No. 862,187. PATENTED AUG. 6, 1907.

J. P. NIKONOW.

TURBINE AND REGULATING MEANS THEREFOR.

APPLICATION FILED SEPT. 16, 1906.

4 SHEETS—SHEET 1.

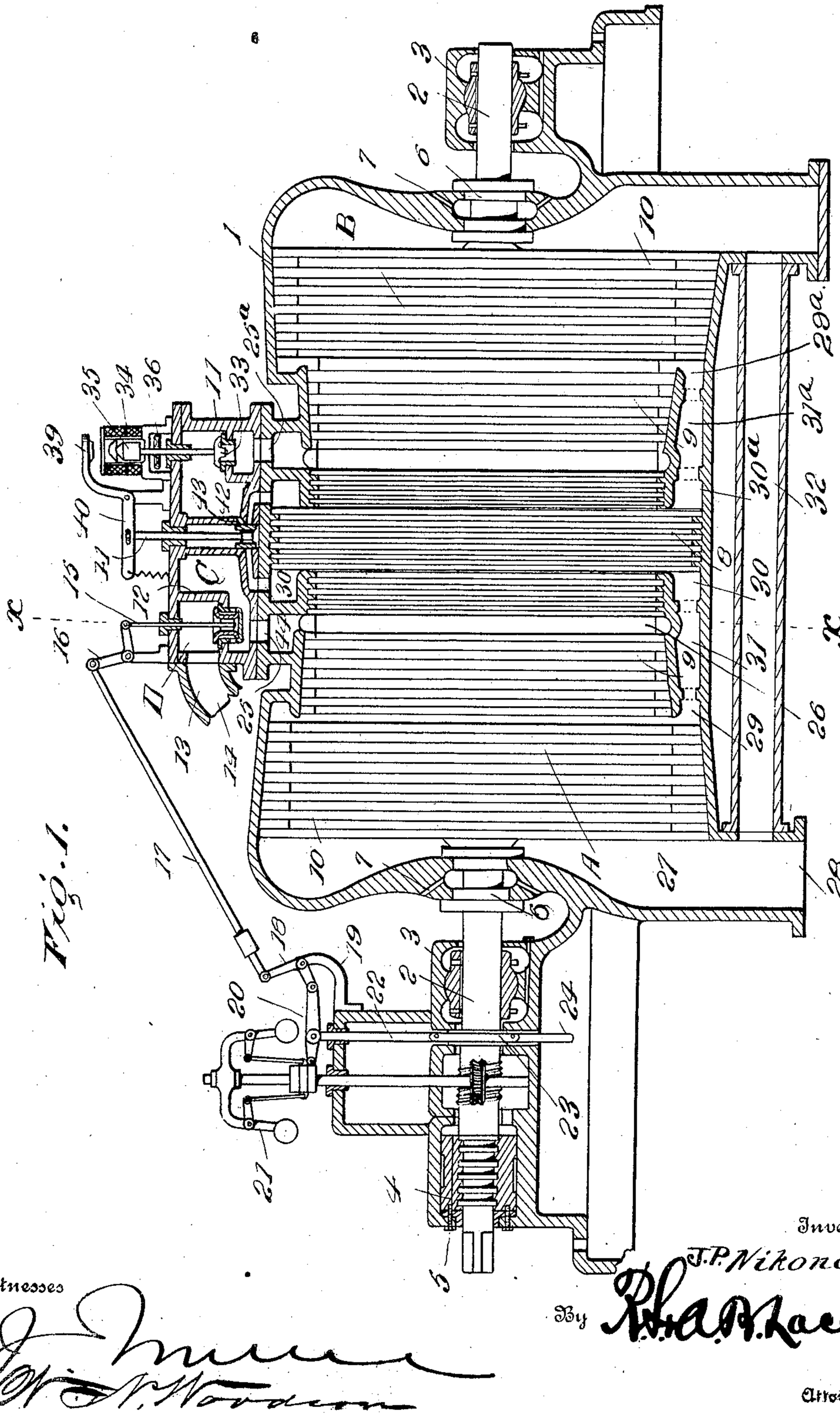

Fig. 1.

Witnesses

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4 SHEETS—SHEET 2.

