No. 890,635. PATENTED JUNE 16, 1908.

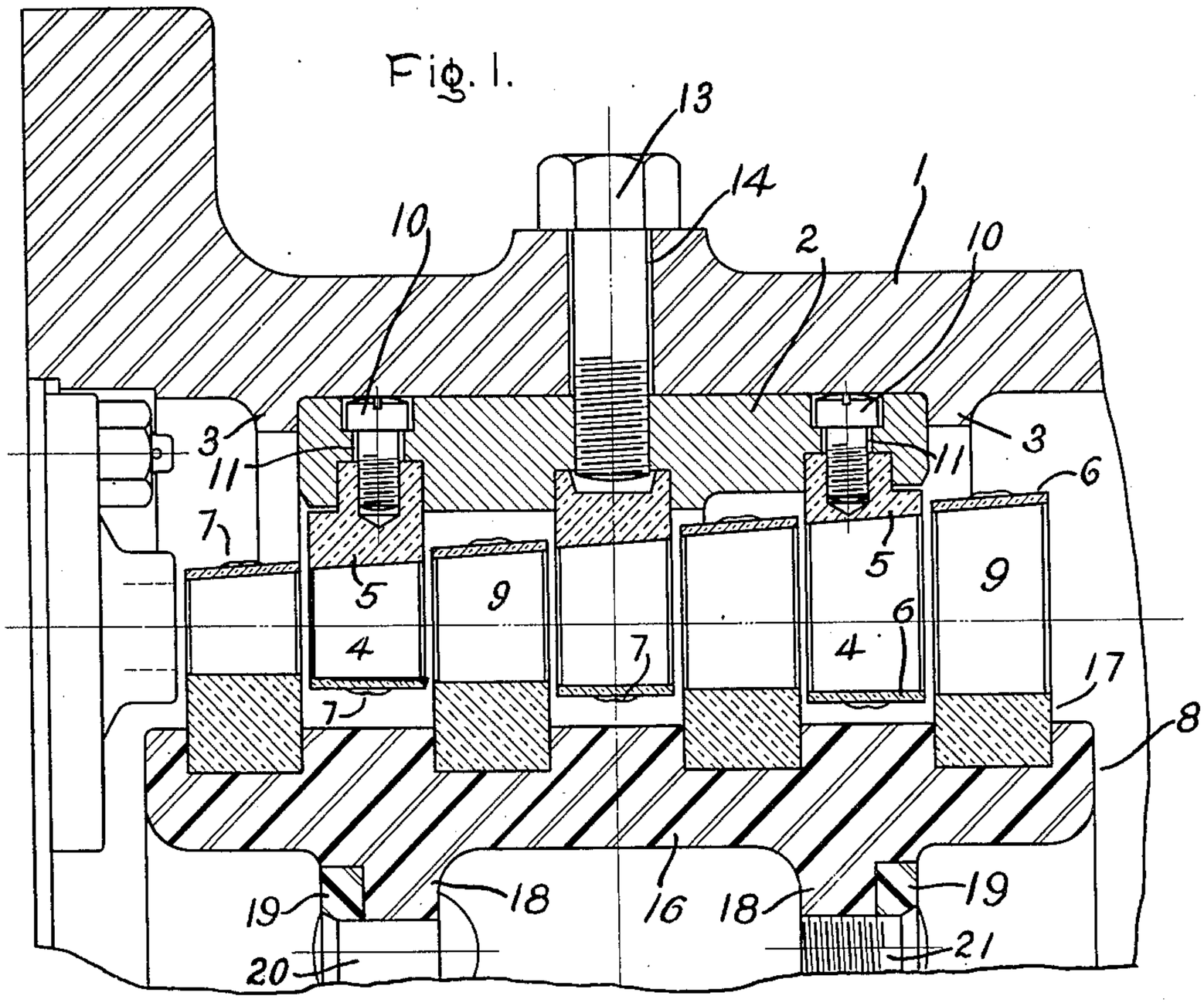
C. FOX.

ELASTIC FLUID TURBINE.

APPLICATION FILED FEB. 14, 1906.

3 SHEETS—SHEET 1.

Fig. 1.



