No. 725,673. PATENTED APR. 21, 1903.

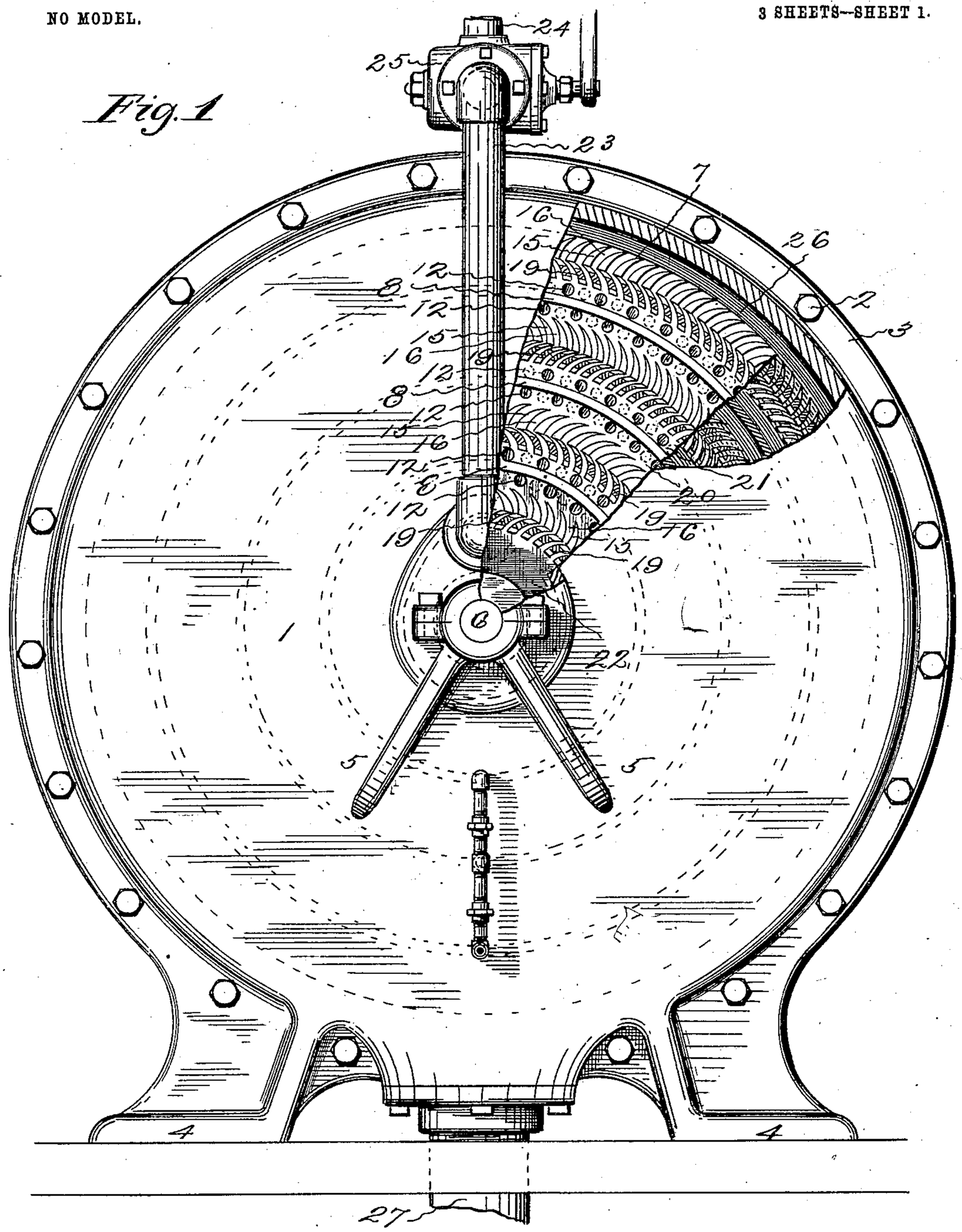
A. W. CASE.

