

APPLICATION FILED AUG. 19, 1909.

2 SHEETS—SHEET 1.

Fig. 2.

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STEAM TURBINE.

APPLICATION FILED AUG. 19, 1909.

Patented Aug. 23, 1910.

2 SHEETS—SHEET 2.

968,262.

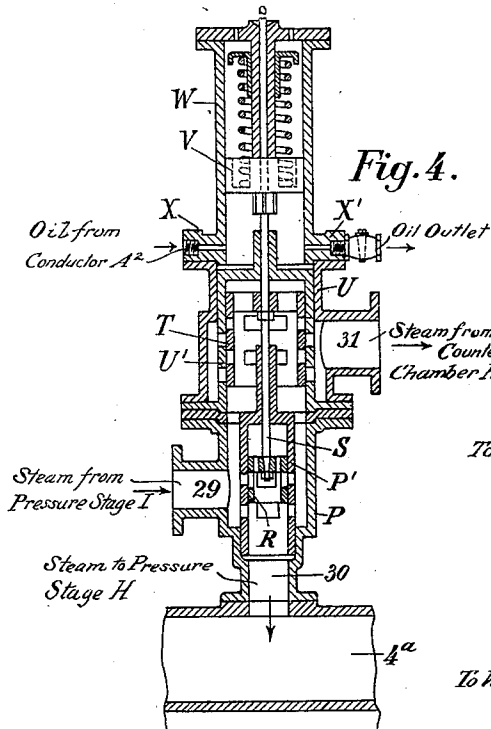


Fig. 4.

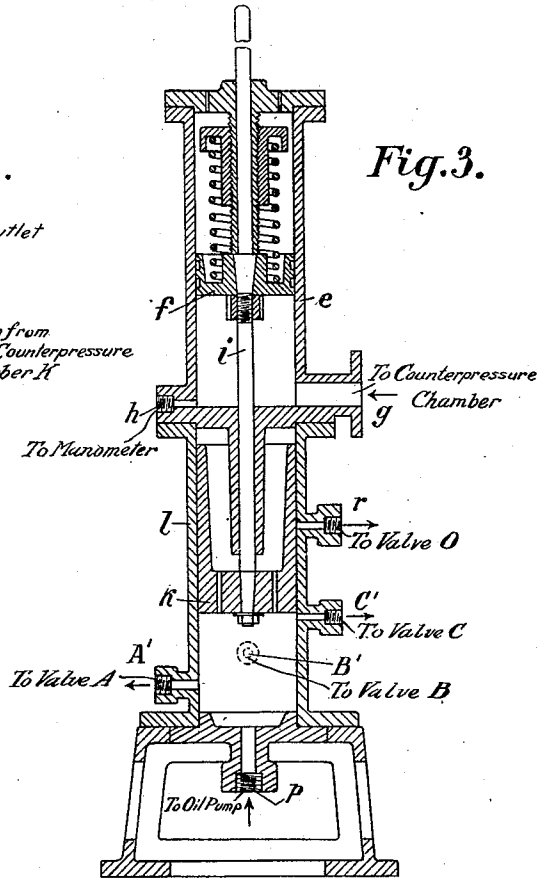


Fig. 3.

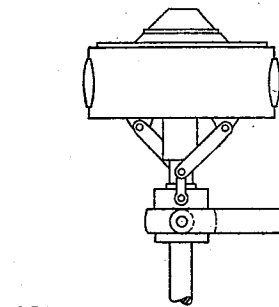


Fig. 5.

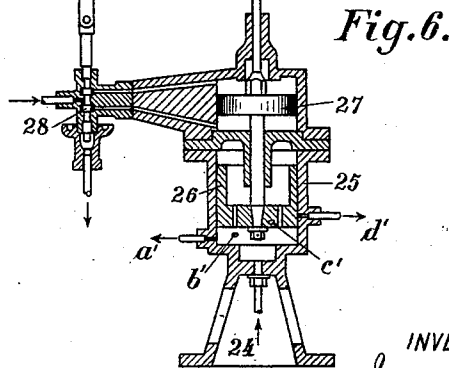


Fig. 6.

WITNESSES:

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UNITED STATES PATENT OFFICE.

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STEAM-TURBINE.

968,262.

Specification of Letters Patent.

Patented Aug. 23, 1910.

Application filed August 19, 1909. Serial No. 513,649.

