No. 801,345. PATENTED OCT. 10, 1905.

F. SVOBODA.

REGULATING DEVICE FOR TURBINES.

APPLICATION FILED NOV. 22, 1902.

2 SHEETS—SHEET 1.

Fig. 5.

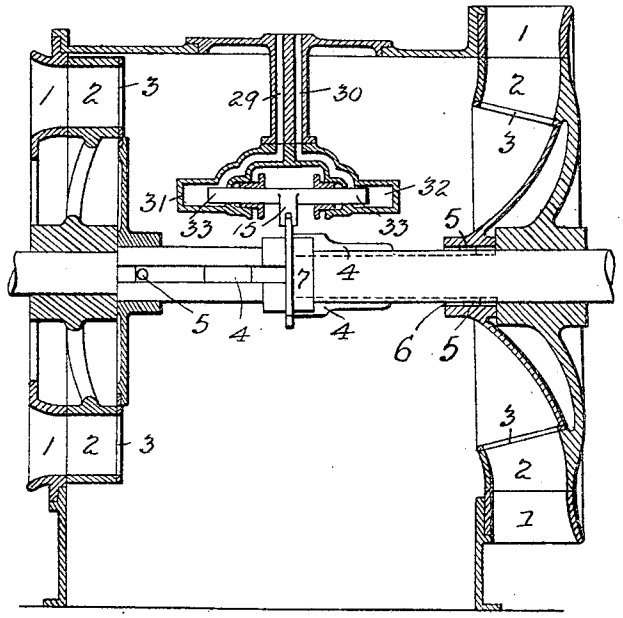


Fig. 1.

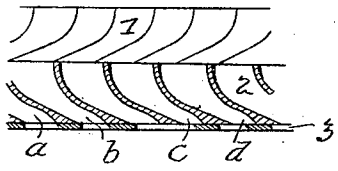


Fig. 4.

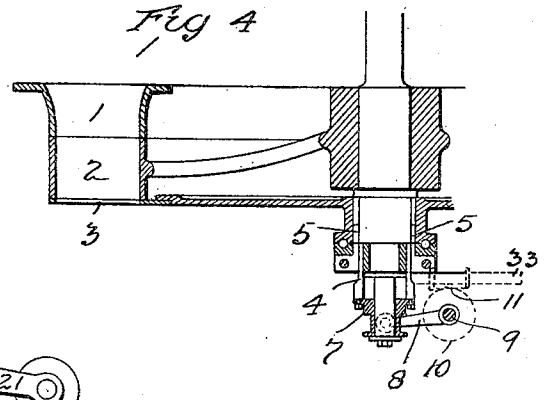


Fig. 8.

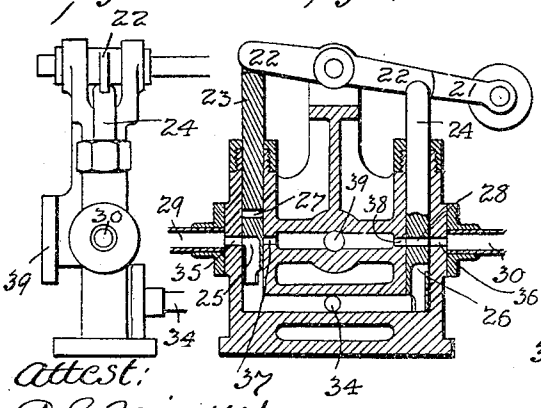
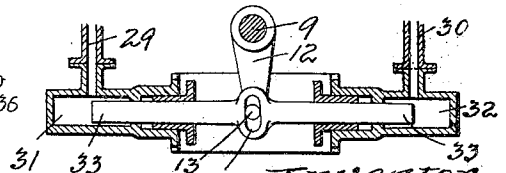


Fig. 9.

Fig. 10.



Attest:
C. S. Middleton
L. B. Middleton

Inventor.
Franz Svoboda.
By Richards & Co
Attys

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Fig 6

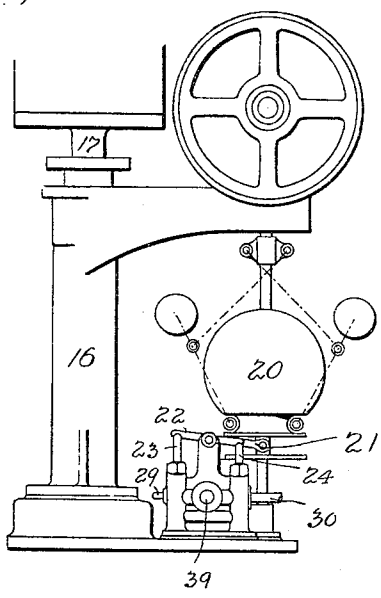


Fig. 7.

