No. 840,376. PATENTED JAN. 1, 1907.

R. H. RICE.

ELASTIC FLUID TURBINE.

APPLICATION FILED JUNE 14, 1906.

3 SHEETS—SHEET 1.

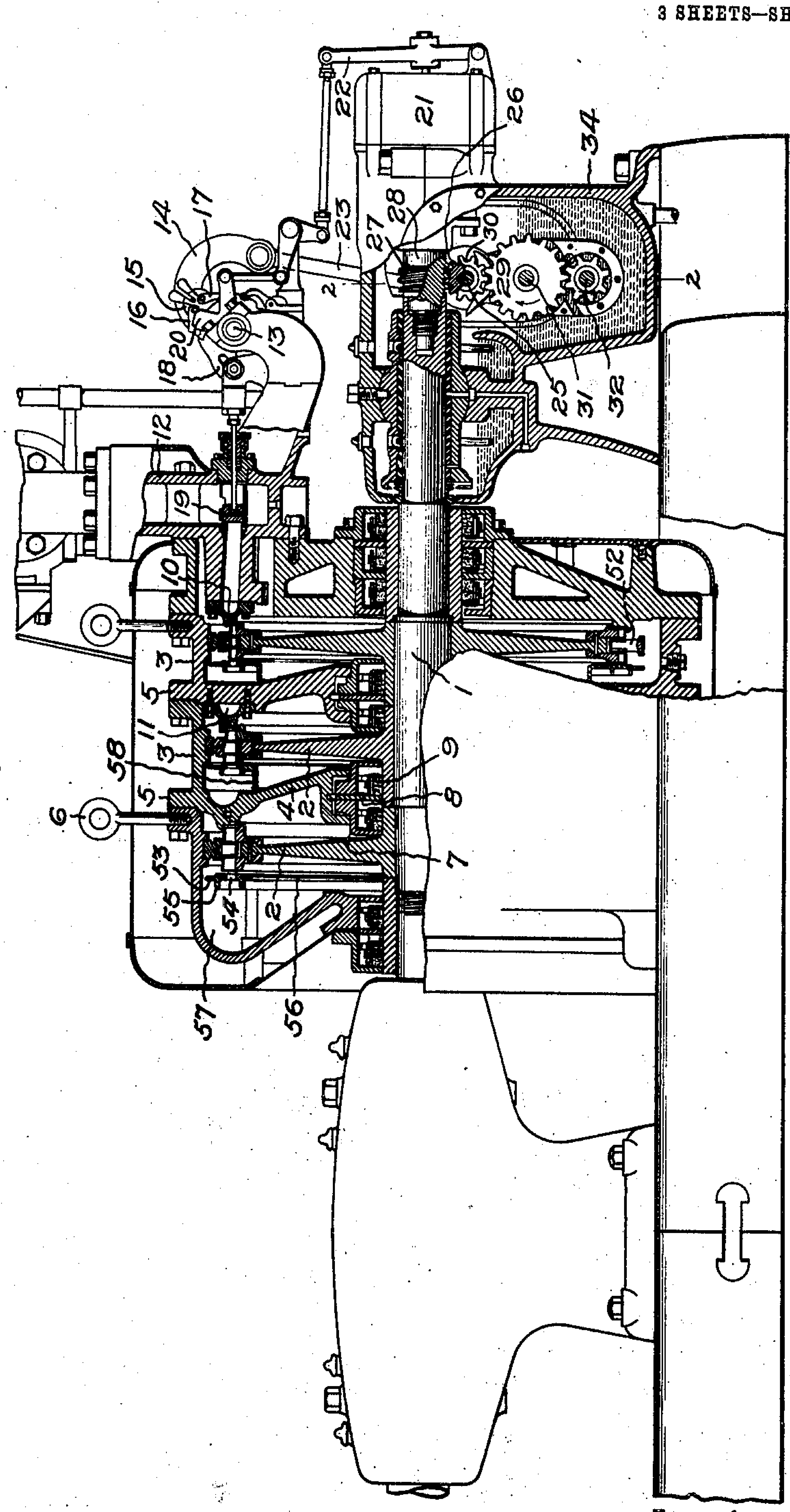

Fig. 1.