To all whom it may concern:

Be it known that I, JAN PROCNER, a subject of the Czar of Russia, and residing at Pabianice, in the Empire of Russia, have
5 invented certain new and useful Improvements Relating to Steam Counter-Pressure Turbines, of which the following is a specification.

Steam turbines are already known in
10 which the steam after it has yielded up its work in the turbine which it leaves with a certain pressure is utilized for other workshop purposes. In turbines of this kind the steam consumption, that is to say, the
15 quantity of steam passing through the turbine per unit of power and time is constant so that the manufacturing needs must under all circumstances be adapted to this quantity of steam which leaves the turbine.
20 There are very few manufactures, however in which the demand for steam can be maintained completely in agreement with the steam consumption of the reaction turbine. In view of this defect what are termed "tapping" turbines have been proposed from
25 which the steam can be taken for heating purposes but only at a pressure of from two to three atmospheres while the remainder of the steam passes into the low pressure
30 stage and from this into the condenser.

The present invention goes a step further as it allows the constant steam pressure necessary for the manufacturing purposes to pass from the turbine, high-pressure steam
35 being supplied to the turbine so that the turbine while performing work produces a reduction of the steam pressure to the pressure required for the manufacturing purposes in such a manner that from 50 to 60%
40 of the initial pressure is utilized for the production of power. Thereupon the same steam with the residue of its pressure, that is to say at a pressure of 7 to 5 atmospheres, is again utilized for manufacturing purposes and in this manner the motive power
45 for the manufacture is obtained practically free of cost.

In accordance with the present invention the turbine may rotate at a constant speed
50 the output may be either variable or constant, the reaction constant and the quantity of steam passing through it variable, but this is not dependent upon the output of the turbine but upon the quantity of steam utilized

in the second application. This object
55 is attained by a development of the steam turbine described in the specification of my co-pending application Serial Number 498,857 dated May 28th, 1909. This principal application relates to a multi-pressure
60 stage radial turbine in which for the purpose of modifying the operation of the turbine it is possible to increase or reduce the number of the operative pressure stages or the number of the nozzle pipes operative in
65 each pressure stage or to modify both together. With this object a number of radially arranged nozzle-pipes are provided in each pressure stage, these pipes being provided with nozzles on their ends opening
70 radially inward relatively to the vane rim of the rotor while, upon their outer ends opening toward a steam supply chamber located concentrically to the turbine chamber, they are provided with admission valves.
75 The admission valves of the nozzles pipes of the various normally operating pressure stages being located in the same radial plane are always controlled simultaneously and in the same sense so that the regulation is effected
80 simultaneously in all the pressure stages.

By the provision of an exhaust chamber behind the last pressure stage the turbine
85 may be constituted as a counter-pressure turbine and in accordance with the present invention is rendered suitable for the purpose in view owing to the fact that it is provided on the one hand with a governor for
90 controlling the nozzles and on the other hand with an appropriate automatic turbine-chamber control, both regulating means being operative simultaneously. The nozzle control is actuated in the known manner
95 indirectly by means of oil under pressure from a centrifugal spring governor, while the automatic turbine chamber control is acted upon by the reaction of the turbine in such a manner that it renders the turbine
100 chambers operative and inoperative automatically by means of oil likewise under pressure. The double regulation acts in such a manner that the reaction and the quantity of steam passing through the turbine are not dependent upon the output of
105 the turbine but upon the quantity of steam utilized in the second application.

The invention is illustrated by way of

example in the accompanying drawing in which:—

Figure 1 is a diagrammatic representation of a multi-stage turbine in longitudinal section, Fig. 2 is a cross section of the same, Fig. 3 is a section of the automatic turbine chamber control, Fig. 4 is a section of a double valve for rendering the turbine chambers operative and inoperative, Fig. 5 is a section of a nozzle admission valve, Fig. 6 shows a governor with a nozzle control acting indirectly.

