No. 780,497. PATENTED JAN. 24, 1905.

H. F. FULLAGAR.

STEAM TURBINE.

APPLICATION FILED JUNE 15, 1904.

3 SHEETS—SHEET 1.

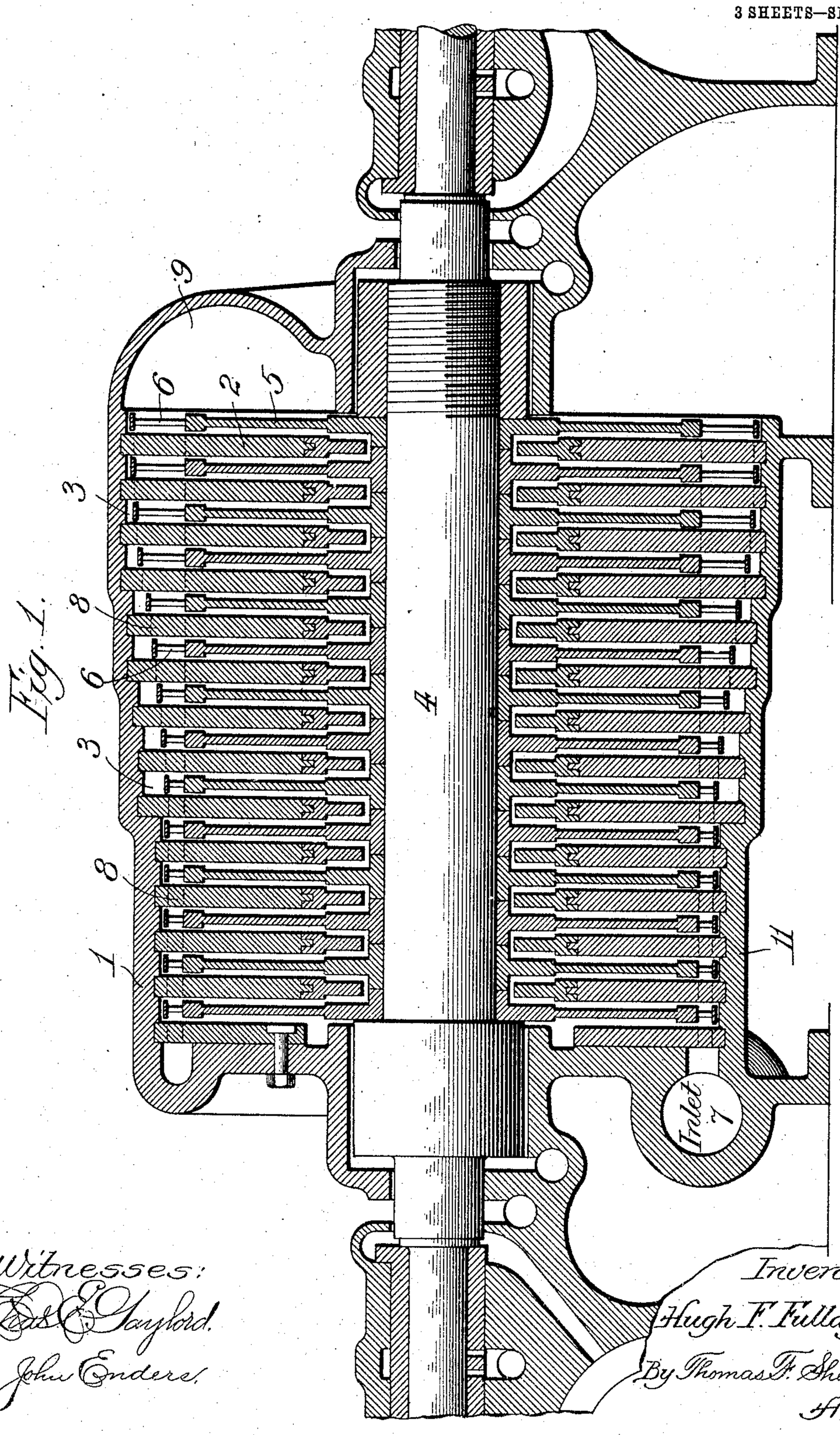


Fig. 1.

