No. 705,124. Patented July 22, 1902.

G. O. M. OLSSON.

APPARATUS FOR CONTROLLING THE SPEED OF STEAM TURBINES.

(Application filed June 28, 1901.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 3.

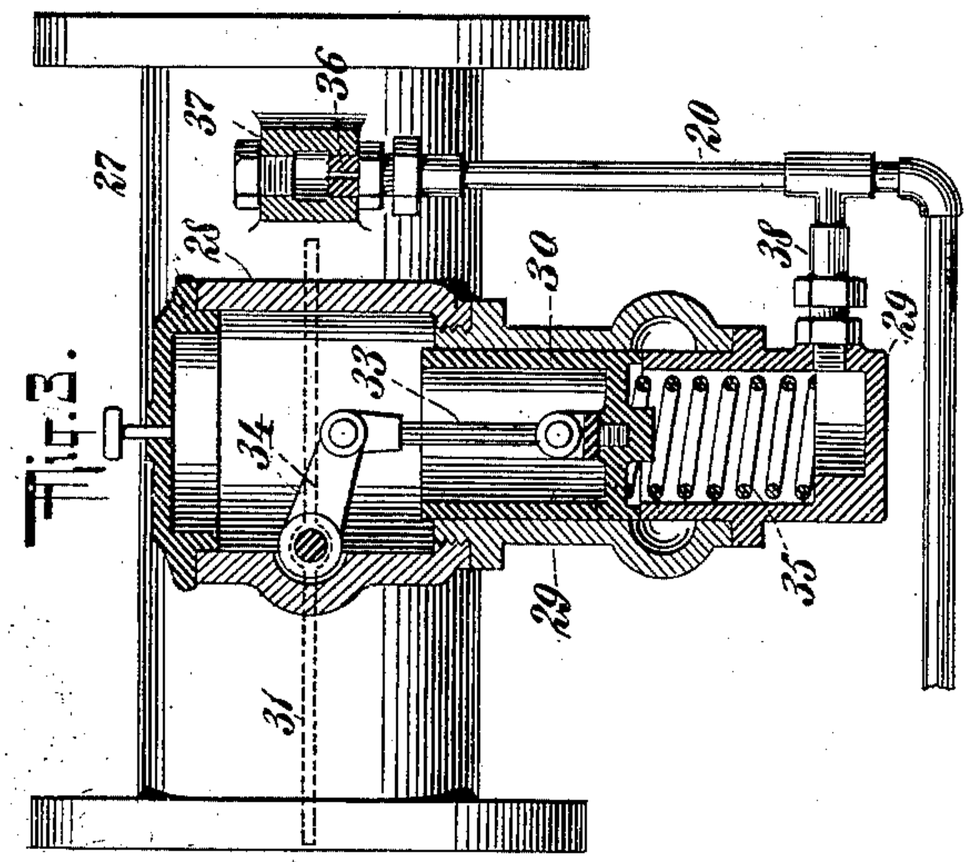


Fig. 4.

