C. W. DAKE.

ELASTIC FLUID TURBINE.

APPLICATION FILED DEC. 16, 1907.

911,577.

Patented Feb. 9, 1909.

3 SHEETS—SHEET 1.

Fig. 1.

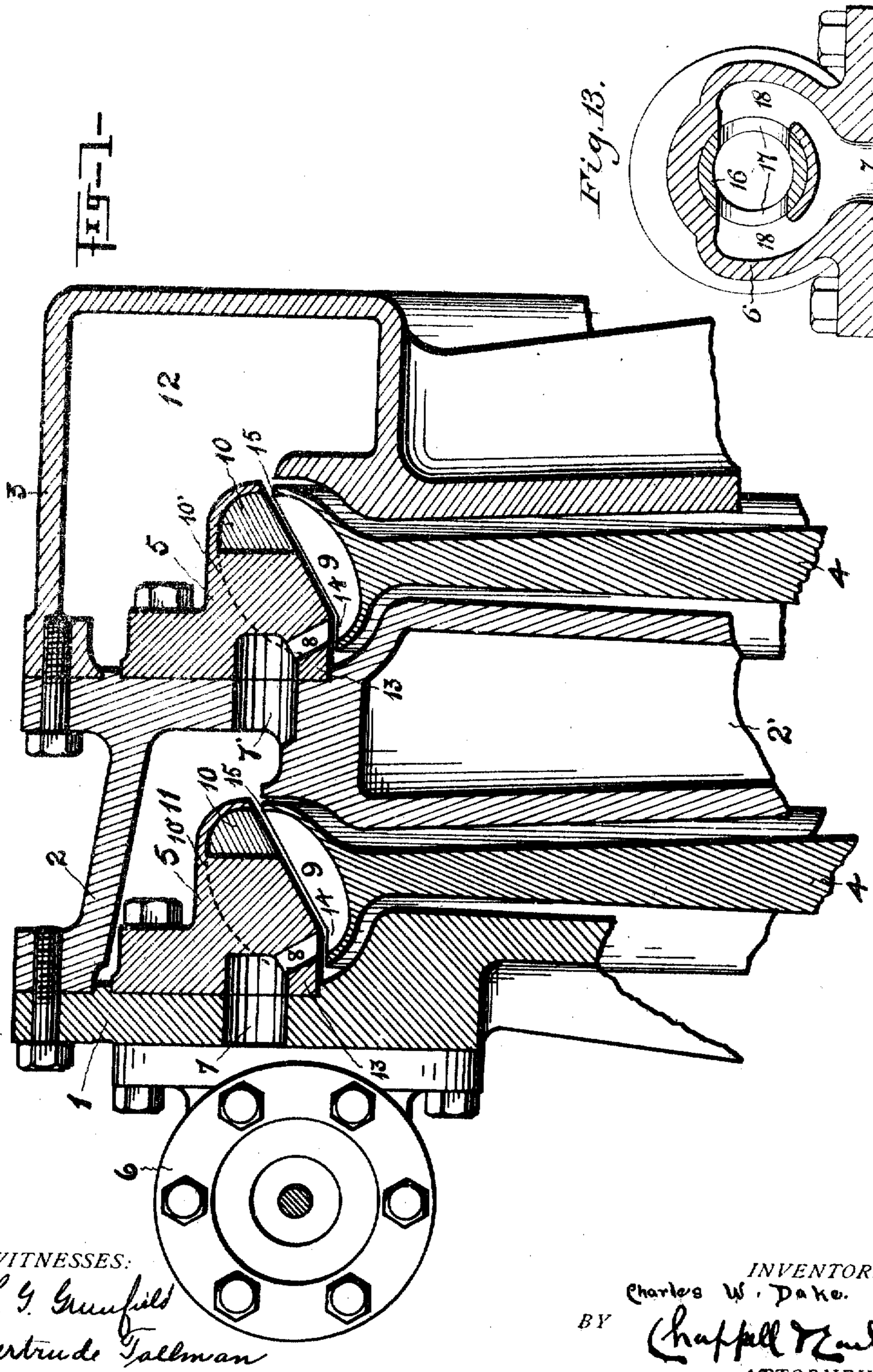

Fig. 13.

WITNESSES:

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3 SHEETS—SHEET 2.

Fig. 2.