Witnesses:
Ed. E. Gaylord.
John Enders.

Inventor:
Hugh F. Fullagar,
By Thomas F. Sheridan,
Att'y.

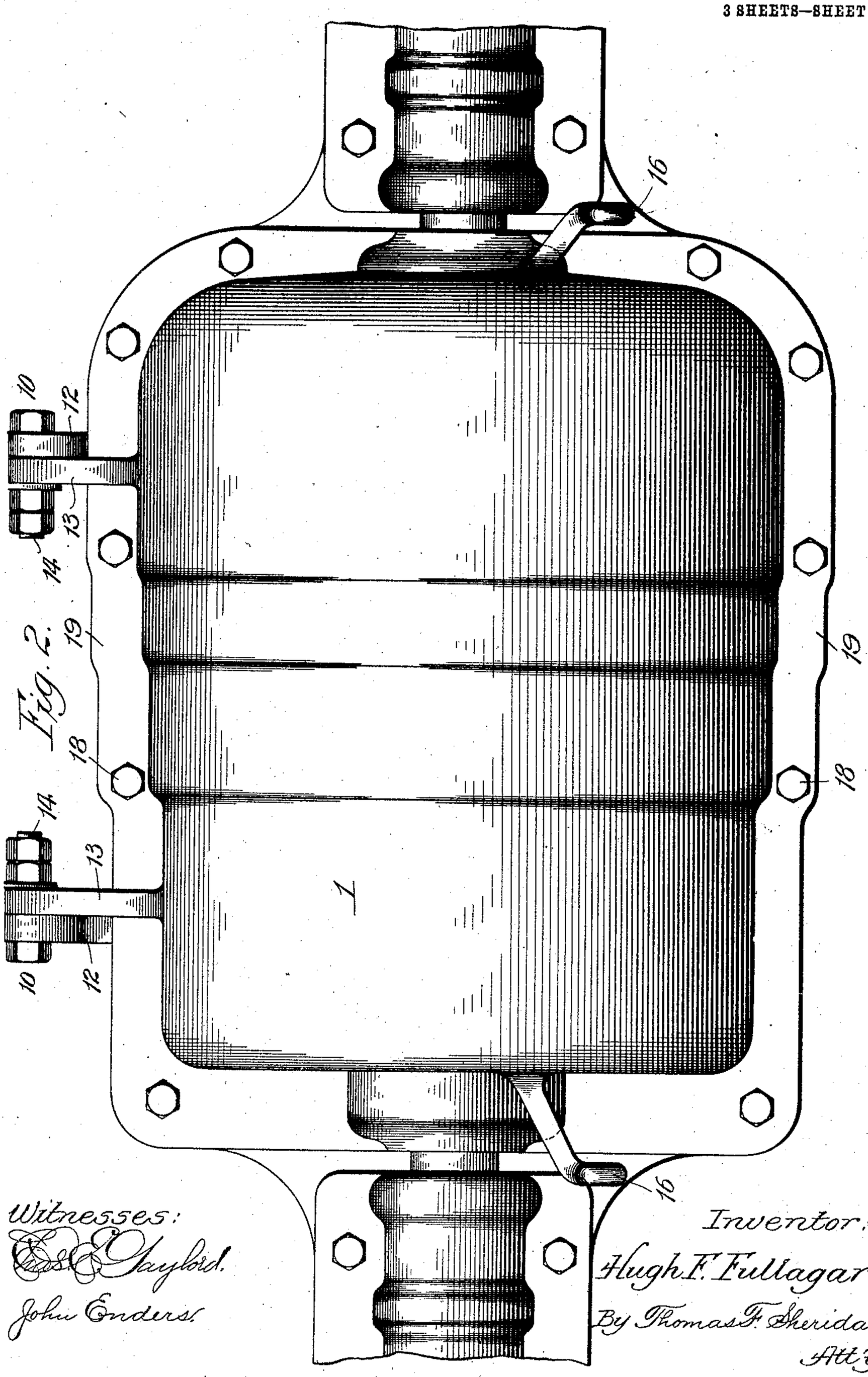
No. 780,497. PATENTED JAN. 24, 1905.