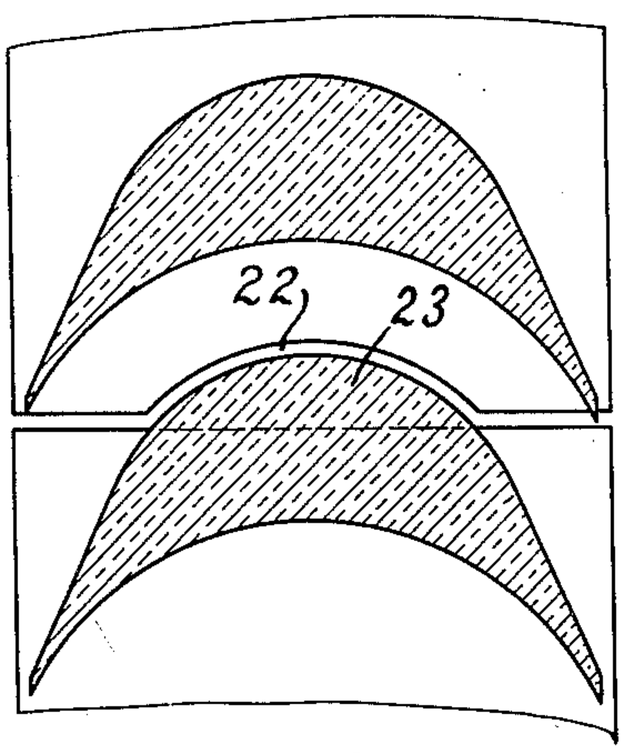


Fig. 2.

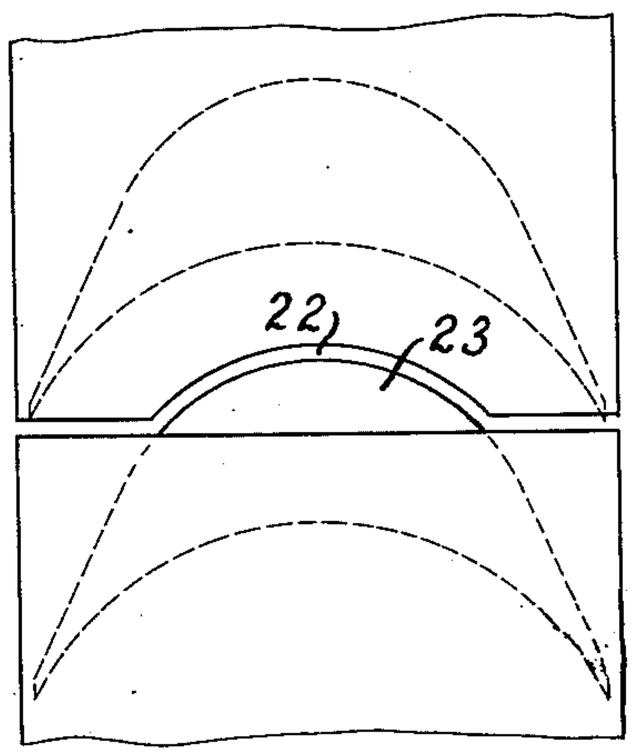


Fig. 3.

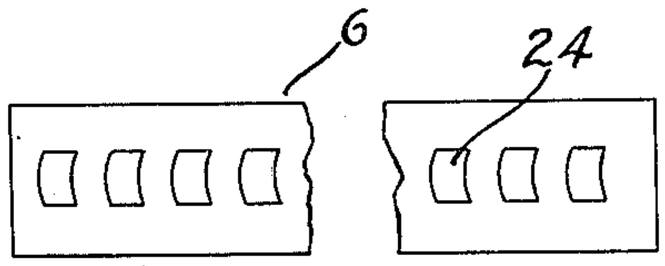


Fig. 5.

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3 SHEETS—SHEET 2.

Fig. 4.