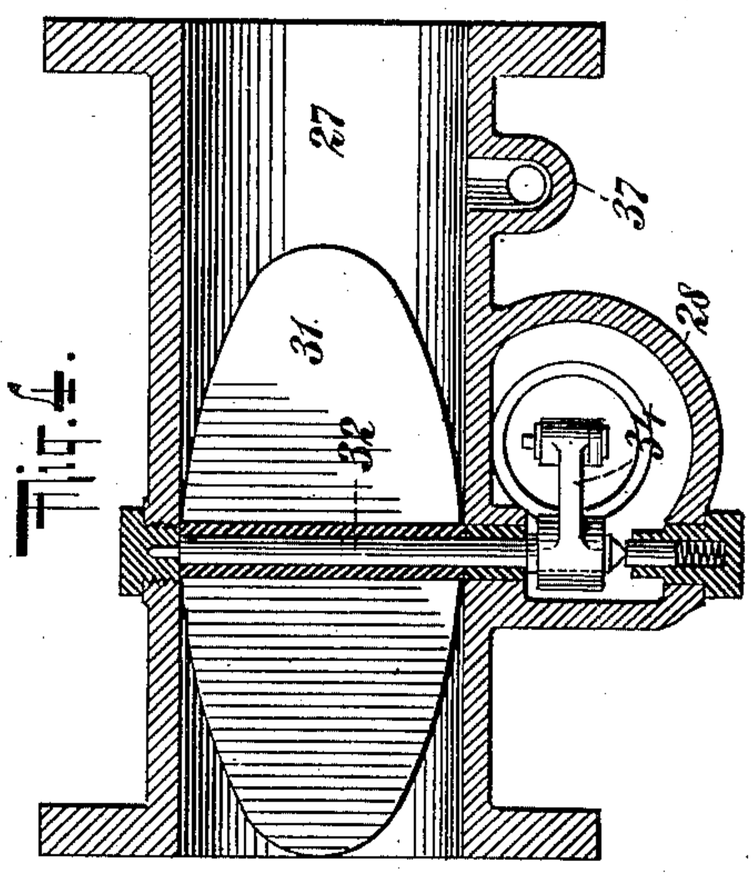
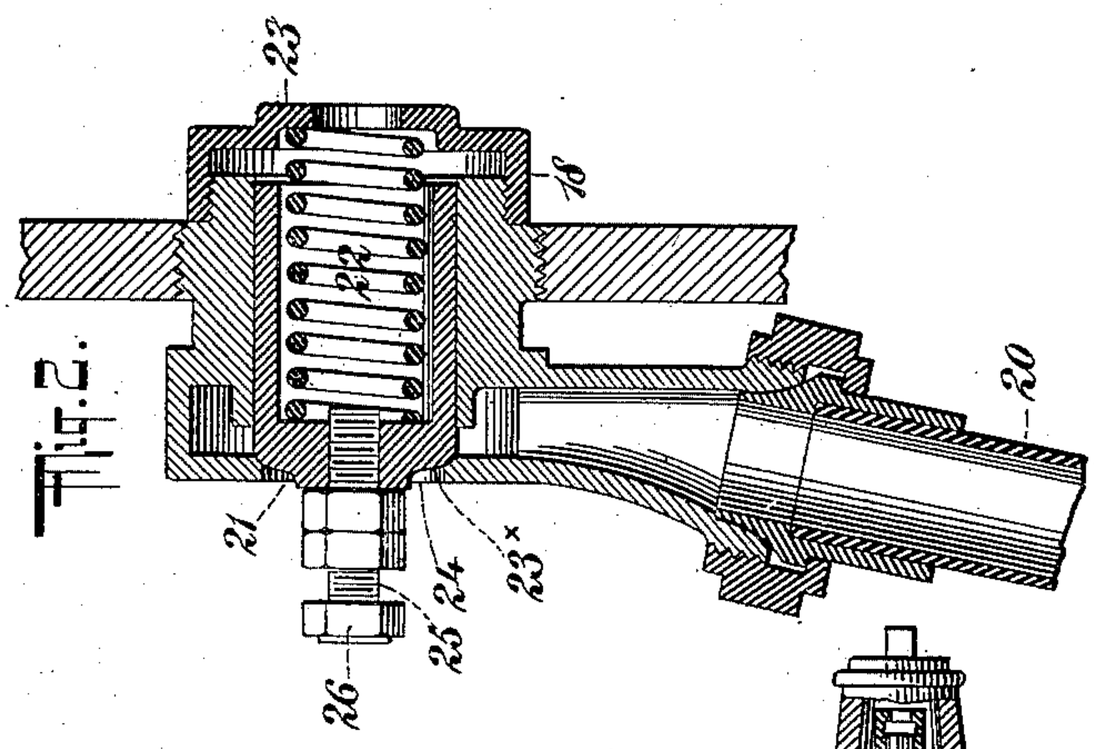