DUPLEX STEAM TURBINE.

APPLICATION FILED AUG. 11, 1902.

NO MODEL. 3 SHEETS—SHEET 1.

Fig. 1



Witnesses

C. F. Kilgore.

Ella T. Shea.

Inventor

Alfred Wells Case, by

Harry P. Williams

Attorney

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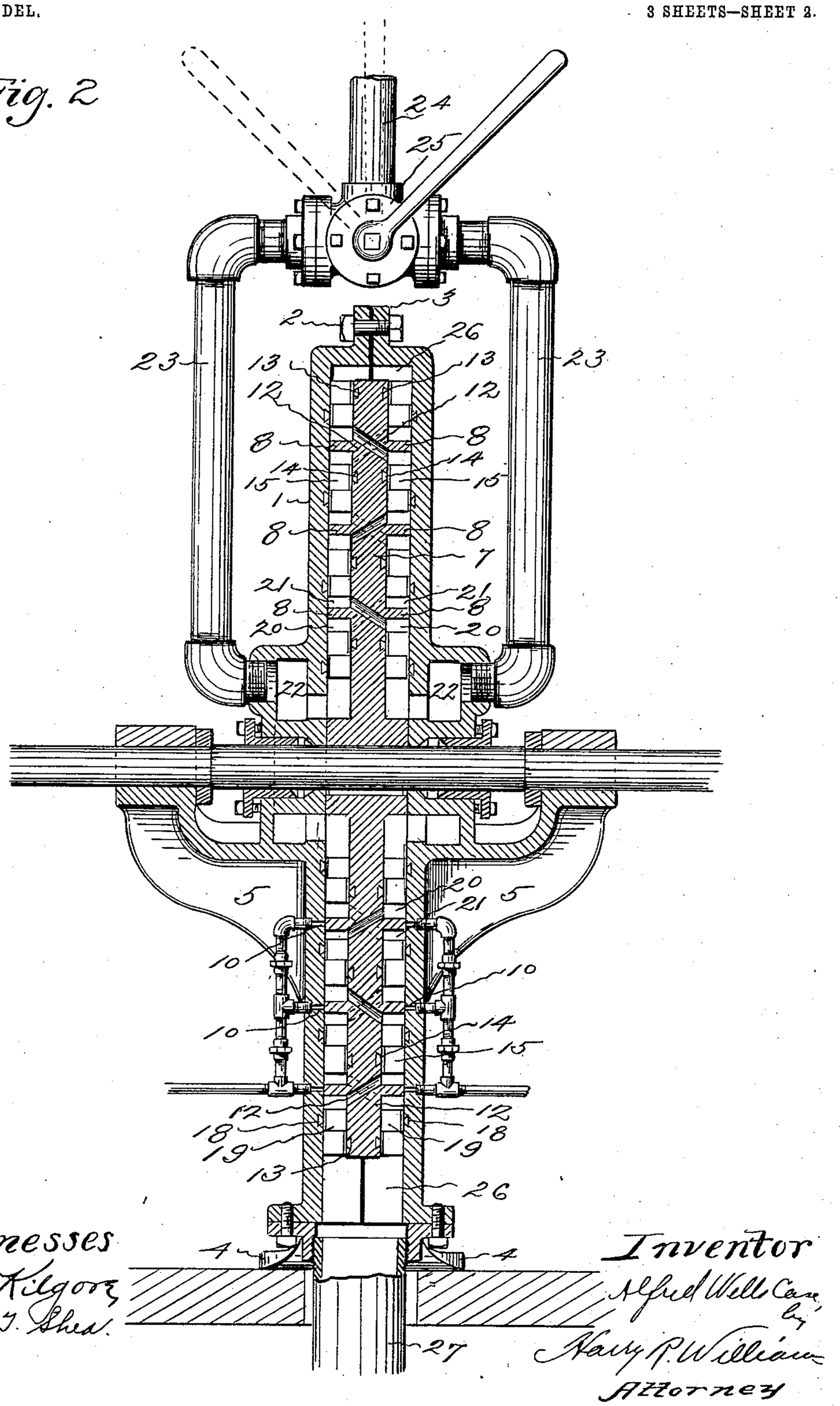
NO MODEL. 3 SHEETS—SHEET 2.