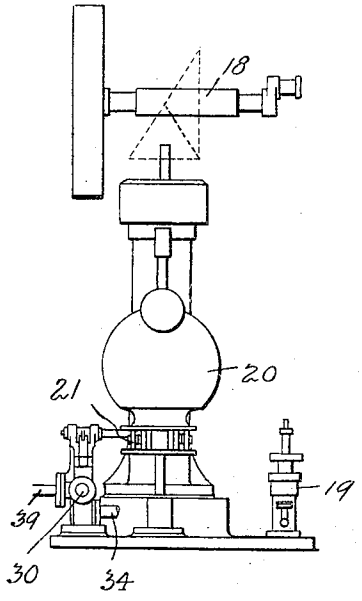


Fig. 2.

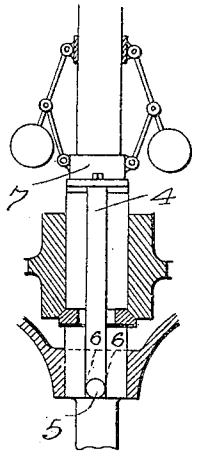
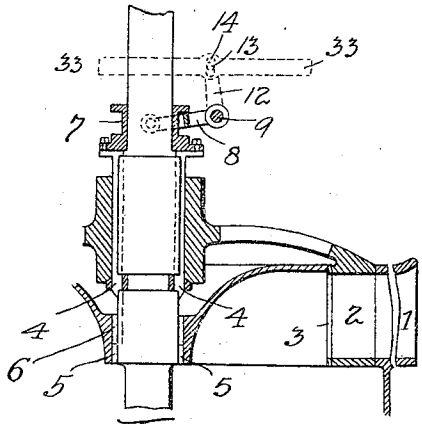


Fig. 3



Attest:
C. S. Middleton
L. B. Middleton

Inventor.
Franz Svoboda.
by Richards & Geier
Attys.

UNITED STATES PATENT OFFICE.

FRANZ SVOBODA, OF ZÖLYOM, AUSTRIA-HUNGARY.

REGULATING DEVICE FOR TURBINES.

No. 801,345. Specification of Letters Patent. Patented Oct. 10, 1905.

Application filed November 22, 1902. Serial No. 132,441.

To all whom it may concern:

Be it known that I, FRANZ SVOBODA, a subject of the Emperor of Austria-Hungary, residing at Zölyom, in the Empire of Austria-Hungary, have invented a new and useful Regulating Device for Turbines, of which the following is a specification.

My invention relates to reaction turbines, and has for its object to regulate the velocity of the turbine and the water-supply according to the expense or consumption of power by throttling the water discharging from all passages of the revolving wheel, the throttling device being connected with a speed-governor either directly or by means of an interposed hydraulic high-pressure regulator.

In the accompanying sheets of drawings, Figure 1 shows a developed round section through the middle of the passages of the guiding and revolving wheels of an axial-flow turbine. Fig. 2 is a section on a vertical plane through the shaft of a vertical Francis turbine. Fig. 3 is a section on a vertical plane ninety degrees from the plane of Fig. 2 through the shaft of the same turbine. Fig. 4 is a section on a vertical plane through the shaft of a vertical-flow turbine. Fig. 5 is a section on a vertical plane through the shaft of a horizontal compound turbine. Fig. 6 is a side elevation of the hydraulic accumulator with the speed-governor and the regulating device. Fig. 7 is the front elevation of the speed-governor and the regulating device. Fig. 8 shows, on an enlarged scale, the regulating device in end elevation. Fig. 9 is, on an enlarged scale, a longitudinal section through the regulating device; and Fig. 10 is a longitudinal section through the axis of the hydraulic reverser.

The throttling-disk 3, (in axial turbines a circular disk and in radial-flow turbines a cylindric or conical body,) which effectuates the throttling of the passages of the revolving turbine-wheel 2, has openings in the same number and of the same form or shape as the passages of the said revolving wheel 2. In Fig. 1 of the drawings, *a* and *b* indicate open passages, and *c* and *d* throttled passages of this revolving wheel 2. The displacement of the disk 3 during the revolution of the turbine is obtained by means of two prisms 4, Figs. 2, 3, 4, and 5, which are set in two grooves placed at one hundred and eighty degrees on the shaft of the turbine-wheel. The two prisms are movable and have a cylindric shoulder 5 engaging in an inclined rabbet 6, Fig. 2, in the hub of the throttling-disk 3. By displacing the prisms parallel to the axis of the turbine-wheel consequently circumferential displacement of the disk 3 is produced. The two prisms 4 are secured to a shell 7, which may be the shell of the speed-governor, as shown in Fig. 2, or this shell may be embraced by a forked lever 8, Fig. 4, to the pivot 9 of which is secured a cog-wheel 10, which engages with the toothed middle portion 11 of the double plunger 33 of the hydraulic high-pressure regulator, or also to the pivot 9 of the forked lever 8 a counter-lever 12, Figs. 3 and 10, may be secured, the pin 13 of which engages with the slot 14 of the double plunger 33, or, finally, the double plunger itself may move with its forked middle projection 15 the shell 7, Fig. 5.