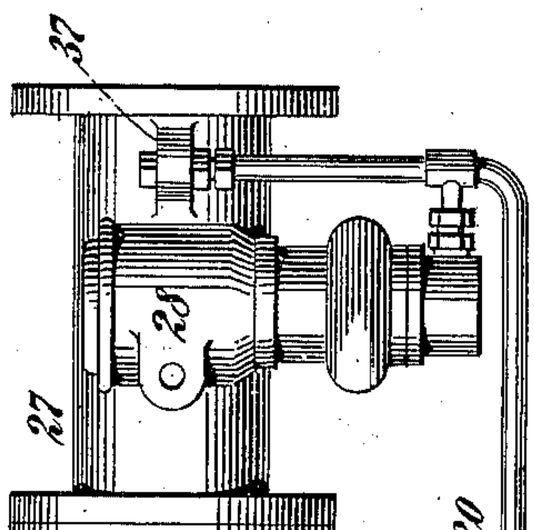
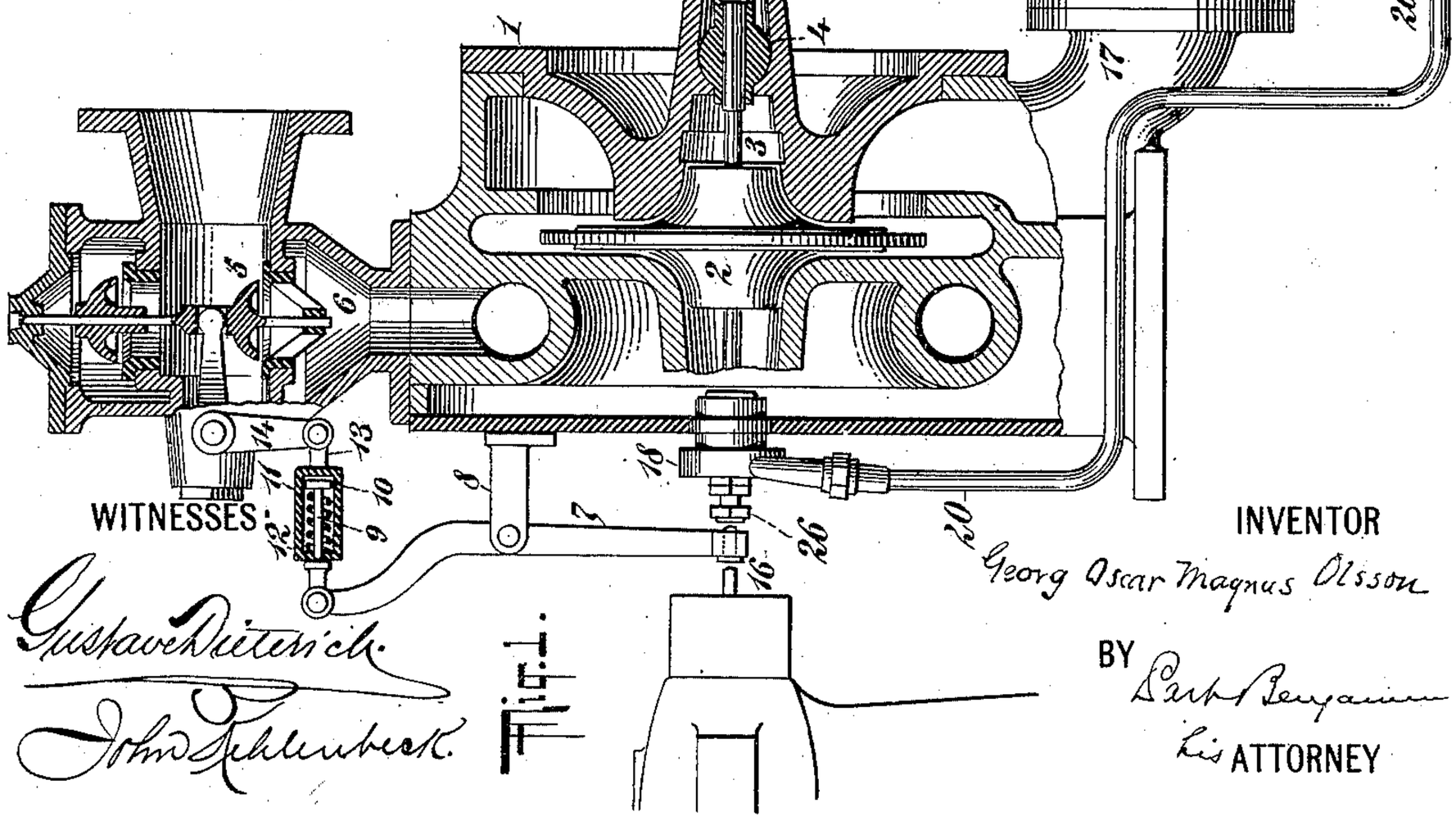


