

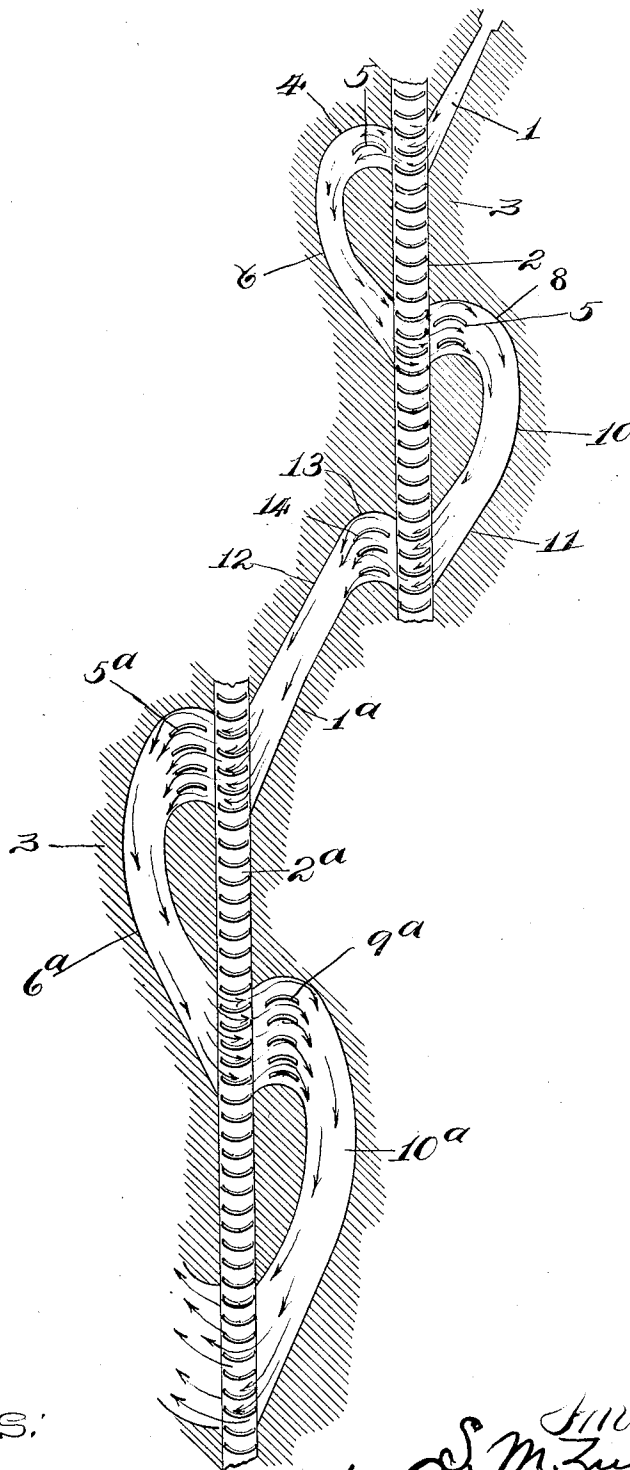
No. 789,197.

PATENTED MAY 9, 1905.

S. M. ZURAWSKI.

TURBINE.

APPLICATION FILED MAR. 21, 1904.



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TURBINE.

SPECIFICATION forming part of Letters Patent No. 789,197, dated May 9, 1905.

Application filed March 21, 1904. Serial No. 199,116.

To all whom it may concern:

Be it known that I, STANISLAUS M. ZURAWSKI, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Turbines, of which the following is a full, clear, and exact specification.

My invention relates to elastic-fluid turbines, such as those employing steam, air, or gas, and more particularly to that type known as "parallel-flow" turbines; and my invention has for its object to provide an improved, simple, and compact form of a compound turbine.

The invention consists in the features of novelty hereinafter more fully described with reference to the accompanying drawing, and particularly pointed out in the claims.

