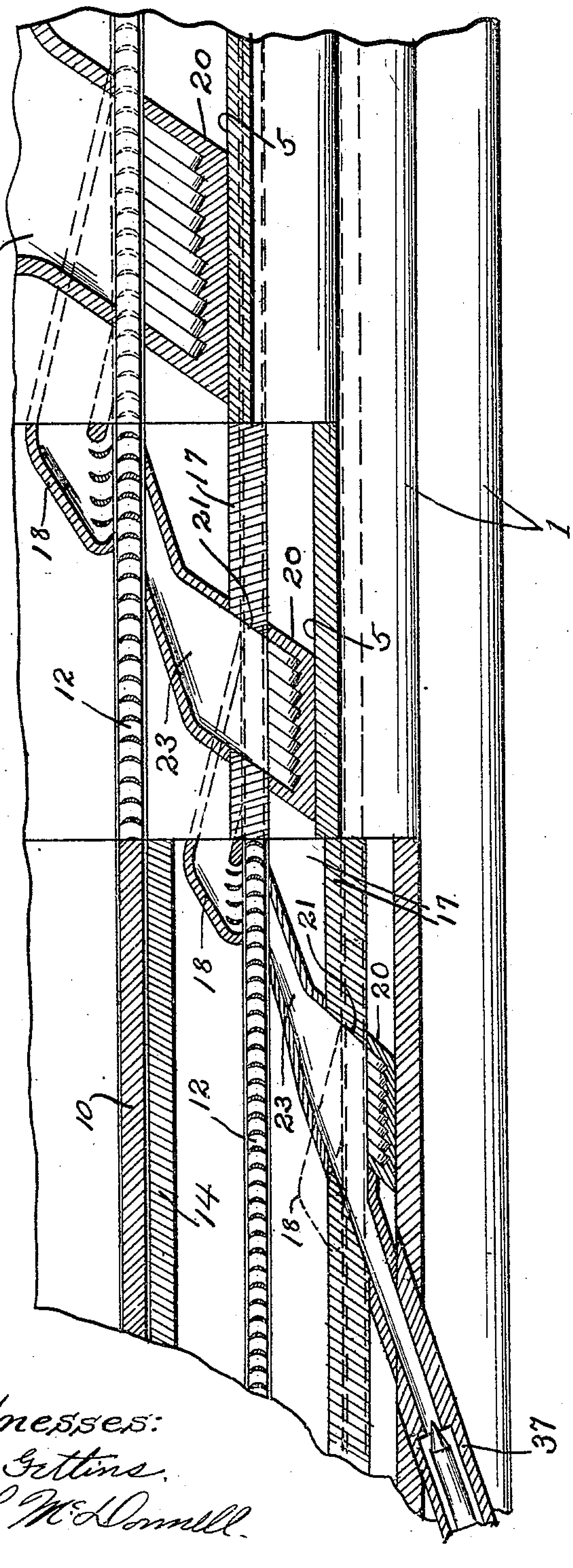

Fig. 3.

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Fig. 4.

