No. 862,118. PATENTED JULY 30, 1907.

J. W. SMITH.

STEAM TURBINE.

APPLICATION FILED MAR. 30, 1906.

2 SHEETS—SHEET 1.

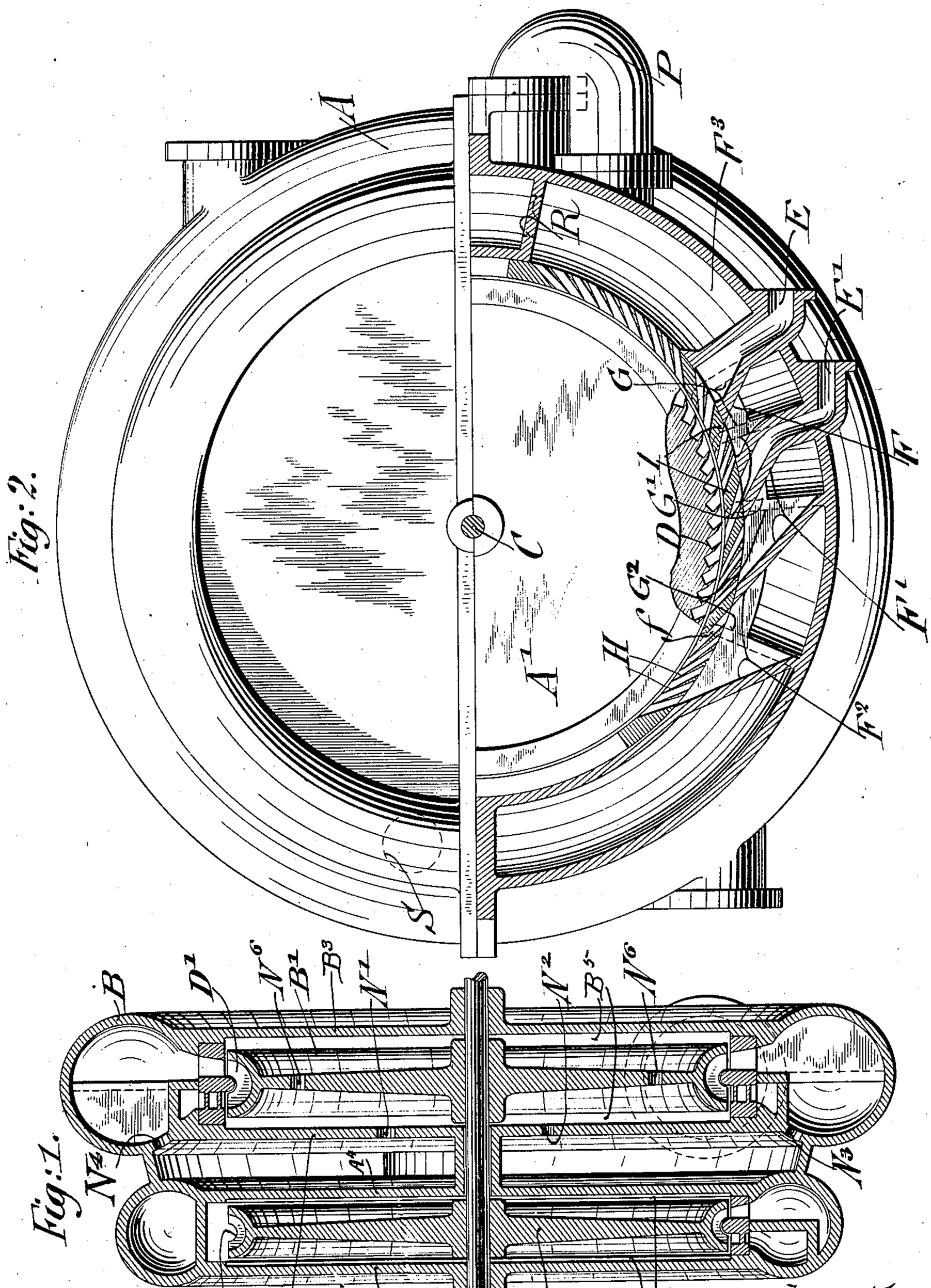

Fig: 2.

