No. 754,400 PATENTED MAR. 8, 1904.

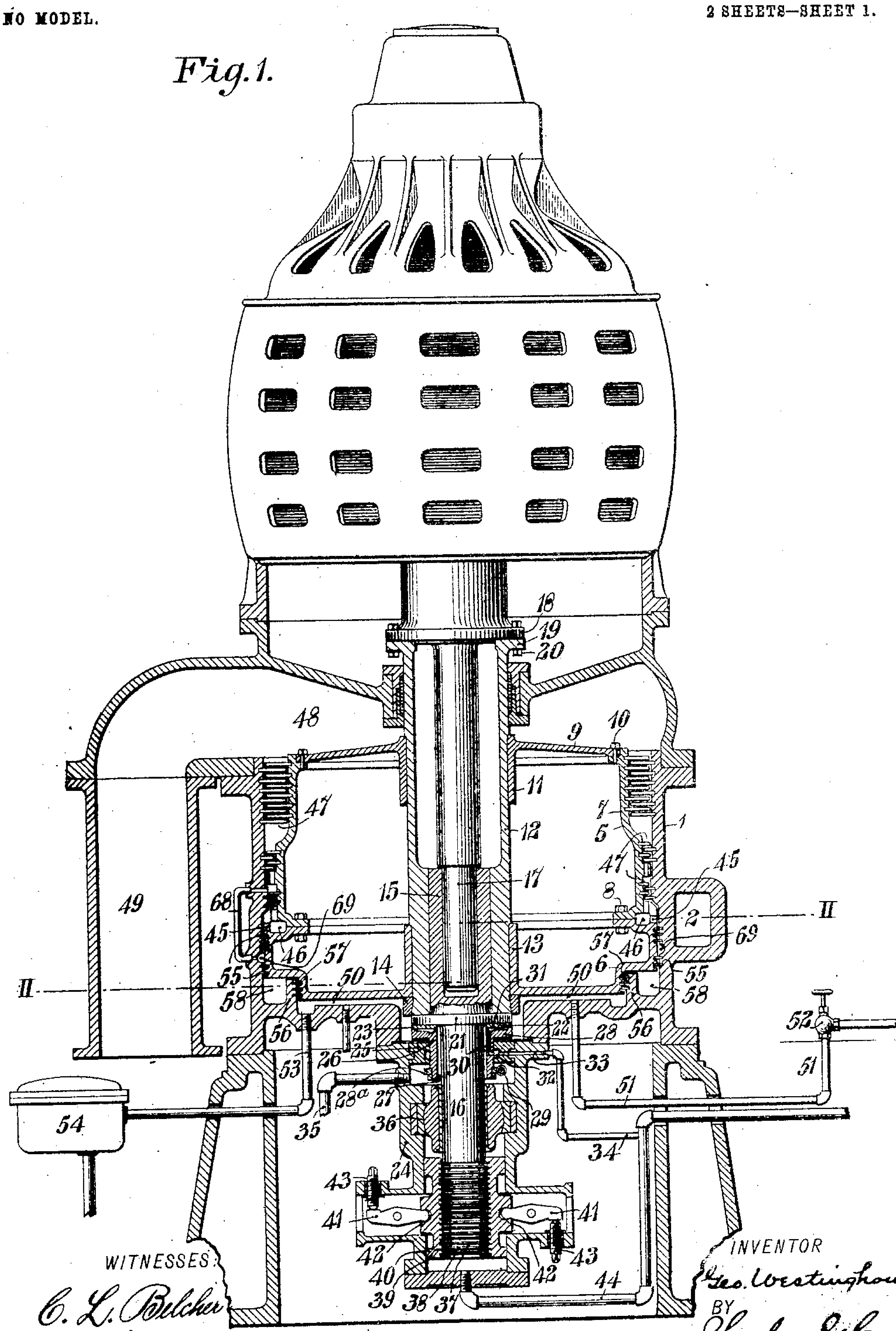
G. WESTINGHOUSE.

VERTICAL FLUID PRESSURE TURBINE.

APPLICATION FILED JUNE 24, 1903.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.



WITNESSES:

C. L. Belcher

J. C. Morse

INVENTOR

Geo. Westinghouse

BY

Wesley G. Carr

ATTORNEY

No. 754,400. PATENTED MAR. 8, 1904.