Fig. 2.







WITNESSES:

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Fig. 1.

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Fig. 7.

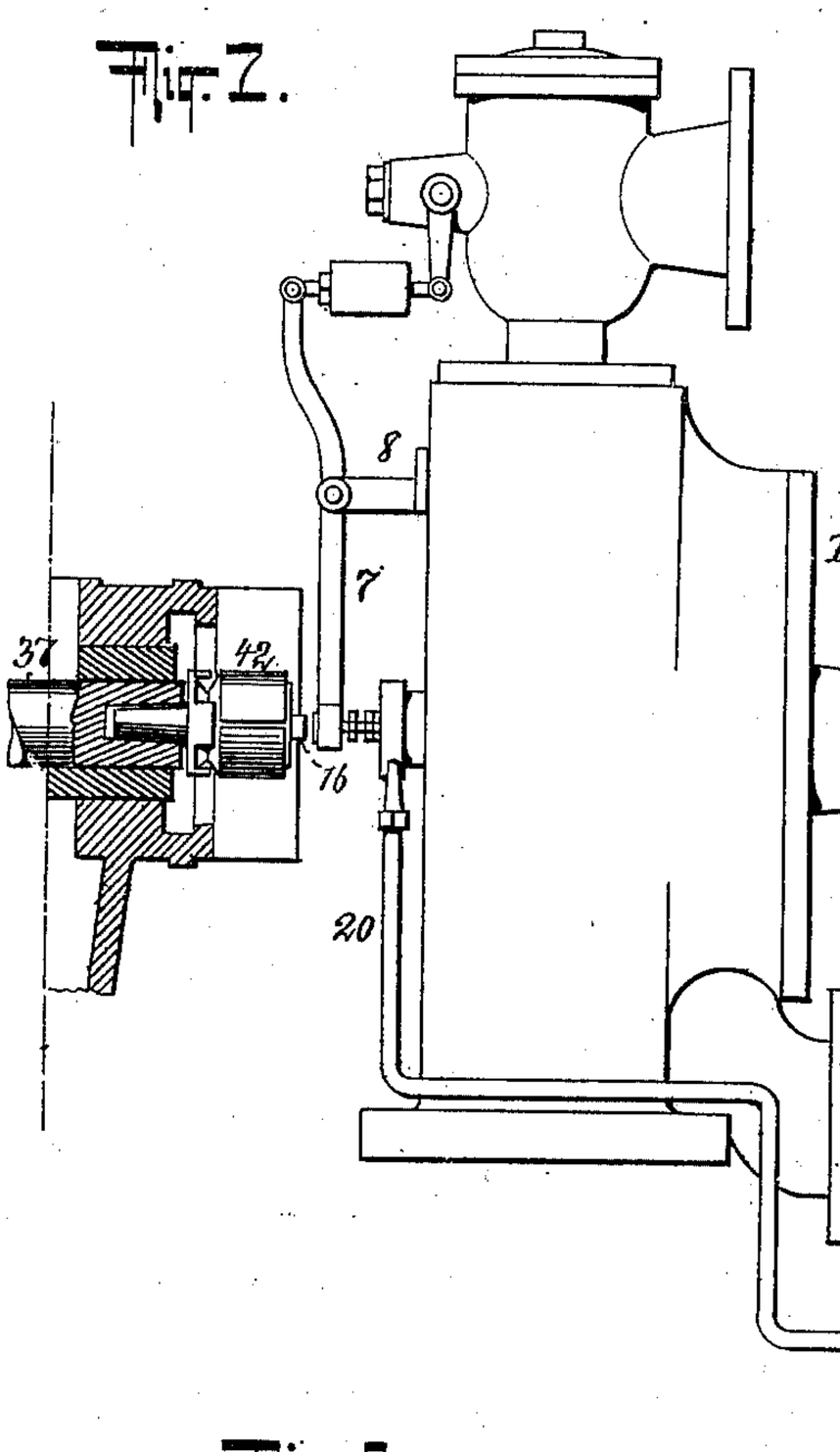


Fig. 5.