As in the construction described in the specification of my co-pending application Serial Number 498,857 dated May 28th 1909 the turbine comprises a number of pressure stages for example four pressure stages I II III IV and in each pressure stage a blade wheel 5 comprising two concentrically disposed rows of blades 11, 13 are arranged. The steam distributing chamber 4 is located concentrically with the turbine chamber 3. A number of radially arranged nozzle pipes 8 proceed inwardly from this chamber 4 and as shown in Fig. 2 in the example here illustrated four such nozzle pipes are employed. The inner ends of these pipes terminate in nozzles 10 so that the steam from these nozzles acts through the rims of blades 11 and through reversing blades 12 upon the outer rim of blades 13. On its end opening toward the steam distributing chamber 4 each of these nozzle pipes is provided with a special control valve which is hereinafter described each of these valves being marked *a, b, c, d*, in Fig. 2 in accordance with its radial position. The steam passes through the socket 7 into the annular chamber 4 of pressure stage I and through the admission valves *a, b, c, d* which are then open into the corresponding nozzle pipes 8 with full initial pressure. In all the pressure stages all the admission valves are normally open under spring pressure and the series of valves *a, b, c, d* are closed separately under the action of oil under pressure. As in the construction described in the specification of the application referred to these valves may be given the form illustrated in Fig. 5. In the slotted cylinder 16 a piston slide valve 17 likewise slotted is arranged and is connected by means of a rod 18 with a piston 19 located in a cylinder 21 arranged outside the turbine casing; it is pressed downward in this cylinder by means of a spring 20. The cylinder 21 is provided with an admission and a discharge socket 23 and 23^a respectively for oil under pressure which acts upon the lower side of the piston 19. By means of an oil pump which is driven off the turbine shaft or off the governor spindle the oil under pressure is forced through the tubular connection 24 (Fig. 6) into the nozzle control 25, 26 acted upon by the governor in the known manner by means

of the slide valve 28 and piston 27 by means of oil under pressure, the oil passing from this control as required through the tubular connections *a', b', c', d'*, for closing the admission valves *a, b, c, d*.

The turbine chambers 3, 3^a, 3^b are connected with the counter pressure exhaust chamber K by the double valves A B C (which are of the construction illustrated in Fig. 4) and their connection pipes D E F G H J. The chamber 3^c of pressure stage IV is connected with the chamber K by a single acting exhaust valve C². From the pressure stage I the steam is able to pass through the pipe D and the lower valve A to the annular chamber 4^a of pressure stage II, or through the pipe D the upper valve A and the pipe E into the exhaust chamber K. In a similar manner the steam is able to pass from turbine chamber 3^a of pressure stage II through the pipe F and the lower valve B into the annular chamber 4^b of pressure stage III or through the pipe F, the upper valve B and the pipe G into the exhaust chamber K. From the turbine chamber 3^b of pressure stage III the steam is able to pass through the pipe H, and lower valve C into the annular chamber 4^c of pressure stage IV, or through pipe H, and upper valve C and pipe J into the exhaust chamber K. From pressure stage IV the steam flows through the exhaust valve C² into the exhaust chamber K. The counter pressure exhaust chamber K is provided with a live steam valve L a safety valve M and a non-return valve N. The steam coming from the chamber K passes through the non-return valve N and a tubular socket O which if necessary may be fitted with a lateral nozzle O' to the live steam conduit in cases where the turbine is not running and steam is required for manufacturing purposes.

The double valves A, B, C, illustrated in Fig. 4 comprise the following parts: the lower casing P the middle casing U and the upper casing W. The casing P is provided with a lateral tubular branch or socket 29 and a lower tubular branch or socket 30 and comprises a slotted cylinder P'. A piston slide valve R which is likewise slotted is arranged in this cylinder. The rod S of this piston carries above it a second piston slide valve T, which is likewise slotted and which is movable in a slotted cylinder U'. At its upper end the piston rod S is connected with a spring controlled piston V arranged in the casing W to and from which oil under pressure is admitted and discharged through tubular sockets X, X' and acts from below upon the piston V. The double valve A (Fig. 4) is acted upon by closing T when R is open.

In the position of the two valves illustrated in Fig. 4 steam is flowing from pres-

sure stage I through the socket 29 into the casing P and as the slots in the cylinder P' and slide valve R register, it is able to pass through the socket 30 into the steam supply chamber of pressure stage II. If the valve P' R is closed however the valve T, U' is open and the steam flowing through the socket 29 is able to pass through the slots in the valve T, U' to the socket 31 through which it is conducted to the exhaust chamber. The double valves B and C are automatically operated in a similar manner. The single valve C² consists only of the lower casing P with slide valve P', R and the upper casing W with piston V and spring. Normally it is closed under spring pressure and is operated simultaneously with the double valve C. It is opened as soon as R, P' in the valve C is opened.