Witnesses
Edward A. Pear
Fannie Fisk

Inventor
John W. Smith
By his Attorneys
Goepel & Goepel

No. 862,118. PATENTED JULY 30, 1907.

J. W. SMITH.

STEAM TURBINE.

APPLICATION FILED MAR. 30, 1906.

2 SHEETS—SHEET 2.

Fig: 3.

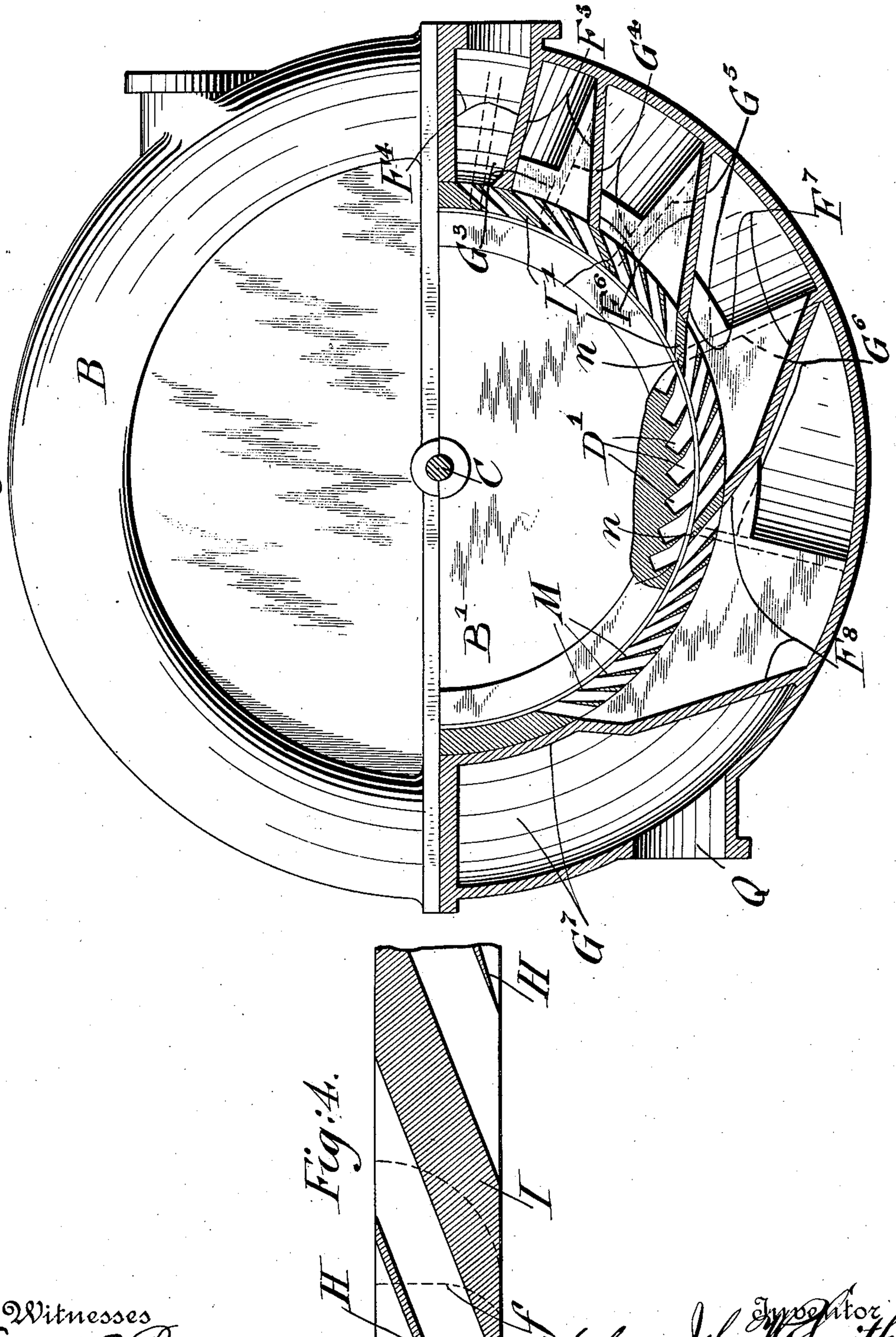

Fig: 4.