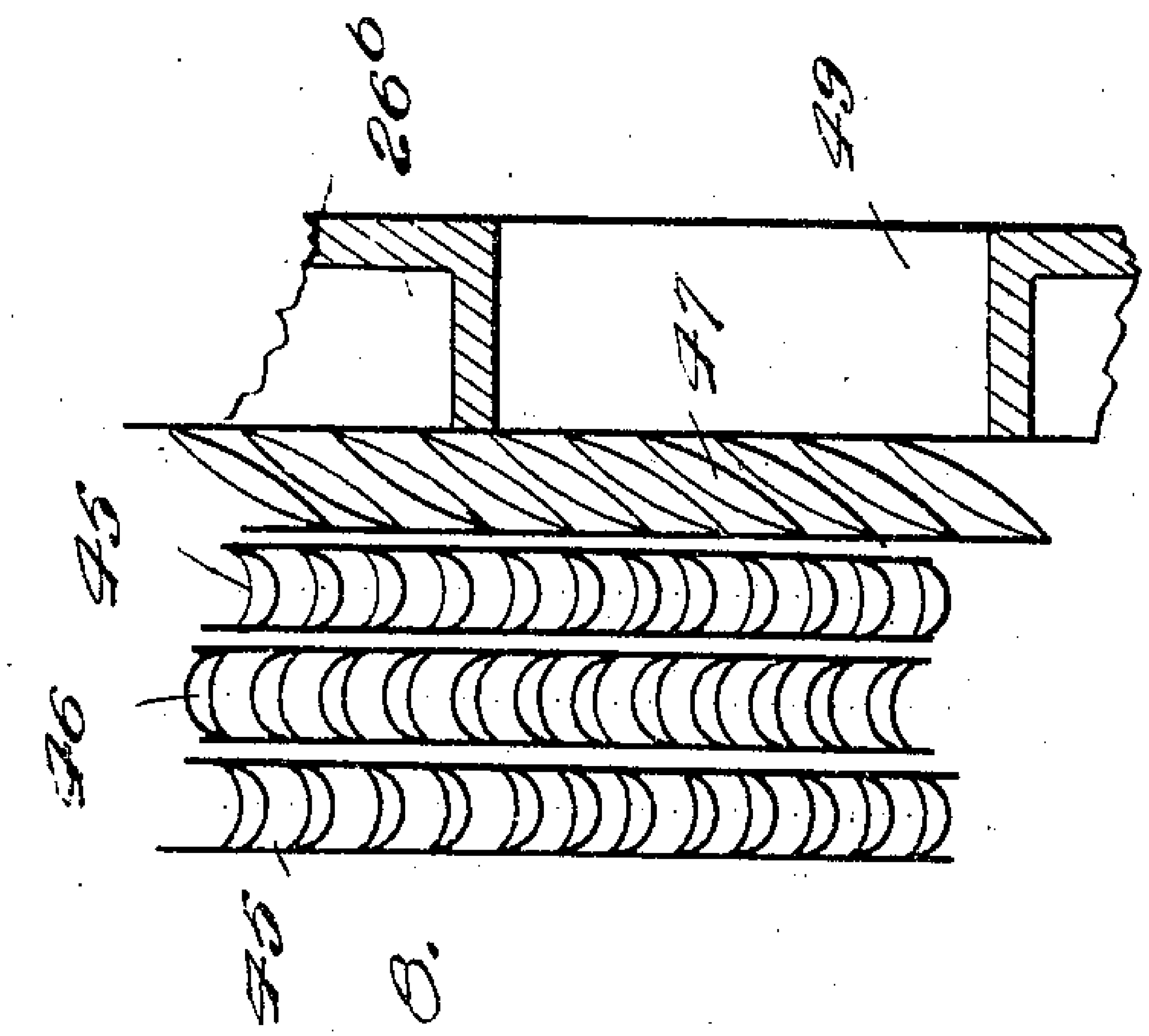

Fig. 8.

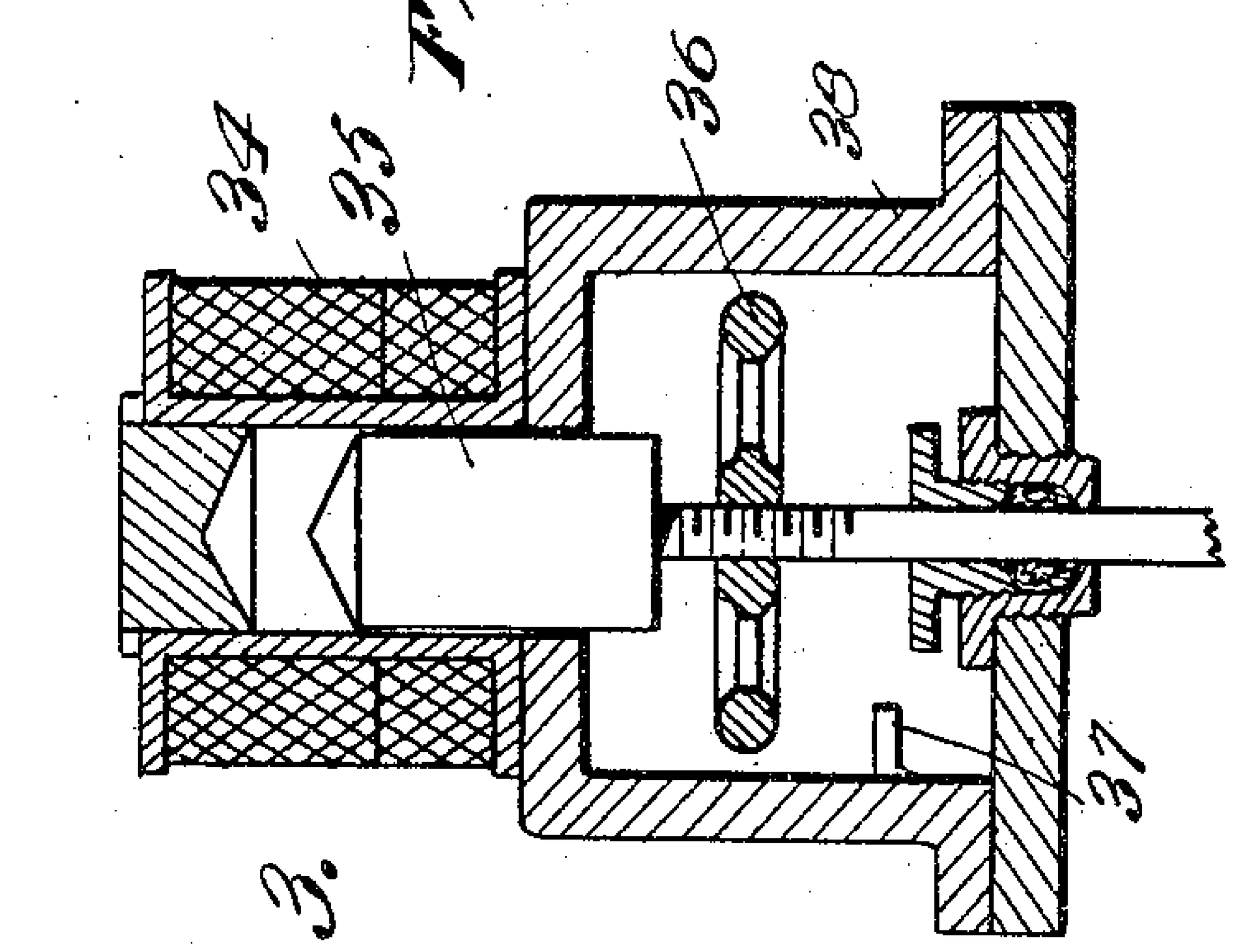

Fig. 3.