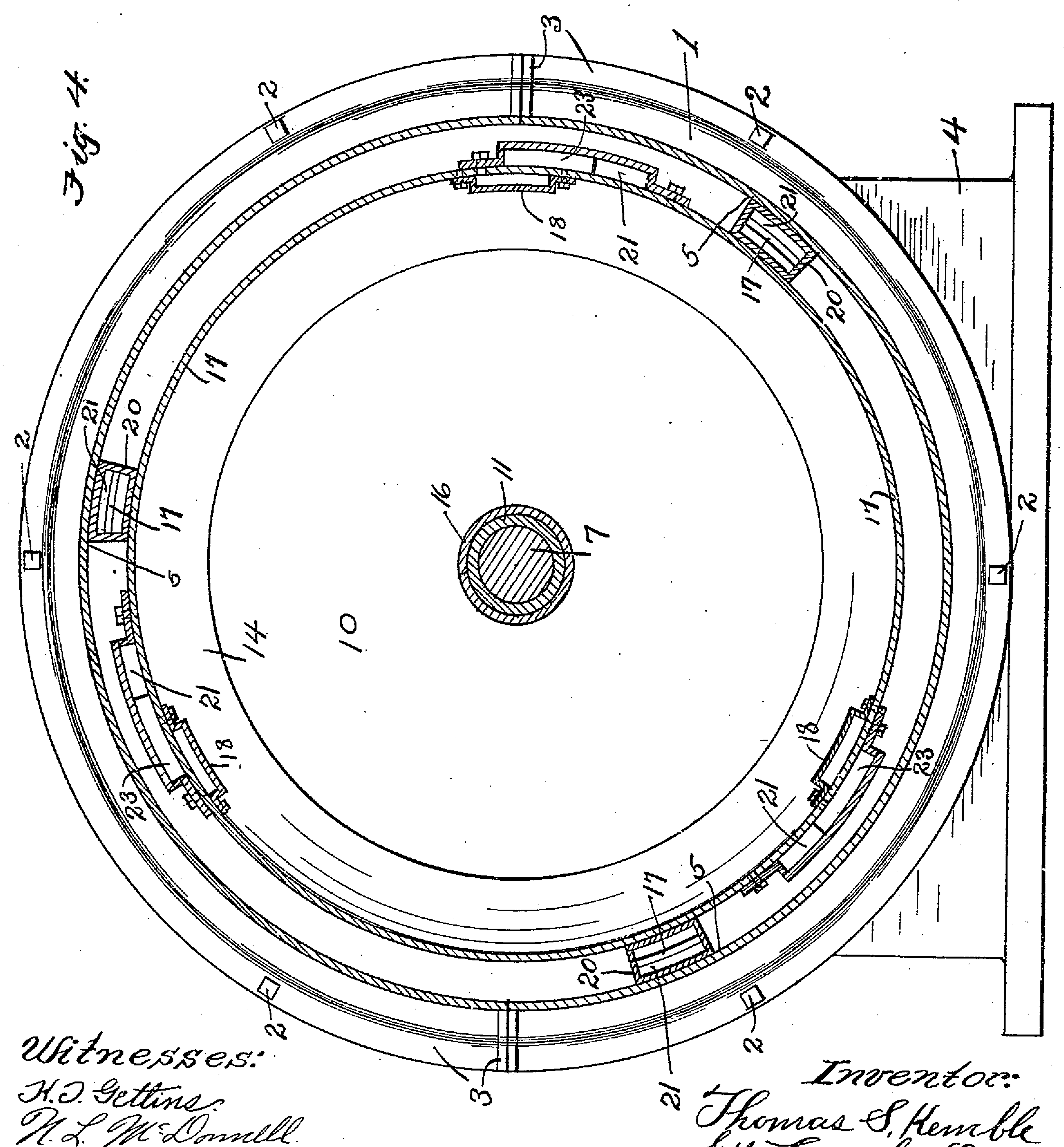

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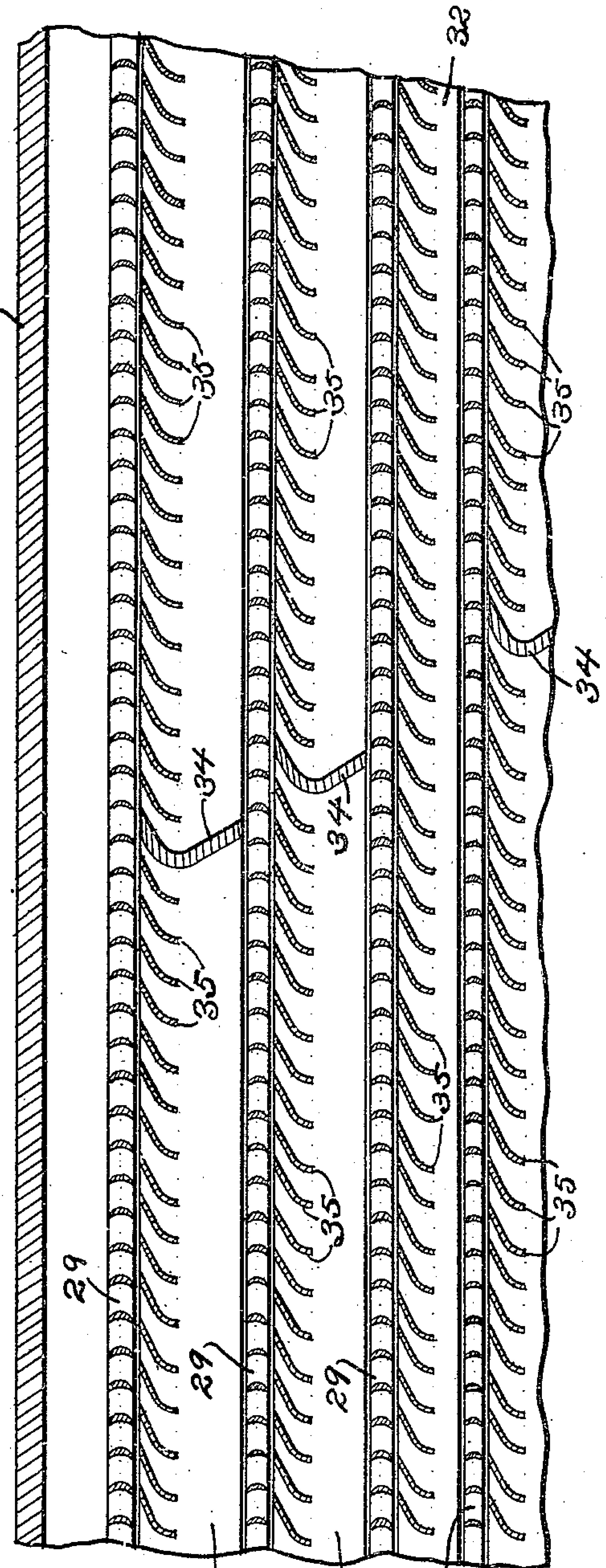
Fig. 5.



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UNITED STATES PATENT OFFICE.

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TURBINE.

951,373. Specification of Letters Patent. Patented Mar. 8, 1910.

Application filed February 19, 1909. Serial No. 478,759.

To all whom it may concern:

Be it known that I, THOMAS S. KEMBLE, a citizen of the United States of America, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Turbines; and I hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use the same.

This invention relates to new and useful improvements in turbines.

One object of the invention is to provide a simple type of construction wherein a multi-impact vane circle or a number of multi-impact vane circles may be combined in series with other moving vane circles within the same casing.

Another object is to provide a turbine which will carry an overload with the least possible waste of energy.

The turbine shown in the drawings may be described as a multi-stage, multi-cellular type with multi-impact high pressure stages, and single impact low pressure stages, but with only one circle of moving vanes in each stage, the advantage of which may be shown as follows. The single-impact, single stage type though of simple design, requires such high vane velocities as to necessitate gearing and rendering it impracticable for high powers. The multi-stage, multi-cellular type with a single-impact in each stage, requires, in order to use a moderate vane velocity, a considerable number of stages with an accompanying multiplicity of parts. The multi-stage, multi-cellular type with say two impacts in each stage, requires, to use the same vane velocity, only the square root of the number of stages required with a single impact. It is customary however in this case to have two rotating vane circles in series, with a circle of guide vanes between in each stage. Furthermore, whether there be two impacts or only one in each stage, it is necessary, as they are now made, either to make the vanes of the first circle extremely short or to make them of very small diameter compared with the low pressure vane circles, or to use only a very small part of the circumference, or to strike a mean among the three methods. The necessity of this arises from the great difference in specific volume between the high and the low pressure steam. I propose, as aforesaid, to use the multi-stage, multi-cellular type with multi-impact high pressure stages, and possibly single-impact low pressure stages. Furthermore, I propose to eliminate the extra moving vane circles in the multi-impact stages, and to use what would otherwise be the idle part of the circumference, for succeeding impacts on the same moving vane circle.

