

A. GOSLING.

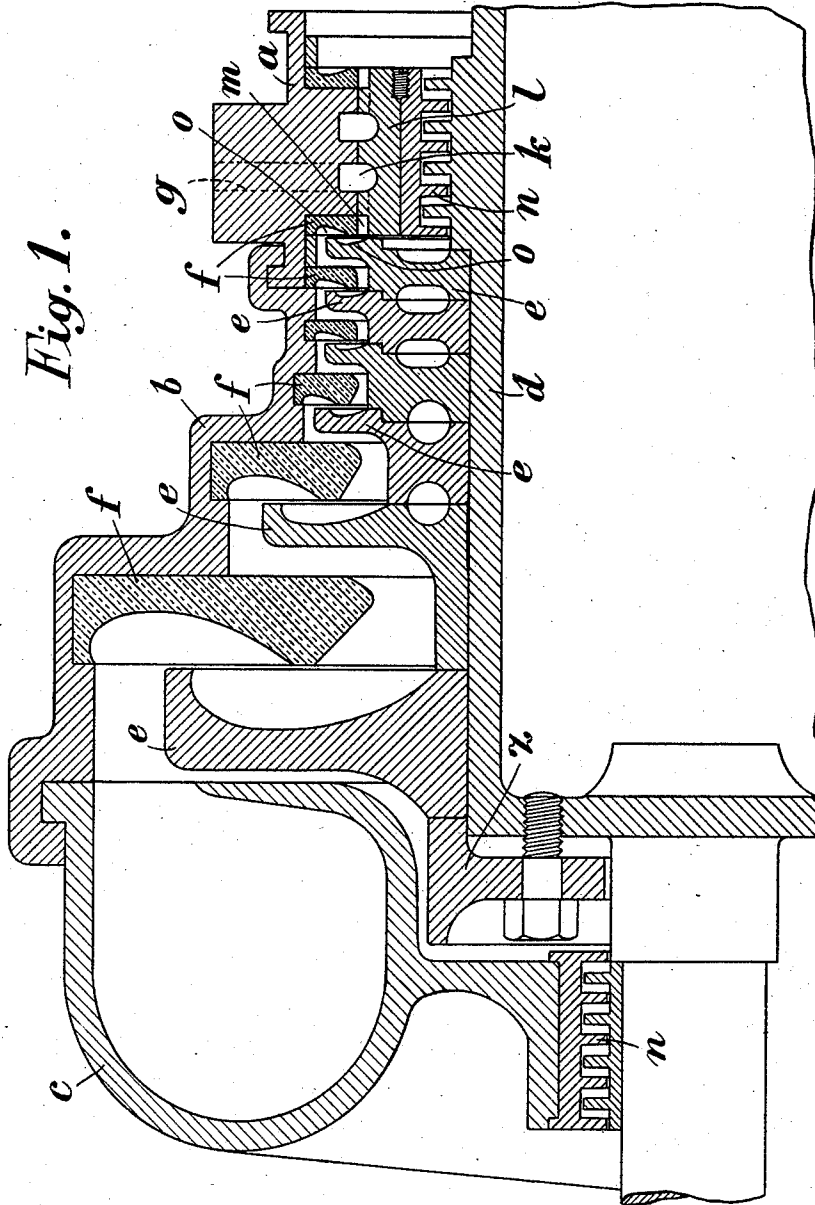
TURBINE.

APPLICATION FILED JAN. 17, 1912.

1,066,106.

Patented July 1, 1913.

4 SHEETS—SHEET 1.



Witnesses
Grace P. Breton
Mary H. Farr.