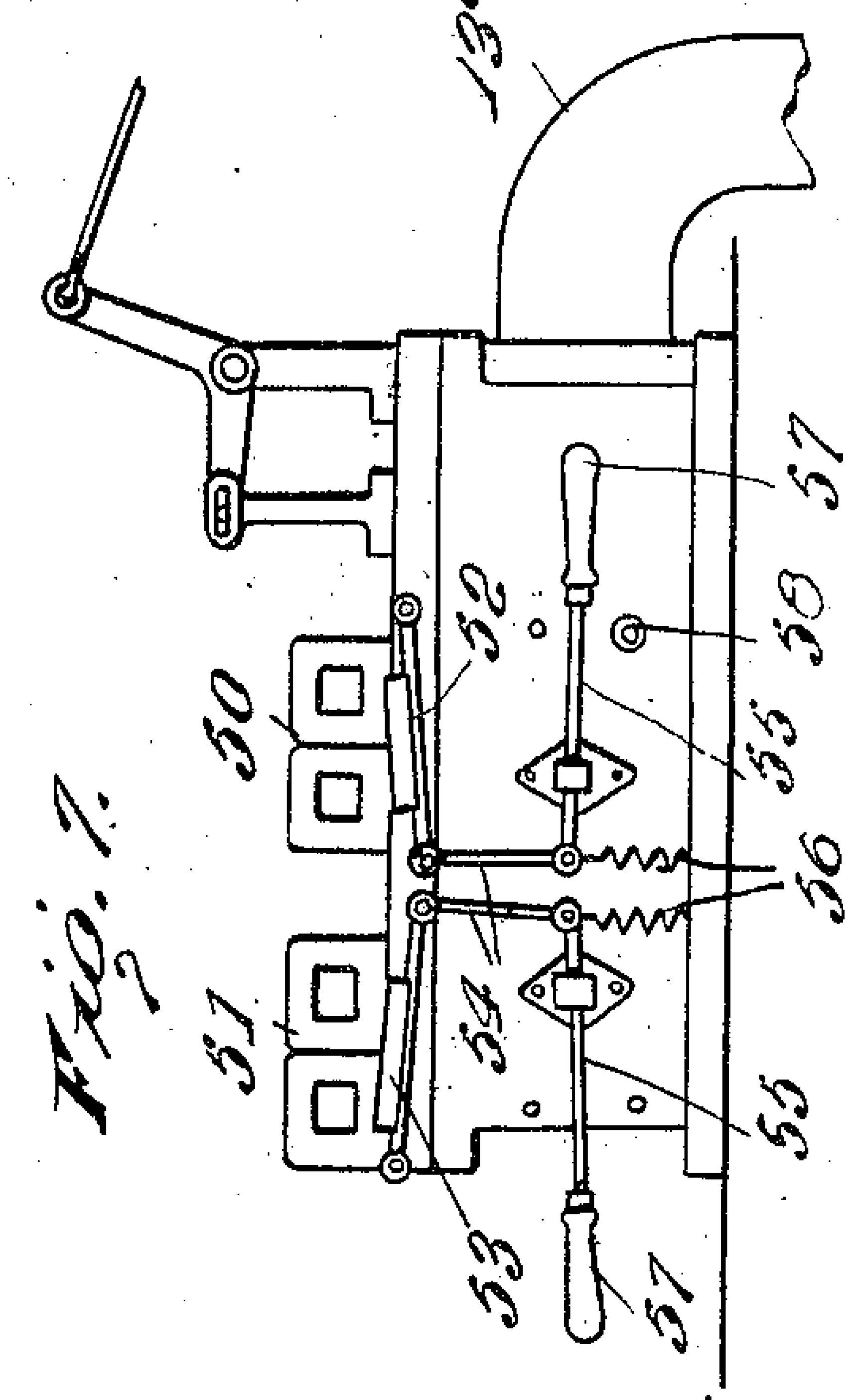

Fig. 7.

