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J. Y. DAHLSTRAND

STEAM TURBINE

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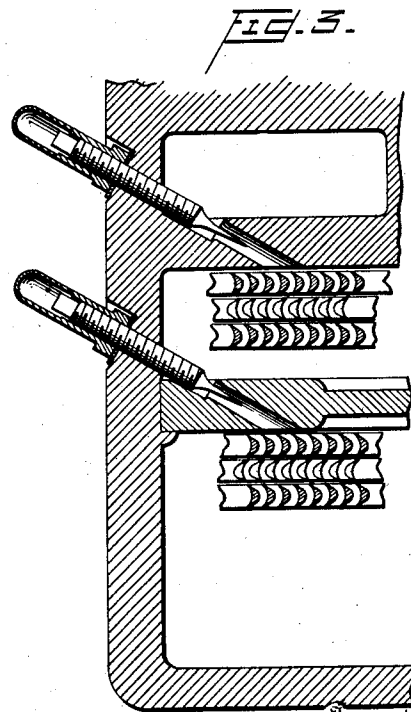
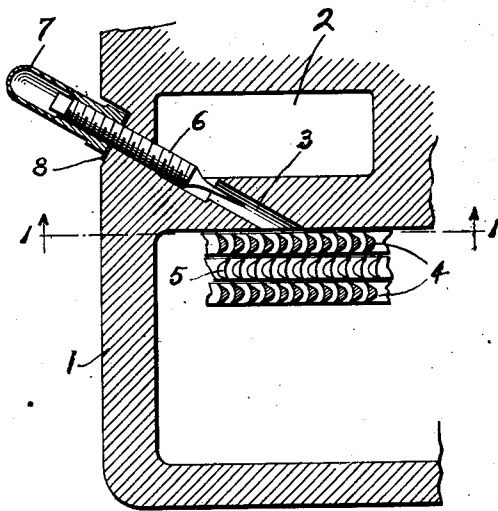
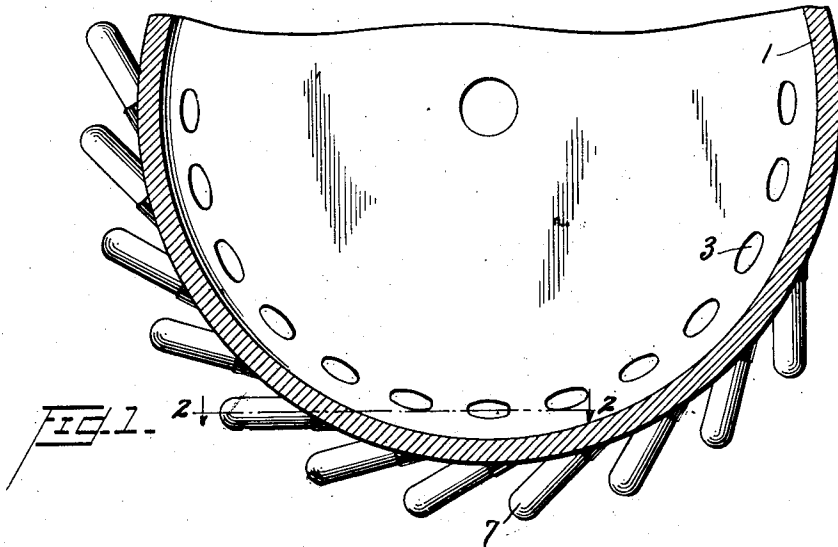


FIG. 2.

FIG. 3.

Inventor

Josef Y. Dahlstrand

By

Edward C. Sacrett

Attorney

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UNITED STATES PATENT OFFICE.

JOSEF YNGVE DAHLSTRAND, OF WELLSVILLE, NEW YORK, ASSIGNOR TO STANDARD
TURBINE CORPORATION, OF WELLSVILLE, NEW YORK, A CORPORATION OF NEW
YORK.

STEAM TURBINE.

Application filed September 11, 1922. Serial No. 587,304.

To all whom it may concern:

Be it known that JOSEF Y. DAHLSTRAND, citizen of the United States, residing at Wellsville, in the county of Allegany and State of New York, has invented certain new and useful Improvements in Steam Turbines, of which the following is a specification, reference being had therein to the accompanying drawing.

The present invention relates to steam turbines of the impulse type, and more particularly to the nozzling of steam turbines.

The object of this invention is to produce a steam turbine having the capability of being adjusted to suit different conditions of steam pressure and back pressure and to satisfy different power requirements.

Turbines of the impulse type utilize the kinetic energy of steam jets impinging on curved blades fixed to a rotor to convert the potential energy of steam under pressure into mechanical work. These jets are produced by expanding the steam in nozzles which extend at an angle to the plane of the rotor and which have restricted throats communicating with the steam under pressure and mouths opening at points closely adjacent the path of the rotor blades.