H. F. FULLAGAR.

STEAM TURBINE.

APPLICATION FILED JUNE 15, 1904.

3 SHEETS—SHEET 2.



Witnesses:
Chas. L. Gaylord.
John Enders.

Inventor:
Hugh F. Fullagar
By Thomas F. Sheridan,
Att'y.

No. 780,497. PATENTED JAN. 24, 1905.

H. F. FULLAGAR.

STEAM TURBINE.

APPLICATION FILED JUNE 15, 1904.

3 SHEETS—SHEET 3.

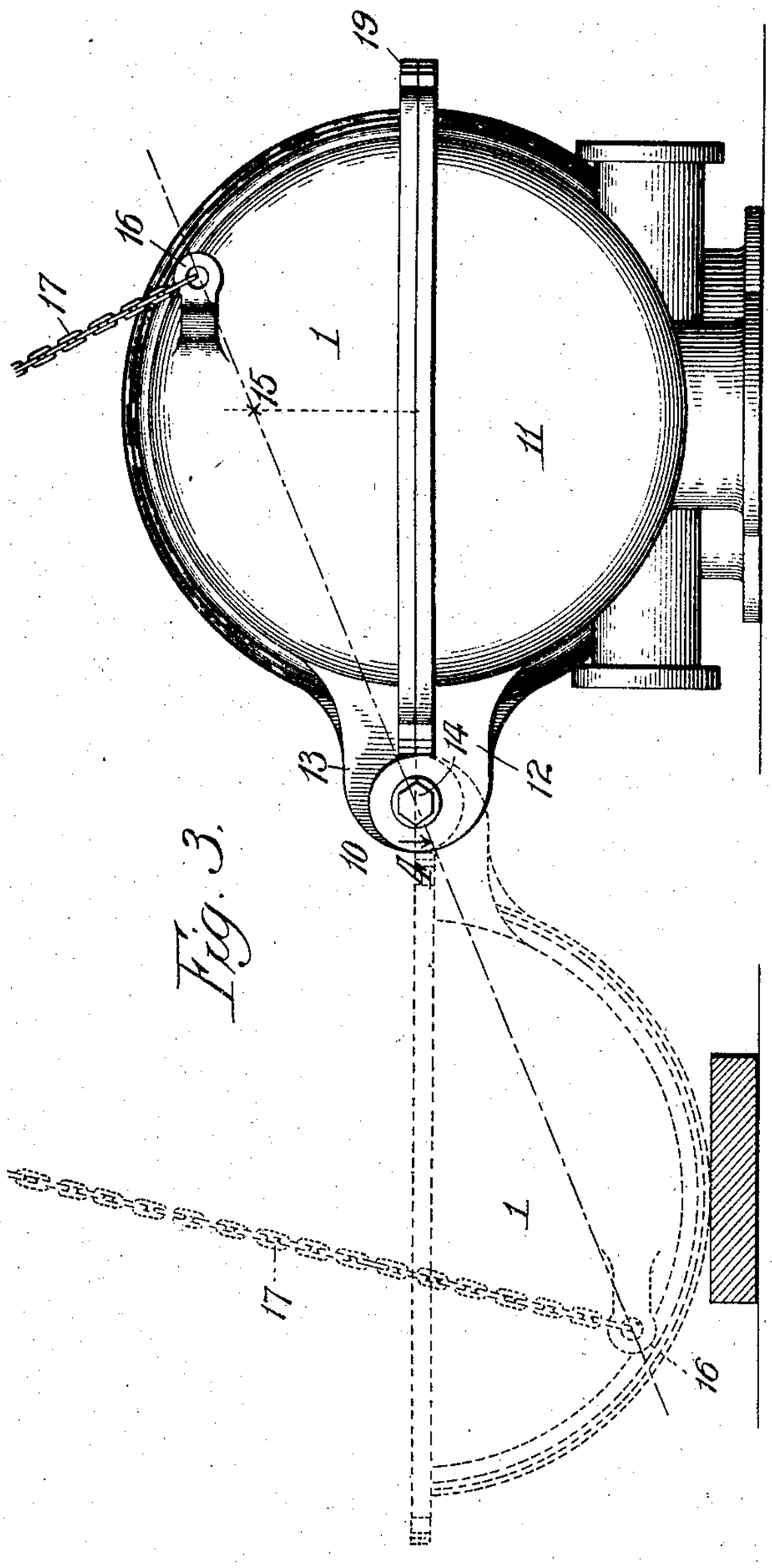


Fig. 3.

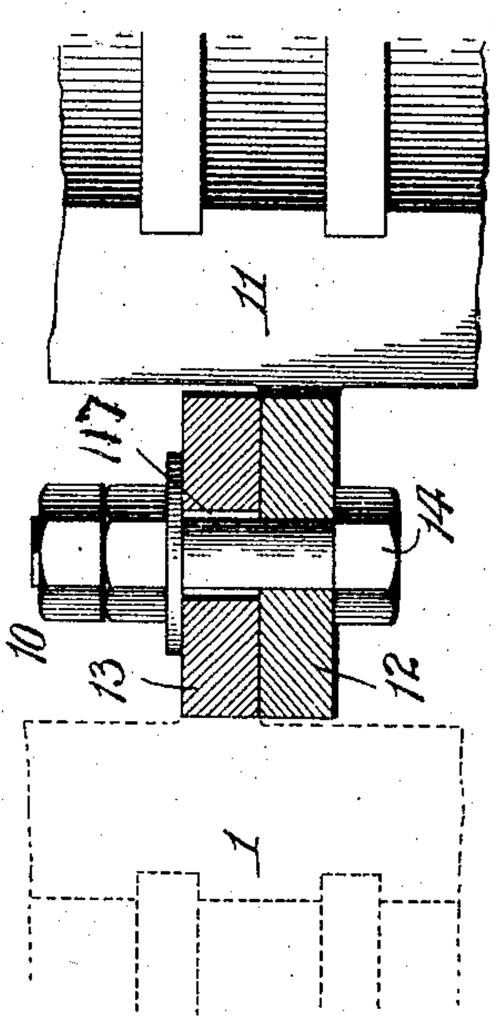


Fig. 4.

Witnesses:
Chas. E. Gaylord.
John Enders.

Inventor:
Hugh F. Fullagar,
By Thomas F. Sheridan,
Att'y.

No. 780,497. Patented January 24, 1905.

UNITED STATES PATENT OFFICE.

HUGH FRANCIS FULLAGAR, OF NEWCASTLE-UPON-TYNE, ENGLAND.

STEAM-TURBINE.

SPECIFICATION forming part of Letters Patent No. 780,497, dated January 24, 1905.

Application filed June 15, 1904. Serial No. 212,713.

To all whom it may concern:

Be it known that I, HUGH FRANCIS FULLAGAR, a subject of the King of Great Britain, residing at Newcastle-upon-Tyne, Northumberland, England, have invented certain new and useful Improvements in Steam-Turbines, of which the following is a specification.

In steam-turbines of the longitudinal-flow or drum type, in which the rotary shaft or drum is provided with a large number of blades and the casing with a corresponding number of alternating annular partitions supporting fixed guide-blades, it is usual to form the casing in halves joining in a horizontal plane through the axis of the shaft, so that the upper half can be removed and the shaft or drum lifted out if necessary. All of the blades are thus exposed for inspection as to their condition. For this purpose and to prevent injury to the blades there have heretofore been used guiding-rods secured to the lower half of the casing and passing vertically through holes in the upper half or cover, so as to insure a vertical lifting or motion of vertical translation in the removal of the cover. This means, however, is inconvenient, for not only is it necessary to use care to prevent binding when the cover is simply lifted, but it must be turned over by means of a crane if an inspection of the cover is to be made, and this operation, if the cover is large, requires considerable room. Moreover, in some situations—as, for example, on board ship—guide-rods are impracticable, as the inertia of the cover will be sufficient when the ship rolls to bend the rods unless they are of abnormal strength. Furthermore, in the process of manufacture it is desirable to frequently lift the cover sufficiently to examine the boring-tool or other purpose, for which existing means is inconvenient.