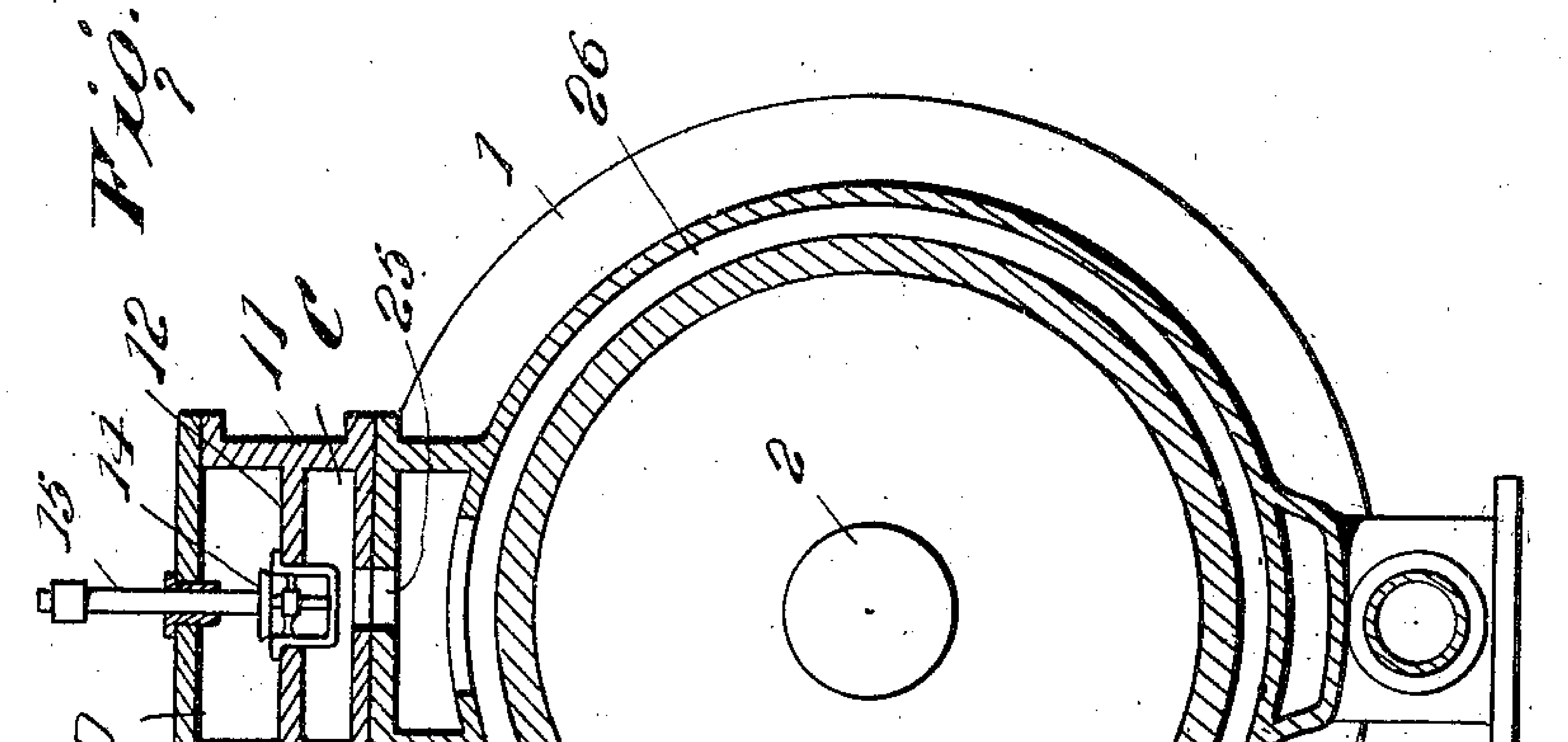

Fig. 2.

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4 SHEETS—SHEET 3.

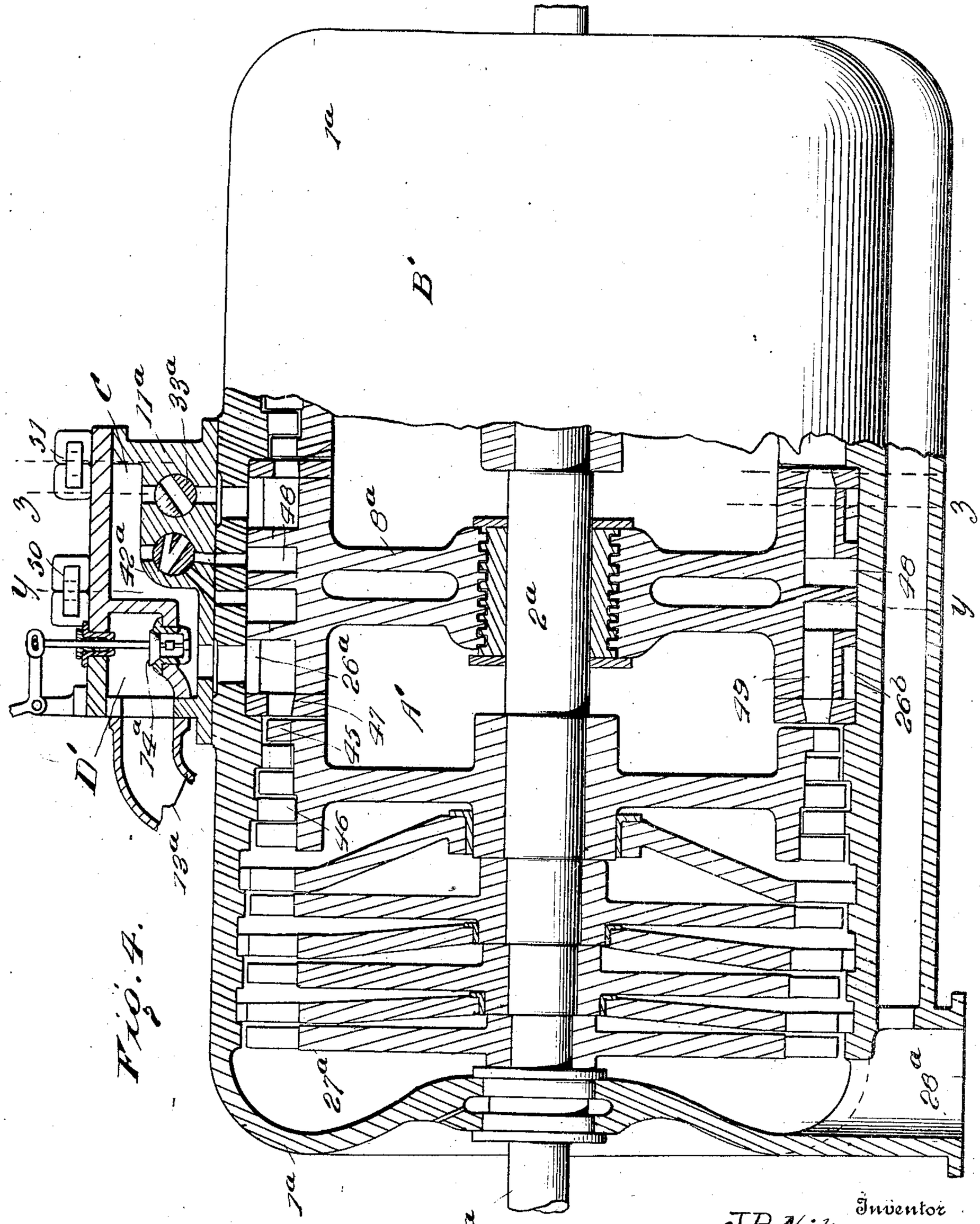

Fig. 4.