The hydraulic high-pressure regulator is arranged as follows: A little hydraulic accumulator, comprising a cylinder 16, with plunger 17 and weight, Fig. 6, has on its cylinder a bracket serving to support the gearing 18 of the speed-governor. This gearing works a little forcing-pump 19, which furnishes the high-pressure water for the accumulator. The shell 20 of the speed-governor is embraced by a forked lever 21, Figs. 6, 7, and 8, to the shaft of which a double lever 22 is secured, which presses with its two ends upon two pins 23 24, Figs. 6, 7, 8, and 9, which may reciprocate in a casing, and are held in upper position by the high-pressure water. These pins have bores 25, 26, 27, and 28, Fig. 9, which are destined to establish communication with adjoining bores of the casing and following conduits. The high-pressure water comes from the accumulator through the pipe 34 and branches to the right and left hand, where it raises the pins till they abut against the double lever 22. The bores 35 36 of the casing establish, by means of the adjoining conduits 29 30, the communication with two water-cylinders 31 32 of the hydraulic reversing-gear. Two other bores 37 38 of the casing are in communication with the discharging-pipe 39, which is led to the head water or to the tail water, and owing to the atmospheric pressure is always kept filled with water. If now by means of the regulating device the high-pressure water is allowed to pass from the accumulator to the conduits 29 and 30, and consequently to the cylinders 31 and 32, the double plunger is removed in the one or the other direction and displaces the throttling device.

The regulating device acts in the following manner: If the throttling device is in direct connection with the speed-governor, the throttling-disk 3 is open at the lowest position of the shell of the speed-governor and remains open until the normal velocity of the turbine is attained. When the velocity increases, the balls of the speed-governor come into operation, the shell is raised, and with the shell the prisms. The throttling-disk is moved, and the passages of the revolving-wheel are throttled in such a manner that the power of the turbine is *in equilibrio* with the requisite of power.

Each change in the expense of power alters the velocity of the turbine, and consequently of the speed-governor, which commands the throttling device.

If the turbine is connected with the hydraulic high-pressure regulator, the passages of the revolving wheel remain open, because as long as the normal velocity of the turbine is not yet recovered, owing to the lowest position of the shell of the speed-governor, the communication for the high-pressure water is established from the accumulator through the bore 25 of the pin 23 and the conduit 29 to the water-cylinder 31, in which the end of the plunger acts to keep the throttling device open.

As soon as the normal velocity is reached the shell of the speed-governor is raised and the double lever 22 first turned in its horizontal position corresponding to the normal working of the turbine. The two pins 23 and 24 are in equal height, and all conduits are closed, so that accidental displacement of the throttling mechanism is not possible. If the velocity of the turbine further increases and passes over the normal velocity, the shell of the tachometer is further raised, and the pin 23 establishes communication, through its bore 27, with the water-cylinder 31 and the discharge-pipe 39. Through its bore 26 the pin 24 establishes communication between the accumulator and the cylinder 32, so that the plunger moves in the opposite direction, which effectuates the throttling. After few oscillations of the double plunger the throttling device is so regulated that the power of the turbine and the expense of power by working are balanced. As the pressure of the water may be chosen at will, this high-pressure regulator is very effective even at small dimensions, and as at normal velocity all conduits are closed and the high-pressure water is only used in the case of throttling its consumption is a minimum, and the loss of power for regulating is very little.

Having now described my invention, what I claim is—

1. In a regulating device for turbines the combination with the shaft of the turbine of two prisms sliding in grooves of said shaft and having cylindric shoulders, a throttling-disk on the turbine-shaft, inclined rabbets in the hub of the said disk and engaging with the shoulders of the prisms, a motor for actuating the prisms, and a speed-governor controlling the motor, substantially as described.

2. In a regulating device for turbines the combination with the shaft of the turbine of two prisms sliding in grooves of said shaft and having cylindric shoulders, a throttling-disk on said shaft, the hub of which disk has inclined rabbets engaging with the shoulders of the prisms, an accumulator, a hydraulic high-pressure regulator comprising two water-cylinders and a double plunger connected with the prisms of the throttling device, a speed-governor, a lever connected with the shell of said speed-governor and two pins in a casing which pins are connected with said lever and have bores establishing, by means of bores in the casing and adjoining conduits, communications between the accumulator and the cylinders of the high-pressure regulator, substantially as described and for the purpose set forth.

In witness whereof I have hereunto set my hand in presence of two witnesses.

FRANZ SVOBODA.

Witnesses:
HANS PAPPENHEIM,
ALVESTO S. HOGUE.