According to my invention to overcome these disadvantages I join the upper and lower halves of the casing along one side by two or more means of attachment resembling hinges, either formed in one or permanently attached to the casing or arranged to be fixed thereto when required. Lifting-eyes are provided upon the ends of the cover remote from the hinges and are preferably located in a plane determined by the hinges and the center of gravity of the cover. On lifting the cover by these eyes it is easily swung over upon its hinges into a horizontal inverted position, in which all its blades are accessible. The hinges are provided with sufficient clearance around the hinge-pin to allow the usual fastening-bolts to draw the two halves of the casing together in making the joint. They are also provided with guiding portions formed by extending the hinge-lugs in planes perpendicular to the axis of the turbine-shaft. The purpose of the guiding portions is to prevent binding of the parts during the opening of the casing, and thus assist the hinge in its function of constraining the cover to move in planes perpendicular to the axis of the turbine-shaft, so as to prevent contact of and injury to the internal structure of the motor. One edge of the cover may by these means be easily lifted to examine the tool in boring, and in the finished machine the two halves are during inspection so connected that they cannot swing and injure the blades.

The accompanying drawings illustrate the application of my invention, wherein—

Figure 1 is a vertical section of a turbine; Fig. 2, a plan view thereof; Fig. 3, an end elevation thereof; and Fig. 4, a horizontal section of the hinge on line 4 4 of Fig. 3 with portions of the casing to which it is attached.

The turbine illustrated in the drawings and to which this invention is applied consists of a casing made in two parts 1 11, which are united in a horizontal plane through the axis of the shaft 4 by means of bolts 18. The interior construction is of the usual kind in longitudinal-flow turbines. Guiding-blades 8 are secured in transverse annular partitions 2, attached to the casing. These transverse partitions alternate with disks 5 on the shaft, in the outer margin of which are mounted movable blades 6. Steam enters at the inlet 7 and passing through the motor is guided by the stationary guiding-blades 8 to the movable blades 6, causing these latter, with their supporting-disks and shaft, to rotate. Steam exhausts finally at the outlet 9. The two halves of the casing are connected by hinges 10 in addition to the fastening-bolts 18. These

hinges are constructed by the usual lugs 13 (see Figs. 2 and 3) on the upper half of the casing and lugs 12 on the lower half of said casing, and the lugs are united by hinge-bolts 14. Clearance or lost motion 117 (see Fig. 4) is provided in the hinges by making the hole in, preferably, one of the lugs slightly larger than the bolt 14. The purpose of such clearance is to allow adjustment in finally uniting the parts of the casing in operative correlation by the bolts 18. Guiding means are provided on the lugs of the hinges by extending said lugs along their margin in planes perpendicular to the axis of the turbine-shaft. This provides extensive guiding-surfaces upon the hinge-lugs. The purpose of the guiding means is to assist in constraining the cover-section of the casing to swing in planes perpendicular to the axis of the turbine-shaft.

Lifting-eyes 16 are provided (see Fig. 3) at the ends of the upper half or cover-section 1 of the casing. These eyes are located in a plane which is determined by the axis of the hinge connection 10 and the center of gravity 15 of the upper half or cover-section of the casing and which is represented on the drawings by line *p*. They are located at the ends of this cover-section to avoid interference between the crane-tackle 17 and the free edges or flanges 19 of the cover-section when it is swung over. The eyes are located in the aforesaid plane for the purpose of having the weight of the cover-section evenly distributed in any position of the cover.