G. WESTINGHOUSE.

VERTICAL FLUID PRESSURE TURBINE.

APPLICATION FILED JUNE 24, 1903.

NO MODEL. 2 SHEETS—SHEET 2.

Fig. 2.

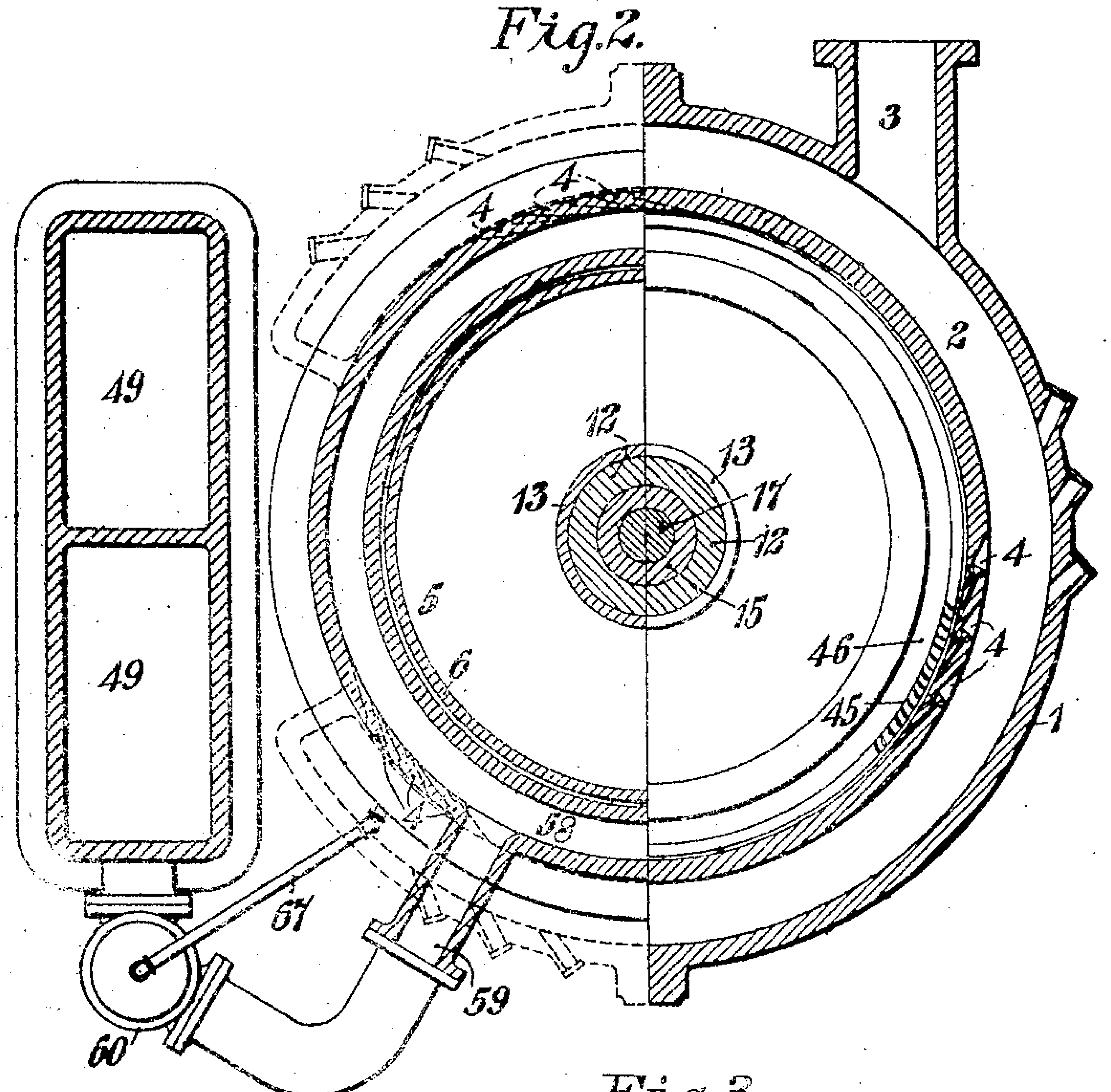
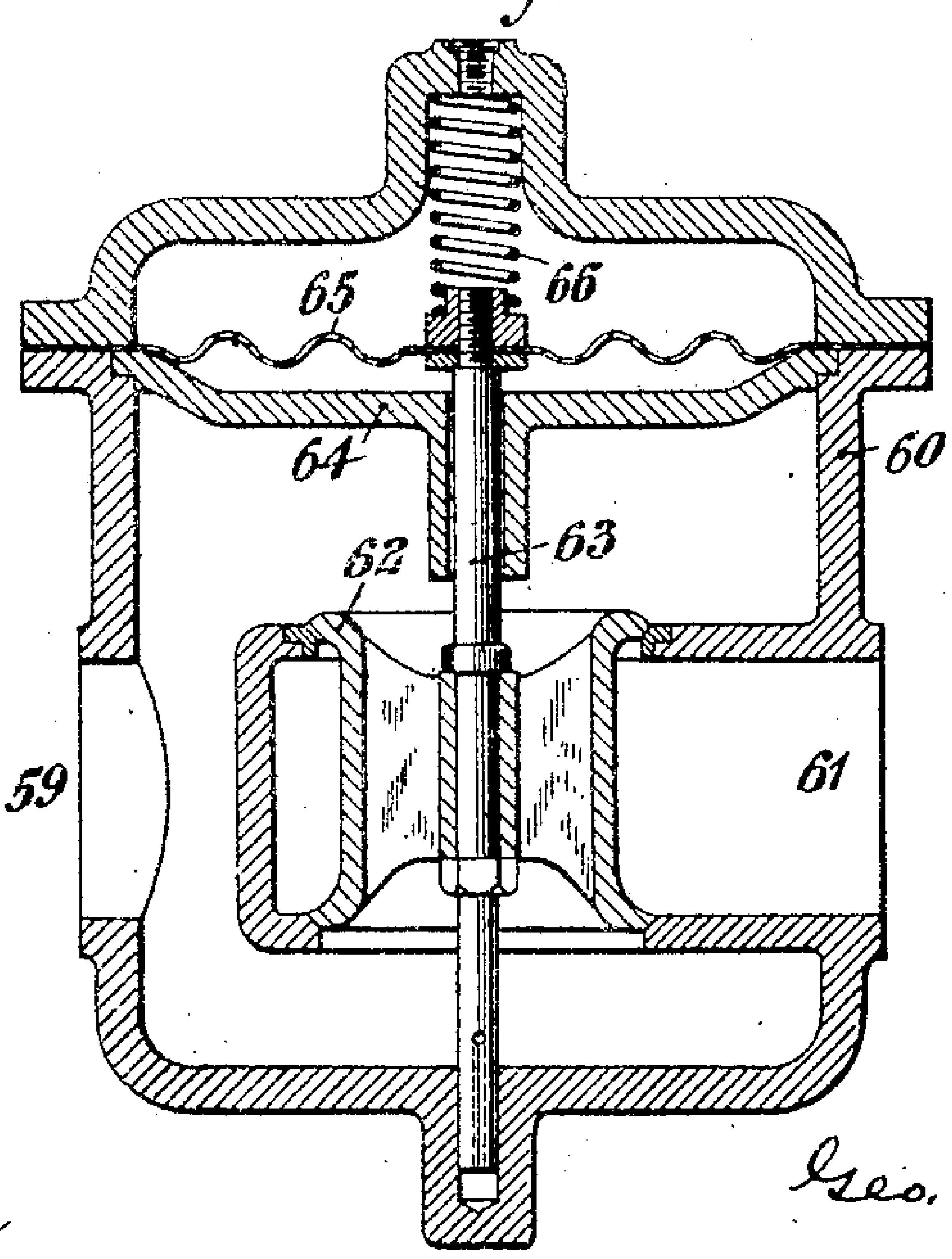