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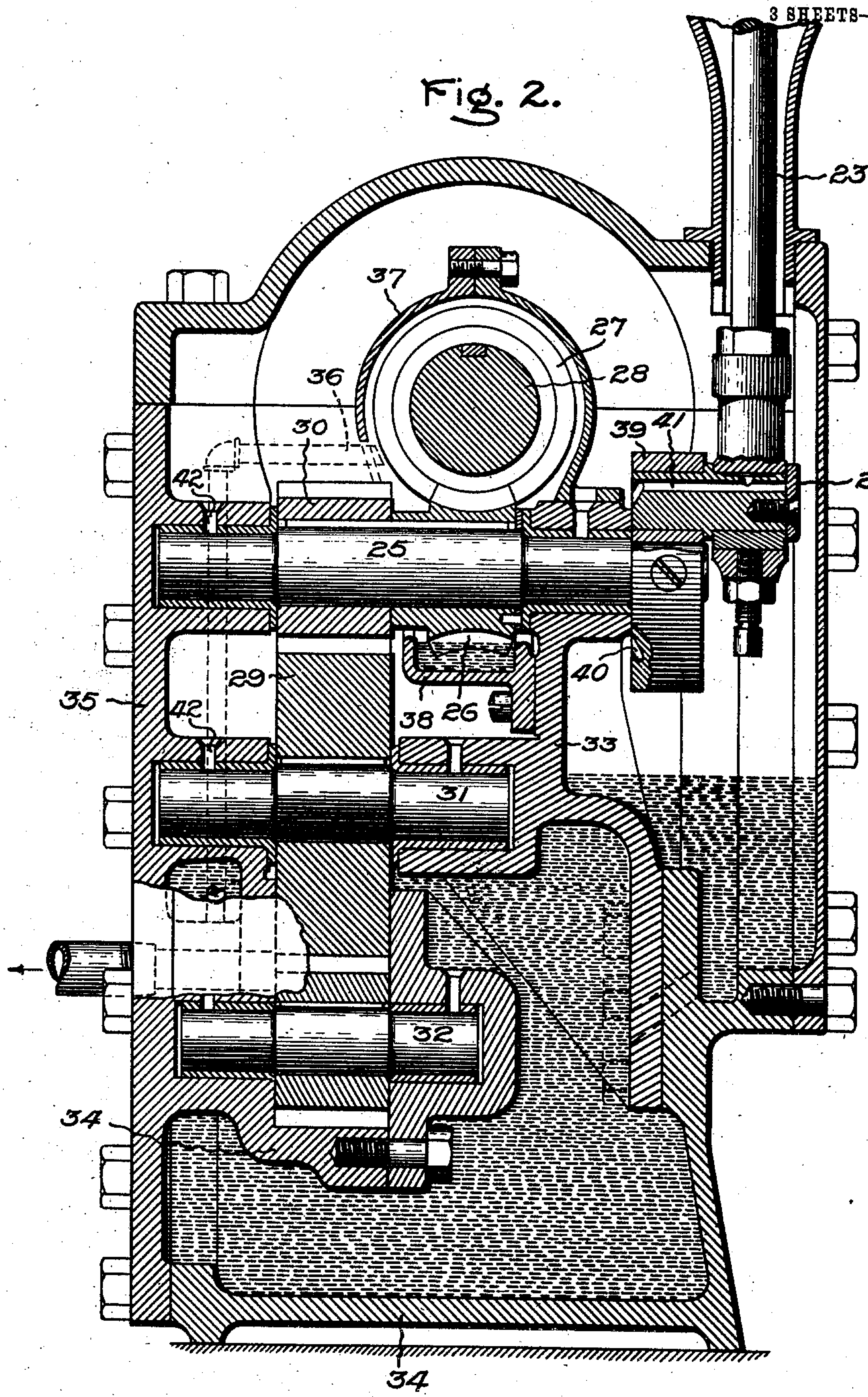
3 SHEETS—SHEET 2.

Fig. 2.



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3 SHEETS—SHEET 3.

Fig. 3.