In conjunction with this turbine the automatically acting turbine-chamber control illustrated in Fig. 3 is used. A spring controlled piston *f* is arranged in a casing *e* and upon the under side of this piston a counter pressure of from 5 to 7 atmospheres (equal to about 50% of the initial pressure) prevailing in the exhaust chamber K acts. This counter pressure steam is discharged through a socket *g'* to which the control is fitted by means of the socket *g* (Fig. 3). This casing *e* communicates with a pressure gage through another tubular socket *h*. The piston rod *i* carries at its lower end a balanced oil piston *k* which simultaneously serves as a cataract. In the lower part of the casing *l* receiving the piston *k* a number of tubular sockets A' B' C' are arranged which correspond to the number of the pressure stages normally out of operation, the socket A' serving for rendering pressure stage II operative and inoperative by acting upon the oil piston of the double valve A of the socket B' for influencing pressure stage III through the double valve B and the socket C' for rendering pressure stage IV operative and inoperative by means of the double valve C and the single valve C². Oil under pressure is supplied from the oil pump through a socket *p* to the lower part of the casing *l* underneath the piston *k*. Another socket *r* is provided above the socket C' and oil under pressure is supplied through it to act upon the live steam valve L arranged on the exhaust chamber K.

The operation of this turbine in conjunction with the regulating nozzle control and the automatic turbine chamber control is as follows. When the slide valve R in the double valve A is closed and the slide valve T open (Fig. 4) the steam flows through the socket 7 with its full initial pressure into the steam supply chamber 4 and thence into the nozzle arms 8 corresponding to the number of the open nozzle pipes *a*, *b*, *c*, *d*, acts upon the rotor of pressure stage I whereupon the

waste steam flows with approximately half the initial pressure through the pipe D, valve A and pipe E into the exhaust chamber K and thence into the manufacturing installation. When the reaction in the exhaust chamber K increases less steam is used temporarily in the manufacturing installation and consequently the turbine must allow less steam to pass. Owing to this increase of pressure in the exhaust chamber K which is connected by a pipe and socket *g* (Fig. 3) with the casing *e*, the piston *f* rises and by means of the piston *k* covers the opening A' through which oil under pressure proceeds toward the cylinder of the double valve A (Fig. 4) and passes beneath the piston V through the socket X. Consequently the piston V rises the valve R opens while the valve T simultaneously closes; the steam is therefore no longer able to pass through the socket 31 into the exhaust chamber but must pass through the socket 30 into the steam distributing chamber 4^a of pressure stage II and thence through an equal number of nozzle tubes to those in pressure stage I, act upon the rotor of pressure stage II. The speed of rotation of the turbine then increases because with the given output the operative surface afforded to the steam has become larger, that is to say because the output in question is distributed over two turbine wheels. The increased speed of rotation causes the governor (Fig. 6) to move the piston 27 upward owing to the action of the oil under pressure thereby freeing the tubular socket *a'* for the discharge of oil under pressure. This oil under pressure proceeds to the connection 23 in all four valves *a* (Fig. 5) lifts the piston 19 and locks the slide valve 16, 17 in all the valves *a*. The quantity of steam flowing through the turbine has therefore become reduced without altering the output, the reaction and the number of revolutions, as after obturating one or more nozzles the latter becomes reestablished at the normal. The waste steam then passes from pressure stage II through the pipe F, double valve B and pipe G into the exhaust chamber K. Similarly by appropriately acting upon the valves B, C, C² the steam is conducted if necessary to the pressure stages III and IV and only then to the exhaust chamber K.

When the steam piston *f* and the oil piston *k* (Fig. 3) move upward from their lowest position under the influence of the counter pressure acting upon the piston *f* the conduit A' is freed for the oil under pressure flowing through the tubular socket *p*, so that oil is able to flow from this conduit for actuating the double valve A in such a manner that the valve T is closed and the valve R is opened. Upon the further rise of the piston *k* owing to the freeing of the conduit B' (Fig. 3) the upper

valve of the double valve B is closed and the lower valve opened. This is effected through the pipe C' for acting upon the double valve C and the single valve C².

5 With this means and in dependence upon the counter pressure acting upon the steam piston *f* or upon the steam consumption required for the time being in the manufacturing installation, the number of vane

10 wheels or pressure stages operative for the time being can be automatically increased or decreased because in proportion as the counter pressure increases, and the piston *f* is consequently lifted owing to the exposure of

15 the passages A' B' C', the number of the pressure stages is increased in the same proportion, and when the counter pressure falls is correspondingly reduced; in this connection it must be remembered that when the

20 counter pressure falls that is to say the consumption of steam increases in the manufacturing installation the turbine must use more steam and consequently pressure stages

25 must be cut out while when the counter pressure rises which is equivalent to a diminution of the consumption of steam in the manufacturing installation the turbine must use less steam, which result is attained by