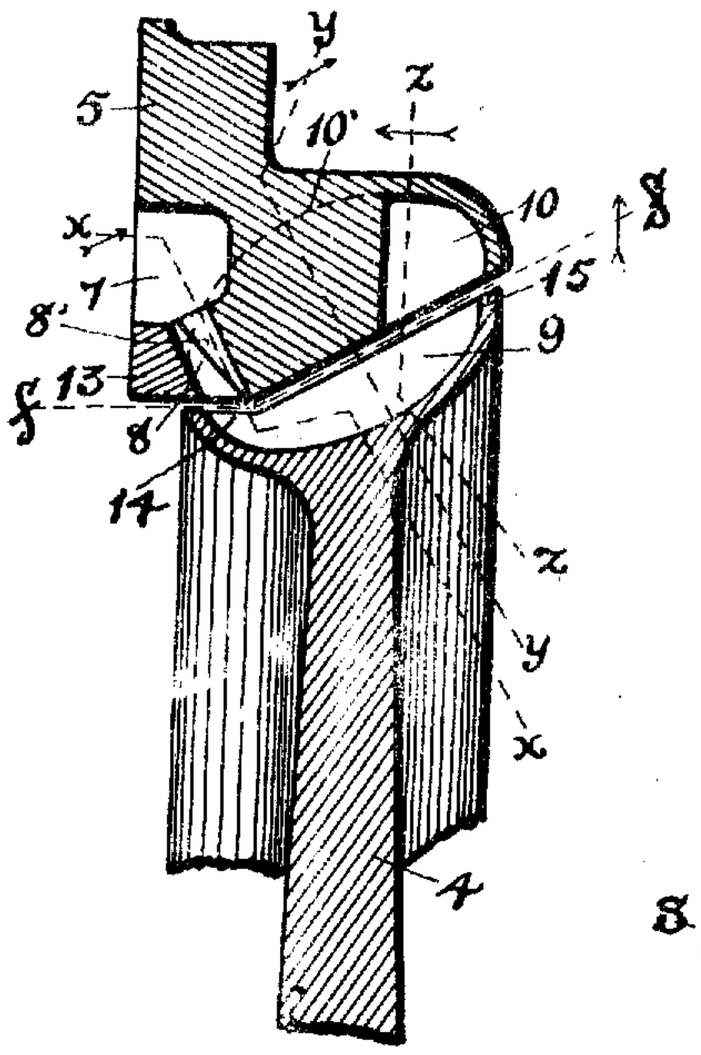


Fig. 3.

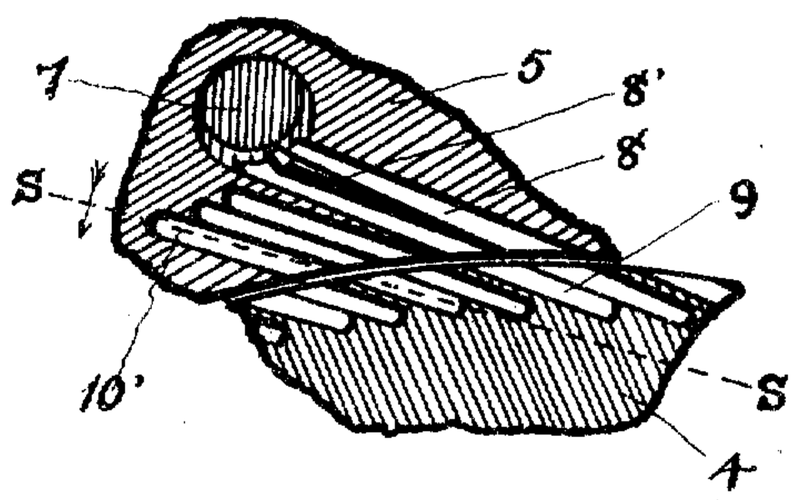


Fig. 4.

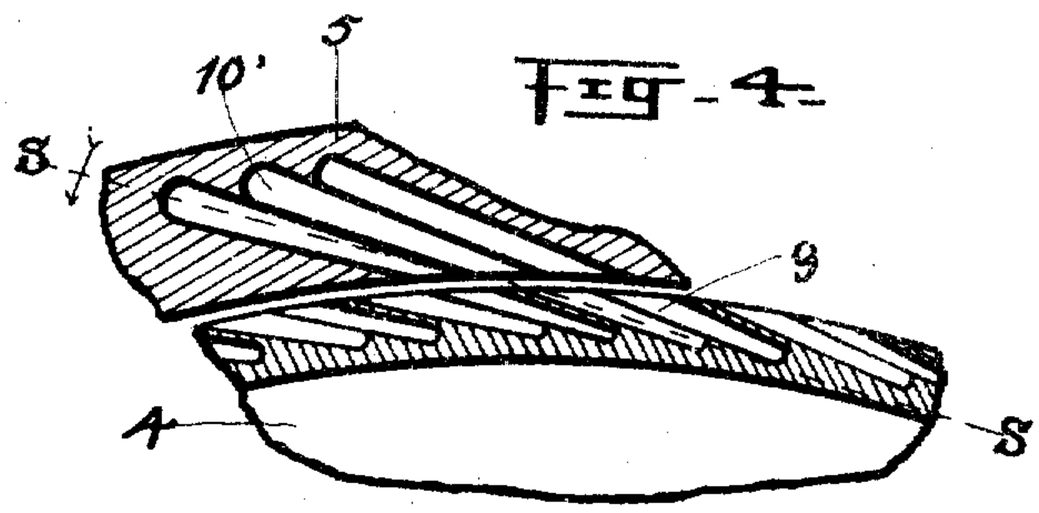


Fig. 5.