Fig. 2



Witnesses
C. F. Kilgore
Ella J. Shea.

Inventor
Alfred Wells Case
by
Mary P. Williams
Attorney

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NO MODEL. 3 SHEETS—SHEET 3.

Fig. 3

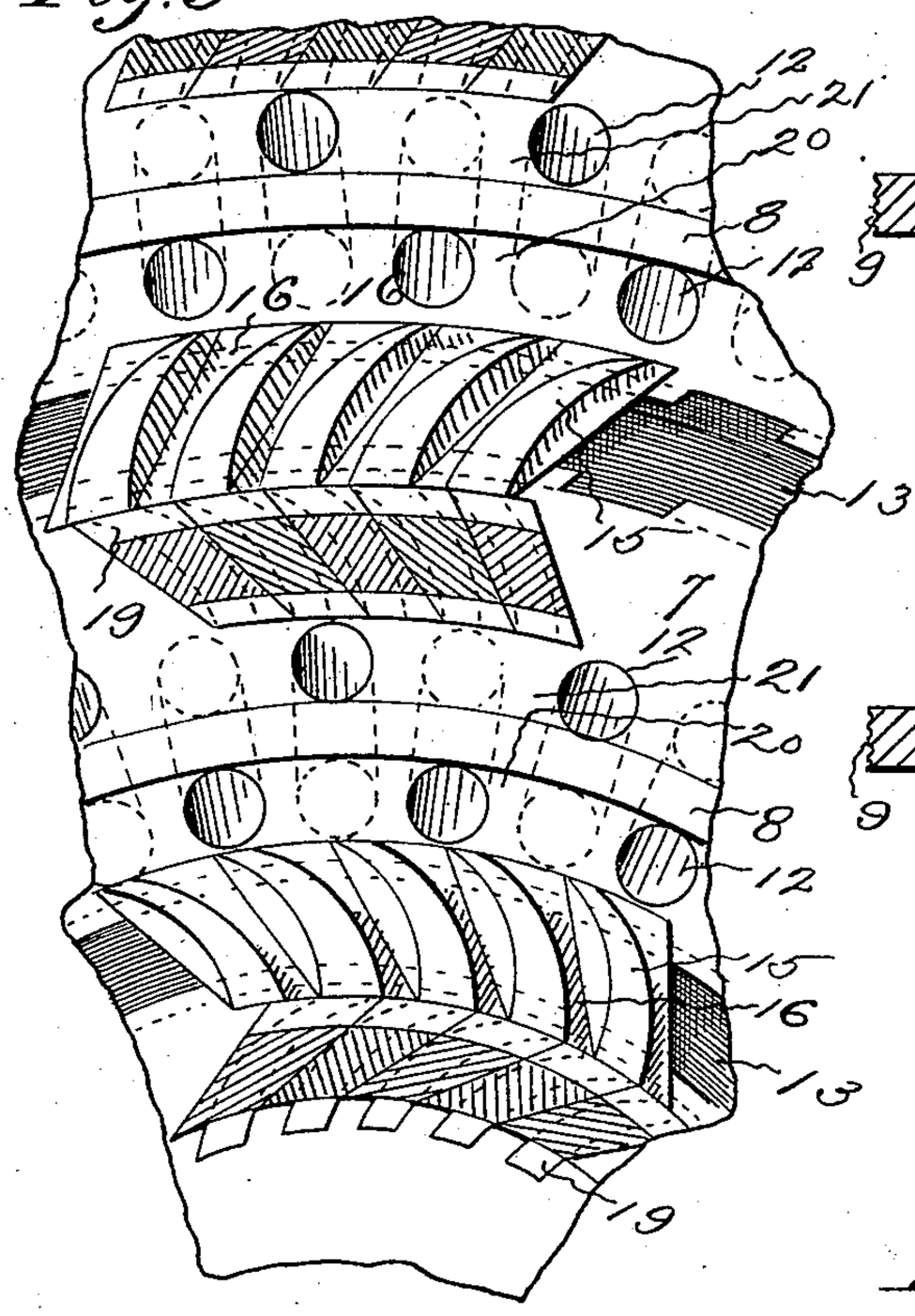


Fig. 4

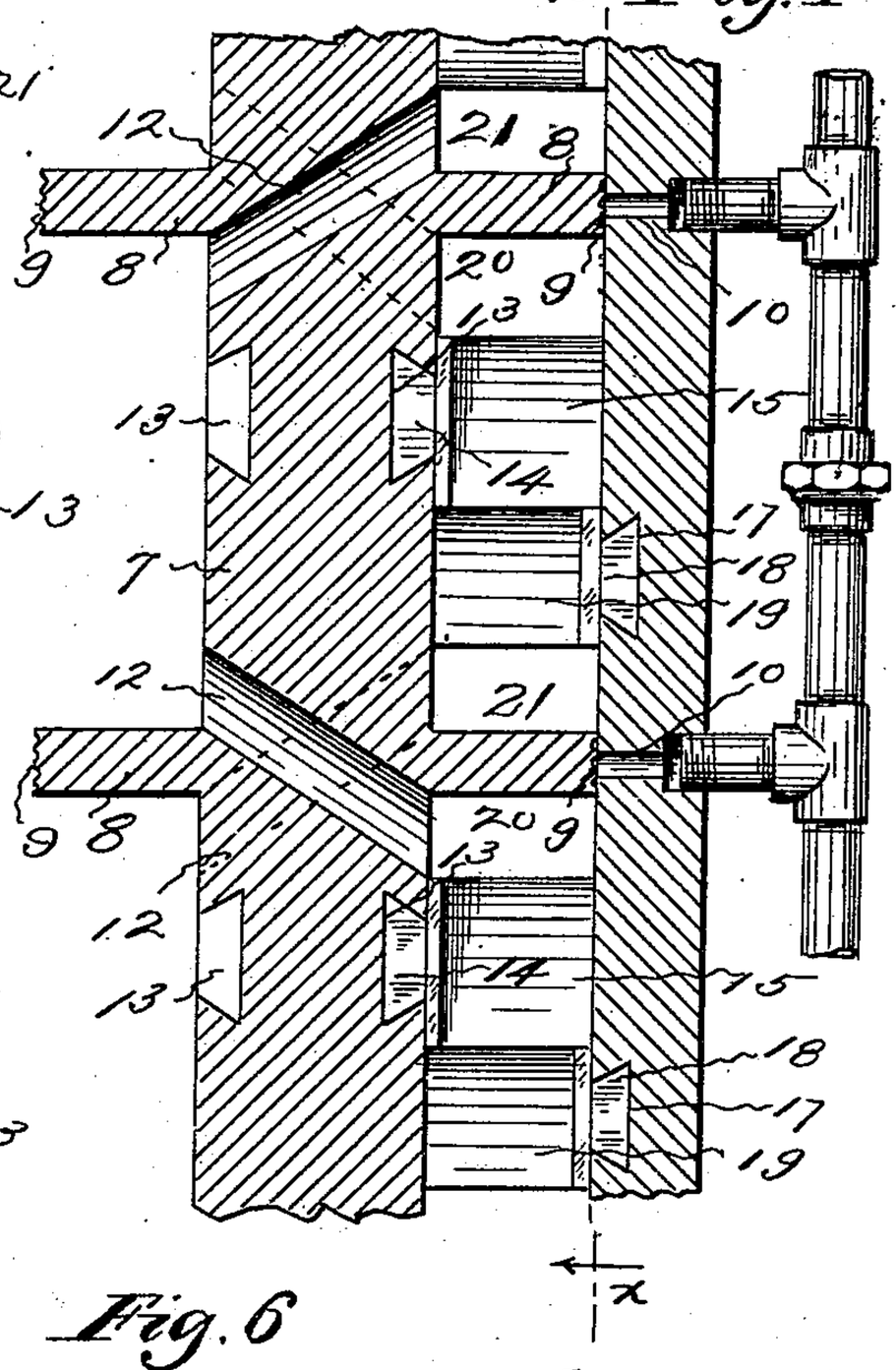


Fig. 5

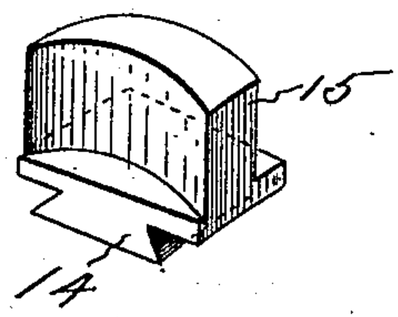