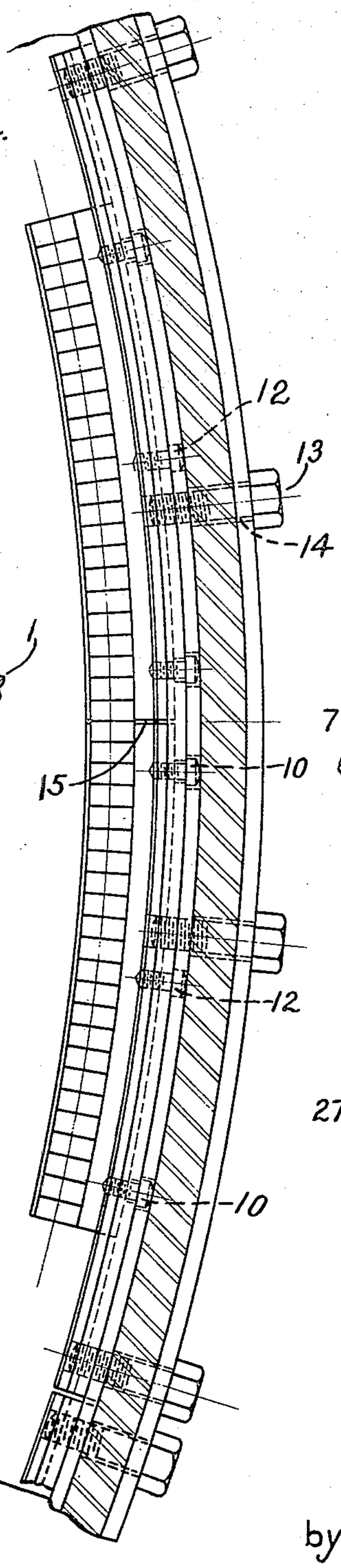


Fig. 8.

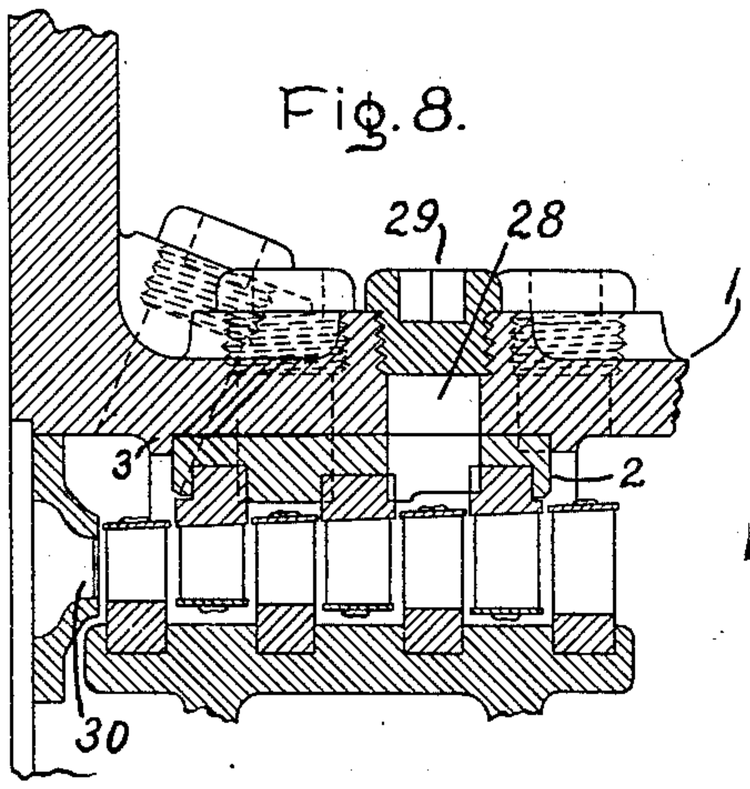


Fig. 6

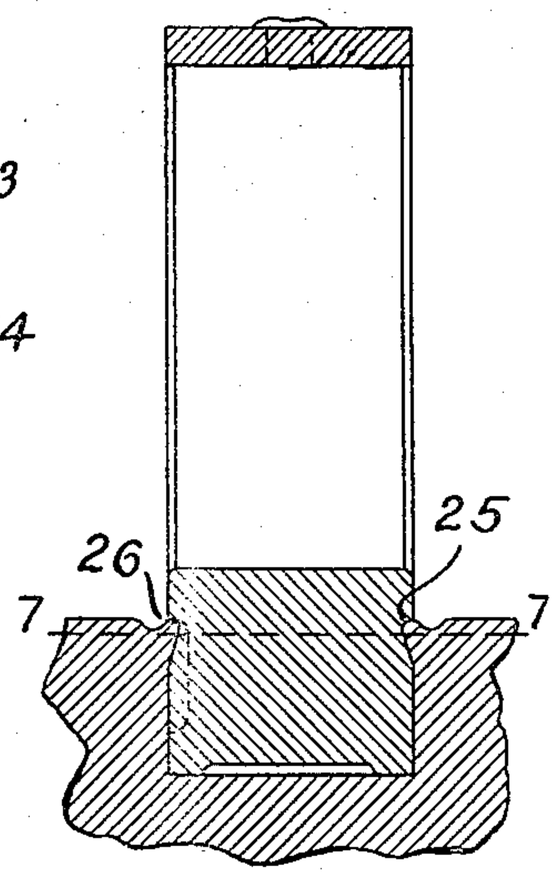
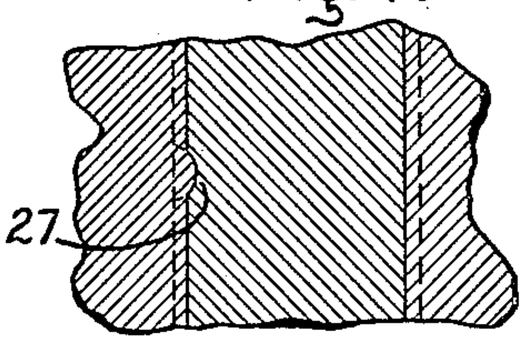