Inventor
Allen Gosling
By Sturtevant & Mason
Attorneys

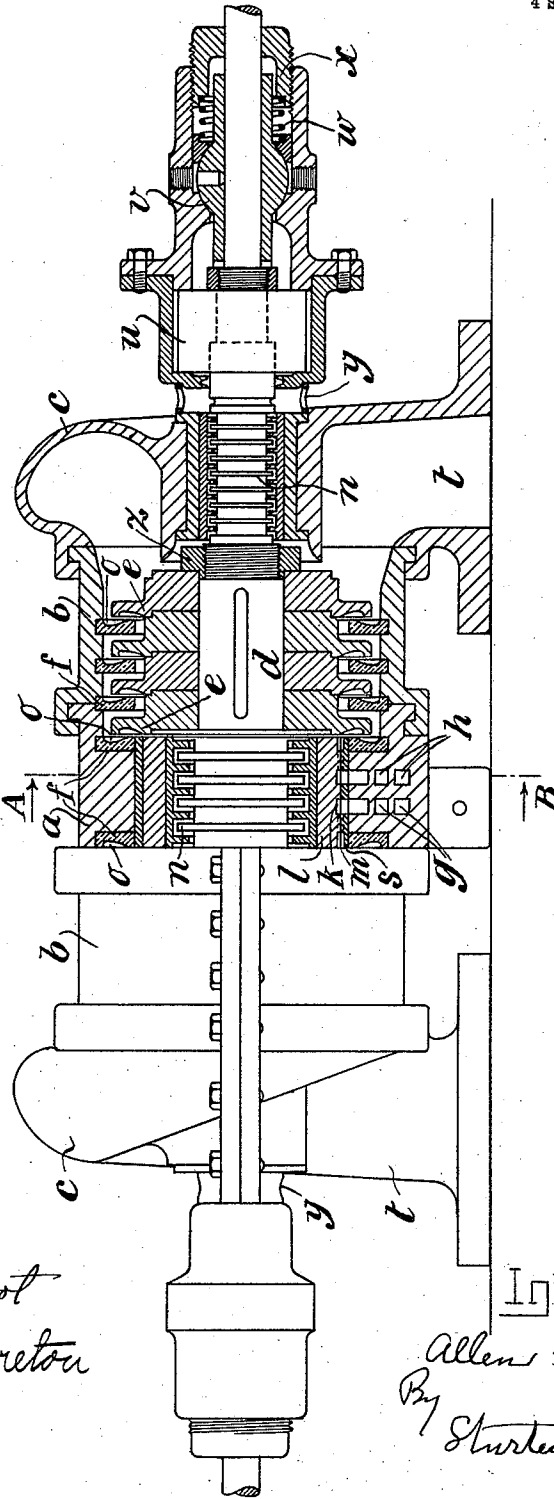
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4 SHEETS—SHEET 2.

Fig. 2.