The turbine as shown in the drawings comprises a casing which is preferably provided with a plurality of nozzles for supplying the actuating fluid, and in which is arranged a driving shaft. On the driving shaft are rigidly mounted the members or disks which carry the vane circles. A predetermined number of the vane circles are designed to receive two or more impacts each and the remainder of the vane circles are preferably designed to receive a single impact each from the same stream of actuating fluid. The multi-impact vane circles preferably increase in diameter from the high pressure side toward the low pressure side of the turbine. The actuating fluid from each main feed nozzle is admitted to the casing so that it strikes first a portion of the vane circle on the first multi-impact vane carrying member at one point passing therethrough and is then directed back through the same vane circle at a different part of the turbine circumference and is then carried, by means of suitable passageways arranged in the casing, across the vane circle outside of said vane circle to the next multi-impact vane circle where it passes through a portion of the vanes on said second multi-impact vane circle and is again directed back through the same vane circle at a different part of the circumference of the turbine and is again carried across said second multi-impact vane circle outside of said second vane circle to the third multi-impact vane circle and passes through said vane circle and is directed back through the same circle at a different part of the circumference of the turbine and is then carried across the third multi-impact vane circle outside of said vane circle and then through the first single impact vane circle and then by successive stages directly through the succeeding single impact vane circles.

As shown the casing is provided with six nozzles which are preferably arranged in pairs, one of the nozzles of each pair of nozzles being arranged to act directly on the first multi-impact vane circle, and the other nozzle of each pair of nozzles being arranged to direct the actuating fluid into the confined passageway through which the original stream of the actuating fluid is flowing after passing through the first stage. It will therefore be seen that instead of admitting the auxiliary steam to a receiver between two pressure stages the auxiliary steam is directed into the original stream, which is passing from one stage to another, in the same direction as said original steam is traveling. The new steam coming in at a considerable velocity accelerates the first stream of steam giving to it some of the energy which would be lost by the expansion of the auxiliary steam to the lower pressure and by eddying in a receiver.

In the accompanying drawings Figure 1 is a side elevation of a turbine embodying my invention. Fig. 2 is a section on line 2—2, Fig. 1. Fig. 3 is a section on line 3—3, Fig. 1, on an enlarged scale. Fig. 4 is a section on line 4—4, Fig. 2, on an enlarged scale. Fig. 5 is a section on line 5—5, Fig. 2, on an enlarged scale.

Again referring to the drawings, 1 represents the outer shell or casing of the turbine, which for convenience in this particular instance is formed in four parts, the sections being secured together by means of bolts 2 which pass through suitable flanges 3 on the exterior of the casing. The casing is also preferably provided with a base 4. On the inside of the casing are formed a series of annular shoulders or surfaces 5, the object of which will appear later. A shaft 7 extends through the casing and is suitably supported in bearings (not shown) outside of the casing and on said shaft 7 are rigidly secured the vane carrying members. As shown in the drawings there are three multi-impact vane carrying members and four single impact vane carrying members, but the relative numbers may be varied according to circumstances. The multi-impact vane carrying members, as shown, are identical in form, each comprising a disk 10 which is provided with an annular hub or flange 11 by means of which the disk is secured to the shaft 7 and which also serves to maintain the proper spacing of the disks in the casing. Each disk 10 is provided around its periphery with a suitably arranged vane circle 12. The interior of the casing is divided into what we may term a high-pressure section and a low-pressure section by means of a wall or partition 13.

The high-pressure section is sub-divided into three pressure-stage forming compartments by means of diaphragms 14, each pressure stage being arranged to include one of the multi-impact vane carrying members. Each diaphragm 14 is provided with a flange or sleeve 16 near its center and around its periphery is provided with an L-shaped flange 17. On the inner side of each of the flanges 17 are arranged three passageway forming members 18 which of course correspond in number to the number of main feeding nozzles and the passageway forming members 18 on each flange 17 are so arranged that both the inlet and outlet thereof are in proximity to the same vane circle and at the same side of said vane circle so that the actuating fluid passing through the vane circle from the opposite side thereof will enter one such passageway and passing therethrough will be directed back against and through the same vane circle at a different part of the circumference of the turbine. On each of the surfaces 5 are arranged three passageway forming members 20 and the intake of each of the passageways 20 is arranged opposite the outlet of one of the passageway forming members 18 and the outlet of each of the passageway forming members 20 is arranged to register with an opening 21 which is formed in the flange 17 of the diaphragm 14 which separates the next pressure stage. The opening 21 in the flange 17 of the diaphragms 14 are formed at a greater radius than the radius of the preceding vane circle. A passageway 23 extends from each of the openings 21 across the intervening space to the vanes on the next vane carrying member, the outlet of each passageway being arranged opposite the inlet of a passageway 18 on the flange of the next succeeding diaphragm 14. Passageways 25 are formed between the partition 13 and the wall of the casing.