Witnesses
Edward A. Pear
Fannie Fisk

Inventor
John W. Smith
by his
Attorneys
Church & Church

UNITED STATES PATENT OFFICE.

JOHN W. SMITH, OF ERIE, PENNSYLVANIA, ASSIGNOR TO BALL ENGINE COMPANY, OF ERIE, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

STEAM-TURBINE.

No. 862,118. Specification of Letters Patent. Patented July 30, 1907.

Application filed March 30, 1906. Serial No. 308,883.

To all whom it may concern:

Be it known that I, JOHN W. SMITH, a citizen of the United States, and a resident of Erie, county of Erie, and State of Pennsylvania, have invented certain new and useful Improvements in Steam-Turbines, of which the following is a specification.

This invention relates to improvements in steam-turbines, and more particularly to improvements in that class of steam-turbines, which have chambers of gradually increasing cross-section arranged along the path of the rotating buckets, to guide the steam in a spiral path from the inlet to the exhaust.

The invention has for its object to provide means for balancing the different pressures exerted by the steam on the different parts of the rotating member of the turbine, so as to obviate any loss in efficiency by unequal strains.

The invention has further for its object to provide an improved means of by-passing steam, which consists therein, that steam is impinged directly against the buckets of the turbine wheel, instead of supplying steam of high pressure to a stage of comparatively low pressure as heretofore, for the purpose of increasing the rotatory force of the turbine wheel to make it capable of meeting over-load conditions.

The invention has further for its object to arrange release blades in respect to the nozzle blanks, so as to be in line with the central portion of the nozzle blanks.

To accomplish the first of these objects the invention consists in providing the casing of the turbine with means for supplying steam to its chamber, of a pressure higher than that of the outlet casing.

For the second of these objects, the invention consists of an additional nozzle for impinging steam directly against the buckets to meet over-load conditions.

The invention consists for accomplishing the last of these objects of the arrangement of the release blades in respect to the nozzle blanks so that the blank extends far enough ahead of the tip of the release blade to allow the density of the steam of one bucket to fall to that of the adjacent stage, before the nozzle of the adjacent stage directs the steam into a bucket which has just left a stage carrying a higher pressure. The tip of the release blades being arranged so as to be in line with approximately the central portion of the nozzle blanks.

The invention consists further of certain novel features of construction and combinations of parts which will be more fully described hereinafter and finally pointed out in the claims.

In the accompanying drawings, Figure 1 represents a transverse central section of my improved steam-turbine, showing a high pressure turbine and a low pressure turbine mounted on one common shaft, Fig. 2 represents a side view of the high pressure turbine partly in section and partly in elevation, Fig. 3 shows a side view of the low pressure casing partly in section and partly in elevation, and Fig. 4 shows a cross-section of my improved nozzle blanks, showing the arrangement of the release blade relatively thereto.

Similar letters of reference indicate corresponding parts.