Witnesses

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4 SHEETS—SHEET 4.

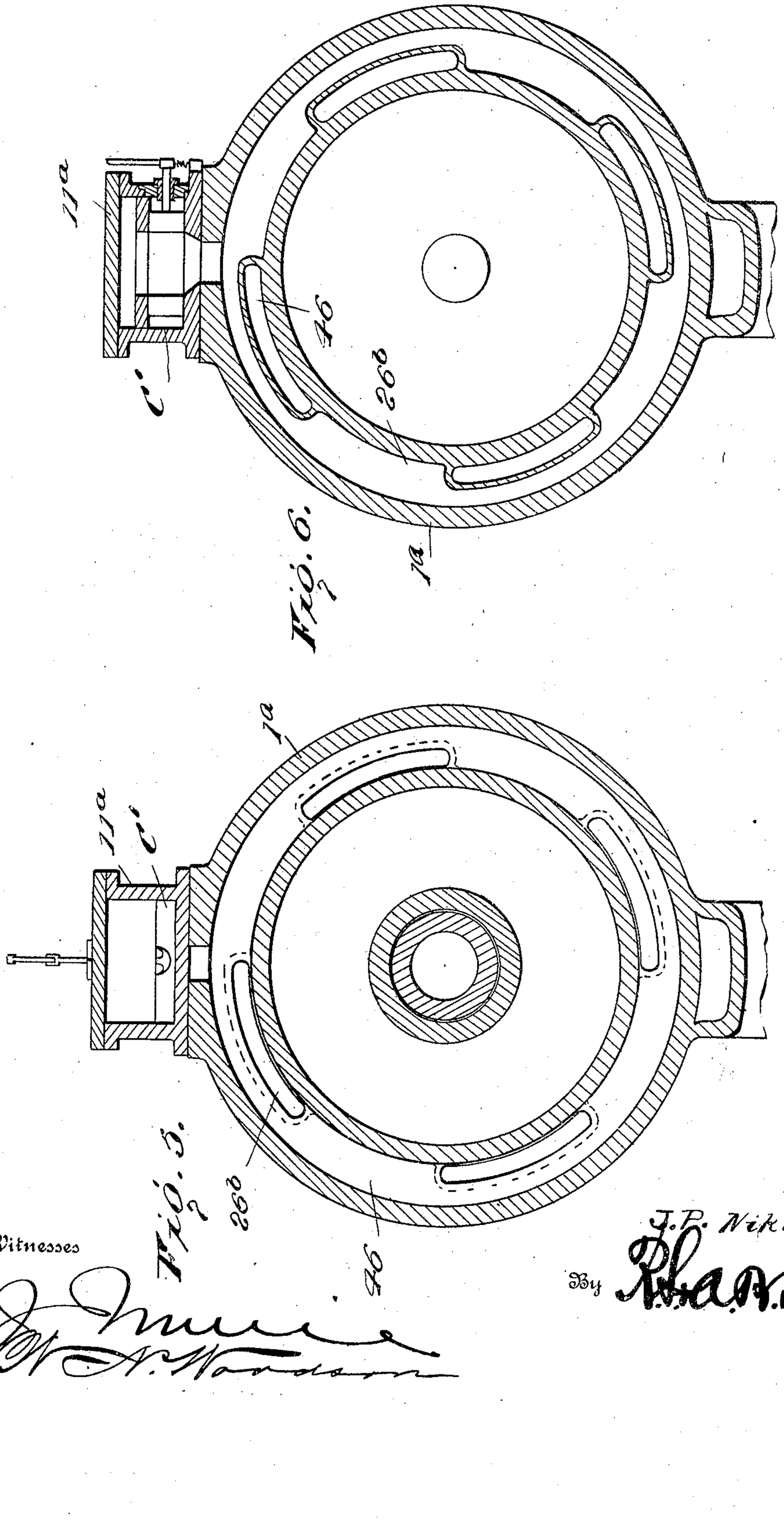

Fig. 4.

Fig. 5.

Witnesses

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UNITED STATES PATENT OFFICE.

JOHN P. NIKONOW, OF PITTSBURG, PENNSYLVANIA.

TURBINE AND REGULATING MEANS THEREFOR.

No. 862,187. Specification of Letters Patent. Patented Aug. 6, 1907.

Application filed September 15, 1906. Serial No. 334,710.

REISSUED

To all whom it may concern:

Be it known that I, JOHN P. NIKONOW, a subject of the Czar of Russia, residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Steam-Turbines and Regulating Means Therefor, of which the following is a specification.

This invention contemplates certain new and useful improvements in turbines of either the reaction or impulse type and the aim of the invention is to develop a double turbine unit, the invention being comprehended in a turbine structure embodying two main parts each of which is capable of working separately or both together, under the automatic and common regulation of a main throttling valve and centrifugal or other governor, both parts being connected and disconnected automatically by means of a controlling valve, all as will be hereinafter fully described.

A further object of the invention is to provide an improved means whereby the turbine will be efficient and able to withstand any work up to an overload.

It is well known that turbines as ordinarily constructed, when running under light load, say below one-half the normal, have usually very low efficiency, due to the fact that the steam is throttled before admittance into the first rotary disk with blades. This decrease in the kinetic efficiency is overcome and compensated for in my turbine owing to the fact that steam is admitted with full pressure under full load in both parts of the turbine and under one-half load (and below) under full load in one part only of the turbine, the efficiency thus being very high for very large working limits.