Fig. 7.



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ELASTIC FLUID TURBINE.

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3 SHEETS—SHEET 3.

Fig. 9.

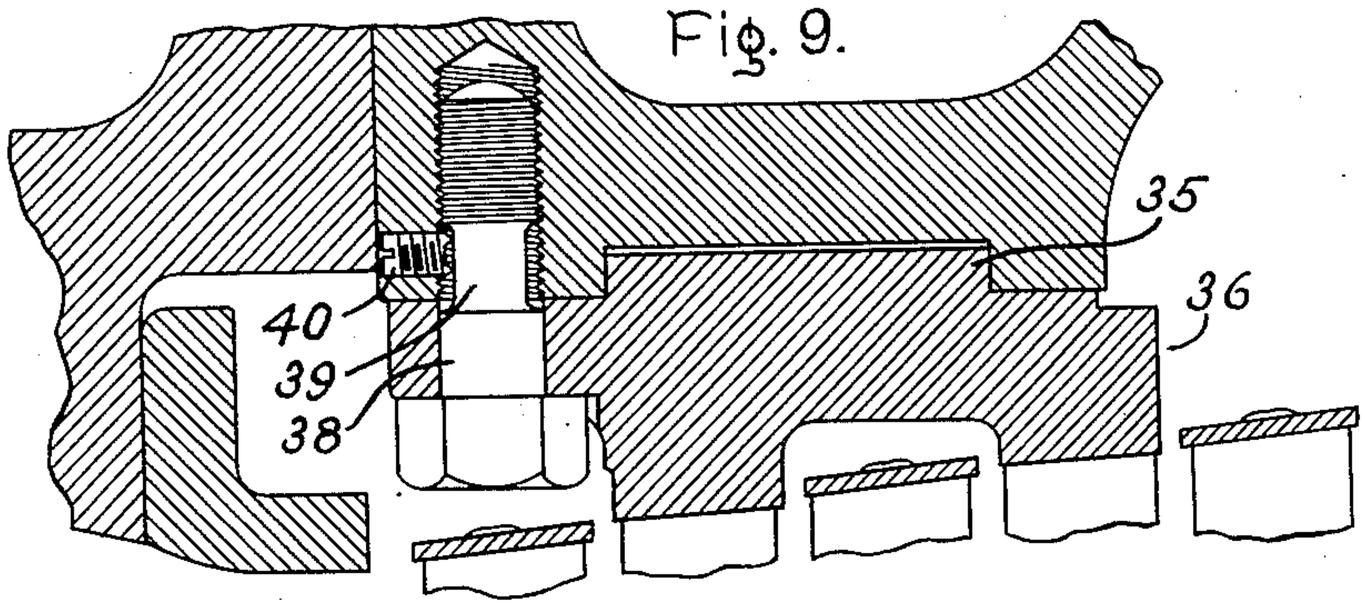
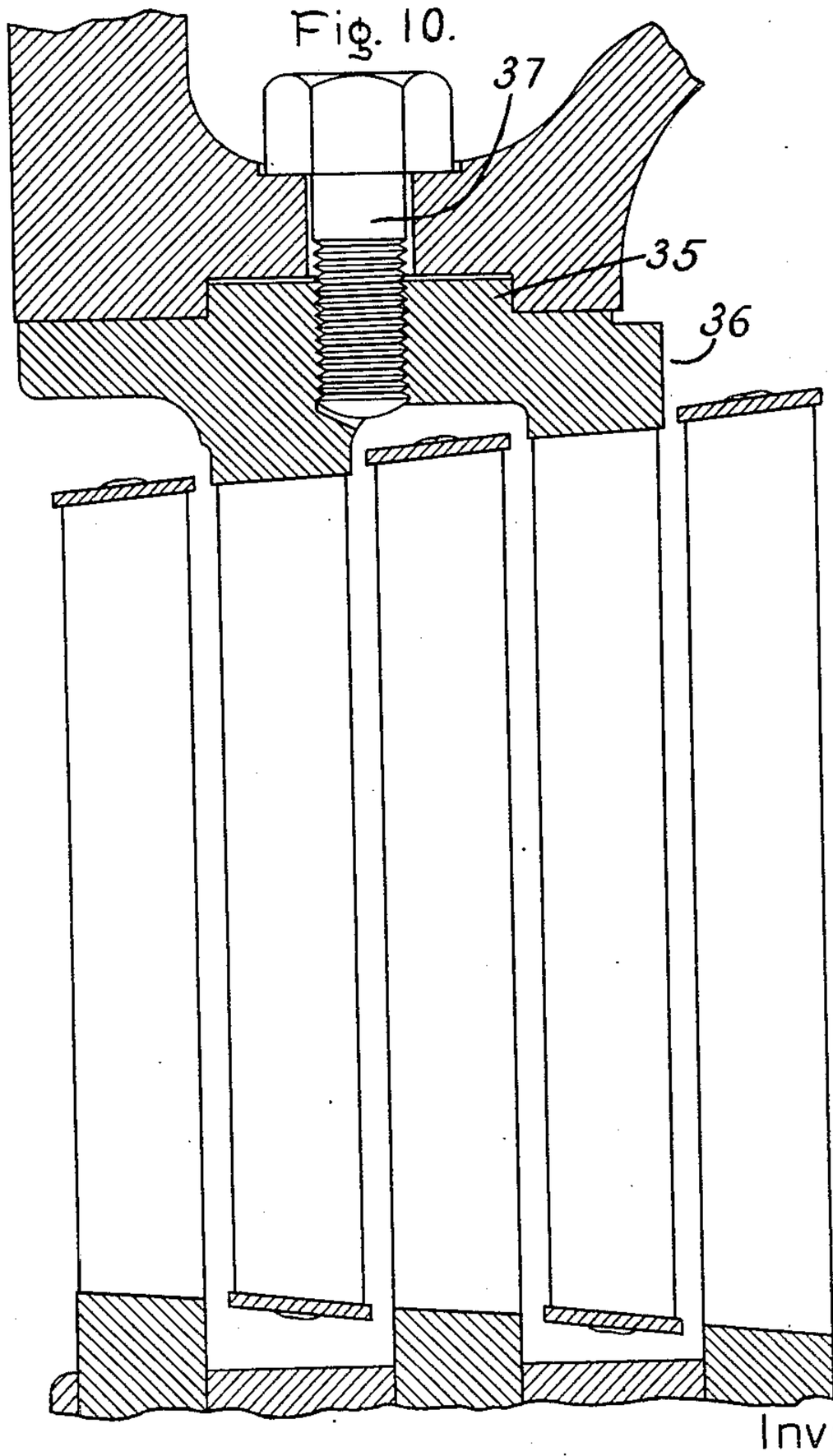


Fig. 10.



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UNITED STATES PATENT OFFICE.

CHARLES FOX, OF QUINCY, MASSACHUSETTS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELASTIC-FLUID TURBINE.

No. 890,635. Specification of Letters Patent. Patented June 16, 1908.

Application filed February 14, 1906. Serial No. 301,036.

To all whom it may concern:

Be it known that I, CHARLES FOX, a citizen of the United States, residing at Quincy, county of Norfolk, State of Massachusetts, have invented certain new and useful Improvements in Elastic-Fluid Turbines, of which the following is a specification.

The present invention has for its object to improve the construction of elastic fluid turbines, the said improvements being directed more especially to turbines intended for marine propulsion, but they are applicable to turbines intended for other purposes.