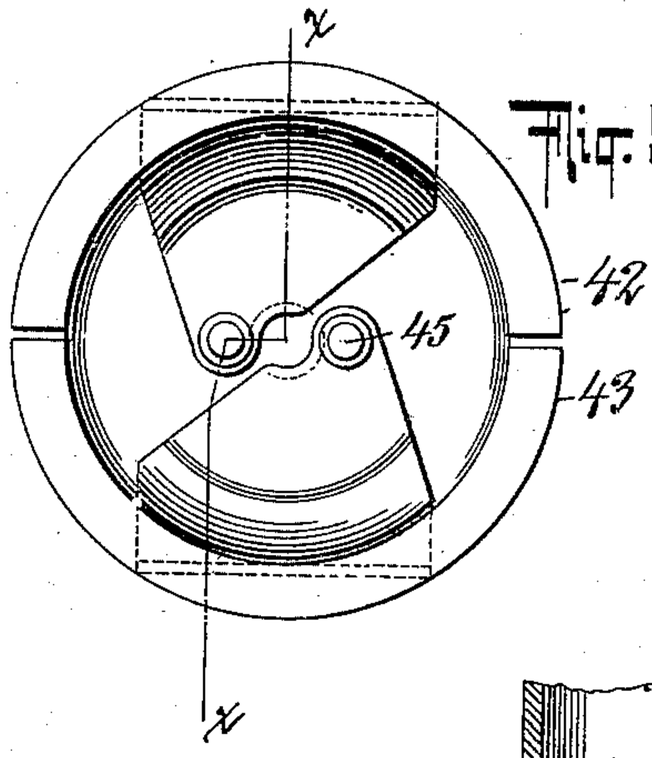
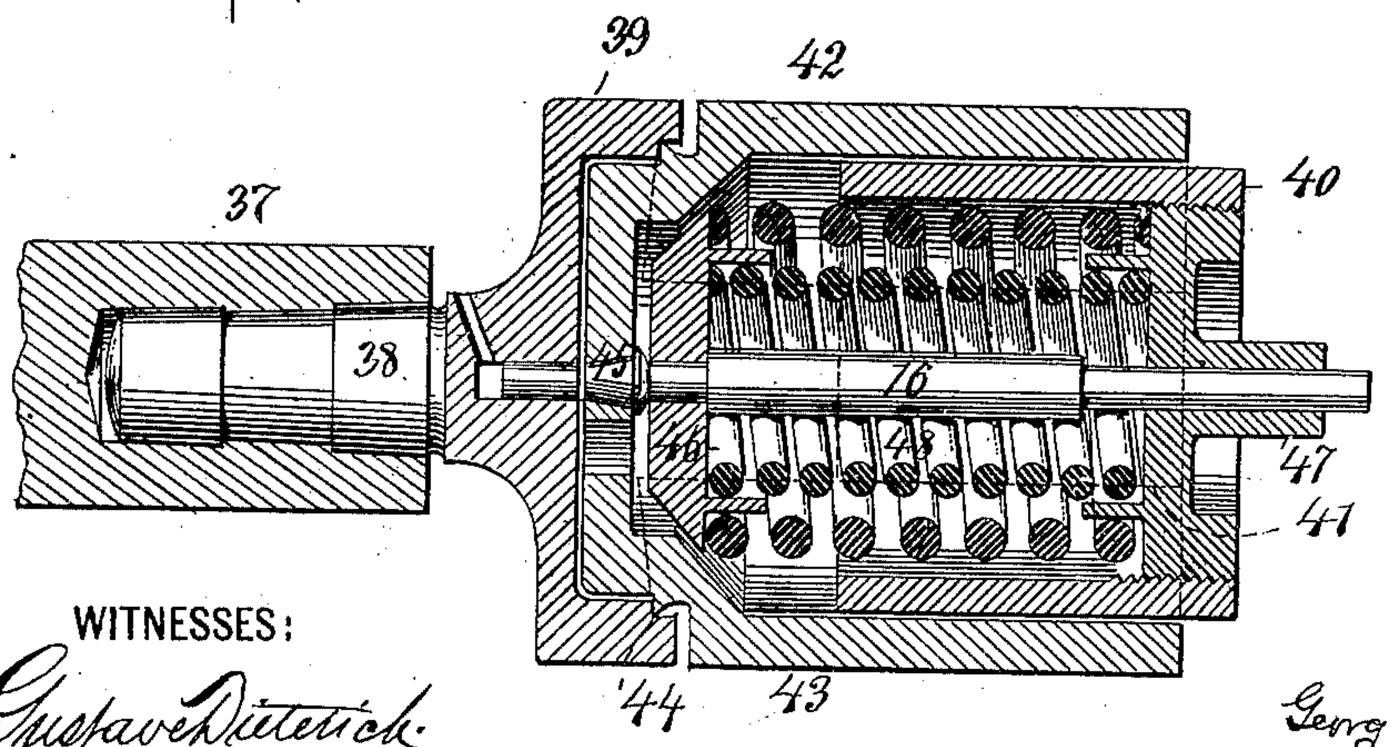


Fig. 6.