For a full description of the invention and the merits thereof and also to acquire a knowledge of the details of construction, reference is to be had to the following description and accompanying drawings, in which:

Figure 1 is a longitudinal sectional view of a turbine of the reaction type, embodying the improvements of my invention, the revoluble parts being shown in side elevation or in outline. Fig. 2 is a transverse sectional view on the line *x—x* of Fig. 1. Fig. 3 is an enlarged detail sectional view of the solenoid for elevating one of the valves, and its concomitant parts. Fig. 4 is a partial side elevation and a partial section of a turbine of the impulse type embodying the improvements of my invention. Figs. 5 and 6 are transverse sectional views thereof on the lines *y—y* and *z—z* respectively of Fig. 4. Fig. 7 is a detail side elevation of the valve chest illustrated in Fig. 4. Fig. 8 is a diagrammatic view of some of the blades of the impulse turbine illustrated in Fig. 4.

Corresponding and like parts are referred to in the following description and indicated in all the views of the drawings by the same reference characters.

Referring to the drawings, the numeral 1 designates the turbine case through the ends of which the driving shaft 2 extends, the ends of said shaft being journaled in boxings or bearings 3 and one end of the shaft being extended in the thrust bearing 4 that is susceptible of regulation by means of screws 5 or similar devices, so that the entire revolving part of the turbine may be adjusted properly relatively to the stationary part or case.

6 designates stuffing boxes in the ends of the case, through which the shaft extends, and 7 designates passages for the admission of water or other cooling medium, supplied from any desired source, (not shown).

The case 1 is provided intermediate of its ends and preferably at its middle with a solid portion or partition 8 containing stuffing channels and dividing the case into two separate parts, designated A and B respectively. The stuffing channels insure that the steam shall not pass from one part of the turbine into the other, except as hereinafter prescribed. Each of these separate parts of the turbine includes two sets of revoluble blades, between stationary blades one set being larger than the other and the larger set being located outermost, the set of smaller diameter being designated 9 and the larger set 10, in both parts of the turbine respectively. And the case is, as best shown in Fig. 1, shaped to accurately accommodate the respective sets of blades of different diameters. The steam chest 11 is divided by the wall 12 into two compartments C and D, and the compartment D is in direct and open communication with the steam in the pipe 13. In the wall or partition 12 a port is formed to establish communication between the compartment D and the compartment C and for the purpose of controlling this communication, I have provided the puppet valve 14, which is cup shaped, as shown, and fits within the port and is provided with a stem 15 secured at its upper end to the bell crank lever 16. This in turn is connected by means of the longitudinally extensible link 17 with another bell crank 18 fulcrumed on the upwardly extending arm of a frame or bracket 19, and the bell crank 18 has one of its two arms pivotally connected to the lever 20 at one end, the other end of said lever being directly connected to the collar of the centrifugal governor or regulator 21, which automatically actuates the valve 14 to admit for any given load the necessary volume of steam in the compartment C of the steam chest. In order to overcome or avoid standing still friction of the governing mechanism leading to the valve 14 I provide the depending arm 22 which has a strap 23 encircling an eccentric on the drive shaft 2, so that as the shaft rotates, the valve 14 will be caused to continuously pulsate or vibrate within its seat. If desired, a rod 24 may engage the same eccentric as the arm 22 for the purpose of operating a water pump. The shaft of the centrifugal governor or regulator 21 is engaged with the drive shaft 2 in the usual manner as by the worm gear shown.

The compartment C of the steam chest serves for both parts A and B of the turbine, but the only open ports

leading therefrom to the revoluble elements of the turbine is that communication between the steam chest and the part A. In the present instance this open communication is effected by means of the port 25 which is always open and leads into the annular steam chamber 26. Hence it will be seen that as the steam is permitted to pass, by means of the valve 14 into the compartment C of the steam chest, to operate the part A alone, the same will pass freely into the chamber 26, thence into the series of blades 9 and through the same and thence in expansion, through the larger series of blades 10, finally passing into the exhaust chamber 27 and out through the exhaust port 28 into the condenser (not shown). In passing from the high pressure series of blades 9 to the low pressure series 10, the steam enters the low pressure chamber 29 which is in communication with the annular channel 30 around the smaller series of packing channels, by means of the cross passage 31.

As both parts A and B of my improved turbine are essentially similar, differing only in the automatic means for coupling them together or disconnecting one from the other, I have deemed it necessary to describe only the part A, with respect to its revoluble elements and interior arrangements.

From the description up to this point, it is evident that the axial pull produced by the steam in the reaction turbine when only one part is working, is counterbalanced by the surface of the packing channels which are equal in diameter to the turbine steam chamber 26 and the surface of the first blades of the high pressure series. Furthermore, the larger surface of the solid intermediate portion of the case, designated 8 in Fig. 1, will counterbalance the axial pull or strain in that portion of the turbine containing the low pressure blades 10 because the steam from the intermediate or low pressure steam chamber 29 may affect the surface of the central portions of the solid part 8 by means of the circular channel 30 as such channel is in communication with the low pressure chamber 29 through the instrumentality of the cross passage 31.

As shown best in Fig. 1, both parts A and B of my improved turbine have their exhaust passages connected together by means of the pipe or channel 32. Hence, when only one part is working, the other is under the pressure of the condenser, and running *in vacuo*, has no loss from steam friction.

As stated at the outset of this specification, one of the primary objects of my invention is to provide means for automatically connecting the two parts A and B together, so that a double turbine unit may be developed. This result is accomplished by means of a valve 33 which controls the communication between the compartment C of the steam chest and the revoluble elements of the part B, said valve when open allowing the steam to pass through into the part B through the port 25ª. The valve 33 is controlled and operated by means of a solenoid 34 which preferably has two coils, to wit, one main coil, in series with the line (or taken from the secondary coil of a series transformer) and another coil in shunt. As the electric current increases, for instance, in load to a certain point, the series coil becomes energized and draws up the plunger 35 which is secured to the stem of the valve 33, thereby opening the valve 33 and admitting steam from the compartment C of the steam chest into the part B of the turbine. As it is incumbent upon the main governor 21 to regulate the steam pressure for both sides or parts A and B of the turbine alike, the valve 33 is designed to have only two positions, namely, fully closed or fully opened, and it is of such size as to allow the steam to flow into the part B under full pressure thereby avoiding any throttling effect upon the steam.