In the accompanying drawings, which illustrate one of the embodiments of my invention, Figure 1 is a partial longitudinal section of one of the stages of a multi-stage turbine; Fig. 2 is a plan view showing the relation of the ends of the bucket segments, the said buckets being in section; Fig. 3 is an inverted plan of the ends of the bucket segments; Fig. 4 is an enlarged sectional view of the casing, showing a set of intermediates in place; Fig. 5 is a plan view of a bucket cover; Figs. 6 and 7 are detail views of the bucket securing means; Fig. 8 is a partial sectional view of a turbine showing sight openings or peep-holes; and Figs. 9 and 10 show detail sectional views of the intermediate bucket supports for a low pressure stage.

1 represents the sectional casing of the turbine, having a finished inner surface to receive the holder 2 for the intermediate buckets.

It is preferable but not essential to provide internal shoulders 3 to engage the sides of the holder and prevent it from moving endwise. They also reduce the strain on the bolts. The holder is provided with a cylindrical periphery and is adapted to fit the inside of the casing. Its inner surface is provided with as many grooves as there are rows or segmental rows of intermediates for a given stage. The buckets 4 are preferably but not necessarily cast into bases 5 and the latter fit snugly into the grooves in the holder to prevent axial movement. The bucket bases are arranged in segments of suitable length. The inner ends of the buckets are provided with covers 6 which are secured in place by tenons 7 formed integral therewith. In the present case each bucket has a tenon, but a less number can be provided, if desired. Each of the segmental bucket bases is removably secured to the holder. In a structure of this kind, particularly for marine work, it is highly desirable to arrange the retaining bolts in such manner that they can not work loose during service and permit the intermediate buckets to engage the wheel 8 or its buckets 9, also to prevent the bolts from working out and dropping into the casing where they are liable to do great damage. On ship-board the space is of course limited, and anything which tends to insure the parts remaining in their proper position under all conditions is of course advantageous. To carry out this feature of the invention the holders are drilled from the outside to receive the screws or bolts 10, and the parts are so arranged when assembled that the heads of the screws or bolts will engage the inner wall of the casing and thus be prevented from backing out and loosening the buckets. The body portions of certain of the screws passing through the holder into the bases are separated therefrom by a small space 11 so as to permit the bases to freely expand and contract under changes in temperature independently of the holder. In other words, these screws are not body-bound in the holder. Each bucket segment is, however, provided with one body-bound screw or bolt 12, Fig. 4. This bolt serves to center or locate the segment with respect to the holder, and the ends being secured by the screws 10 are free to change in length with changes in temperature. I can substitute a dowel pin for the bolt 12, but it is preferable to use a bolt, since it serves not only as a dowel pin but as a securing device as well.

In order to secure the holders to the casing radially-extending bolts 13 are provided which are screwed into the holder and pass freely through the casing, a space 14 being left around each bolt. To state the matter in other words, the bolts are not body-bound in the casing but are in the holder. This arrangement permits the holder to expand and contract due to temperature changes independently of the bucket segments and the casing. The holders are made in segments, and where two or more segments are provided, as in the low pressure stages, small spaces 15, Fig. 4, are provided between them to prevent the expansion and contraction of one segment from effecting the other or others. The intermediate bucket bases are also similarly separated by small spaces for the same reason.

The wheel comprises a drum 16 having peripheral grooves to receive the bases 17 of the buckets. These buckets are preferably but not necessarily cast into segmental base pieces, and the latter are secured in place by suitable means, as will appear later. The wheel drum is provided with one or more internal shoulders 18. In the present illustration two such shoulders are provided. Bolted, riveted, or otherwise secured to the shoulders are steel disks 19, the latter being attached to a hub or hubs carried by the shaft. One of these disks is shown as united with a shoulder by rivets 20, the other by screws or bolts 21, it being understood that a plurality of such devices are provided and equally spaced.