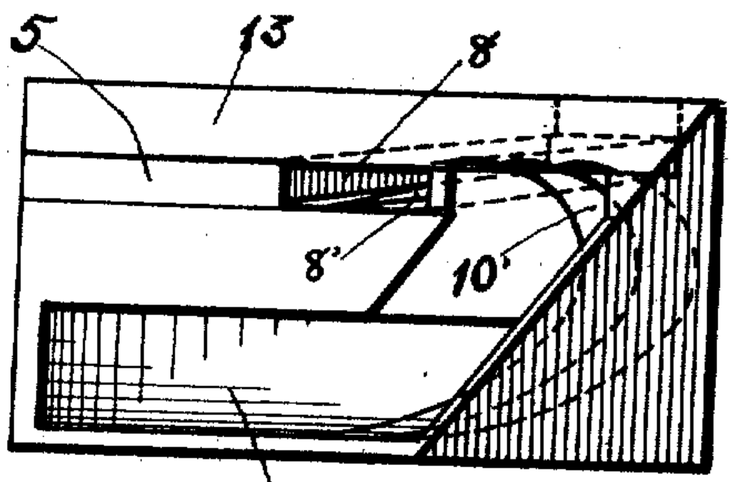
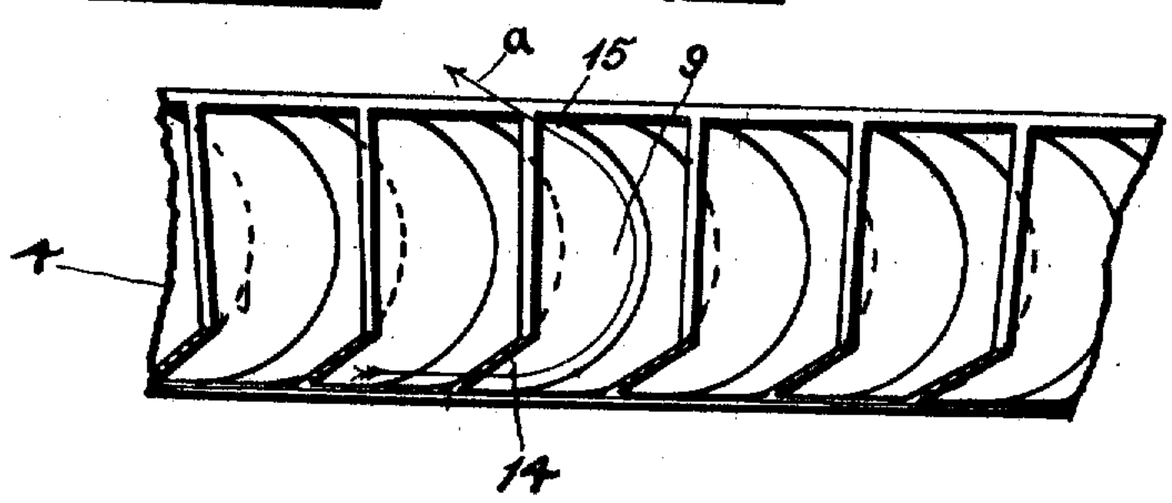


Fig. 6.



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3 SHEETS—SHEET 3.

Fig. 7.