Fig. 6

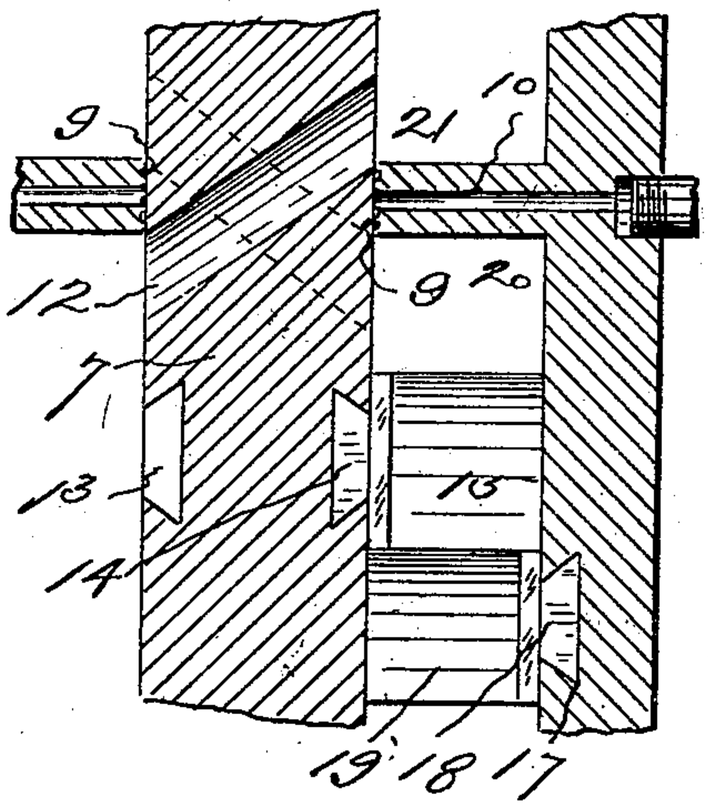
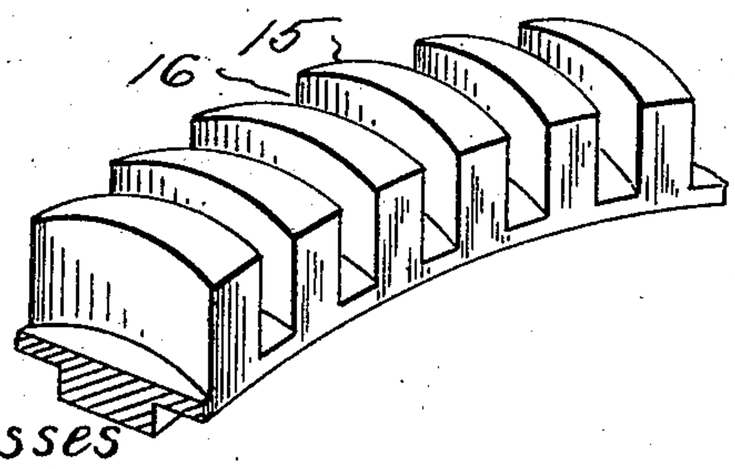


Fig. 7



Witnesses
C. F. Kilgore
Ella J. Shea.