Witnesses

M. D. Suvoit
Grace P. Breton

Inventor

Allen Gosling
By Sturtevant & Mason
Attorneys

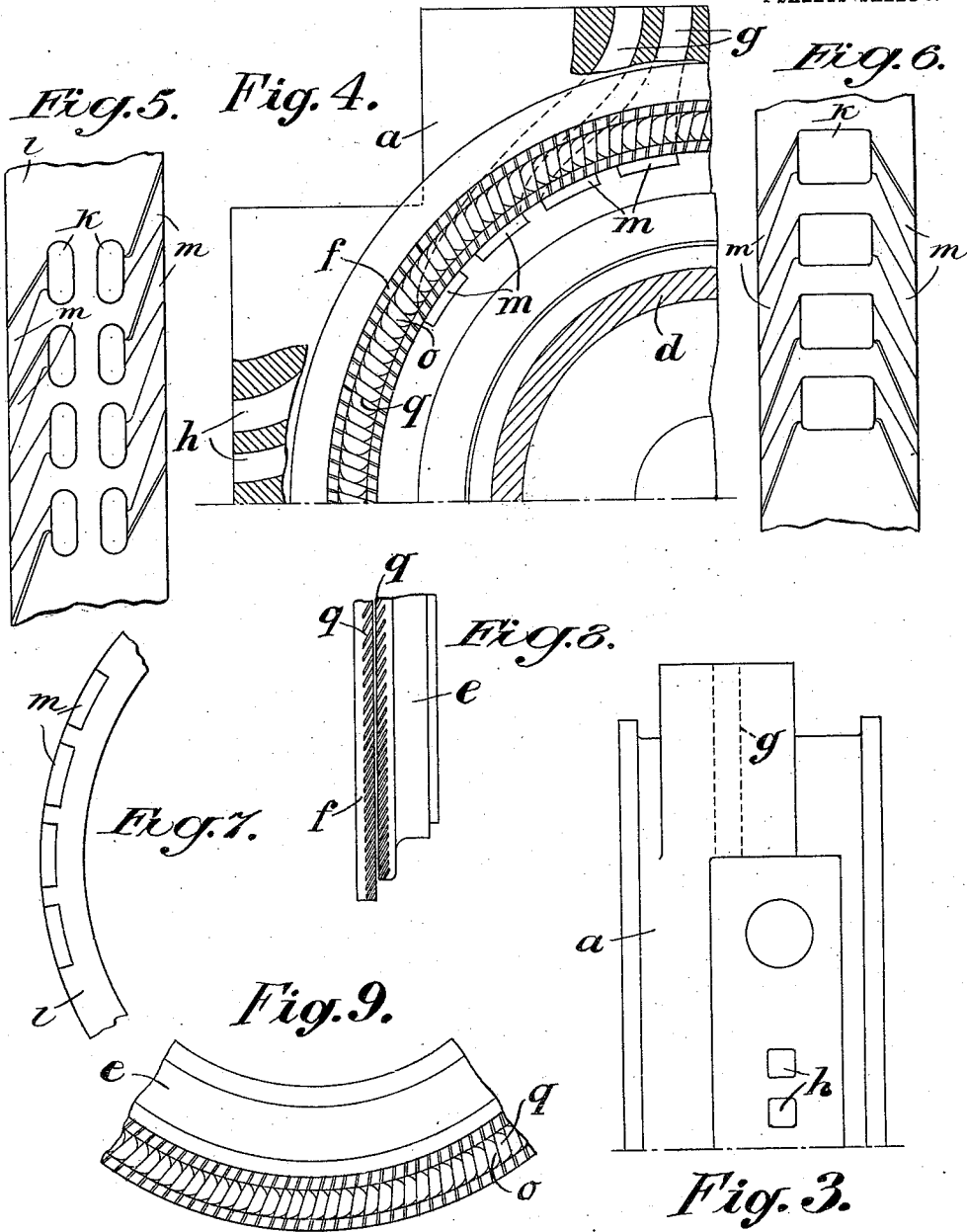
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Witnesses
Grace P. Breerton
Mary H. Farr.

Inventor
Allen Gosling
By Stewart Mason
Attorneys

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4 SHEETS—SHEET 4.

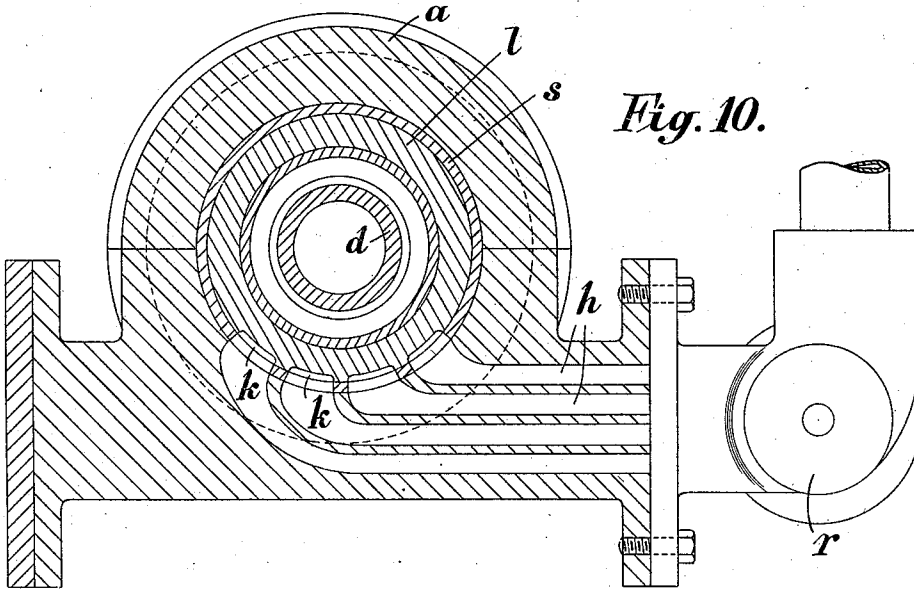


Fig. 10.