In the low-pressure side of the casing are arranged four single impact vane carrying members 27 which are similar in form to the multi-impact vane carrying members, each being provided with a hub forming flange 28 and a vane circle 29. The low-pressure section is also sub-divided into pressure stage forming compartments by diaphragms 30, each of which is provided with a flange or sleeve 31 near the center. Each diaphragm 30 is also provided at its periphery with an annular flange 32 and around each flange 32 is arranged a ring 33 sufficiently larger in diameter to leave a steam passageway between the ring and the flange. The said ring 33 is preferably formed integral with the flange 32 being united thereto by means of partition forming ribs 34 which divide the space between the ring and the flange into three separate passageways and in the passageways thus formed between the ring and the flange are arranged vanes 35 which are preferably held in position by being set into grooves or notches formed in the opposing faces of the said flange and said ring. The said vanes do not extend from side to side of the said passageway but extend from the low-pressure side thereof to about midway of said passageways and also the said dividing ribs do not extend across the passageways but extend from the high-pressure side of the said passageways to the inner edges of the said vanes.

On the outside of the casing are mounted the three main feed nozzles 36, each nozzle being arranged to direct the steam through a portion of the vanes on the first multi-impact vane carrying member and then into the intake of a passageway 18. In proximity to each of the main feed nozzles 36 are arranged the auxiliary feed nozzles 37 which are so disposed that the steam therefrom will pass directly into one of the passageways 23 which connect the respective pressure stages in the multi-impact section of the turbine.

From the foregoing description it will be seen that in the portion of the casing in which the multi-impact vanes are located there are three passageways or courses for directing the flow of the steam, the said passageways corresponding in number to the original feed nozzles, each passageway being of a comparatively limited area and it may be said that each passageway starts at the outlet of a nozzle then cuts the vane circle of the first multi-impact vane carrying member then extends a short distance between the first and second multi-impact vane carrying members when it again cuts the vane circle of the first vane carrying member and then extends up and across outside of said vane circle so that it cuts the vane circle of the second multi-impact vane carrying member, extends a short distance between the second and third vane carrying members, again cuts the circle of the second vane carrying member and extends up and across outside of said multi-impact vane circle and cuts the vane circle of the third multi-impact vane carrying member, extends a short distance between the third multi-impact vane carrying member and the first single impact vane carrying member until it again cuts the vane circle of the third multi-impact vane carrying member, and then each passageway may become approximately equal in width to one third of the circumference of the casing the steam passing directly through each succeeding vane circle of the single impact vane carrying members.

What I claim is,—

1. In a turbine, the combination of a casing, a series of vane circles operatively mounted in said casing, means for supplying an actuating fluid, passageways arranged within said casing to direct the actuating fluid back and forth through one of said vane circles a plurality of times in a continuous stream and a passageway within said casing to conduct the actuating fluid outside of and across said vane circle to a succeeding vane circle.

2. In a turbine, the combination of a casing, a series of vane circles operatively mounted in said casing, said vane circles being of successively increasing diameter from the intake side of the casing, means for supplying actuating fluid to the casing passageways arranged within said casing to direct the actuating fluid back and forth through one vane circle a plurality of times in a continuous stream and passageways within the casing to conduct the actuating fluid outside of and across said vane circle to the next larger vane circle.

3. In a turbine, a casing, a series of vane circles operatively mounted in said casing, a passageway arranged within said casing for directing the actuating fluid through one vane circle at one part, a passageway arranged within the casing for directing the actuating fluid back through the same vane circle at a different part of the circumference of the turbine and a passageway arranged for directing the actuating fluid across and outside of said vane circle to another vane circle.