As is well understood, in order to expand steam in a nozzle below 58% of the initial pressure, the nozzle must be divergent, that is to say, the area of the throat must be smaller than the area of the mouth. The divergence or taper of the nozzle is determined by the ratio of the admission steam pressure to the exhaust or back pressure, and the flow of steam through the nozzle is dependent upon the difference between the admission and back pressures and upon the area of the throat. A turbine operating at a given speed will develop a certain number of horse power depending upon the amount of steam flowing through its nozzles. It follows, therefore, that the nozzling of a turbine is governed by the steam conditions under which the turbine is designed to operate and by the speed and horse power which it is intended that the turbine should develop.

According to the practice heretofore, in designing a turbine to develop a certain horse power at a given speed and under given steam conditions, the throat areas of the nozzles are calculated and then from ve-

locity and specific volumes the areas of the mouths are obtained. Hence practically every turbine has been different from every other one, so far as nozzling is concerned.

According to the present invention, a turbine is built up complete with nozzles reamed straight from end to end, that is, with nozzles of uniform cross sectional area, and each nozzle is provided with means for varying its area to satisfy specific steam conditions and power requirements. The particular form of nozzle contemplated by the present invention is a nozzle of circular cross section, and the particular means for varying the nozzle area is a needle valve projecting into the throat of the nozzle and protruding through the turbine casing so as to be adjustable from the outside. It has been discovered that a turbine equipped with non-expanding nozzles of circular cross section combined with needle valves for varying the expansion ratio can be adjusted in area to satisfy widely different steam conditions and power requirements. The present invention is based on this discovery, and effects the new result that, instead of it being necessary to nozzle each turbine according to the specifications of a particular order, as heretofore, it is possible to build up and keep in stock a number of completely built turbines, one or more of which can be adjusted to satisfy the requirements of an ordinary order. Obviously, this result not only simplifies the manufacturing problem and lowers the cost of production, but also involves the production of a machine of great operating flexibility.

Referring now to the accompanying drawings for a more particular description of the invention:

Figure 1 is a section on line 1—1 of Figure 2.

Figure 2 is a section on line 2—2 of Figure 1 and illustrates the invention applied to a single stage turbine.

Figure 3 is a view similar to Figure 2, showing the application of the invention to a two stage turbine.

The present invention is not concerned with the design of a turbine as a whole, and hence the drawings are more or less fragmentary and diagrammatic. Figure 1 shows a fragment of a simple single stage turbine of the two-row type. The numeral 1 design-

nates the casing in which is formed a space
 or ring 2 for steam under pressure and a
 space for accommodating the rotor. Com-
 municating with 2 are a series of nozzles 3
 through which the steam expands and there-
 by acquires velocity. The steam issuing from
 the mouths of the nozzles impinges on the
 rotor blades 4 and stationary blades 5, and
 then exhausts to the atmosphere or con-
 denser. As indicated, the nozzles are of cir-
 cular cross section and have a uniform cross-
 sectional area, except for the necessary
 rounding of the edges at the bowl. Asso-
 ciated with each nozzle is a needle valve 6
 which has a threaded stem tapped through a
 hole in the casing. A cap 7 is screwed on the
 projecting end of the needle valve stem and
 is adapted to be screwed tight against the
 wall of a suitable recess formed in the cas-
 ing. A copper-packing gasket 8 is inter-
 posed between the end of the cap and the
 wall of the recess to make a steam tight
 joint.

As stated, each nozzle of the turbine has
 associated with it a needle valve. All of
 these valves, or part of them, can be closed
 off entirely or else opened entirely with no
 part of the needle projecting in the throat
 of the nozzle. In the former case no steam
 will flow; in the latter case the maximum
 amount of steam will flow, and since the so-
 called expansion ratio would be 1:1, the noz-
 zles would not be correct except for very low
 steam pressures, in other words, conditions
 where the back pressure exceeds 58% of the
 bowl pressure. Obviously the nozzles can be
 closed off to any desired degree between
 these two extremes. For example, for 80
 lbs. steam pressure and atmospheric exhaust,
 the needle might project into the nozzle $\frac{1}{2}$
 inch; for 150 lbs. pressure the needle might
 project 1 inch, etc. A machine equipped
 with nozzles and valves in accordance with
 this invention could be built up complete and
 put in stock, and it would be possible to care
 for any horse power and speed within the
 range of the maximum nozzling by opening
 a smaller or greater number of nozzles. Fur-
 thermore, any conditions of steam pressure
 and back pressure could be satisfied by the
 extent to which the nozzles are opened.