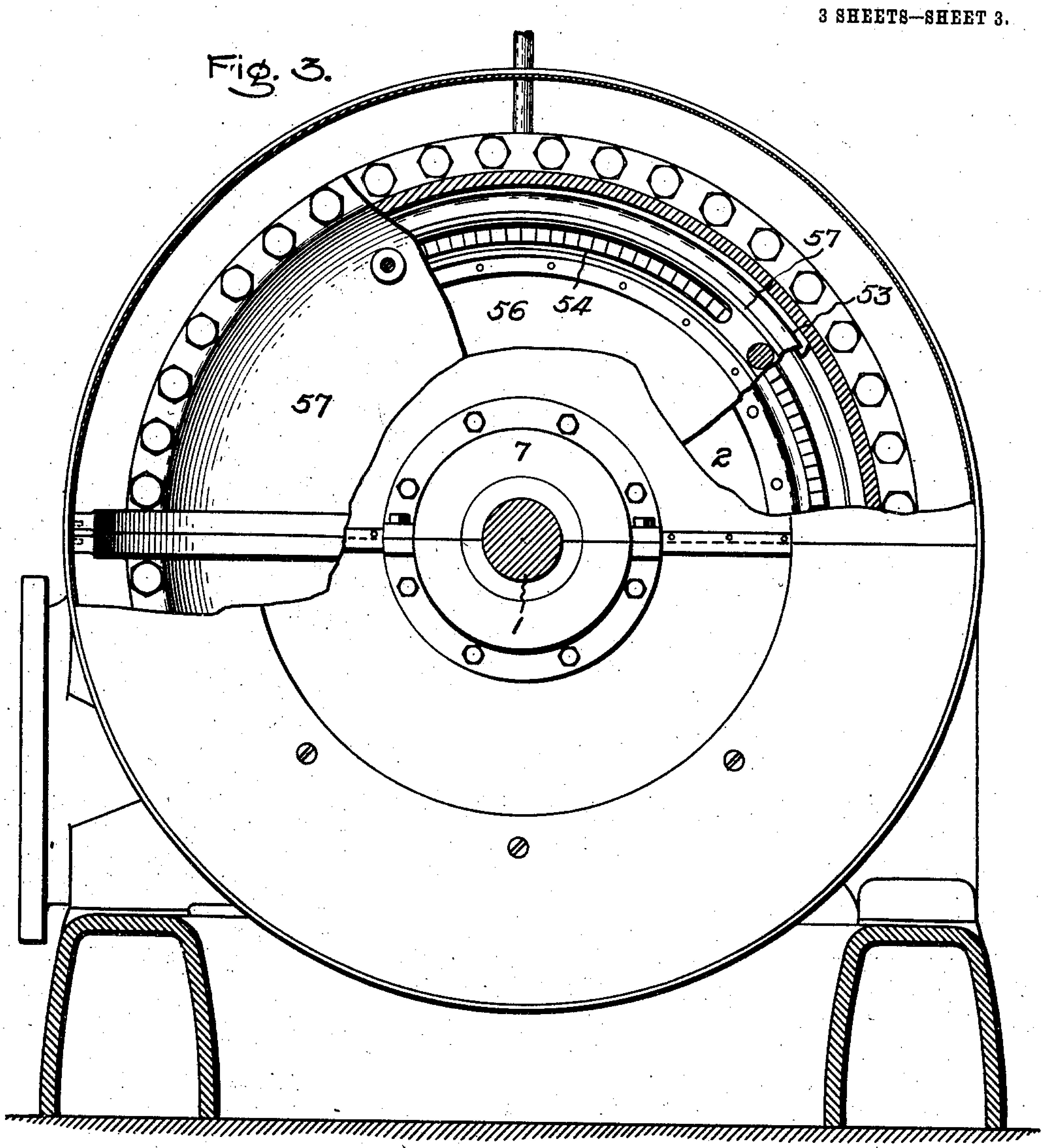
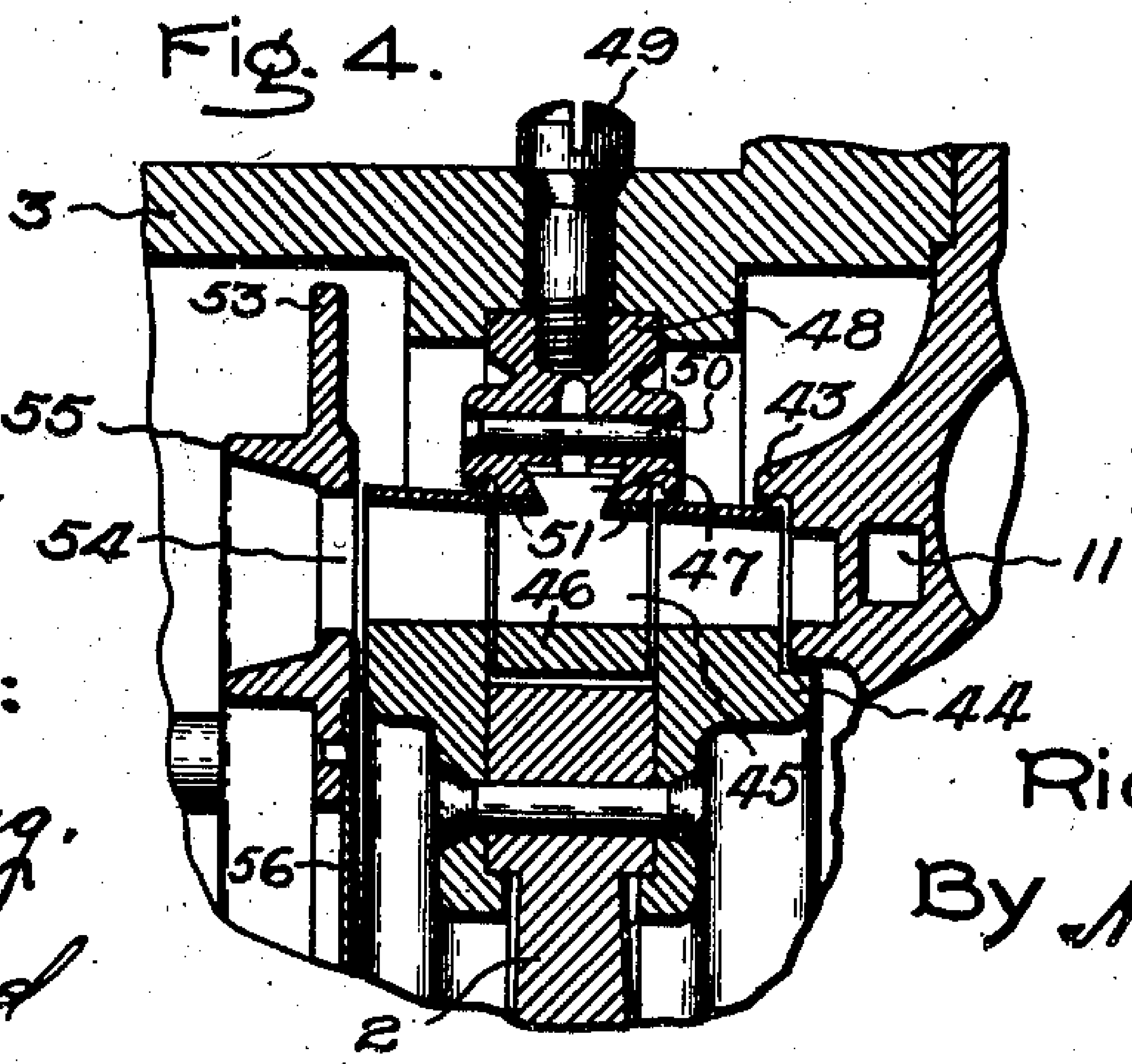