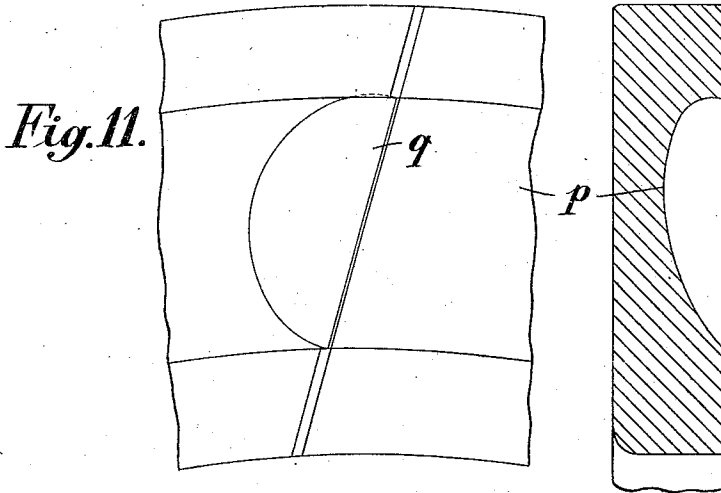


Fig. 11.

Fig. 12.

Witnesses
Grace P. Brexton
Mary H. Farr.

Inventor
Allen Gosling
By Shutevant Mason
Attorneys

UNITED STATES PATENT OFFICE.

ALLEN GOSLING, OF HAZEL GROVE, NEAR STOCKPORT, ENGLAND, ASSIGNOR OF ONE-HALF TO GEORGE BRELSFORD, OF BLACKPOOL, ENGLAND.

TURBINE.

1,066,106.

Specification of Letters Patent.

Patented July 1, 1913.

Application filed January 17, 1912. Serial No. 671,647.

To all whom it may concern:

Be it known that I, ALLEN GOSLING, subject of the King of Great Britain, residing at Hazel Grove, near Stockport, in the county of Chester, in the Kingdom of England, have invented certain new and useful Improvements in and Relating to High-Velocity-Fluid Turbines, of which the following is a specification.

This invention relates to impulse turbines, *i. e.* those working with fluids which are caused to pass through the turbine body at high velocity.

According to this invention the fluid, which may be steam under pressure, is led into the turbine and is passed through expansion nozzles and from thence through pockets or recesses in a number of alternately arranged rotating and stationary members, by which the kinetic energy of the steam is utilized to drive the turbine shaft on the impulse principle. The fluid passes over the back of each rotating member and inside the next stationary member to the next rotating member and so forth, so that the flow is longitudinal instead of radial. The pockets or blades are also of a special type according to the present invention, and several improvements in other respects are introduced.

The invention further consists of the particular constructions as hereinafter set forth and claimed.

The invention is illustrated in the accompanying drawings, in which:—

Figure 1 shows a partial longitudinal section of a turbine constructed in accordance with this invention and adapted for use in conjunction with a condenser for the exhaust. Fig. 2 shows a turbine partly in section and partly in elevation adapted for instance as a non-condensing steam turbine. Fig. 3 is a side view showing the upper half of the central or fluid admission member of the turbine illustrated in Fig. 1. Fig. 4 shows a partial elevation of the member shown in Fig. 3 partly broken away. Fig. 5 shows in plan a portion of a nozzle ring for admitting steam to the two ends of a reversing turbine. Fig. 6 shows a portion of a nozzle ring for a double turbine, the two parts of which rotate in the same direction. Fig. 7 shows a side elevation of the ring shown in either Fig. 5 or Fig. 6. Fig.