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UNITED STATES PATENT OFFICE.

GEORG OSCAR MAGNUS OLSSON, OF STOCKHOLM, SWEDEN, ASSIGNOR TO DE LAVAL STEAM TURBINE COMPANY, A CORPORATION OF NEW JERSEY.

APPARATUS FOR CONTROLLING THE SPEED OF STEAM-TURBINES.

SPECIFICATION forming part of Letters Patent No. 705,124, dated July 22, 1902.

Application filed June 28, 1901. Serial No. 66,368. (No model.)

To all whom it may concern:

Be it known that I, GEORG OSCAR MAGNUS OLSSON, a subject of the King of Sweden and Norway, residing at Stockholm, Sweden, have invented a new and useful Improvement in Apparatus for Controlling the Speed of Steam-Turbines, of which the following is a specification.

Steam-turbines of the well-known De Laval type are commonly provided with an automatic centrifugal regulator, which controls the speed by controlling the steam admission to the wheel in accordance with the load. When the load is removed, the throttle-valve is closed and no steam is admitted to the turbine wheel. Nevertheless, it frequently happens that through the presence of dirt or other foreign matter or because of wear said valve slightly leaks when closed by the regulator. When the steam-turbine is used with a condenser, the effect of such leakage is serious, inasmuch as a very slight admittance of steam to the wheel is sufficient to increase the speed of the latter beyond the tolerated degree—this for the reason that the wheel when the load is removed meets with substantially no resistance from the medium in which it rotates. The object of the present invention is to prevent this undue increase of speed. In another application filed simultaneously herewith, Serial No. 66,367, I have described an apparatus for controlling this undue increase of speed adapted for use in connection with a turbine wheel having its own condenser.

My present invention consists in an apparatus for accomplishing the same result in connection with a steam-turbine combined with a condenser, which condenser may serve to produce a vacuum in several machines connected to it. In such case it is obvious that no means can be employed which would destroy the vacuum in the condenser. I therefore provide an arrangement which acts upon a cut-off valve inserted in the steam-exhaust pipe, and thus interrupt communication between condenser and the chamber in which the turbine wheel rotates.

In the accompanying drawings, Figure 1 is a vertical section of a steam-turbine of said De Laval type exhibiting my apparatus applied thereto. Fig. 2 is an enlarged vertical section of the air-controlling valve. Fig. 3 is a vertical section of the cylinder in which the cut-off-valve-controlling piston operates, together with the associate parts. Fig. 4 is a horizontal section showing said cut-off valve in plan. Fig. 5 is an end view of the weights in a form of regulator adapted to move the pin 16. Fig. 6 is a vertical longitudinal section of said regulator on the line $x\,x$ of Fig. 5. Fig. 7 is a general view showing the device of Fig. 6 for moving the pin 16 connected to my present apparatus and also exhibits a form of condenser which I commonly employ also connected to said apparatus. It is, however, to be distinctly understood that my apparatus is not limited to the use in conjunction therewith of either the regulator of Fig. 6 or the particular form of condenser illustrated in Fig. 7.

Similar numbers of reference indicate like parts.

1 represents the casing; 2, the steam-turbine wheel therein. Said wheel is mounted on a shaft 3, journaled in bearings, one of which is shown at 4, the other bearing and adjacent parts being broken away in Fig. 1 to show the arrangement of the air-valve.

At 5 is a throttle-valve communicating with the channel 6, and this channel leads to one or more steam-nozzles, by which steam is delivered to the wheel. The arrangement of nozzles is well known in connection with turbines of the description referred to and is therefore not illustrated.