Fig. 4.



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UNITED STATES PATENT OFFICE.

RICHARD H. RICE, OF LYNN, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELASTIC-FLUID TURBINE.

No. 840,376. Specification of Letters Patent. Patented Jan. 1, 1907.

Application filed June 14, 1906. Serial No. 321,617.

To all whom it may concern:

Be it known that I, RICHARD H. RICE, a citizen of the United States, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Elastic-Fluid Turbines, of which the following is a specification.

The present invention relates to elastic-fluid turbines, and has for its object to improve their construction, particularly with reference to assembling and taking them down and increasing the accessibility of the parts.

In the accompanying drawings, which illustrate one of the embodiments of my invention, Figure 1 is an axial section of a multistage impact-turbine with certain of the parts in elevation. Fig. 2 is an enlarged section taken on line 2 2 of Fig. 1. Fig. 3 is an enlarged end view with certain of the parts broken away and others in section to illustrate the interior structure of the turbine, and Fig. 4 shows an enlarged section of the means employed to secure the intermediate buckets.

1 represents the main shaft, upon which are bucket-wheels 2, as many of these wheels being provided as are necessary to abstract the energy of the motive fluid. The wheels may be provided with one, two, or more rows of buckets, as desired. Between each two rows of buckets on the same wheel are intermediate buckets for reversing the direction of flow of the steam and discharging it at the proper angle against the adjacent wheel-buckets. Surrounding the wheels is a casing that is made up of sections 3. Each of these sections is made in the form of a ring and is provided with a diaphragm 4, formed integral therewith, and also with flanges 5, by means of which adjacent sections of the casing can be united. The casing is divided along the horizontal axial plane, as shown in Fig. 3, so that the upper half can be moved by a crane attached to the eyebolts 6. Each of the diaphragms is provided with a hub surrounding the main shaft 1, and supported by the hub is a casing 7, divided into two parts by a division-plate 8. Situated on opposite sides of the division-plate are packing-rings 9, that engage with the hubs of the wheels and prevent the free passage of steam from one stage or wheel-compartment to the other.