8 is an edge view showing a portion of one of the rotating and one of the stationary members of the turbine. Fig. 9 is a face view showing a portion of one of the rotating members of the turbine. Fig. 10 shows a cross section of the central portion of the turbine, taken on the line A—B, Fig. 2. Fig. 11 is a detail view showing a portion of one of the turbine rings, with one of the vanes therein forming the face of a pocket, as seen from the front of the ring. Fig. 12 is a radial section through the turbine member or ring showing the shape of the slot in which the pockets are formed.

Referring first to Fig. 1 and to the detail views thereof, *a* is a central or admission member of the turbine casing, and *b* is the casing of the laterally extending portion of the turbine. *c* is the casing of the outlet or exhaust. *d* is the rotating drum or shaft carrying the rotating turbine elements *e* suitably affixed to the said drum *d*. *f* are the stationary turbine elements suitably mounted and fixed in the casing *b* or in the central member *a*. The steam or other working fluid is admitted through apertures *g* in the member *a* to the lefthand end of the turbine shown in Fig. 1, and through apertures *h*, Figs. 3 and 4, to the righthand side of the turbine which is broken away in Fig. 1. The passages *g* extend through the turbine body *a* as indicated for instance in dotted lines in Fig. 4, and lead into recesses *k*, Figs. 1 and 5, in the nozzle ring *l*. The passages *h* which introduce the fluid to the reverse side of the turbine also lead into the recesses *k* to the right hand side of the center plane of the nozzle ring, Fig. 5, in order to deliver the steam to the right hand end of the turbine. The recesses *k* have expanding nozzles *m* extending from them laterally at a suitable angle to the axis of the turbine, to permit expansion of the working fluid to a low pressure while converting its compression energy largely into kinetic energy. Two or more of the recesses *k* may be interconnected or open to one another if required and the nozzles *m* are shown as being connected to separate recesses *k* only by way of example. From the nozzles *m* the working fluid passes out of the ring *l* into pockets *o* in the first rotating member *e*. After passing through these pockets the working fluid then flows through similar pockets *o* in the

stationary ring or stator f which faces the first rotor e , and from the pockets in the first stator f the working fluid passes over the back of the first rotor e , underneath the second stator f and into the pockets of the next rotor e . The flow is continued in this way through the respective rotors and stators, and over the backs of the rotors, but always in a direction which is more or less of a spiral around the shaft, the direction of flow being circumferentially the same as the direction of rotation of the rotors. The stators and rotors may both increase in size toward the end as seen in Fig. 1, in order to allow for further expansion or utilization of the velocity of the working fluid; the fluid escapes to the outlet c which is of volute form and leads to a suitable condenser. n are suitable baffling arrangements or labyrinth packings between the ends of the rotating and stationary parts of the turbine to resist or prevent escape of the working fluid at these parts. The clearances between the rotating and stationary faces of the members e and f may be about $1/32$ of an inch, or more for big turbines. The first three members e and f are of exactly the same dimensions in the example shown, but after this both sets of members are increased in size for the reason already stated.

Turning now to Figs. 8, 9, 11 and 12, the construction of the pockets themselves in the members e and f will be seen. Each member is formed with a groove p of a particular shape, and is slotted to receive blades q which are set at an acute angle to the face of the disk and also to the radius, and which form between them the pockets o . The curvature of the grooves p is determined as follows: The exposed edge of each of the blades q inside the groove p is an arc of a circle of from 120 to 180 degrees in length. In the drawings Figs. 11 and 12, it is assumed to be 180 degrees. As the blade q is inclined to the face of the disk at an acute angle, (about 30 degrees in the example shown,) the edge appears of course from the face as a partly flattened semi-circle or half ellipse. Moreover as the edge of the blade q stands at about 15 degrees to a radial line in the example shown, the outer exposed edge of the blade q in the groove curves inward again a little at the front, and hence the section of the groove p is as seen in Fig. 12. The position of the blade q , that is to say its angle to the face and its inclination to the radius, may be varied within limits, the angle to the face being preferably between 25 and 45 degrees, while the angle of the edge of the blade to the radius will usually be about 15 degrees and will not exceed about 25 degrees. If the edge of the blade forms a less arc than 180 degrees the amount of overhanging at the outer edge of the groove p will be less or