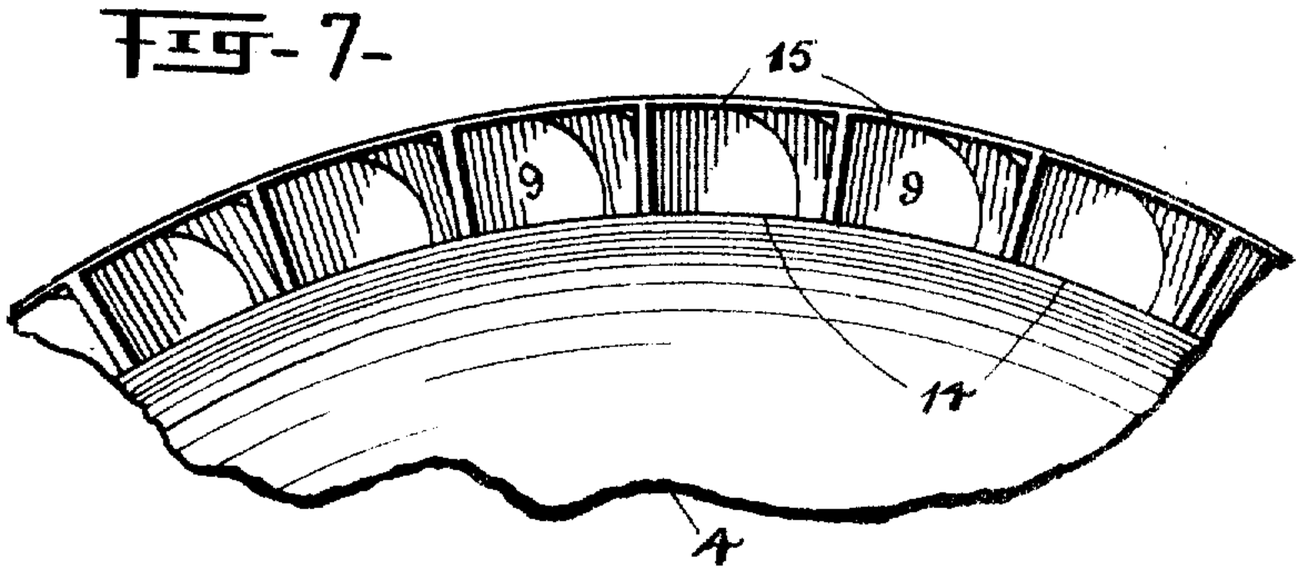


Fig. 8.

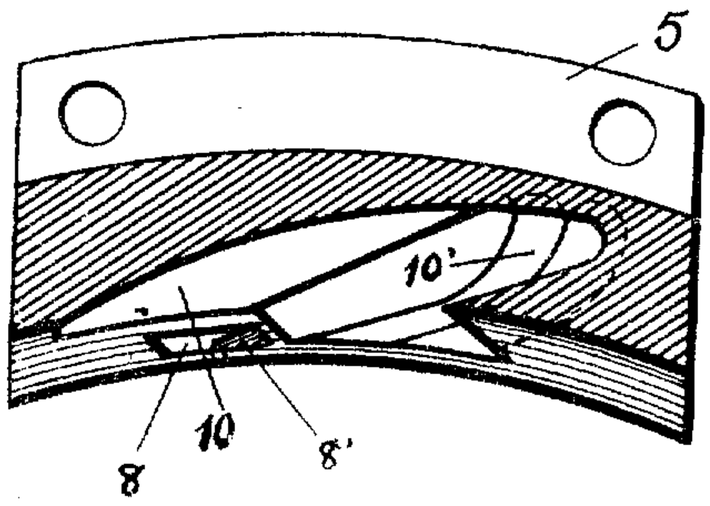


Fig. 9.

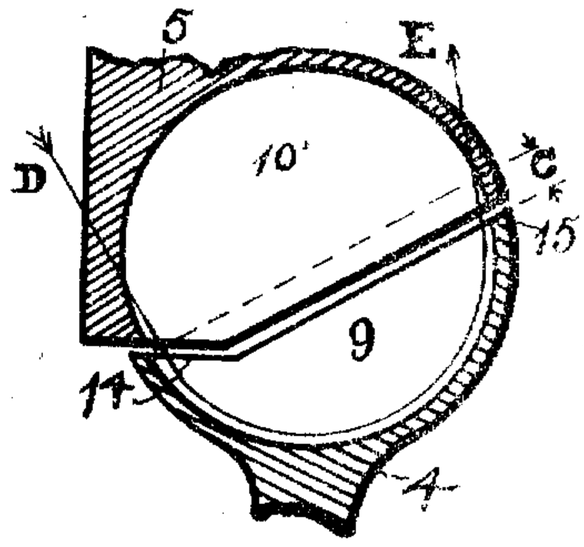


Fig. 10.

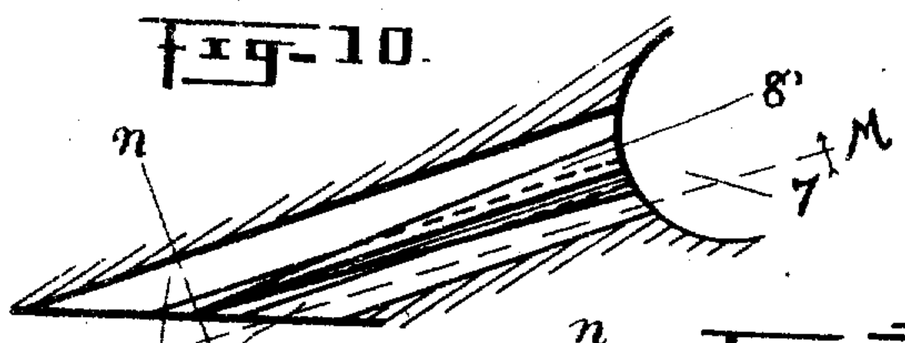


Fig. 12.