Inventor
Alfred Wells Case, by
Harry P. Williams
Attorney

UNITED STATES PATENT OFFICE.

ALFRED WELLS CASE, OF HIGHLAND PARK, CONNECTICUT.

DUPLEX STEAM-TURBINE.

SPECIFICATION forming part of Letters Patent No. 725,673, dated April 21, 1903.

Application filed August 11, 1902. Serial No. 119,190. (No model.)

To all whom it may concern:

Be it known that I, ALFRED WELLS CASE, a citizen of the United States, residing at Highland Park, in the county of Hartford and State of Connecticut, have invented certain new and useful Improvements in Duplex Steam-Turbines, of which the following is a specification.

This invention relates to a steam-turbine which has many small blades arranged annularly on opposite faces of a rotatory disk mounted on the shaft.

The object is to provide a compact and efficient steam-turbine of this nature having the blades so located and arranged that the pressure is equal on opposite faces of the disk, which may be driven either forwardly or backwardly by simply manipulating the throttle-valve.

The embodiment of the invention illustrated by the accompanying drawings has a circular case with arms extending outwardly from the case and supporting the shaft and a perforated disk mounted on the shaft within the case and having on both faces blades that operate in conjunction with blades on the inside faces of the case in such a manner that the disk is rotated at high speed in one direction when the steam is admitted on one side and is rotated at high speed in the reverse direction when the steam is admitted on the opposite side.

Figure 1 of the views is a side elevation of the steam-turbine with a part of the case removed to expose the disk and a part of the disk broken away to show the inner face of the opposite side of the case. Fig. 2 is a diametrical vertical section of the steam-turbine. Fig. 3 is a view, on a larger scale, of a small portion of the face of the disk looking in the direction indicated by the arrows from the plane of the dotted line $x\,x$ of Fig. 4. Fig. 4 is a transverse section of a portion of the disk and one side of the case. Fig. 5 is a detail view of one of the removable blades that may be used. Fig. 6 is a view similar to Fig. 4 showing a modified construction, and Fig. 7 is a detail view showing a modified formation of the blades that may be used.

The case may be formed of two annular plates 1, secured together by bolts 2, that pass through the flanges 3. Feet 4 are formed on the under edge of the case, and outwardly-extending arms 5 are formed on the opposite sides of the case. The shaft 6 is supported by suitable bearings in the upper ends of the arms that extend from the sides of the case. The disk 7 is mounted on the shaft between the sides of the case. On each side this disk has three annular flanges 8, that extend outwardly to the inner surfaces of the side walls of the case and divide the spaces between the side faces of the disk and side walls of the case into chambers. Grooves 9 may be formed in the outer edges of these flanges, and ducts 10, connected with a supply of liquid, may lead through the case to these grooves, so as to provide for a liquid packing or a supply of lubricant between the edges of the flanges and the inner surfaces of the side walls of the case, as shown in Fig. 4. These flanges may, if desired, be formed a part of the case, in which event the liquid will be forced between the edges of the flanges and the faces of the disk, as shown in Fig. 6. Passages 12 are made obliquely through the disk from each chamber on the inside of each flange to the chamber on the outside of each flange on the opposite side of the disk, so as to connect the inner chamber on one side with the next outer chamber on the opposite side of the disk. By means of these passages every other chamber on the same side of the disk is in communication. In the faces of the disk, between the flanges on each side, grooves are formed. These grooves may be dovetailed or undercut in any desired manner. In these grooves are inserted the tenons 14 of curved blades 15, that extend from the faces of the disk to the inner faces of the side walls of the case. These blades are thicker at their inner ends than at their outer ends, so that passages 16 between them increase in area as they extend outwardly, and the blades are preferably so arranged that those which are directly opposite on the other side of the disk curve in opposite directions and those which are in chambers which are in communication with each other curve in the same directions. In other words, the blades which extend from the disk on directly opposite sides are reversed with relation to each other, and those which extend from the disk on the same side in adjacent chambers are reversed with relation to