may be nothing at all. As all the blades q are similar, and are equally spaced apart in slots around the circumference of the respective disks, the shape of the pockets o between these blades q will now be clearly understood. The shape is of vital importance in the working of the turbine as the fluid is intended to pass with as little resistance as possible through the pockets and from one to another, and the shape above described is designed with this object in view. It will be seen that the working fluid when it enters one of the rotating pockets at the inner edge, will flow through the pocket and out from the outer edge thereof and into the opposed pockets of the stationary member and through this latter also in a smooth curve to the outlet at the top thereof and then around the back of the rotating member to the next revolving ring of pockets and so forth. The flow of the fluid therefore is always in smooth curves and a minimum of the energy is wasted in friction, leaving as much energy as possible to be given out to the rotating members as the velocity of the fluid falls. In the smaller sets of pocketed members the edge of each member covers about the middle third of the pockets in the opposite member. In the larger pocketed members the area of the pockets covered is less. Pockets in the co-acting faces might be formed to the desired shape in other ways than that illustrated. The disk members might be cast with these pockets formed in them, or the pockets might be cut out by suitably shaped tools, preferably by machinery designed for the purpose. It has been found convenient however to make the pockets by cutting grooves such as p in Fig. 12, by forming slots across the grooves at the required angles, and by letting in the blades q as illustrated. These blades q are shown as being thinned at the edges in Fig. 11, this being desirable in order to avoid the formation of any blunt edges against which the working fluid might impinge without doing any useful work. Fig. 8 shows that the pockets are similarly directed in the opposed working faces, as is necessary of course in order that the working fluid may circulate properly from one pocket to another, and may flow in a generally spiral direction as it passes through the turbine. The working fluid is admitted to the turbine through suitable valves, by which the fluid can be admitted to one or more of the passages g or h as required, according to the power to be developed. Each of these passages g communicates in the example shown with two of the recesses k and nozzles m (see dotted lines Fig. 4), and the working fluid after being expanded in the nozzles m flows into adjacent sections in the face of the first rotating member e of the turbine. It

is desirable that the admission should be at one part of the circumference in this way, and that as further passages are opened to the working fluid the admission should spread from this one part laterally around the circumference. Even when working with its full amount of fluid and at full power, the turbine will only have its first rotor and stator partially filled with working fluid and this latter will expand or spread laterally so as to fill perhaps the third or the fourth of the sets of the pocketed members with the fluid. Of course the admission of the fluid might be made to take place around the whole circumference of the first turbine ring if preferred but that is not found to be necessary in practice.

In the example of construction shown in Figs. 1 and 3 to 5 the turbine is supposed to be a reversing turbine and the righthand end, which is a replica of the lefthand end but with the pockets oppositely directed, is only used for reverse running. Of course the turbine might be made as a double turbine both ends of which would serve to drive the shaft in the same direction. In this case the nozzles *m* at the righthand side in Fig. 5 would also be downwardly directed instead of upwardly.

Fig. 6 shows a construction with broad central recesses *k* and with expanding nozzles *m* extending from both sides thereof, this being suitable for a double balanced turbine with a single set of admission passages *g* serving to admit the working fluid to both ends of the turbine. It is possible of course to admit two or more different working fluids simultaneously to the same turbine; for instance one passage *g* might admit steam and the next passage might admit combustion gases emanating from an explosion chamber for combustible gas mixtures.

In the example of construction shown in Fig. 1 the nozzle ring *l* fits directly into the bored inner surface of the member *a*, and the slots *m* are cut in the circumferential face of the nozzle ring. The outer face of each nozzle therefore is formed by the inner circumference of the member *a* and by the inner circumference of the first stationary ring *f*. It may be preferable to avoid this arrangement by inserting an intermediate ring between the nozzle ring *l* and the member *a*, and this is indicated at *s* in connection with Figs. 2 and 10, although the same construction is applicable to any turbine of this type.