4. In a turbine, a casing, a series of vane circles operatively mounted in said casing, said vane circles being of successively increasing diameter from the intake side of the casing, a passage way arranged within said casing for directing the actuating fluid through one vane circle at one part, a passageway within said casing for directing the actuating fluid back through the same vane circle at a different part of the circumference of the turbine and a passageway arranged for directing the actuating fluid across and outside of said vane circle to another vane circle of larger diameter.

5. In a turbine, the combination of a casing, a series of vane circles operatively mounted in said casing, passageways arranged within said casing for directing the actuating fluid a plurality of times back and forth in a continuous stream through one vane circle at different portions of said circle and a passageway arranged outside of and extending across said vane circle for directing the actuating fluid from said vane circle to the next vane circle.

6. In a turbine, a series of rotatable vane circles, passageways for directing the actuating fluid through one vane circle from one side then again through the same vane circle from the opposite side at a different part of said circle and a passageway for conducting the actuating fluid outside of and across said vane circle to a succeeding vane circle.

7. In a turbine, a casing, vane carrying members rotatably mounted in said casing, said vane carrying members being of successively increasing diameter, passageways for conducting the actuating fluid back and forth through the vanes on one vane carry-

ing member at different portions of the circumference and passageways arranged at the same side of said vane carrying member as that from which the actuating fluid first passes through said vanes for conducting the actuating fluid outside of and across said vane circle to the vane circle on the next succeeding vane carrying member.

8. In a turbine, a casing, diaphragms arranged in said casing dividing the interior thereof into a plurality of pressure stages, a vane carrying member mounted in each pressure stage, means for supplying an actuating fluid to said casing, passageways arranged in a pressure stage for directing the actuating fluid back and forth through the vanes on the vane carrying member therein a plurality of times and passageways arranged for conducting the actuating fluid from said pressure stage outside of and across the vane carrying member therein to the next pressure stage.

9. In a turbine, a casing, means for dividing the casing into pressure stages, a rotatable vane circle in each pressure stage, a nozzle for directing the actuating fluid into a pressure stage, a passageway arranged within the casing for directing the actuating fluid back through the same pressure stage at a different part of the circumference of the turbine, a passageway arranged for directing the actuating fluid across and outside of said pressure stage to another pressure stage and a nozzle for directing an additional quantity of actuating fluid into said last-mentioned passageway.

10. In a turbine, a casing, diaphragms arranged in said casing dividing the interior thereof into a plurality of pressure stages, a vane carrying member mounted in each pressure stage, passageways for directing the actuating fluid a plurality of times through the vanes on each of a series of said vane carrying members, passageways for conducting the actuating fluid from each pressure stage in which a multi-impact vane carrying member is located outside of and across said vane carrying member to the next pressure stage and passageways for conducting the actuating fluid directly through the vanes on the remainder of said vane carrying members.

11. In a turbine, a casing, a plurality of pressure stages arranged in said casing, a vane carrying member arranged in each pressure stage, a plurality of feed nozzles communicating with said casing and a series of passageways for directing the actuating fluid from said nozzles in continuous streams through the vanes on said vane carrying members, each passageway being arranged to direct the actuating fluid a plurality of times through the vanes on each of a series of said vane carrying members and outside of and across each vane carrying member of said series to the next pressure stage and then directly through the vanes on the remainder of said vane carrying members.

12. In a turbine, the combination of a casing, a vane carrying member arranged in said casing, a partition forming a pressure stage for said vane carrying member, a nozzle arranged to communicate with the interior of said casing at a point such that the fluid therefrom will pass through a portion of the vanes on said vane carrying member, a passageway arranged on the said partition and having its inlet arranged approximately opposite the outlet of said nozzle and having its outlet at the same side as its inlet but spaced a distance therefrom so as to direct the fluid back through the said vane circle and a passageway having its inlet opposite and on the other side of the vane circle from the outlet of the first-mentioned passageway and having its outlet arranged at a greater radius than the said vane circle.