Steam or other elastic fluid is admitted to the turbine by the nozzles 10, which may be expanding or non-expanding in their character. The individual passages of the nozzle or nozzles are preferably, but not necessarily, closely associated in order to reduce spill losses. Between one stage and the next are stage-nozzles 11 of suitable size to handle the steam at its decreased pressure and increased volume. The nozzles may either be formed in the diaphragms, as shown in the third stage, or attached to the diaphragm, as shown in the second stage.

The admission nozzle or nozzles are bolted to the valve-chest 12, the latter being secured to the upper half of the high-pressure head of the machine by bolts. The valves are operated by means of a suitable valve-gear.

Briefly, the governing mechanism comprises a rock-shaft 13, an actuating-lever 14, that is continuously rocking the shaft to and fro, steam-levers 15, secured to the rock-shaft and carrying dogs 16 and 17, and cam-plates 18, located one behind the other, which act on the stems of the valves 19. Each pair of dogs 16 and 17 is arranged to move the cam in one direction or the other, and thus open or close a valve, as the case may be. Their action is controlled by a shield-plate 20, the latter being connected to the governor 21 by means of the lever 22 and suitable adjusting connecting-rods. Each valve is provided with a cam, a steam-lever carrying the actuating-dogs, and a shield-plate, the actuating-lever 14 being common to all of the valves. The lever 14 is actuated by the connecting-rod 23 from the crank 24, the latter being mounted on a secondary or low-speed shaft 25, extending at right angles to the axis of the main shaft and located in a casing forming a part of the bearing-support. Mounted on the low-speed shaft 25 is a worm-wheel 26, Fig. 2, meshing with a worm 27, mounted on or formed integral with the shaft 28, Figs. 1 and 2. In the present instance the worm is cut directly on the shaft 28, and the latter is screwed into a socket formed in the main shaft 1. On the end of this stub-shaft is mounted the governor 21.

In apparatus of this character it is necessary to supply oil to the different parts by a forced circulation, and in order to do this I provide a pump comprising gears 29 and 30, that are mounted upon separate shafts, one above the other, the gear 29 meshing with a pinion 30, mounted on the low-speed shaft 25. The shafts 31 and 32, carrying the gears of the pump, are mounted in suitable bearings carried by a vertical partition 33 and a support 34, located within the support for the main shaft-bearing. The front wall 35 of the casing is made removable, so that after the oil is drained out of the compartment the gears will be exposed. The worm 27 and worm-wheel 26 are supplied with oil by the pipe 36, (shown in dotted lines,) and the worm is provided with a casing 37, that serves to confine the lubricant to the worm.

Situated below the worm-wheel 26 is a tray 38, which catches lubricant discharged from above and retains at all times an amount sufficient to lubricate the wheel. The crank-disk 39 on the low-speed shaft 25 is provided with a recess 40, which catches oil thrown from or working out of the adjacent parts and conveys it into the passage 41, extending through the crank-pin 24, and thus lubricating the bearing-surfaces at this point. The gears 29 and 30 are practically immersed in oil, and the oil thrown from the rotating gears is caught by the bearing-supports adjacent thereto and permitted to flow into the oil-passages 42 and lubricate the shaft-bearings.

In the operation of elastic-fluid turbines it is necessary to reduce as much as possible the losses due to leakage and those due to the fan-like action of the idle and rapidly-rotating buckets. In order to reduce the leakage losses, I provide the nozzles with a lip 43, as shown in Fig. 4, and the adjacent wheel-bucket is provided with a lip 44, that projects under a cylindrical wall of the nozzle and in close proximity thereto. It will thus be seen that for any steam to escape in its passage from the nozzle 11 to the wheel-buckets it must first pass at right angles to its normal path and then turn and flow parallel to its normal path. In the case of the lip 43 the steam, after passing through the radial clearance and turning, will flow in the same direction that it did before; but in the case of the lip 44 the direction of the steam-flow is reversed, thereby greatly increasing the resistance to leakage In both cases the resistance to leakage is high without, however, having contacting surfaces.