7 is a lever having its fulcrum in a stud 8, which projects from the casing 1. The upper end of this lever is connected to the piston-rod 9, which carries the piston 10. This piston is contained in a cylinder 12, supported on rod 13. Between the piston 10 and the end of the cylinder and also surrounding the piston-rod is a coiled spring 11. The rod 13 is connected to one arm of the bell-crank lever 14, the end of the other arm of which is received in a recess in the stem of throttle-valve 5. The lower end of lever 7 is situated

directly opposite a horizontally-moving pin 16. This pin is actuated by a form of regulator represented in Figs. 5 and 6, so that when the pin 16 is moved to the right of Fig. 1 the valve 5 is closed and the steam is shut off, thus diminishing the speed of the turbine wheel. On the other hand, when the pin 16 is moved to the left the valve 5 is lifted, thus admitting more steam to the turbine and augmenting its speed.

One form of centrifugal regulating device for actuating the pin 16 in the manner described is represented in Figs. 5 and 6. 37 is a shaft which is rotated by any suitable gearing from the turbine-wheel shaft. Into a recess in the end of this shaft is inserted the tapered shank 38 of the regulator-body. Said body consists of a recessed circular portion 39 and ring portion 40 and connecting-arms 41, one of which is indicated by dotted lines in Fig. 6. 42 and 43 are two arc-shaped weights surrounding the ring 40 and of bell-crank form, each having a knife-edge 44, by which it is fulcrumed in the circular portion 39 of said body, and each having a pin 45, which bears against the disk 46. Said disk is carried by the pin 16. Within the ring 40, which is threaded, is a nut 47, through which the pin 16 passes. A helical spring 48 is interposed between the disk 46 and nut 47. By operating the nut 47 the pressure of said spring is regulated, and said spring also serves to keep the weights closed in upon the body. When the limit of speed of the turbine, and hence of the shaft 37, is exceeded, the weights 42 43 spread apart by centrifugal force and in so doing move their pins 45 against the disk 46, and the latter moves the pin 16 outwardly and to an extent proportionate to the speed. When the speed diminishes, the pin 16 is moved inwardly by the action of the spring 48. The regulator may be provided with a casing, as shown in Fig. 1. Such a regulator is constructed so that when the speed of the turbine has reached a certain predetermined rate then the apparatus operates to close the throttle-valve 5 to shut off steam from the wheel. It is after this closing of the throttle occurs that the possible leakage of steam around the valve takes place. The turbine-casing is connected to the condenser by the pipe 17. The turbine then running in what is practically a vacuum meets with substantially no resistance from the medium in which it rotates. On the other hand, the constant inflow of a small quantity of steam leaking past the throttle is a constant force, and therefore an accelerating one. Hence all the conditions are present for causing the wheel rapidly to work up to a very high degree of speed, which for obvious reasons is disadvantageous and injurious.

I will now describe the apparatus whereby the cut-off valve is made to close communication between turbine-casing and condenser, by which means steam entering the turbine-casing through the leaking valve accumulates therein and opposes sufficient resistance to the rotation of the turbine wheel to prevent undue increase of speed.

In the wall of the turbine-casing is screwed a hollow block 18. This block has a cylindrical bore in which is placed a hollow cylindrical valve 21. Within said valve is a coiled spring 22, one end of which bears against the nut 23, screwed on the rear end of block 18. The closed end of the piston is beveled on its outer surface and is seated in a correspondingly-beveled opening 24 in the wall of the block 18. In said closed end of the piston is screwed a pin 25, having head 26. This head 26 comes directly opposite the lower end of lever 7, or, in other words, the lower end of lever 7 is interposed between the moving pin 16 of the regulator and the head 26 of the stem 25 of the valve 21.

Connected to the exhaust-pipe 17 or made integral therewith is a pipe-section 27, on the side of which is a casing 28, to which is secured the cylinder 29, containing the piston 30.

31 is the cut-off valve inside of the pipe-section 27, as shown in Fig. 4, having its shaft 32 connected to the piston-rod 33 by the lever-arm 34. Beneath the piston 30 is arranged a coiled spring 35, which operates to raise the piston and hold it in such position as that the cut-off valve 31 normally closes the pipe-section 27.

Extending from the interior of the air-valve casing 18 is a pipe 20, which communicates by a very small aperture 36 with the interior of the hollow lug 37, formed on the side of pipe 27. The interior of said lug communicates with the interior of the pipe 27 between valve 31 and the condenser with which pipe 27 connects. A branch 38 of pipe 20 communicates with the interior of cylinder 29 below the piston 30.