Referring to the drawings, A represents the high pressure casing and B the low pressure casing, A^3 and A^4, being the casing heads of the high pressure casing, B^3 and B^4 the casing heads of the low pressure casing; A^5 the wheel chamber of the high pressure casing and B^5, the wheel chamber of the low pressure casing. In the high pressure casing, a turbine-wheel A^1 provided at its periphery with buckets D is secured to the shaft C. A main nozzle E, serves to impinge the high pressure steam against the buckets D, and a plurality of admission chambers F, F^1, F^2 and F^3 and release chambers G, G^1 and G^2 serve to guide the steam in a spiral path from the admission E to the opening R and the exhaust P. The walls forming the nozzle and the admission chambers extend clear down into operative proximity with the buckets of the turbine-wheel, and form, so as to say, blanks I. Intermediately between these blanks I of substantial thickness are arranged admission blades H comparatively thin and sharpened which serve to guide the steam and to cause it to impinge in several streams against the buckets of the turbine-wheel. The walls inclosing the release chambers and forming the release blades extend also clear down into operative proximity with the buckets of the turbine-wheel and are provided at these ends with scooped shaped portions *f*, which serve to gather up the steam emanating from the buckets of the turbine-wheel, and conduct it against the release blades, which then guide it to the next admission chamber. The scooped-shaped release blades are arranged relatively to the nozzle blanks I, so as to be in line with approximately the central portion of the nozzle blanks, as shown for instance in Fig. 4.

In the low pressure casing B, a turbine wheel B^1 provided at its periphery with buckets D^1, is secured to the same shaft C, as that to which the high pressure turbine-wheel A^1 is secured. A nozzled shaped admission chamber F^4 and admission chambers F^5, F^6, F^7 and F^8 similar to those of the high pressure casing are arranged; the walls of which also have their ends in operative proximity to the buckets of the turbine-wheel forming nozzle blanks II of substantial thickness. Intermediately between these blanks II, admission blades M comparatively thin and sharpened are arranged which serve to guide the steam in several streams and impinge it against the buckets of the turbine-wheel. The low pressure casing is also provided with release chambers G^3, G^4, G^5, G^6 and G^7, the wall

of which form release blades provided at their lower ends with scooped shaped parts in relative position as respect the blanks II in like manner as described in connection with the high pressure turbine, and as shown in the drawings.

In the drawings, Figs. 2 and 3 show but one half of the casing utilized with the arrangement of nozzles, admission and release chambers. If desired, however, especially in large turbines both halves of the casing may be provided with the nozzles, admission and release chambers of the character described. Or, the high pressure casing may be provided in one of its halves with these operative elements, while the low pressure casing might be provided in both halves with the same. In this part of the casing the steam leaving the high pressure casing would pass through R and around the upper or unused portion of this high pressure casing, and enter the upper half of the low pressure casing at S. Owing to the fact that no means for balancing unequal pressures had been devised, no turbine of the multiple impulse type having several pressure stages around the periphery of its turbine wheel was considered practicable. And further, when no wheel chamber pressure was carried the leakage was excessive. In order to obviate these losses and to secure a proper balancing of the turbine-wheel, the pressures of the steam proposed to be used to operate the same, are such that one pressure is above that of the pressure of the wheel shown, one is of the same pressure, and the other of a pressure lower than that of the wheel chamber. Thus, assume the pressure in the wheel chamber to be 24 lbs., the pressure in the nozzle E to be 160 lbs., and the pressure below that of the wheel chamber pressure to be 15 lbs; the steam in the nozzle with the pressure of 160 lbs. will impinge against the buckets and in causing work to be done will fall to 94 lbs. This constitutes the first stage. The steam passing through the first release chamber G enters the admission chamber F and impinges again against the buckets, so that its pressure falls to 62 lbs; constituting the second stage or stage No. 2. With this pressure, it passes through the second release chamber G^1 enters the admission chamber F^1 to be again impinged against the buckets. In doing so and performing useful work, the steam is reduced in pressure to 39 lbs., forming stage No. 3. The steam of this pressure passes through the third release chamber G^2, enters the admission chamber F^2 and in impinging against the buckets and doing useful works falls to the pressure of the wheel casing, namely 24 lbs. This forms stage No. 4. Emanating from the buckets with this pressure, the steam passes through the release chamber A^5 in the direction of and into the admission chamber F^3, which directs the steam so as to impinge it against the turbine-wheel, in doing which its pressure falls to about 15 lbs. or 9 lbs. below that of the wheel chamber pressure, forming stage No. 5. The amount of these pressures both for the high and low pressure are simply given for example, it being clear that other pressures may be used.