The said drawing is a diagrammatic view of a sectional development of my improvements as applied to a parallel-flow turbine of the compound or two-stage type.

1 is a steam-nozzle or nozzle employed for any other elastic fluid under pressure—such, for example, as air, gas, or the expanding products of combustion resulting from the explosion of gas or other explosive substances. In the diagrammatic illustration only one of these inlet or supply nozzles is shown—that is, only one primary nozzle; but it will nevertheless be understood that in practice any desired number may be employed in the manner well understood in this art.

2 represents the buckets of the turbine, which are of a well-known form and construction employed in parallel-flow turbines and which project from the periphery of the turbine-wheel, as usual, in any suitable housing or casing 3, through which the supply-nozzle 1 on one side of the wheel supplies the steam or other fluid to the buckets at such an angle that after impingement against the buckets the fluid discharges or exhausts at the opposite side. I employ one or more additional guides or passages which lead the exhaust-fluid back again to the same wheel at another point or at a series of additional points, thus making a series of successive ap-

plications of the same fluid to the same wheel at different points. Each of these guides for thus reapplying the fluid-pressure is formed with an inlet end 4, arranged directly opposite the outlet end of the nozzle 1, which outlet end is ordinarily flaring, as shown, and this inlet end is provided with a number of supplemental guides 5, which are curved upwardly or in the opposite direction to the curvature of the buckets 2, so as to conform to the direction of the angle of reflection on one side and gradually curve the exhausting fluid in the opposite direction into the neck 6 of the guide, which gradually leads the fluid in a direction complementary to that of the direction of rotation of the wheel and finally discharges it against the wheel again through a nozzle 7, this nozzle 7, like the nozzle 1, being of a gradually-flaring formation, so as to permit the fluid to expand as it nears the buckets, and thereby accelerate its velocity, thus utilizing its kinetic force against the wheel or turbine after it exhausts or discharges from the first point of application. This method of reapplication of the exhausting fluid may be repeated as often as desired, alternately on opposite sides of the turbine-wheel, by multiplying the number of additional guides or passages. In the accompanying illustration I have shown two of such additional guides, the second one having an inlet end or mouth 8 arranged opposite the discharge end of the nozzle 7 on the opposite side of the turbine and provided with a number of supplemental guides or deflectors 9 like the guides or deflectors 5 curved upwardly or inverted with respect to the buckets 2, so as to conform to the glancing fluid as it discharges from the nozzle 7 and exhausts through the buckets and gradually turn such exhausting fluid into the neck 10 of this second guide-passage, which leads it gradually into the direction of rotation of the turbine and finally permits it to again discharge through a nozzle 11 against the buckets 2 at a third point in the circumference of the wheel, each individual guide-passage having one or more of the supplemental guides arranged at the elbow or turn of the passage coterminous with such elbow, or, in other words, as short as

possible, so as to offer no resistance or friction to the pressure fluid after the latter is once started in the right direction. In order that the fluid entering the second guide-passage, however, may have its velocity accelerated, it is important that this second passage be of larger dimensions than the first passage 4 6 7, which is larger than the dimensions of the nozzle 1. Hence the inlet end 8 of the second passage is as large or slightly larger than the discharge end of the nozzle 7, and it preferably contains more of the supplemental guides 9 than the inlet end 4 of the preceding guide-passage, and of course its neck 10 and nozzle 11 are larger than the corresponding parts of such preceding passage, and the nozzle 11 is larger than both the neck 10 and the inlet end 8 of the second passage. In this way I produce a series of successive applications of the same fluid and produce progressive expansion of the fluid not only throughout the series, but in each individual nozzle or passage, and without compression or contraction at any point. After the fluid has been thus expanded and its kinetic force repeatedly utilized a certain number of times it is of course useless to longer retain it; but in some instances, with high pressure and under other conditions, it may be desirable to further retain the fluid after it has been applied and reapplied as many times as practicable to the same wheel and to lead it from such wheel to a second wheel or stage.