Fig. 3.



WITNESSES:

C. L. Belcher

J. C. Morse

INVENTOR

Geo. Westinghouse

BY

Wesley G. Carr

ATTORNEY

No. 754,400. Patented March 8, 1904.

UNITED STATES PATENT OFFICE.

GEORGE WESTINGHOUSE, OF PITTSBURG, PENNSYLVANIA, ASSIGNOR TO THE WESTINGHOUSE MACHINE COMPANY A CORPORATION OF PENNSYLVANIA.

VERTICAL FLUID-PRESSURE TURBINE.

SPECIFICATION forming part of Letters Patent No. 754,400, dated March 8, 1904.

Application filed June 24, 1903. Serial No. 162,909. (No model.)

To all whom it may concern:

Be it known that I, GEORGE WESTINGHOUSE, a citizen of the United States, and a resident of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Vertical Fluid-Pressure Turbines, of which the following is a specification.

My invention relates to fluid-pressure turbines; and it has for its object to provide a machine of this character the rotary member of which shall have a vertical shaft and which, together with the machine or machine member driven thereby, shall be supported by atmospheric pressure or by an elastic-fluid pressure that exceeds atmospheric pressure to such degree as may be necessary in order to substantially relieve the shaft-bearing from end pressure.

My invention consists of the means hereinafter described and claimed for supporting the rotary members of vertical fluid-pressure turbines and the parts supported thereby, as above indicated, and in certain details of construction, as will hereinafter more fully appear.

It has been a general practice to construct all classes of engines with horizontal shafts, and where such engines have been employed for driving dynamo-electric generators the rotating members of such generators, usually the field-magnets, have been mounted directly upon the engine-shafts or coupled either rigidly or flexibly thereto. Turbines having vertical shafts have been employed in certain cases; but where such construction has been adopted difficulty has been experienced in supporting the weight of the rotating parts. I propose to eliminate the difficulties that have heretofore been experienced by supporting the turbine-drum by an elastic-fluid pressure in such manner as to avoid the use of a step-bearing such as has heretofore been considered necessary.

In the accompanying drawings, Figure 1 is a vertical section of a fluid-pressure turbine, the dynamo operated thereby being shown mainly in outline. Fig. 2 is a horizontal sectional view on line II II of Fig. 1, and Fig. 3 is a detail sectional view of an automatic pressure-regulating valve.

The engine here shown is primarily designed for operation by means of steam and for convenience of description will be referred to as a "steam-turbine," without intention, however, of limiting the engine to the use of any specific fluid-pressure to the exclusion of others which it may be found feasible to employ in practice.

The frame or casing 1 of the turbine is provided near its lower end with one or more steam chests or chambers 2, into which the steam is introduced from a boiler at a pressure suitable for operating the engine. As here shown, a single steam chest or box is provided which extends nearly around the casing and the steam is introduced through an inlet-pipe 3. From the steam chamber or chambers, if there be more than one, expansion-nozzles 4 lead to the interior of the casing 1, in which is located a drum 5, here shown as comprising three principal parts, the lower part 6 and middle part 7 being fastened together by means of bolts 8 and the upper part or cap 9 being fastened to the main or middle part by means of suitable tap-bolts or screws 10.

In order to avoid all tendency to unbalancing the rotary member of the turbine by means of the impact of the steam upon the steam-using parts of the same, I preferably introduce the steam through three groups of nozzles one hundred and twenty degrees apart, as indicated in Fig. 2, though a greater or less number of groups might be employed and the spacing might be different from that which is shown. I have also shown each group as comprising three nozzles; but this is also subject to any desired variation as to the number of nozzles employed.

The upper part or cap 9 is provided with a hub 11, which is forced under heavy pressure upon a sleeve 12, and the bottom part 6 is provided with a similar hub 13, which is also forced under heavy pressure upon the lower end of the sleeve 12, the lower part 6 being further held securely in position by means of a ring

14, which is shrunk upon the extreme lower end of the sleeve 12.

Seated in the lower end of the sleeve 12 is the hollow upper end 15 of a shaft 16, which is forced into position under heavy pressure and receives the reduced lower end of the dynamo-shaft 17, this shaft being provided outside the turbine-casing 1 with an integral flange 18, which is fastened to a corresponding flange 19 on the outer end of the sleeve 12 by means of bolts 20. The shaft 16, in the part 15 of which the lower end of the dynamo-shaft is seated, is solid and extends below the drum 5 and is provided with a flange 21, which rests against the lower end of the sleeve 12. Fastened to the lower side of this flange 21, by means of suitable screws or tap-bolts 22, is a wearing-plate 23.

The construction above described is employed because it lends itself to convenience of manufacture; but it is by no means essential and is shown and described merely as one of a variety of suitable structures and not as in any way limiting the invention to such details.