30 rendering additional pressure stages operative. Simultaneously with the increase of the number of pressure stages the number of operative nozzles must be automatically reduced and vice versa when the number of operative pressure stages is reduced, the

35 number of the operative nozzles must be automatically increased. The quantity of steam flowing through the turbine therefore depends directly upon the number of the nozzles operative for the time being. If, how-

40 ever, merely the number of nozzles were to be influenced by the counter pressure upon reducing the number of operative nozzles the output of the turbine would also be reduced, which is not the object aimed at in

45 the present turbine. If the counter pressure should fall still farther after the pressure stages IV, III, II have been cut out that is to say if the consumption of steam in the factory installation should still further

50 exceed the average maximum, the oil piston *k* exposes the tubular connection *r* (Fig. 3) of the automatic control and oil under pressure acts on the live steam valve L shown in Fig. 1 which has been normally

55 held closed by a spring. Under the influence of oil under pressure the valve is opened however so that live steam enters the exhaust chamber until the steam consumption of the manufacturing installation balances the steam passing through the turbine. If the counter pressure in the exhaust chamber should exceed the maximum provided for and the consumption of steam in the

60 installation consequently fall below the predetermined minimum when it is no longer

65

possible to render more turbine chambers operative the safety valve M located on the exhaust chamber opens and permits of the discharge of steam which may be utilized for preliminarily heating the boiler feed 70 water.

From the foregoing it will be understood that the object aimed at is attained in every respect by means of the device described above, and a source of power provided for 75 the manufacturing installation in question the work furnished by which is absolutely free of cost as the whole of the steam passing through the turbine is utilized in the manufacturing installation. 80

At the lower part the turbine chambers, the steam distributing chambers and the exhaust chamber K may be provided with tubular sockets *r, s, t, u, v, w, x, y* for the connection of steam traps. 85

What I claim and desire to secure by Letters Patent is:

1. The combination, with a steam turbine having a plurality of pressure stages, each pressure stage having one or more admission valves, of an exhaust chamber, adjustable means for connecting each pressure stage with, and disconnecting the same from the next lower pressure stage and said exhaust chamber, and controlling means in 95 open relation with said exhaust chamber and connected with said adjustable means for rendering said pressure stages operative and inoperative in dependence on the counter pressure in said exhaust chamber. 100

2. The combination, with a steam turbine having a plurality of pressure stages, each pressure stage having one or more admission valves, of an exhaust chamber, adjustable means for connecting each pressure stage 105 with, and disconnecting the same from the next lower pressure stage and said exhaust chamber, and automatic controlling means in open relation with said exhaust chamber and connected with said adjustable means 110 for rendering said pressure stages operative and inoperative in dependence on the counter pressure in said exhaust chamber.

3. The combination, with a steam turbine having a plurality of pressure stages, each 115 pressure stage having one or more admission valves, of an exhaust chamber, double valves and pipes substantially as shown, connected with the latter for bringing each pressure stage into open relation with, and disconnecting the same from the next lower pressure stage and said exhaust chamber, spring-pressed means for operating said double valves, and automatic controlling means 120 comprising a casing having two chambers, one chamber containing a spring-pressed piston and being in open relation with said exhaust chamber, the second chamber having an oil inlet and a plurality of outlets in open relation with said means for operating 130

said double valves, and a piston in the latter chamber connected with the former piston for closing and opening said outlets.

4. The combination, with a steam turbine
5 having a plurality of pressure stages, each pressure stage having one or more admission valves, of an exhaust chamber, double valves and pipes, substantially as shown, connected with the latter for bringing each pressure
10 stage into open relation with and disconnecting the same from the next lower pressure stage and said exhaust chamber, spring-pressed means for operating said double valves; automatic controlling means comprising a casing having two chambers, one
15 chamber containing a spring-pressed piston and being in open relation with said exhaust chamber, the second chamber having

an oil inlet and a plurality of outlets in open relation with said means for operating said
20 double valves, and a piston in the latter chamber connected with the former piston for closing and opening said outlets, a live steam valve on said exhaust chamber, and means for operating the latter valve, said
25 second chamber having another outlet in open relation with the latter means, for the purpose specified.

In testimony, that I claim the foregoing as my invention, I have signed my name in
30 presence of two subscribing witnesses.

JAN PROCNER.

Witnesses:

WLADYSDAW KRAJEWSKI,
CYRILL FREDWICK.