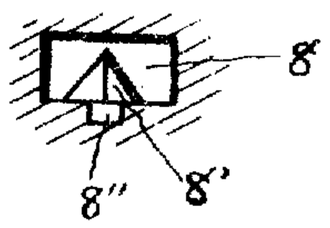
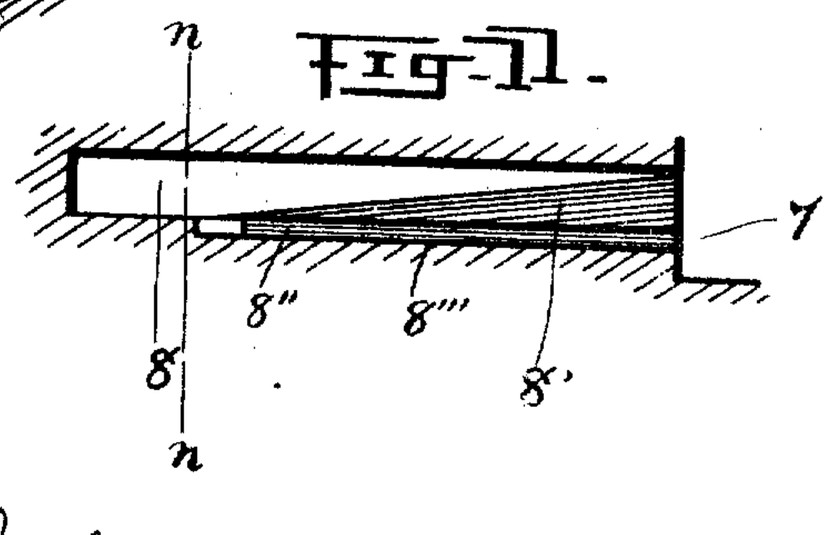


Fig. 11.



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UNITED STATES PATENT OFFICE.

CHARLES W. DAKE, OF GRAND RAPIDS, MICHIGAN, ASSIGNOR TO THE DAKE-AMERICAN STEAM TURBINE COMPANY, OF GRAND RAPIDS, MICHIGAN, A CORPORATION OF MICHIGAN.

ELASTIC-FLUID TURBINE.

No. 911,577. Specification of Letters Patent. Patented Feb. 9, 1909.

Application filed December 16, 1907. Serial No. 406,722.

To all whom it may concern:

Be it known that I, CHARLES W. DAKE, a citizen of the United States, residing at the city of Grand Rapids, county of Kent, State of Michigan, have invented certain new and useful Improvements in Elastic-Fluid Turbines, of which the following is a specification.

This invention relates to improvements in elastic fluid turbines.

The objects of this invention are: first, to simplify the construction of such devices generally, having due regard to their efficiency; second, to provide an improved form of bucket in the turbine wheel; third, to provide an improved form of reversing guide passage and guide passage block; fourth, to provide an improved construction of nozzle; fifth, to provide an improved form of nozzle, permitting proper expansion of steam in a nozzle having parallel sides; sixth, to provide an improved form and construction of bucket and reversing guide passage in which the steam in acting on the bucket is turned less than 180°, and with the friction reduced to a minimum; and seventh, to provide a construction and arrangement of bucket nozzles and reversing guide passages whereby the buckets of the turbine wheel will be substantially filled with steam from the reversing guide passage when it receives the direct impact of the jets from the nozzles, thus economizing the steam at its initial pressure.

Further objects and objects relating to details of construction will definitely appear from the detailed description to follow.

I accomplish the objects of my invention by the devices and means described in the following specification.

The invention is clearly defined and pointed out in the claims.

A structure embodying the features of my invention is clearly illustrated in the accompanying drawing, forming a part of this specification, in which:

Figure 1 is a longitudinal detail sectional view through the buckets and guide passages of a double-phase turbine; Fig. 2 is a detail sectional view through the jacket of the turbine wheel guide passage block and nozzle block, showing further details of construction; Fig. 3 is a detail vertical sectional view through the nozzle guide passage block and turbine wheel, taken on the irregular line X—X of Fig. 3; Fig. 4 is a similar detail sectional view through the reversing guide passages and block and the turbine buckets, taken on the irregular line Y—Y of Fig. 2; Fig. 5 is a detail view taken on the plane of the irregular line F—F of Fig. 2, looking upward, certain details being indicated by dotted lines; Fig. 6 is a similar detail view taken on the plane of the said irregular line F—F of Fig. 2, looking down on the periphery of the turbine wheel, which is shown developed into the flat; Fig. 7 is a detail side elevation view of a portion of the turbine wheel, looking towards the right of Fig. 2, that figure being separated on the line F—F of said Fig. 2; Fig. 8 is a detail sectional elevation through the nozzle and guide passage block, taken on a line corresponding to line Z—Z of Fig. 2; Fig. 9 is a detail sectional view through buckets and guide passages taken on a line corresponding to line S—S of Figs. 3 and 4; Fig. 10 is an enlarged detail sectional view showing details of the nozzle construction, taken on a line corresponding to line X—X of Fig. 2, through one of the nozzles and adjacent parts; Fig. 11 is an enlarged detail longitudinal view taken on a line corresponding to line M—M of Fig. 10; and Fig. 12 is a transverse detail sectional view on the line corresponding to line N—N of Figs. 10 and 11. Fig. 13 is a detail sectional view of the valve 6 appearing in Fig. 1.

In the drawing, the sectional views are taken looking in the direction of the little arrows at the ends of the section lines, and similar numerals of reference refer to similar parts throughout the several views.

Considering the numbered parts of the drawing, the casing of the turbine consists of a front plate 1, an intermediate plate and ring 2, and a back plate and ring 3, all of which are suitably bolted together or held together by suitable screws. The intermediate plate extends down between the turbine wheels at 2′. The back part of the same is made to correspond to the front plate 1 in its provision for seats for the guide passage and nozzle blocks and flanges, which are numbered the same in the primary and secondary part of this double-stage turbine here illustrated. In a single-stage turbine, the intermediate plate and ring 2 would of course be omitted and the front plate 1 and back plate 3 would be brought

together, thus showing that the number of stages in the turbine is simply increased by increasing the number of intermediate plates 2 and adding the necessary turbine wheels.

Portions of the turbine wheels 4 only are shown, it being a matter of common practice the way these turbine wheels are secured to the shaft and the shaft supported within the casing.

Guide blocks 5 containing the reverse guide passages 10 are provided for each section of the wheel and secured to a suitable plate. The valve 6 is provided for controlling the passage of steam to the nozzles, the same being delivered through the passage 7 to the nozzles of the primary turbine wheel, and after having passed from that, is delivered through the secondary passage 7′ to the nozzles of the second turbine wheel. The nozzles 8, one or more, deliver from the passage 7 obliquely and tangentially to the buckets 9 of the turbine wheel. A pyramidal-shaped core 8′ is provided in one side of the nozzle 8, having a suitable rib 8″ on one flat side which fits into a slot 8‴ in the side of the block 5. A ring 13 is clamped between the block 5 or series of blocks 5, where there is a plurality, which forms one side of the nozzle passage 8, thus producing a structure which can be easily manufactured by a milling machine, and one into which the pyramidal core can be readily inserted by forming a suitable key seat 8‴ or slot in the side of the block 5 to receive the same. This block 8′, being pyramidally conical and inserted into the nozzle passage 8, permits the steam to expand in the said nozzle, the sides of which are parallel to each other and this permits the expansion of the steam without flaring the sides of the nozzle, and consequently delivers the same in direct parallel lines to most effectively act upon the buckets of the turbine wheel or rotor.

The buckets 9 of the turbine wheel 4 are oblique and cut on a true circle by a milling machine in the stepped form, heretofore patented to me, and a broad notch 14 is cut in the dividing walls, which separate the buckets from each other, the opposite sides of the buckets projecting outwardly at 15, so that the walls between the buckets are on an oblique line to the periphery of the wheel, as clearly appears in Figs. 1, 2 and 9, and by this means less than half of the circle is embraced in the curvature of the said buckets 9. The remainder of the circle is embraced in the reversing guide passages 10, which are separated from each other and the nozzles 8 by the dividing plate 10′, the form of the buckets clearly appearing in Fig. 9. The course of the steam or elastic fluid through the rotor buckets is indicated by the curved arrow D—E in Fig. 9 and by the arrow A in Fig. 6. The half of the circle is indicated by the dotted line in Fig. 9, and these lines show the extent of shortening of the discharge end of the passage accomplished by the particular form of bucket and guide passage which I have produced.

It will be noted that the diameter of the turbine wheel on the bucket at the discharge side is greater than at the receiving side or ends of the buckets. By thus locating the buckets and manipulating the milling tool by cutting the steps therein, the discharge end of the bucket will be broader than the receiving end, so that the discharge of steam from the buckets after it has done its work, is greatly facilitated and the reaction of the steam or elastic fluid is secured to the fullest extent. The amount of the widening of the buckets is proportioned to give the best results with the least friction of the fluid in the buckets.