Seated in the bearing-housing 24 below the plate 23 and rigidly fastened thereto is a ring 25, the interior of which is provided with a screw-thread to engage a corresponding thread in a cylinder 26, which surrounds the shaft 16 and between which and the shaft is a considerable circumferential space 27. The upper end of the cylinder 26 is extended to form a horizontal flange 28, the upper face of which normally makes a close fit with the lower face of the wearing-plate 23. The cylinder 26 is provided near its lower end with a worm-wheel 28ª, which is keyed or otherwise rigidly fastened thereto, and mounted in suitable bearings in the bearing-housing is a worm-pinion 29, which meshes with the worm-wheel 28ª, and when rotated serves to turn the cylinder, and thus raise or lower it, according to the direction of rotation, provision being thus made for any desired adjustment for taking up of wear or for any other purpose. The cylinder 26 is also provided with a small passage 30, which communicates at its upper end with oil-distributing grooves 31 in the upper face of the cylinder 26 and its flange 28. The lower end of the passage 30 is connected by an annular passage 32 to a horizontal passage 33, to which oil is supplied through a pipe 34, the waste oil being discharged through a pipe 35.

A suitable ball-and-socket bearing 36 is provided between the bearing-housing 24 and the shaft 16 in order to take care of any flexure of the shaft 16 which may occur in operation. The lower end of the shaft is also provided with a series of grooves 37 and annular flanges 38, which coöperate with corresponding rings 39 on a longitudinally-adjustable cylindrical head 40, levers 41 being provided, in such position that their inner ends engage with suitable sockets 42 in said cylindrical head, and screws 43 being provided for engaging with the outer ends of the levers, so as to adjust the head in the one direction or the other in order to take up wear and secure the packing engagement between the annular flanges 38 and the rings 39 that may be desired in practice. Oil is supplied to these bearing devices through a pipe 44, and the surplus oil is discharged through the pipe 35.

The drum 5 is provided adjacent to the exhaust ends of the supply-nozzles 4 with a circumferential series of blades 45, the spaces between which open into an annular chamber 46.

Located above the annular chamber 46 is a series of steam-using devices 47, which may be of any number, dimensions, and form which satisfactory operation may dictate, and since these devices constitute parts of my present invention only to the extent that they are parts of a satisfactorily operative turbine I deem it unnecessary to give any detailed description of them. After the steam passes the upper or last set of steam-using devices it exhausts into a chamber 48, which communicates by means of a passage or passages 49 with suitable condensing apparatus, (not shown,) so that when the turbine is in operation as a condensing-engine a considerable degree of vacuum will be maintained in the upper end of the casing above the rotary parts. By reason of this vacuum atmospheric pressure in the space 50 between the lower end of the drum and the lower end of the casing will serve to either partially or wholly support the drum, depending upon the degree of vacuum and the area of that portion of the drum which is subjected to this pressure. The air may be introduced to the space 50 through any suitable small inlet, that here indicated being a pipe 51, provided with a suitable valve 52. I also provide a drain-pipe 53, having an ordinary trap 54 for conducting away any water which may result from condensed steam that may leak into the space 50. In case atmospheric pressure is not sufficient to support the rotary member of the turbine and the rotary member of the dynamo driven thereby the fluid-pressure introduced into the space 50 from a pump or compressed-air reservoir through the pipe 51 may be increased to the desired degree by adjusting the valve 52. In case the air-pressure in the space 50 becomes excessive—that is, more than is necessary to float the moving parts—the wearing-plate 23 will be lifted an almost inappreciable degree from the flange 28 of the cylinder 26, but sufficiently to relieve the pressure in the space 50 to the necessary extent.

In order to prevent so far as possible the leakage of steam into the space 50, I provide suitable packing-rings 55 near the lower end of the drum at its maximum diameter, and I also provide the casing with an annular flange 56, between which and the corresponding portion of the drum I provide another set of packing-rings 57. The space or chamber 58 between these two sets of packing-rings is connected to the port 59 of a valve-casing 60. The opposite port 61, which is normally closed by the valve 62, connects with the exhaust-passage 49. The stem 63 of the valve 62 extends loosely through a partition-wall 64 and is connected to the middle of a flexible diaphragm 65. The valve is normally held to its seat by means of a coil-spring 66, supplemented by fluid-pressure, the space above the diaphragm 65 being connected, by means of a pipe 67, to the space 50 in order to provide the fluid-pressure. It follows from this construction that if leakage steam accumulates in the chamber 58 it will pass into the lower part of the valve-casing 60 and through the space around the valve-stem into the space above the partition 64 and below the flexible diaphragm 65. The air-pressure in the space 50, which is also exerted above the diaphragm 65 by reason of the pipe connection between the two spaces, in conjunction with the spring 66, will normally hold the valve closed; but if the leakage steam increases sufficiently so that its pressure actuates the diaphragm 65 the valve 62 will be opened and the steam will be exhausted from the chamber or space 58 to the exhaust-passage, the arrangement being such that any desired predetermined pressure in excess of that in the chamber 50 may be maintained in chamber 58. A further safeguard is provided against the leakage of steam in the form of a pipe 68, which connects an annular space 69 above the packing-rings 55 with the steam-using devices at a workable point above the annular chamber 46.