The bases of the buckets are made in segments and since the convex portion of one bucket projects beyond a plane passing through the edges of the adjacent bucket on the next segment, overlap, in other words, as shown in Figs. 2 and 3, it is necessary, in order to remove one segment without disturbing the other or others, that special provision must be made. This is attained by providing one end of the base of each segment with a recess 22, preferably conforming to the shape of the overhanging bucket on the adjacent segment. The opposite end of each segment is provided with an overhanging bucket 23, as shown in Fig. 2, which registers with the recess but is of somewhat smaller size. By reason of this, one segment can be inserted or lifted bodily from its support without loosening or in any way disturbing the adjacent segment or segments, and the bucket pitch may be as small as desired. The end bucket 23 may overhang the base, or it may extend to the bottom of said base. In the latter case a somewhat better support for the bucket is provided. This means that each bucket segment will have an overhanging bucket at one end and a concave recess on the other. In the case of intermediate buckets where only one segment is provided the ends need not be so provided. When two intermediate bucket segments are employed the adjacent ends may be arranged as described and the opposite ends left plane. However, when these bucket segments are made in large quantities it will be found best to make each segment like every other segment, *i. e.*, with one overhanging bucket and one recess, assuming that only one row of buckets is provided on each base. Where two or more rows are provided, the portion of the base at the ends of each row will be similarly arranged. In those cases where the convex portion of the bucket does not intersect a plane passing through the bucket ends, in other words, overlap, as in the low pressure stages, the ends of the bases may be made plane.

The buckets of the wheel and intermediate segments are provided with covers 6, also made in sections, and provided with opening 24 of the character shown in Fig. 5 to receive the correspondingly shaped tenons on the buckets. The ends of the sections in said low pressure stages are made plane Fig. 5, and when assembled register with the plane of division between segments. The line of division between the sections is located between the end buckets of the adjacent segments. In the other stages the line of division is similarly located and conforms in general outline to the shape of the ends of the segments. From this it follows that in inserting or removing one segment it is unnecessary to disturb the bucket cover of the adjacent segment or segments.

In order to secure the wheel buckets in place the bases are circumferentially grooved on each side as at 25, and the metal of the drum adjacent thereto, as at 26, is forced into them by any suitable means, as shown in Fig 6. To remove the buckets the reverse operation is followed.

In order to prevent the segments from creeping circumferentially, each is provided with one or more radial grooves 27—at right angles to the grooves 26—and at the same time the metal is forced into the circumferential grooves it is forced into the radial grooves. Usually one radial groove will be found to be sufficient for each segment. The side walls of the grooves in the wheel drum may be straight or one of them may overhang slightly, if desired, to give additional security. The metal forced into the radial groove also constitutes a centering or alining device and the bucket bases are free to expand and contract each side thereof, it being understood that small spaces are provided between the adjacent ends.

At times it is highly desirable to look into the casing to ascertain whether or not the clearances are correct, and where the end thrust is heavy at times, as in a marine turbine, it becomes very important. It is undesirable to remove or disturb any of the operating parts of the machine, so I provide one or more sight openings 28, Fig. 8, and normally close the outer end with a screw threaded plug 29. Each sight opening is so directed as to expose to view the end of the nozzle 30 and the adjacent row of wheel buckets or the wheel and intermediate buckets. Where two or more openings are provided for each stage, they are preferably staggered, as shown, so as not to unduly weaken the casing. A bright light may be reflected into the sight opening to illuminate the parts, or it may be large enough to admit a small incandescent or other lamp.

The nozzle 30 may be of the expanding or non-expanding type, as best suits the conditions. It converts more or less of the pressure of the motive fluid, whatever its charac-

ter, into velocity, and the wheel and intermediate buckets coöperate to abstract the velocity by successive operations.

In Figs. 9 and 10 is shown an arrangement particularly suited for the low pressure stages where the intermediate buckets are long. The interior of the casing is grooved to receive the projection 35 formed on the holder 36, the latter being made of cast metal and the buckets fused thereto. The buckets are arranged in rows of which one, two, three or more may be provided to meet the requirements. The buckets are comparatively flat, that is to say, they do not overlap and the bases, therefore, do not require the special arrangement of the ends previously described. The bases are secured to the casing by bolts 37, the latter being body-bound in the base but not in the casing. In addition to this, a centering or locating body-bound bolt 38 is provided for each base which is situated at one side of a plane passing through the bolts 37 and preferably between two of them. In order to prevent this bolt from backing out in service, it is provided with a portion 39 of reduced cross section, and engaging with said portion is a screw 40. The head of the latter engages a wall of the turbine casing,—in this case one of the transverse faces of a section of the casing—and is thus prevented from backing out. Fig. 9 shows clearly that the bolt 38 is body-bound in the casing and also in the holder or base, and Fig. 10 that the bolts 37 are body-bound in the holder or base but not in the casing. This arrangement permits each segmental holder or base to expand and contract independently of the other segment or segments, at the same time preserving its alinement. I may substitute a dowel pin for the bolt 38, but it is preferable to use a bolt, as it also forms a securing device.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In an elastic fluid turbine, the combination of a support, a plurality of buckets, a bucket supporting base, a device for anchoring the base with respect to the support at one point, and one or more other devices for attaching the base to the support which permit it to freely expand and contract.