The guide passage 10′ formed by the partition 10′ opens back of the nozzle 8, as clearly appears in Figs. 3, 4 and 8, and consequently fills the buckets 9 of the turbine wheel with the expanded steam, and before the bucket passes under the nozzle 8, and consequently the bucket is partially filled with steam and the full effect of the impact of the nozzle is best secured in this way, the second expansion of steam having just passed from the bucket 9 when it is thus passed partially filled to the delivery point of the nozzle 8.

The direction of the steam to the nozzles and the action of the buckets is also indicated by the arrow A in Fig. 6, showing that the angle through which the steam passes in acting upon the buckets of the rotor is much less than 180°.

It will be seen that my improved turbine is very easy to manufacture. The different passages can be readily cut by a milling machine. Making the guide block 5 and the ring 13 of separate parts enables the formation of the nozzle passage very readily by a milling machine, making it possible to readily form the seat for inserting the expanding core 8′ and all of the parts can be quickly and effectively assembled. I desire to remark, however, that the same formation of passages that I have here illustrated may be otherwise produced, and I wish to claim the particular form of buckets and passages, no matter how they may be produced. I wish to claim the formation of the parts broadly, and I also wish to claim the special features of the organization of the structure.

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

1.—In an elastic fluid turbine, the combination of a suitable casing having the front plate suitably flanged; a turbine wheel with buckets 9 at its periphery containing a broad notch 14, and the outwardly-projecting por-

tion 15, the said buckets being of the stepped form; a guide passage block 5 with reversing guide passages 10 therein, separated by a suitable partition 10′ for reversing the steam discharged from the said turbine buckets; a nozzle 8 cut into the side of the said block 5 in advance of the guiding passage 10 therein; a pyramidal core 8′ with a rib at one side seated in a suitable seat at the side of said passage 8, the point of said cone arranged towards the discharge end of said nozzle; a separate ring or segment 13 clamped between the said guide passage block and the said flange; a passage 7 through the flange into the guide block 5; and a suitable valve for controlling the supply of elastic fluid thereto, all co-acting substantially as described and for the purpose specified.

2. In an elastic fluid turbine, the combination of a suitable casing, having the front plate suitably flanged; a turbine wheel with buckets 9 at its periphery containing a broad notch 14, and the outwardly-projecting portion 15, shortened by substantially the depth of the notch; a guide passage block 5 with reversing guide passages 10 therein, separated by a suitable partition 10′ for reversing the steam discharged from the said turbine buckets; a nozzle 8 cut into the side of the said block 5 in advance of the guiding passage 10 therein; a pyramidal core 8′ with a rib at one side seated in a suitable seat at the side of said passage 8, the point of said cone arranged towards the discharge end of said nozzle; a separate ring or segment 13 clamped between the said guide passage block 5 and the said flange; a passage 7 through the flange into the guide block 5; and a suitable valve for controlling the supply of elastic fluid thereto, all co-acting substantially as described and for the purpose specified.

3. In an elastic fluid turbine, the combination of a suitable casing, having the front plate suitably flanged; a turbine wheel with buckets 9 at its periphery containing a broad notch 14, and the outwardly-projecting portion 15, shortened by substantially the depth of the notch, the said buckets being of the stepped form; a guide passage block 5 with reversing guide passages 10 therein, separated by a suitable partition 10′ for reversing the steam discharged from the said turbine buckets; a nozzle 8 cut into the side of the said block 5 in advance of the guiding passage 10 therein; and a pyramidal core 8′ with a rib at one side seated in a suitable seat at the side of said passage 8, the point of the said cone arranged towards the discharge end of said nozzle, all co-acting substantially as described and for the purpose specified.

4. In an elastic fluid turbine, the combination of a suitable casing, having the front plate suitably flanged; a turbine wheel with buckets 9 at its periphery containing a broad notch 14, and the outwardly-projecting portion 15, shortened by substantially the depth of the notch; a guide passage block 5 with reversing guide passages 10 therein, separated by a suitable partition 10′ for reversing the steam discharged from the said turbine buckets; a nozzle 8 cut into the side of the said block 5 in advance of the guiding passage 10 therein; and a pyramidal core 8′ with a rib at one side seated in a suitable seat at the side of said passage 8, the point of the said cone arranged towards the discharge end of said nozzle, all co-acting substantially as described and for the purpose specified.

5. In an elastic fluid turbine, the combination of a suitable casing; a turbine wheel with buckets 9 at its periphery containing a broad notch 14, and the outwardly-projecting portion 15, shortened by substantially the depth of the notch, the said buckets being of the stepped form; and suitable nozzles projecting within the broad notch of the said buckets to deliver elastic fluid thereto, all co-acting substantially as described and for the purpose specified.