In case the vacuum should fail from any cause sufficient air-pressure may be supplied to the space 50 through the pipe 51 to float the moving parts, as will be readily understood.

While I have illustrated and described my invention as embodying the application of fluid-pressure directly to the bottom of the drum as affording the most simple and economical means, it is to be understood that such pressure may be applied to a separate piston located in a separate cylinder and of such dimensions that the rotary parts may be supported thereon. It will also be understood that other fluids than compressed air may be utilized and that the form, dimensions, and relative arrangement of parts may be varied from what is here shown and described. It will be further understood that the invention may be utilized in a non-condensing engine by employing supporting fluid under a sufficient degree of artificial pressure.

I claim as my invention—

1. In a fluid-pressure turbine having a vertical shaft, means for supplying the propelling fluid at or near the bottom of the turbine and means for exhausting the same at the top, in combination with means for applying such supplemental fluid-pressure to the bottom of the rotary member of the turbine as to substantially support the weight of the rotating parts.

2. In a fluid-pressure turbine having a vertical shaft and operated by fluid-pressure introduced at or near the bottom and exhausted at the top, a body of compressed fluid between the bottom of the rotating member and its casing to receive the downward thrust of the rotating parts due to gravity.

3. In a fluid-pressure turbine, the combination with a casing having one or more steam-chests and supply-nozzles, of a drum having steam receiving and utilizing members and means for supplying fluid-pressure between the lower end of the drum and the casing to receive the downward pressure exerted by gravity upon the moving parts.

4. In a fluid-pressure turbine having a vertical shaft and having a partial vacuum above its rotary member, means for applying fluid-pressure to the bottom of the rotary member to so supplement the upward atmospheric pressure as to substantially relieve the shaft-bearing from the weight of the moving parts.

5. In a fluid-pressure turbine, the combination with a casing and a rotary member having suitable steam-utilizing parts and a vertical shaft, of means for applying fluid-pressure to the rotary member in opposition to gravity in such degree and over such surface as to substantially relieve the shaft-bearing from the weight of the moving parts.

6. In a condensing steam-turbine, the combination with a casing and a rotary member having a vertical shaft and mounted in said casing, of means for supplying compressed fluid to the casing beneath the rotary member and means for automatically adjusting said pressure in accordance with the degree of vacuum in the exhaust chamber or passage.

7. The combination with a vertical steam-turbine and a dynamo-electric generator supported and driven thereby, of means for subjecting the rotary member of the turbine to an upwardly-acting fluid-pressure of such degree as to float the moving parts of the turbine and dynamo and thus relieve the shaft-bearing from the weight of said parts.

8. The combination with a vertical steam-turbine and a dynamo supported and driven thereby, of means for supplying fluid-pressure to the lower end of the rotary member of the turbine and means for regulating the fluid-pressure in order to float the moving parts.

9. The combination with a vertical steam-turbine and a dynamo supported and driven thereby, of means for applying regulated fluid-pressure to the lower end of the turbine to float the moving parts and a pressure-regulat-

ing valve controlled by the resultant of the opposing pressures of the supporting fluid and leakage steam.

10. The combination with a vertical steam-turbine and a dynamo supported and driven thereby, of means for applying an upwardly-acting fluid-pressure to the moving parts, independently of the shaft-bearing, of such degree as to wholly or largely relieve the shaft-bearing from the weight of said parts.

In testimony whereof I have hereunto subscribed my name this 15th day of June, 1903.

GEO. WESTINGHOUSE.

Witnesses:

WESLEY G. CARR,

BIRNEY HINES.