In operation when it is desired to inspect the interior working parts of the turbine the fastening-bolts 18 are removed and the crane-tackle 17 applied to the lifting-eyes 16. The cover-section is then swung over by the crane upon the hinges 10 in its inverted position, as shown in dotted lines in Fig. 3. It will be understood that by these means all interference between the delicate internal structure of the motor is avoided, the parts disengaging from operative relation in planes perpendicular to the axis of the turbine. The invention should similarly be applied in the removal of the rotating parts from the lower half of the casing after the cover-section has been swung back. This may be obviously done by hinging to the lower half of the casing opposite the casing-hinges, by means of guide-hinges similar to those hereinbefore described, a framework the free ends of which are caused to engage the ends of the shaft and locked thereto, if desired. The crane-tackle is then applied to the frame, and it, together with the shaft and attached disks, is swung back in an opposite direction to that of the cover-section and in a similar manner free from all interference between the working parts because of its constraint to motion only in planes perpendicular to the turbine-shaft.

I claim—

1. In a longitudinal-flow turbine, means including a hinge connection constraining the parts of a turbine to disengage from operative relation in planes perpendicular to the axis of the turbine, substantially as described.

2. In a steam-turbine of the longitudinal-flow type, a casing in parts, and a connection between the parts constraining said parts to move in planes perpendicular to the axis of the shaft, substantially as described.

3. In a steam-turbine of the longitudinal-flow type, a casing in parts, and a hinge connection between the parts constraining said parts to move in planes perpendicular to the axis of the shaft, substantially as described.

4. In a steam-turbine of the longitudinal-flow type, a casing in parts, a connection between the parts comprising hinges, guiding means on the lugs of said hinges extending in planes perpendicular to the axis of the shaft constraining said parts to move in planes perpendicular to the axis of the shaft, substantially as described.

5. In a steam-turbine of the longitudinal-flow type, a casing in parts, a hinge connection between the parts, and means providing lost motion between the parts in planes perpendicular to the axis of the shaft, substantially as described.

6. In a steam-turbine of the longitudinal-flow type, a casing in parts, a connection between the parts comprising hinges, guiding means on the lugs of said hinges extending in planes perpendicular to the axis of the shaft, and means providing lost motion between the parts in planes perpendicular to the axis of the shaft, substantially as described.

7. In a steam-turbine of the longitudinal-flow type, a casing in parts, a connection between the parts constraining said parts to move in planes perpendicular to the axis of the shaft, and means on one of the parts for lifting said part and located in a plane determined by the connection and the center of gravity of said part, substantially as described.

8. In a steam-turbine of the longitudinal-flow type, a casing in parts, a hinge connection between the parts, and means on one of the parts for lifting said part and located in a plane determined by the connection and the center of gravity of said part, substantially as described.

9. In a steam-turbine of the longitudinal-flow type, a casing in parts, a connection between the parts comprising hinges, guiding means on the lugs of said hinges extending in planes perpendicular to the axis of the shaft, and means on one of the parts for lifting said part and located in a plane determined by the connection and the center of gravity of said part, substantially as described.

10. In a steam-turbine of the longitudinal-flow type, a casing in parts, a hinge connection between the parts, means providing lost motion between the parts in planes perpendicular to the axis of the shaft, and means on

one of the parts for lifting said part and located in a plane determined by the connection and the center of gravity of said part, substantially as described.

11. In a steam-turbine of the longitudinal-flow type, a casing in parts, a connection between the parts comprising hinges, guiding means on the lugs of said hinges extending in planes perpendicular to the axis of the shaft, means providing lost motion between the parts in planes perpendicular to the axis of the shaft, and means on one of the parts for lifting said part and located in a plane determined by the connection and the center of gravity of said part, substantially as described.

12. In a steam-turbine of the longitudinal-flow type, a casing in parts, a connection between the parts comprising hinges, guiding means on the lugs of said hinges extending in planes perpendicular to the axis of the shaft, means providing lost motion between the parts in planes perpendicular to the axis of the shaft, means on one of the parts for lifting said part and located in a plane determined by the connection and the center of gravity of said part, and clamping mechanism for securing the separable parts together independent of the hinging mechanism, substantially as described.

HUGH FRANCIS FULLAGAR.

Witnesses:
WALTER HEATHCOTE GOLDING,
ELIAS YEOMAN.