In the turbine shown in Figs. 2 and 10 there are four sets of equal pocketed members *e* and *f* and the fluid therefore works practically non-expansively. The central member *a*, the intermediate casings *b*, the volute shaped exhaust casings *c* and many other parts of the device may be substan-

tially the same as in Fig. 1, and will not require a detailed description. In this case however the admission passages are shown as being arranged at opposite sides of the member *a* near to the bottom thereof; the passages *h* lead to the righthand half of the turbine as shown in section, Fig. 10, these passages *h* communicating with a valve *r* which admits the working fluid to one or more of the passages *h* as required. This valve *r* may be of any suitable construction such for instance as that described in English patent specification No. 6782 of 1905, above referred to. The valve at the other side for admitting the working fluid to the passages *g* is similar. From the passages *g* or *h* the working fluid reaches recesses *k* in the member *l*; in this case there is a ring *s* surrounding the member *l* as before mentioned, and formed with holes opposite the recesses *k*, but closing over the outer faces of the nozzles *m*. In Figs. 5 to 7 the nozzles *m* are shown as expanding circumferentially and not radially, but in Fig. 2 it is shown how the nozzles may also expand radially toward and away from the axis of the turbine, if the slots are sloped inwardly and outwardly in the members *l* and *a* respectively. The exhaust from the casings *c* is taken out in the construction of Fig. 2, through the bases *t* at the ends of the turbine casings from which the exhaust gases can be led to any outlet. It will be sufficiently obvious that instead of having the exhaust outlets at the ends of a double turbine the outlets might be at the middle while the admission to the parts of the turbine would be at the ends thereof, two nozzle rings, admission valves, et cetera, being provided, one at each end; this will not require any illustration. Fig. 2 shows a suitable construction of the bearings for the driving end of the turbine shaft, *u* being a well known form of double thrust bearing while *v* is a well known form of ball and socket bearing, one of the socket members being held in place by a spring *w* and gland *x*. The parts of the turbine casing beyond the exhaust casings *c* may be slotted or perforated at *y* as shown to permit of the escape of any steam or condensed moisture which has found its way past the baffle arrangements *n*.

The invention is not limited to the precise details of construction illustrated. Various modifications may be made without departing from the scope of the invention. For instance the passages through which the working fluid flows from one stationary member to the next rotating member may be made in the form of smoother curves if required by suitably shaping the walls at each side thereof. The angles of the blades *q* may be varied in the turbine in the subsequent rings as compared with the first rings

thereof if this is found desirable in order to utilize in a more effective manner the energy of the working fluid. Experimental results however have not shown the necessity of this and good results have been obtained by experiments in cases where the blades g are all set at the same angle in the turbine. The way in which the rotating members may be held on the drum or shaft d may be varied, but in the example shown these members are suitably keyed on the drum d and held in place by rings z at the ends which are screwed in place or fastened by suitable screw studs.

15 Instead of using double turbines as above described single ended turbines might be used, if suitable means were provided for taking up any longitudinal unbalanced thrust. There would probably be little or
20 no such thrust however as the pressures are practically balanced on opposing faces throughout the turbine. In a double turbine the two ends may be worked independently if required, the one being worked up to
25 full load before the other is thrown into action.

I declare that what I claim is:—

1. In an impulse turbine, the combination of a rotating member and a stationary member, coöperating annular projecting portions on both of said members formed with a plurality of pockets in opposing faces thereto and said pockets being of smooth curvature and the annular members so disposed relatively to one another that the working fluid passes first through the sets of oppositely placed pockets and then over the back of the rotating member inside the inner circumference of the next fixed member.
40 ber.

2. In a turbine the combination of a rotating member and a stationary member, a plurality of co-acting projecting portions formed with pockets respectively on the rotating and stationary members, the pairs of pocketed faces being disposed close to one another, while a space is left around the tops and backs of the pocketed projections such that a path is left for the working fluid to
50 flow through the sets of pockets in the opposing faces of each pair of pocketed members, and over the backs of said members in smooth curves, directly to the next set of pockets.