It will be noted that the admission chamber F^3, is not, as usual, arranged in order as to size with the other members but is arranged adjacent the main-nozzle E. Thus the chamber with the pressure lower than that of the wheel chamber is arranged in close proximity to that member having the highest pressure. So that, with the highest pressure at one place exerting a force on the turbine-wheel in one direction, and the pressure of the wheel chamber at a place adjacent the place acted upon by the high pressure, exerting a force on the turbine-wheel in the opposite direction, a counterbalancing of the turbine-wheel is obtained. This arrangement of pressures reduces leakage, and at the same time tends to counterbalance the excess radial pressure; for while the steam in stages 1, 2, and 3, tends to force the bucket wheel away from the nozzle, the wheel chamber pressure acting on the circumference of the turbine-wheel at stage No. 5 tends to force the bucket wheel against the nozzle. In actual practice the pressure fluctuates and there is always an excess in the vertical direction tending to raise the turbine-wheel and release some of the load on the turbine bearings, however, this excess force is never equal to the weight of the moving element.

The steam leaving the buckets of the high pressure casing passes into the pipe P which is in communication with the admission chamber F^4 of the low pressure casing, and with a pressure of 15 lbs. impinges against the buckets, and then leaving the same enters the release chamber G^3, with its pressure reduced to 9½ lbs. This constitutes stage No. 6. The steam then passes successively through admission chamber F^5 and release chamber G^4; admission chamber F^6 and release chamber G^5; admission chamber F^7 and release chamber G^6; and admission chamber F^8, release chamber G^7 and exhaust pipe Q, constituting successively stages numbers 7, 8, 9 and 10, with pressures of 5.95 lbs, 3.71 lbs., 2.33 lbs., 1.45 lbs. and with 1 lb. at the exhaust pipe Q.

Holes N^1, N^2, N^3 and N^4 are arranged in the low pressure casing head B^4 nearest the low pressure casing, as shown in Fig. 1, the object of which is to supply a suitable wheel chamber pressure, which in this instance is equal to the pressure in the last stage before entering the buckets for the last time. By this arrangement the low pressure wheel chamber would always have a pressure equal to that stage, which represents one stage before final exhaust. In order to equalize the pressure in the low pressure wheel chamber, the turbine-wheel B^1 is provided with holes N^6.

The fundamental principle of balancing when steam is admitted in the high pressure casing at one entrance hinges on two features, the most important of which is the carrying of a suitable pressure in the wheel chamber, while the second is to place the negative stage adjacent the high pressure stage. As the density of steam in the buckets has been reduced to the pressure of the wheel chamber, there is no objection in allowing all the steam to escape into the wheel chamber. Should the buckets be filled with steam at a high density just before entering the wheel chamber, these buckets would immediately empty themselves in the wheel chamber, which would impair the efficiency. In the form shown in the drawings, the stages are disconnected at the point where the pressure on the wheel chamber is carried. Hence there is no bucket displacement loss. Thus the means described form practically a perfect counterbalanced condition. The fundamental principle which is common to both the high and low pressure turbines is the carrying of a

suitable wheel chamber pressure equal to at least one stage higher than the pressure in the outlet of said casing.

A second form of balancing is made use of in the low pressure case which is effected by allowing the steam to be admitted on opposite sides.

In those cases where the requirements of an overload had to be met, it was usual to supply an additional amount of high pressure steam to a stage of comparatively low pressure which allows expansion to take place without impinging on the moving buckets. This method is generally known as by-passing the steam. This method of by-passing has the disadvantage that high pressure steam is delivered to a stage carrying a comparatively low pressure, thus sacrificing a large percentage of the kinetic energy. My improvement consists therein that an additional nozzle is provided, which is supplied with high pressure steam and which serves to impinge the steam of this pressure directly against the buckets of the turbine-wheel before mixing with the comparatively low stage pressure. This has the advantage of utilizing all of the kinetic energy in the steam, and by this utilization to so increase the overload efficiency. The improved nozzle construction hereinbefore referred to is shown clearly in Fig. 2.