In the accompanying drawing I have shown an example of such a modification of the invention, 1^a being the supply-nozzle or guide of the second stage, and 2^a the second wheel or turbine. In the diagrammatic development shown in the drawing the second wheel or turbine 2^a appears as though on an axis parallel with that of the wheel 2; but it is of course understood that the two wheels in practice are concentric and that the nozzle 1^a is connected by a passage or neck 12 with the exhaust outlet or passage 13 of the first stage or turbine, this exhaust-passage 13 being substantially the same in construction and formation as the inlet ends 4 8 of the guide-passages before described, only one is of a size proportionate to the outlet-nozzle 11 so that as the steam or fluid discharges from the latter it will have an opportunity to expand in the passage 12 13, the inlet end of which latter is provided with a number of the supplemental curved guides 14 like guides 5 9, before described; but their number is preferably greater than the number of guides 9 in the mouth 8 of the preceding guide-passage. The fluid discharging through the passage 12 expands in the flaring nozzle 1^a against the buckets 2^a of the second stage, as before described with reference to the first stage, and it may be caught as it discharges from the buckets 2^a and repeatedly applied to the second wheel

alternately on opposite sides by suitable guides 6^a 10^a, containing the supplemental guides 5^a 9^a, and gradually increasing in size, like the guide-passages described with reference to the first stage, for producing successive expansion of the fluid throughout the series of applications.

Having thus demonstrated how the turbines may be compounded, it is apparent that the stages may thus be multiplied *ad libitum*.

In describing the invention I have referred to the passages for again directing steam or fluid against the same wheel as being located alternately on opposite sides of the wheel and to the points of application as being situated alternately on opposite sides, as this is probably the most direct and simplest form of construction and more desirable than one in which the passages take the exhaust fluid from one side and lead it around the periphery of the wheel back again to the same side, and it possesses the material advantage in function that it equalizes or substantially equalizes the pressure on opposite sides of the wheel and in a measure balances it and avoids end thrust.

It is also obvious that while I have described a construction in which the steam is partially expanded in the primary or inlet nozzle and is progressively expanded in the succeeding series of passages and nozzles it might, nevertheless, be admitted to the buckets of the turbine-wheel without any previous expansion in the primary nozzle. On the other hand, the steam might be given its entire expansion before it is admitted through the primary nozzle, and the area or cross-section of the succeeding guides or passages might be kept constant or of a uniform size throughout the entire range.

In a compound turbine or multiple-stage turbine thus constructed it will be seen that I am enabled to reduce the number of turbine-wheels or the number of stages for a given ratio of expansion and to keep the peripheral speed of the various wheels substantially constant.

Having thus described my invention, what I claim as new therein, and desire to secure by Letters Patent, is—

1. In a parallel-flow turbine, the combination of a working member having buckets, means for directing a fluid against said buckets at one point in the circumference of said working member, a passage leading from the point of exhaust of said first point of application to a second point of application on the same working member, a second working member and a direct guide-passage connecting the exhaust from said first working member directly with the first point of application on said second working member and in a direction lengthwise of the axis of the turbine.

2. In a turbine the combination of a tur-

bine-wheel having buckets, guide-passages
connected across the buckets for directing
the same working fluid against the buckets
of the same wheel at different points in the
circumference thereof, and a second stage or
5 turbine-wheel having its inlet connected with
the exhaust of the last one of the said guide-
passages of the first stage.

3. In a turbine the combination of two
10 turbine-wheels having buckets, guide-pas-
sages connected across the buckets of each
wheel for directing the same working fluid

against the buckets of each wheel at differ-
ent points in the circumference thereof, a
passage connecting the exhaust from one of 15
said wheels to the first or guide passage of
the other of said wheels, the guide-passages
of the latter of said wheels being larger than
those of the former.

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