The intermediate buckets 45 are cut or formed integral with the base 46. The outer ends of the buckets are provided with dovetail projections 47, that enter a dovetail groove in a support 48, the latter being seated in a groove formed in the inner wall of the casing. The supports are secured in place by bolts 49, entering from the outside and provided with conical surfaces just below the head to prevent leakage. The buckets 45 are secured to the support by axially-extending bolts or rivets 50. The segments carrying the buckets are slipped into the supports from one end and afterward secured in place by forcing the sides of the support together. With such a construction there is a groove extending circumferentially, and in order to cover this over so that a smooth surface will be presented to the steam a lining-strip 51 is provided having holes punched out to receive the dovetail ends of the bucket 45. This strip is mounted in place before the intermediates are assembled.

In order to reduce the rotation losses of the idle-wheel buckets, the nozzle-rings are made to extend entirely around the wheel-buckets, particularly in the early stage or stages where the nozzle passages or sections cover only a small portion of the periphery of the wheel. The intermediate buckets extend only partially around the wheel, and the remaining portion is filled by a blank cylindrical wall 52, Fig. 1. The same arrangement is followed in each of the succeeding stages, the arc covered by the nozzles increasing around the wheel from the high to the low pressure end.

In order to reduce the rotation losses on the exhaust side of the wheel, a shield 53 is provided, Fig. 4. This is provided with an orifice 54, corresponding to the active portion of the bucket-wheel adjacent thereto. The remainder of the shield is made smooth and flat and occupies a position in close proximity to the wheel-buckets. The shield is provided with concentric rings or flanges 55, the opposed walls of which diverge to a greater or less extent to assist in exhausting the steam from the buckets. The shield is supported by a plate 56, the latter being made fast to a diaphragm or other suitable support. In all of the stages except the last, which is connected to the exhaust-conduit 57, it is desirable to prevent as much as possible the tendency of the steam to flow toward the shaft and through the packing of the adjacent stage without doing useful work. This is accomplished by providing the shield 53 with lips 58, extending circumferentially and in close proximity to the diaphragms.

In accordance with the provisions of the patent statutes I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other means.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. An elastic-fluid turbine comprising rela-

tively rotating parts, in combination with a main shaft, a valve mechanism, a secondary shaft driven by the main shaft, gearing between the main and secondary shafts, a means driven by the secondary shaft for actuating the valve mechanism, and a lubricating-pump geared to and driven by the secondary shaft.

2. An elastic-fluid turbine comprising relatively rotating parts and a main shaft, in combination with a bearing therefor, a secondary shaft carried by the bearing-support, gearing between the main and secondary shafts, a gear-pump also carried by the bearing-support, and a gear mounted on the secondary shaft and meshing with one of the pump-gears for driving it.

3. An elastic-fluid turbine comprising relatively rotating parts and a main shaft, in combination with a bearing therefor, a secondary shaft extending at right angles to the main shaft and carried by the bearing-support, a reciprocating member driven by the secondary shaft, gearing between the shafts, a gear-pump comprising meshing gears, shafts therefor extending parallel to the secondary shaft, and a gear mounted on the secondary shaft and meshing with one of the gears of the pumps to drive it.

4. An elastic-fluid turbine comprising relatively rotating parts and a main driving-shaft, in combination with a bearing therefor, a secondary shaft extending at right angles to the main shaft, gearing between the two, a casing inclosing the gearing to confine the lubricant and insure proper distribution thereof, bearings for the secondary shaft, a gear-pump, and a support that is common to the bearings of the secondary and pump-shafts.

5. In an elas c-fluid turbine, the combination of a fluid-discharging device, a bucket-wheel, a lip on the discharging device which projects over the periphery of the wheel, and a cylindrical projection on the wheel that extends under the discharging device.

6. In an elastic-fluid turbine, the combination of a support that is split to provide a yielding clamping member and contains a bucket-receiving groove, buckets, the ends of which extend into the groove, and means for causing the parts of the support to clamp the buckets.

7. In an elastic-fluid turbine, the combination of a split support having a dovetail groove, buckets with the ends mounted therein, means for clamping the parts of the support to hold the buckets, and a lining-strip inserted between the support and the main body of the buckets.

8. In an elastic-fluid turbine, the combination of wheel-buckets and fluid-discharging devices, a shield to reduce the rotation losses of the idle buckets, and a circumferential flange coöperating with the shield to reduce the tendency of the motive fluid to leave its normal path.

In witness whereof I have hereunto set my hand this 12th day of June, 1906.

RICHARD H. RICE.

Witnesses:
JOHN A. MCMANUS, Jr.,
PHILIP F. HARRINGTON.