13. In a turbine, the combination of a casing, a plurality of diaphragms arranged in said casing dividing said casing into pressure stages, a vane carrying member arranged in each pressure stage, a nozzle arranged to communicate with the interior of said casing at a point such that the fluid therefrom will pass through the vanes on the adjacent vane carrying member, a passageway arranged on the partition adjacent to the first vane carrying member, said passageway having its inlet arranged approximately opposite the outlet of said nozzle and having its outlet at the same side as its inlet but spaced a distance therefrom so as to direct the fluid back through the said vane circle, a passageway having its inlet opposite and on the other side of the vane circle from the outlet of the first-mentioned passageway and having its outlet arranged at a greater radius than the said vane circle and communicating with an opening in said diaphragm, a passageway arranged between the wall of said casing and said diaphragm, the outlet of said passageway being arranged to direct the fluid through the vanes on the next succeeding vane carrying member, a passageway arranged on the next succeeding diaphragm adjacent to the second vane carrying member, said passageway having its inlet arranged approximately opposite said last-mentioned passageway and having its outlet at the same side as its inlet but spaced a distance therefrom so as to direct the fluid back through the same vane circle and a passageway having its inlet opposite and on the other side of the vane circle from the outlet of the last-mentioned passageway and having its outlet arranged at a greater radius than the last-mentioned vane circle.

14. In a turbine, the combination of a casing, a plurality of partitions arranged in

said casing dividing said casing into pressure stages, a vane carrying member arranged in each pressure stage, a nozzle arranged to communicate with the interior of said casing at a point such that the fluid therefrom will pass through a portion of the vanes on the adjacent vane carrying member, a passageway arranged on the diaphragm adjacent to the first vane carrying member, said passageway having its inlet arranged approximately opposite the outlet of said nozzle and having its outlet at the same side as its inlet but spaced a distance therefrom so as to direct the fluid back through the said vane circle, a passageway having its inlet opposite and on the other side of the vane circle from the outlet of the first-mentioned passageway and having its outlet arranged at a greater radius than the said vane circle and communicating with an opening in said diaphragm, a passageway arranged between the walls of said casing and said diaphragm, the outlet of said passageway being arranged to direct the fluid through a portion of the vanes on the next succeeding vane carrying member, a nozzle arranged to direct the fluid directly into said passageway, a passageway arranged on the next succeeding partition adjacent to the said second vane carrying member, said passageway having its inlet arranged approximately opposite said last-mentioned passageway and having its outlet at the same side as the inlet but spaced a distance therefrom so as to direct the fluid back through the same vane circle and a passageway having its inlet opposite and on the other side of the vane circle from the outlet of the last-mentioned passageway and having its outlet arranged at a greater radius than the last-mentioned vane circle.

15. In a turbine, the combination of a casing, a plurality of diaphragms of successively increasing diameter arranged in said casing, each diaphragm being provided with an annular flange around its periphery, a vane carrying member arranged in each pressure stage, each vane carrying member having a less radius than the next succeeding diaphragm, a nozzle arranged to communicate with the interior of said casing at a point such that the fluid therefrom will pass through the vanes on the first-vane carrying member, a passageway arranged on the diaphragm adjacent to the first vane carrying member, said passageway having its inlet arranged approximately opposite the outlet of said nozzle and having its outlet at the same side as its inlet but spaced a distance therefrom so as to direct the fluid back through the said vane circle, a passageway having its inlet opposite and on the other side of the vane circle from the outlet of the first-mentioned conduit and having its outlet arranged at a greater radius than the said vane circle and communicating with an opening in said diaphragm, a passageway arranged between the wall of said casing and the flange on said diaphragm, the outlet of said passageway being arranged to direct the fluid through the vanes on the next succeeding vane carrying member, a passageway arranged on the next succeeding diaphragm adjacent to the second vane carrying member, said passageway having its inlet arranged approximately opposite said last-mentioned passageway and having its outlet at the same side as its inlet but spaced a distance therefrom so as to direct the fluid back through the same vane circle and a passageway having its inlet opposite and on the other side of the vane circle from the outlet of the last-mentioned passageway and having its outlet arranged at a greater radius than the last-mentioned vane circle.

In testimony whereof, I sign the foregoing specification, in the presence of two witnesses.

THOMAS S. KEMBLE.

Witnesses:
VICTOR C. LYNCH,
N. L. McDONNELL.