each other. In the inner faces of the side walls of the case, between the flanges, are grooves 17, arranged to receive the tenons 18 of the curved blades 19, that extend from the inner faces of the side walls of the case to the side faces of the disk. The stationary blades are substantially the same shape as the rotatory blades attached to the disk, and they are arranged so that their thinner outer ends lie adjacent to the thicker inner ends of the blades that are attached to the disk. This arrangement provides passages between the fixed blades which are smaller in area at their outer ends than at their inner ends. The stationary blades are set oppositely to the blades attached to the disk, so that steam passing between them is projected into the cavities of the blades attached to the disk. The blades are so located that there is an annular chamber 20 inside and an annular chamber 21 outside of each flange. The passages 12 through the disk connect the chambers 20 on one side with the chambers 21 on the opposite side. Of course, if desired, the blades could be made integral with the disk and with the sides of the case instead of being made removable.

The inlet-chambers 22 communicate with the annular chambers 20 near the hub of the disk. These chambers are connected by branch pipes 23 with a steam-supply pipe 24, that is provided with a throttle-valve 25. The space 26 around the outside of the disk at the bottom is connected with the exhaust-pipe 27. When the valve is turned to one position, one branch will be opened, so that steam will enter on one side only. When steam enters on one side, it passes first through the curved passages between the blades attached to the inside of that side of the case and is projected in jets against the concave faces of the opposing blades attached to the disk. After passing between these blades the steam escapes through the diagonal passages to the opposite side of the disk into the next outer chamber and then passes between the curved blades attached to the inside of that side of the case and is projected in jets against the concave faces of the blades attached to that side of the disk. After passing between these blades the steam is again directed to the other side of the disk between the case-blades and then is again directed to the opposite side to act upon blades in the same manner. By means of this construction and arrangement of the blades the steam-pressure is exerted upon opposite sides of the disk practically with the same force, so that the disk is balanced and not forced against one side of the case any more than the other. Should there be any leakage past the flanges into the chambers which are not in use, it will not affect the operation of the turbine, for the reason that the leakage will simply escape to the branch of the inlet-pipe that is not in use. When the valve is turned to the opposite position, the branch of the supply-pipe that was first used will be closed and the other branch opened, so that steam will be admitted to the opposite side of the disk and will then be directed to the blades on one side and then to the blades on the opposite side, and as these blades are arranged oppositely to those to which the steam was before directed the disk will be rotated in the reverse direction.

If it is not desired to have the turbine reversible, the blades on the disk may all be arranged in the same direction, and the blades on the case may be all arranged oppositely, and steam may be admitted on both sides of the disk at the same time.

This turbine is simple to construct and can be made very compact. There is a large area of active working surface, so that great power can be obtained with a small-sized machine, and if high pressure is used the pressure is so balanced that there is but little friction between the adjacent stationary and movable surfaces.

I claim as my invention—

1. A steam-turbine consisting of a cylindrical case, a shaft extending through the case, a disk mounted on the shaft, annular flanges without openings through them, extending from the sides of the disk and dividing the spaces between the sides of the disk and the sides of the case into annular chambers, annularly-arranged curved blades extending from the sides of the disk into each annular chamber, and annularly-arranged curved blades extending from the sides of the case into each annular chamber in opposition to the disk-blades, and passages connecting the several annular chambers, substantially as specified.