6. In an elastic fluid turbine, the combination of a suitable casing; a turbine wheel with buckets 9 at its periphery containing a broad notch 14 and the outwardly-projecting portion 15, shortened by substantially the depth of the notch; and suitable nozzles projecting within the broad notch of the said buckets to deliver elastic fluid thereto, all co-acting substantially as described and for the purpose specified.

7. In an elastic fluid turbine, the combination of a suitable casing; a turbine wheel within the said casing having buckets therein of the recurved type; a guide passage block 5 therein with reversing guide passages 10 therein, separated by a suitable partition 10′ for reversing the steam discharged from the said turbine buckets; a nozzle 8 cut into the side of the said block 5 in advance of the guiding passage 10 therein; a pyramidal core 8′ with a rib at one side seated in a suitable seat at the side of said passage, the point of said cone arranged towards the discharge end of said nozzle, all co-acting substantially as described and for the purpose specified.

8. In an elastic fluid turbine, the combination of a suitable casing; a turbine wheel within the said casing having buckets therein of the recurved type; a guide passage block with reversing guide passages therein; a nozzle 8 cut into the side of the said block 5, in advance of the guiding passage 10 therein; a pyramidal core 8′, with a rib at one side seated in a suitable seat at the side of said passage, the point of said cone arranged towards the discharge end of said

nozzle, all co-acting substantially as described and for the purpose specified.

9. In an elastic fluid turbine, the combination of a suitable casing; a turbine wheel within the said casing having buckets therein of the recurved type; a guide passage block with reversing guide passages therein; a nozzle 8 cut into the side of the said block; a pyramidal core 8′, with a rib at one side seated in a suitable seat at the side of said passage, the point of said cone arranged towards the discharge end of said nozzle, all co-acting substantially as described and for the purpose specified.

10. In a multi-stage turbine, the combination of the front plate, suitably flanged; an intermediate ring or plate 2—2′ conformed at one side to the said flange and formed similar to the flange plate on its opposite side, and a back plate and ring 3, conformed to said plate 2 2′; guide passage blocks arranged on and secured to the respective flanges; and turbine wheels in each of the said compartments arranged to be acted upon by the elastic fluid, as specified.

11. In an elastic fluid turbine, the combination of a suitable casing; a turbine wheel within the casing, one side of the periphery of which is of greater diameter than the other; over-lapping buckets of the recurved type formed in the said periphery, the receiving ends of which are at the lesser diameter, and the discharge ends of which are at the larger diameter, the said discharge ends being correspondingly broader than the receiving ends, a nozzle arranged to deliver to the receiving ends of said buckets, as specified.

12. In an elastic fluid turbine, the combination of a suitable casing; a turbine wheel within the casing, one side of the periphery of which is of greater diameter than the other; buckets of the recurved type formed in the said periphery, the receiving ends of which are at the lesser diameter, and the discharge ends of which are at the larger diameter, the said discharge ends being correspondingly broader than the receiving ends, a nozzle arranged to deliver to the receiving ends of said buckets, as specified.

13. In an elastic fluid turbine, the combination of a suitable casing; a turbine wheel within the casing having buckets; a block secured within the casing having a nozzle to deliver an elastic fluid to the turbine wheel; and stepped guide passages to receive elastic fluid from the said buckets at their discharge end and to deliver said elastic fluid to the wheel buckets back of the said nozzle, all coacting substantially as described and for the purpose specified.

14. In an elastic fluid turbine the combination of a suitable casing; a turbine wheel within the casing having buckets; a nozzle arranged to deliver elastic fluid to the buckets, the said nozzle having a pyramidal core arranged in a slot in the side of the said nozzle, all coacting as described and for the purpose specified.

15. In an elastic fluid turbine the combination of a casing; suitable turbine wheels with buckets therein; a nozzle passage to deliver steam to the said buckets; a pyramidal core with a rib at one side, seated in a suitable seat at the side of the said nozzle passage, the point of said cone arranged toward the discharge end of the nozzle, as specified.

16. In an elastic fluid turbine the combination of a suitable casing; a turbine wheel within the casing having buckets; a nozzle arranged to deliver elastic fluid to the buckets; a tapered core arranged in the side of said nozzle, all coacting as described and for the purpose specified.

17. In an elastic fluid turbine, buckets of the U-shaped, recurved type, formed open at the side at the receiving end, the receiving end of the buckets being longer than the discharge end, the walls between the buckets being of a form to correspond to the shorter discharge end, a nozzle arranged to deliver to the receiving ends of said buckets, as specified.

In witness whereof, I have hereunto set my hand and seal in the presence of two witnesses.

CHARLES W. DAKE. [L.S.]

Witnesses:
LULU GREENFIELD,
GERTRUDE TALLMAN.