3. In a turbine the combination of a rotating part and a stationary part, sets of pockets in the opposing faces of said parts of a form such that each is separated from the next by a wall whose inner edge forms the arc of a circle, while the faces of the said walls are at an acute angle to the face of the pocketed surface, and the edges of said walls are at an acute angle to the radius of the pocketed surface, said members being formed and co-acting one with another
65

so that a path is left for the working fluid to flow through the sets of pockets in the opposing faces of each pair of pocketed members and over the backs of said members in smooth curves directly to the next set of pockets. 70

4. In a turbine, rotating and stationary members formed with pockets separated from one another by division walls standing at an angle greater than 20 degrees to the face of the pocketed surface, the edges of said division walls standing at an angle greater than 10 degrees to the radius of the pocketed surface, said members being so disposed relatively to one another that the working fluid passes first through the sets of oppositely placed pockets and then in the form of smooth curves over the back of the rotating member inside the inner circumference of the next fixed member. 75 80 85

5. In a turbine the combination of rotating members, stationary members, a turbine casing internally bored cylindrically along a portion of its length, a ring on the turbine shaft having its outer cylindrical surface conforming to the bored surface of the turbine casing, said cylindrical surface being recessed to form rings, pockets in the sides of said rings, rings mounted on the turbine casing, pockets on the sides of said rings co-acting with the pockets of the rotor, projecting ends on said rings formed to co-act with the recesses in the cylindrical surface on the rotating member to act as nozzles. 90 95 100

6. In a turbine the combination of rotating members, stationary members, a turbine casing internally bored cylindrically along a portion of its length, a ring on the turbine shaft having its outer cylindrical surface conforming to the bored surface of the turbine casing, said cylindrical surface being recessed to form rings, pockets in the sides of said rings, rings mounted on the turbine casing, pockets on the sides of said rings co-acting with the pockets of the rotor, projecting ends on said rings formed to co-act with the cylindrical recessed surface of the rotating member to form a nozzle extending at an angle to the axis of the turbine, the walls of the said nozzle being divergent in the direction of flow of the working fluid. 105 110 115

7. In a turbine the combination of rotating members, stationary members, a turbine casing internally bored cylindrically along a portion of its length, rings on the turbine shaft having their outer cylindrical surfaces of less diameter than the diameter of said bored portion of the casing, said cylindrical surfaces being recessed to form rings, pockets in the sides of said rings, rings mounted on the turbine casing, pockets on the sides of said rings co-acting with the pockets of the rotor, projecting ends on said rings
120 125 130

formed to co-act with the recesses in the cylindrical surface on the rotating member to act as nozzles.

8. In a turbine, the combination of a shaft, two sets of rotating members fixed on the said shaft, but axially spaced from each other, a turbine casing, two sets of stationary members on said casing but axially spaced from each other and corresponding to said two sets of rotating members, said casing being internally cylindrically bored intermediate said two sets of stationary members and a ring on said shaft intermediate said two sets of rotating members, the outer surface of said ring conforming with said bored surface and being recessed to form with said bored surface a chamber and nozzle in connection therewith for supplying working fluid to each of said sets of rotating members.

9. In a turbine, the combination of a rotating member and a stationary casing, annular members formed with rings of pockets in the face thereof and attached to the rotating and stationary members in such positions that the rings of pockets cooperate in pairs and a space is left around the tops and backs of the annular members so that the working fluid is caused to flow through the sets of pockets in the opposing faces of each pair of pocketed members and over

the backs of said members in smooth curves, directly to the next set of pockets.

10. In a turbine, the combination of a rotating member and a stationary casing, annular members having sets of pockets in the face thereof, said pockets being of a form such that each is separated from the next by a wall whose inner edge forms the arc of a circle while the faces of the said walls are at an acute angle to the face of the pocketed surface and the edges of said walls are at an acute angle to the radius of the pocketed surface, said annular members being attached to the rotating and stationary members in such positions that the sets of pockets cooperate in pairs, and a space is left around the tops and backs of the annular members so that the working fluid is caused to flow through the sets of pockets in the opposing faces of each pair of pocketed members and over the backs of said members in smooth curves, directly to the next set of pockets.

In witness whereof, I have hereunto signed my name this 6th day of January 1912, in the presence of two subscribing witnesses.

ALLEN GOSLING.

Witnesses:

HUBERT A. GILL,
GEORGE BRELSFORD.