In view of the fact that the magnetic pull is much stronger for a short distance than a long one, the solenoid will release the plunger 35 again, under a heavier load than that which is necessary to draw the plunger up. Therefore, there is no point of load in which there exists any unbalanced condition for said plunger.

The valve 35, as shown closes by its own weight, but it is manifest that a spring may be added if found necessary.

The shunt coil is provided in addition to the series coil in order that the valve 33 may be operated from a switchboard or the like, if necessary, by means of any suitable controlling mechanism such as a double throw switch, so that the operator may introduce a current into the auxiliary shunt coil either with or against the series coil, thereby increasing or decreasing the magnetic force of the solenoid. If desired, and found necessary, the valve 33 may also be operated manually by means of a hand wheel 36, as best shown in Fig. 3. This hand wheel operates to raise the valve by being mounted with screw threaded engagement on the threaded portion of the valve stem, so that by turning the hand wheel down until it strikes a lug 37 projecting forwardly from one arm of the supporting bracket 38 and thence continuing the rotary movement of the hand-wheel, the valve may be raised. Under ordinary conditions, when this hand wheel is not in use, it must be raised relatively to the stem of the valve so as to not interfere with the electric actuation of the valve.

In addition to the function of automatically coupling together the parts A and B of the turbine, the solenoid 34 is arranged to automatically admit steam to both the low and high pressure sets of blades so that the turbine may work up to an overload. Under overload, with corresponding increase of current, the solenoid 34 pulls the armature 39 downwardly. This armature is mounted upon the arm of a lever 40 fulcrumed intermediate of its ends and spring returned as shown. The lever 40 is connected by means of a pin and slot to the stem 41 of an over load valve 42 controlling two ports 43. These ports establish communication between the compartment C of the steam chest and the two passages having open communication by means of two ports 44 with the two channels 30 and 30ª. As these channels communicate by means of the cross passages 31, 31ª with the low pressure admission chambers 29 and 29ª, it is obvious that when the valve 42 is opened, high pressure steam will be admitted directly to the low pressure blades 10. As these blades are of larger size than the high pressure blades 9 in view of the fact that under ordinary conditions they work under half expanded steam, it is manifest that the turbine may develop more energy and thus work up to an over load, by the arrangement described, provided of course that the valve 14 is of sufficient size to allow this additional or extra steam to flow.

The generic principles of my invention are applica-

ble to turbines of the impulse type as well as those of the reaction type, one embodiment of which latter type has been hereinbefore described. As an adaptation of the invention to a turbine of the impulse type, reference is to be had to Figs. 4, 5, 6, 7, & 8 of the drawings. Here the two parts A′ and B′ are substantially alike as to their revoluble and other interior elements, the case 1^a being divided into two substantially equal parts as shown, by means of the central abutment or partition 8^a of the case, the shaft 2^a extending through the ends of the said case. The steam chest 11^a, furthermore, is divided into the two compartments C′ and D′, the latter being connected to the steam supply pipe 13^a. The steam is admitted into the high pressure chamber 26^a by the opening of the valve 14^a and the expanded steam escapes from the exhaust chambers 27^a, through the exhaust port 28^a, all substantially like the construction heretofore described with respect to the reaction turbine. In this modification, each part A′ and B′ of the turbine includes rotary blades 45 and stationary blades 46 and 47, the latter being of nozzle formation as illustrated in Fig. 6, and the intermediate stationary portion of the turbine case, 8^a is provided with an annular channel 48 communicating by means of cross passages 49 with the stationary blades 47.

As best shown in Figs. 4, 6 and 8, the chamber 26^a communicates or opens into the first series of blades for only a sectional part of the circumference thereof, by means of cross passages 26^b, whereas under certain conditions as will be herein after specified, the cross passages 49 also admit steam to the remainder of the first series of blades. The relative proportions of the two series of admission channels 26^b and 49, as to the number and size of each series may be varied according to the requirements of different installations, for instance, the series of passages 26^b may include one-half or two-thirds of the circumference of the first blades and the cross passages 49 the remainder of the circumference of the first blades in the series, and these two series of cross passages 26^b and 49 preferably alternate as shown best in the diagrammatic view, Fig. 8.

In the steam chest 11^a is mounted the valve 33^a designed to control the admission of steam from the compartment C′ into the compartment B′ of the impulse turbine, and in said steam chest is also mounted the overload valve 42^a, governing the admission of steam from said compartment C′ to the annular channel 48. Valves like the valves 33 and 42 may be embodied in this modified form of turbine of the impulse type, but for the purpose of illustrating another modification or embodiment of the invention I have shown the valves 33^a and 42^a which rotate to open and close their respective ports instead of raising and lowering, and which are operated by two independent electro magnets 50 and 51. The armatures 52 and 53 of these magnets are, as best shown in Fig. 7, connected by means of links 54 to arms 55 on the ends of the valve stems and are returned to their normal positions by means of springs 56. The arms 55 may be provided with handles 57 for manual actuation, and steadying pins 58 may be employed if desired.

When this turbine is working up to its normal load, the steam is admitted into only a sectional part of the first blades, through the cross passages 26^a. Under overload, the valve 42^a will be opened by this electro-magnet and steam will be thereby admitted into the annular channel 48 and thence through the cross passages 49 into the remainder of the blades' circumference, so that the full force of the steam will be directed against the blades.