Figure 3 indicates the application of the
 invention to a multiple stage turbine. As
 shown, the nozzles of each stage have asso-
 ciated therewith needle valves, thus provid-
 ing for adjustment of turbines of this type
 and securing correct energy and velocity
 distribution throughout the turbine.

Now having fully disclosed the present in-
 vention, what is claimed as new and is de-
 sired to secure by Letters Patent is:

1. In a steam turbine, the combination
 of a rotor having buckets thereon, a plu-
 rality of nozzles adjacent thereto, and means
 for varying the flow of steam through, and

for varying the ratio of the throat and tip
 areas of said nozzles, said means includ-
 ing adjustable needles projecting into the
 throats of the nozzles and formed to pro-
 gressively increase the nozzle area from the
 throat to points in the nozzle substantially
 short of the tips thereof, whereby when the
 needles are moved inwardly the throat areas
 are decreased and increased when moved
 outwardly, said needles being fixed in their
 adjusted positions.

2. In a steam turbine, the combination of
 a rotor having buckets thereon, a plurality
 of nozzles of uniform circular cross section,
 means for varying the flow of steam through,
 and for varying the ratio of the throat
 and tip areas of, said nozzles, said means in-
 cluding adjustable needles projecting into
 the throats of the nozzles and formed to pro-
 gressively increase the nozzle area from the
 throat to points in the nozzle substantially
 short of the tips thereof, whereby when the
 needles are moved inwardly the throat areas
 are decreased and increased when moved
 outwardly, said needles being fixed in their
 adjusted positions.

3. In a steam turbine, the combination of
 a rotor having buckets thereon, a plurality
 of nozzles adjacent thereto, separate means
 for controlling the flow of steam to each
 nozzle and for varying the ratio of the
 throat and tip areas thereof, said means in-
 cluding adjustable needles projecting into
 the throats of the nozzles and formed to
 progressively increase the nozzle area from
 the throat to points in the nozzle substan-
 tially short of the tips thereof, whereby
 when the needles are moved inwardly the
 throat areas are decreased and increased
 when moved outwardly, said needles being
 fixed in their adjusted positions.

4. In a steam turbine, the combination of
 a plurality of nozzles, means for controlling
 the flow of steam to some of the nozzles of
 a given stage, and for varying the ratio of
 the throat and tip areas thereof, said means
 including adjustable needles projecting into
 the throats of the nozzles and formed to pro-
 gressively increase the nozzle area from the
 throat to points in the nozzle substantially
 short of the tips thereof, whereby when
 the needles are moved inwardly the throat
 areas are decreased and increased when
 moved outwardly, said needles being fixed
 in their adjusted positions.

5. In a steam turbine, the combination of
 a plurality of nozzles, means for controlling
 the flow of steam to some of the nozzles of a
 given stage and for varying the ratio of the
 throat and tip areas thereof independently
 of each other, said means including adjust-
 able needles projecting into the throats of
 the nozzles and formed to progressively in-
 crease the nozzle area from the throat to
 points in the nozzle substantially short of

the tips thereof, whereby when the needles are moved inwardly the throat areas are decreased and increased when moved outwardly, said needles being fixed in their adjusted positions.

6. In a steam turbine, the combination of a plurality of stages, a plurality of nozzles in one of said stages, means for controlling the flow of steam to some of the nozzles of said stage and for varying the ratio of the throat and tip areas thereof, said means including adjustable needles projecting into the throats of the nozzles and formed to progressively increase the nozzle area from the throat to points in the nozzle substantially short of the tips thereof, whereby when the needles are moved inwardly the throat areas are decreased and increased when moved outwardly, said needles being fixed in their adjusted positions.

7. In a steam turbine, the combination of a plurality of stages, a plurality of nozzles in more than one of said stages, means for controlling the flow of steam to some of the nozzles of each of said stages and for varying the ratio of the throat and tip areas thereof, said means including adjust-

able needles projecting into the throats of the nozzles and formed to progressively increase the nozzle area from the throat to points in the nozzle substantially short of the tips thereof, whereby when the needles are moved inwardly the throat areas are decreased and increased when moved outwardly, said needles being fixed in their adjusted positions.

8. In a steam turbine, a nozzle and an adjustable needle that is circular in cross-section, said needle being located in the nozzle axially thereof and so formed that longitudinal elements of its surface are convex to the axis of the needle.

9. In a steam turbine, a nozzle that is circular in cross-section and of substantially uniform cross-sectional area throughout, and an adjustable needle that is circular in cross-section, said needle being located in the nozzle axially thereof and so formed that longitudinal elements of its surface are convex to the axis of the needle.

In testimony whereof I hereunto affix my signature.

JOSEF YNGVE DAHLSTRAND.