The operation of the apparatus is as follows: The air-valve 21 is normally closed by the action of its spring 22, so that no air then passes into the pipe 20. By the operation of the condenser withdrawing the air through the hole 36 from pipe 20 and branch pipe 38 a vacuum is produced under the piston 30, so that said piston is forced into its downward position against the action of spring 35 by normal air-pressure coming on its upper side, and the valve 31 is thus opened, as indicated in dotted lines, Fig. 3, leaving free communication between the condenser and the turbine-casing. As already stated, an increase of speed of the turbine wheel beyond some predetermined amount causes movement of the pin 16 of the regulator to the right, with the effect of closing the throttle-valve 5. If now any leakage of steam occurs past the valve 5 after it has been closed, the effect is to drive the turbine wheel to a still higher speed, and therefore the pin 16 of the regulator is moved still farther to the right, pushing the lower end of lever 7 against the pin 26 of the air-valve in casing 18 and opening said valve against the action of its spring 22. Air

then can enter the pipe 20 and pass through the branch pipe 38 to the chamber beneath the piston 30, thus equalizing the pressure on both sides of said piston, and so enabling the coiled spring 35 to push up said piston, and so close the valve 31. The steam then entering the turbine-casing from the leaking valve can no longer escape and forms a resisting medium to the movement of the turbine wheel, which soon sufficiently reduces the speed thereof. It is true that through the hole 36 a small quantity of air will be admitted to the condenser; but as this hole is very small the entrance of air is not sufficient to destroy the condenser-vacuum.

The form of condenser which is represented in Fig. 7 is of the injector type. 49 is the inlet for the cooling-water. 50 is the pipe whereby the condenser is connected to the exhaust-pipe 27. 51 is the outlet for the condensed steam and water. 52 is a valve for closing by hand connection between the condenser and the regulator. The construction of this condenser is old and well known and consists in a body 53, having at the top a nozzle 54, which draws the water in a jet through the inner shell 55. In said shell is a series of perforations drilled at an angle in the direction of the outflowing water, through which holes steam of course passes, meets the outcoming water, and is so carried onward, thus producing a vacuum in the pipe 27.

I claim—

1. The combination of a steam-turbine wheel, a casing inclosing the same, means for admitting steam under pressure into said casing, means for reducing atmospheric pressure existing within said casing, a valve constructed to cut off connection between said reducing means and said casing, and means for operating the said valve; whereby steam may be imprisoned in said casing and a resisting medium to the rotation of said wheel thus provided.

2. The combination of a steam-turbine wheel, a casing inclosing the same, means for admitting steam under pressure into said casing, means for reducing atmospheric pressure within said casing, a valve constructed to cut off connection between said reducing means and said casing, and means automatically operating to close said valve when said wheel has attained a certain predetermined speed of revolution.

3. The combination of a steam-turbine wheel, a casing inclosing the same, means for admitting steam under pressure into said casing, means for reducing atmospheric pressure within said casing, a valve constructed to cut off connection between said reducing means and said casing, and means actuated by said wheel for closing said valve when said wheel shall have attained a certain predetermined speed of revolution.

4. The combination of a steam-turbine wheel, a vacuum-chamber inclosing the same having a steam-inlet and an outlet-conduit through which the atmosphere is exhausted from said chamber, a valve in said outlet-conduit a cylinder, a piston therein controlling said valve, a spring acting on one side of said piston, means for producing a vacuum on the same side of said piston and thereby causing the same to compress said spring and open said valve, and means for destroying said vacuum and causing said spring to act on said piston to close said valve; the said last-named means being actuated by said turbine wheel after it has attained a certain predetermined speed, substantially as described.

5. The combination with the steam-turbine wheel 2, casing 1, and pipe 27 of the air-valve 18, means for opening the same actuated by said turbine wheel after said wheel shall have attained a certain predetermined speed, cylinder 29, piston 30, valve 31 in said pipe 27, intermediate mechanism between said piston and valve, spring 35 bearing on said piston, and pipe 20 communicating with said pipe 27, and with said cylinder 29, substantially as described.

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Witnesses:
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M. FRANSÉN.