From the foregoing description in connection with the accompanying drawings, it will be seen that I have provided an improved turbine embodying a double turbine unit or two distinct and separate parts in the one case, both capable, by automatic regulations, of operating together and of being disconnected one from the other so that one alone may run, and that I have provided means in the regulating apparatus to accomplish this purpose, all combining to effect economies in the installation and maintenance. For instance, in an electric plant, instead of using two separate turbo-generator units, both in parallel for heavy night load, and shutting down one unit at day time, my turbine may be used, as it will perform automatically, as before set forth, both day and night equally with the same degree of efficiency. It is therefore evident that the cost of my turbine will be much less than the cost of two separate units for the same work.

Having thus described the invention, what is claimed as new is:

1. In a turbine, the combination of a driving shaft, two distinct revoluble elements mounted in common upon said shaft, means for admitting steam to one of said units, and means automatically governed by the load for admitting the steam to both of said units simultaneously.

2. In a turbine, the combination of a case, a driving shaft journaled therein, the case being provided with an intermediate abutment or partition dividing it into two distinct compartments, a revoluble element in each of said compartments, a steam chest, one compartment of which has open communication with the first set of blades of one compartment of the case and has a valved communication with the other compartment of the case, means, governed by the load, for automatically admitting steam to the said compartment of the steam chest, and means also governed by the load for controlling the valved communication between the steam chest and the said compartment of the case.

3. In a turbine, the combination of two distinct turbine units which embody revoluble blades, means governed by the load for admitting steam to both units simultaneously, and means for automatically admitting high pressure steam to low pressure blades of both units, said last named means being actuated by the other means as set forth.

4. In a turbine, the combination of two revoluble elements embodying high pressure blades and low pressure blades, and a high pressure chamber communicating with the first blade of the high pressure series, and a low pressure chamber communicating with the last blade of the high pressure series and the first blade of the low pressure series, there being provided a passage communicating directly with the low pressure chamber at one end, a high pressure chamber independent of the first named high pressure chamber and communicating with the said passage at its other end, and means governed by the load for automatically admitting high pressure steam to the second mentioned high pressure chamber, for the purpose specified.

5. In a turbine, the combination of two distinct turbine units, each embodying a revoluble element, a steam chest common to both units and divided into compartments, one of said compartments having open communication with one unit and a valve controlling its communication with the other unit, means for admitting steam into the said compartment, a solenoid, and a plunger having operative connection with the said valve, the plunger being arranged to be moved by the energization of said solenoid, substantially as described.

6. In a turbine, the combination of two distinct turbine units, each embodying a revoluble element, a steam chest

common to both units and divided into compartments, one of said compartments having open communication with one unit and a valve controlling its communication with the other unit, means for admitting steam into the said compartment, a solenoid, a plunger having operative connection with the said valve, the plunger being arranged to be moved by the energization of the solenoid, and means for manually opening said valve.

7. In a turbine, the combination of two distinct turbine units, each embodying a revoluble element, a steam chest common to both units and divided into compartments, one of said compartments having open communication with one unit and a valve controlling its communication with the other unit, means for admitting steam into the said compartment, a solenoid, a plunger having operative connection with said valve, the plunger being arranged to be moved by the energization of the solenoid, and means for manually opening said valve, said means comprising a threaded valve stem, a hand wheel having threaded engagement with said stem, and a stop for the movement of said hand wheel in one direction, substantially as described.

8. In a turbine, the combination of two distinct turbine units, each embodying a revoluble element, a steam chest common to both units and divided into compartments, one of said compartments having open communication with one unit and a valve controlling its communication with the other unit, means for admitting steam into the said compartment, a solenoid, a plunger having operative connection with the said valve, the plunger being arranged to be moved by the energization of the solenoid, an armature also arranged to be attracted by said solenoid, and an overload valve designed to be actuated by the movement of said armature, the turbine units embodying both high pressure and low pressure blades, there being passages provided for directly admitting high pressure steam to the low pressure series of blades, the said admission of steam being controlled by said overload valve.

9. In a turbine, the combination of two distinct turbine units, each embodying a revoluble element, a steam chest common to both units and divided into compartments, one of said compartments having open communication with one unit, and a valve controlling its communication with the other unit, the units embodying high pressure blades and low pressure blades and means for admitting high pressure steam directly to the low pressure blades, said means including an armature arranged to be attracted by a solenoid, a plunger being arranged to be moved by the energization of said solenoid, an automatically returned lever on one arm of which the armature is carried, and a valve operatively connected to the other arm of said lever, and there being provided ports and passages for the live steam, the said ports being controlled by said valve.

10. In a turbine, the combination of a case, a driving shaft mounted in said case, the case being provided with an intermediate partition or abutment dividing it into two distinct compartments, two distinct turbine elements each provided with blades mounted in common upon said shaft within the respective compartments of the case, and means automatically governed by the load for admitting steam to one of said compartments or to both of said compartments simultaneously.

11. In a turbine, the combination of a case, a driving shaft journaled therein, the case being provided with an intermediate abutment dividing it into two distinct compartments, a revoluble element in each of said compartments, each revoluble element embodying a series of high pressure blades and a series of low pressure blades, means automatically governed by the load for admitting steam to one of said revoluble elements, or to both of said revoluble elements simultaneously, and means also governed by the load for admitting steam directly to the low pressure blades of both elements as well as to the high pressure blades.

12. In a turbine, the combination of a case, a driving shaft journaled therein, two distinct revoluble elements mounted in common upon said shaft and within the case, a steam-chest, one compartment of which has open communication with the first set of blades of one revoluble element, and a valved communication with the first set of blades of the other revoluble element, means governed by the load for automatically admitting steam to the said compartment of the steam-chest, and electrically actuated other means also governed by the load for controlling the valved communication between the steam-chest and the other revoluble element.

In testimony whereof I affix my signature in presence of two witnesses.

JOHN P. NIKONOW. [L. S.]

Witnesses:
VERYL B. BROUGHTON,
BIRNEY HINES.