In arranging adjacent to each other around the periphery of a series of buckets, several pressure stages, it is obvious, that the density of the steam in the buckets corresponds to the different stages. Hence, a constant change of density takes place, as the bucket passes from one stage to an adjacent stage. The blanks I of the high pressure casing or blanks II of the low pressure casing, should extend far enough ahead of the tip of the release blade to allow the density of the steam in the bucket to fall to that of the adjacent stage, before the nozzle of the adjacent stage directs the steam into a bucket, which has just left a stage that carried a higher pressure. In the embodiment of the invention shown in the drawings the tips of the release blades are arranged as to be in line with about the central part of the nozzle blank. It is necessary in designing the release blade to so construct it that the steam from one stage will not escape into an adjacent stage and at the same time this release blade should be so designed so as not to cause undue shock to the steam from the bucket.

I do not wish to limit myself to the particular form and structure of the improvements herein shown and described as I have chosen them as one embodiment of my invention. Many changes might be made without departing from the spirit of my invention.

Having thus described my invention I claim as new and desire to secure by Letters Patent:

1. In a steam-turbine having a casing with an inlet and an outlet, a wheel-chamber, and means for guiding steam of different pressures from the inlet to the outlet, means for supplying steam to the wheel-chamber of a pressure equal to one of the pressures of the steam guided by the means, and higher than the pressure of the outlet.

2. In a steam turbine having a casing with an outlet, a wheel chamber and a turbine-wheel acted upon by pressure equal to, greater and less than that of the wheel chamber, positive means communicating with the wheel chamber for supplying steam of one pressure thereto higher than that at the outlet, and means for directing steam of high pressure, against that part of the turbine-wheel which is adjacent to the part acted upon by the steam of a pressure lower than that of the wheel chamber.

3. In a steam-turbine having a casing forming a wheel-chamber and having a nozzle and a plurality of guide-chambers arranged therein for guiding steam of different pressures; means forming communication between one of said guide-chambers and the wheel-chamber, the admission-chamber having the lowest pressure being arranged close to the nozzle guiding the steam of high pressure.

4. In a steam-turbine having a casing forming a wheel-chamber and having a nozzle and a plurality of admission-chambers of gradually increasing cross section arranged therein for guiding steam of different pressures, means forming communication between one of said admission-chambers and the wheel-chamber, the admission-chamber having the lowest pressure being arranged close to the nozzle guiding the steam of high pressure.

5. In a steam-turbine having a high pressure casing, and a low pressure casing adjacent thereto having a wheel-chamber, and forming a compartment with the high pressure casing, holes in the low pressure casing at the side nearest the high-pressure casing for the passage of steam from the low pressure casing, through the compartment to the wheel-chamber of the low pressure casing.

6. In a steam-turbine, a plurality of nozzle blanks and a plurality of release blades arranged relatively to the nozzle blanks so as to be in line with some part of the nozzle blanks.

7. In a steam-turbine, a plurality of nozzle blanks and a plurality of release blades arranged so as to be in line with approximately the central portion of the nozzle blanks.

8. In a steam turbine having a casing with an outlet, a turbine-wheel with buckets, a nozzle, and means guiding steam in a stream from the nozzle to the outlet, an additional and separate nozzle not in communication with the first nozzle, arranged intermediately between the first nozzle and the outlet for directing steam separate from the stream of the first nozzle and outlet, directly against the buckets.

9. In a steam turbine having a casing with an outlet, a turbine-wheel with buckets, a nozzle, and means for guiding the steam in a stream through a spiral path from the nozzle to the outlet, for successively impinging the steam against the buckets; an additional and separate nozzle not in communication with the first nozzle, intermediately between the first named nozzle and outlet for directing steam in a stream separate from that passing from the first nozzle in a spiral path to the outlet, directly against the buckets.

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

JOHN W. SMITH.

Witnesses:
ROBERT L. ROBERTS,
WM. BLOOD.