2. In an elastic fluid turbine, the combination of a support, a bucket supporting base, a device for anchoring the base, and one or more bolts for securing the base to the support which are body-bound in the base and are loose in the support.

3. In an elastic fluid turbine, the combination of a support, a bucket supporting base, a screw-threaded means for securing the base to the support, and a wall for preventing the means from loosening.

4. In an elastic fluid turbine, the combination of a bucket-supporting base, a holder, a means securing the base to the holder and permitting it to expand and contract, a casing, and means securing the holder to the casing which permit the said holder and casing to expand and contract independently of each other.

5. In an elastic fluid turbine, the combination of a bucket-supporting base, a holder, a means for locating the position of the base with respect to the holder, and a means for securing the base and holder which permit the two to expand and contract independently, a support for the holder, and means uniting the holder and support which permit the two to expand and contract independently.

6. In an elastic fluid turbine, the combination of a bucket-supporting base, a holder therefor having a groove to receive the base, a support for the holder, screw-threaded means for attaching the base to the holder which are prevented from backing out by the support, and a means for uniting the holder and support.

7. In an elastic fluid turbine, the combination of a bucket base, a holder therefor, screw-threaded means extending inwardly from the periphery of the holder to secure the base, a casing which supports the holder and also prevents the screw-threaded means from backing out, and means for securing the holder to the casing.

8. In an elastic fluid turbine, the combination of bucket bases situated side by side, a holder having grooves to receive the bases and prevent axial movement, radially-extending screw-threaded means for uniting the base and the holder, and a support for the holder which prevents the screw-threaded means from backing out and at the same time permits the bases and the holder to expand and contract independently thereof.

9. In an elastic fluid turbine, the combination of a bucket base, a holder therefor, a bolt for securing the holder and base which is body-bound in both parts, one or more other bolts for securing the parts which are body-bound in the base only, a support, and bolts for securing the holder and support which are body-bound in the holder only.

10. In an elastic fluid turbine, the combination of relatively movable parts, a casing therefor having a screw threaded opening through which the clearance between the said parts can be observed, and a removable plug for the said opening.

11. In an elastic fluid turbine, the combination of a grooved base having a plurality

of buckets, and a holder therefor, the metal of which is forced into the groove to prevent the base from creeping circumferentially.

12. In an elastic fluid turbine, the combination of a bucket base having circumferential and radial grooves, with a holder therefor, the metal of which is forced into the said grooves to hold the base against radial movement and also to prevent creeping.

13. In an elastic fluid turbine, the combination of a support, a segmental bucket base carrying a plurality of overlapping buckets, a recess in the end of one segment registering with the end bucket of the adjacent segment, so that one segmental base can be removed without disturbing the other, and a means for securing the base to the support.

14. In an elastic fluid turbine, the combination of a support, a segmental bucket base carrying a plurality of overlapping buckets, each base having a recess in one end and an overhanging bucket at the other, the recess and bucket registering when the parts are assembled on the support, and bucket securing means.

15. In an elastic fluid turbine, the combination of segmental bases, each common to a plurality of overlapping buckets and provided with a recess registering with a bucket on the adjacent segment at one end and a projecting bucket on the other, and segmental covers for the buckets, the line of division between cover segments being located between the buckets of adjacent segments.

16. In an elastic fluid turbine, the combination of a support, with segmental bases each carrying a plurality of buckets, an end bucket on one segment overlapping a bucket on an adjacent segment.

17. In an elastic fluid turbine, the combination of a support with segmental bases each carrying a plurality of buckets, an end bucket on one segment overlapping the base and a bucket on an adjacent segment, in the direction of flow of the motive fluid.

18. A rotor for steam turbine, consisting of a rotor disk, and abutting segments secured thereto having buckets formed therein, one end of each segment overlapping the end of the adjacent segment.

In witness whereof, I have hereunto set my hand this 10th day of February, 1906.

CHARLES FOX.

Witnesses:
CHAS. E. HATHAWAY,
JOHN F. HANLY.