2. A steam-turbine consisting of a cylindrical case, a shaft extending through the case, a disk mounted on the shaft, annular flanges dividing the spaces between the sides of the disk and the side of the case into annular chambers, annularly-arranged curved blades extending from the sides of the disk into each annular chamber, annularly-arranged curved blades extending from the sides of the case into each annular chamber in opposition to the disk-blades, and passages extending through the disk from each inner annular chamber to the next outer annular chamber on the opposite side of the disk, substantially as specified.

3. A steam-turbine consisting of a cylindrical case, a shaft extending through the case, a disk mounted on the shaft, flanges dividing the spaces between the sides of the disk and the sides of the case into annular chambers, annularly-arranged curved blades extending from the sides of the disk into each of the annular chambers, the blades directly opposite each other on opposite sides of the disk curving in reverse directions, annularly-arranged curved blades extending from the sides of the case into each of the chambers in opposition to the disk-blades, passages extending through the disk and connecting di-

agonally the opposite annular chambers, and inlet-ports arranged on opposite sides of the case near the shaft, substantially as specified.

4. A steam-turbine consisting of a cylindrical case, a shaft extending through the case, a disk mounted on the shaft, flanges dividing the spaces between the sides of the disk and the sides of the case into annular chambers, curved blades with tenons located in annular mortises formed in the sides of the disk, curved blades with tenons located in annular mortises in the sides of the case, the adjacent blades on the disk and blades on the case curving in opposite directions, and passages connecting the annular chambers, substantially as specified.

5. A steam-turbine consisting of a cylindrical case, a shaft extending through the case, a disk mounted on the shaft, flanges dividing the spaces between the sides of the disk and the sides of the case into annular chambers, annularly-arranged blades extending from the sides of the disk, the openings between the disk-blades being larger in area at the outer than at the inner ends, annularly-arranged blades extending from the sides of the case in opposition to the disk-blades, the openings between the case-blades being smaller in area at the outer than at the inner ends, substantially as specified.

6. A steam-turbine consisting of a cylindrical case, a shaft extending through the case, a disk mounted on the shaft, annular flanges without openings through them, extending from the sides of the disk and dividing the spaces between the sides of the disk and the sides of the case into annular chambers, annularly-arranged blades removably connected with the sides of the disk in each annular chamber, and annularly-arranged blades removably connected with the sides of the case in each annular chamber and extending in opposition to the disk-blades, substantially as specified.

7. A steam-turbine consisting of a case, a shaft extending through the case, a disk mounted on the shaft, flanges extending from the sides of the disk to the sides of the case, annular grooves formed in the sides of the disk, blades with tenons inserted in the annular grooves in the disk, annular grooves formed in the sides of the case, blades with tenons inserted in the grooves in the case, and passages connecting the chamber between the flanges, substantially as specified.

8. A steam-turbine consisting of a case, arms extending outwardly from the sides of the case, a shaft supported by bearings in the arms, a disk mounted on the shaft, annular flanges on the sides of the disk and extending to the sides of the case, curved blades extending from the sides of the disk between the flanges, curved blades extending from the sides of the case between the flanges in opposition to the disk-blades, and passages connecting the chambers on opposite sides of the disk, substantially as specified.

9. A steam-turbine consisting of a case, a shaft extending through the case, a disk mounted on the shaft, flanges dividing the spaces between the sides of the disk and the sides of the case into annular chambers, blades with curved openings between them arranged on the sides of the disk between the flanges, blades with curved openings between them arranged on the sides of the case between the flanges in opposition to the disk-blades, passages connecting the annular chambers between the flanges, inlet-ports opening to the annular chambers on opposite sides of the disk near the shaft, branch pipes connecting the inlet-ports with a supply-pipe, and a valve for directing the steam to either one of the branch pipes, substantially as specified.

10. A steam-turbine consisting of a case, a shaft extending through the case, a disk mounted on the shaft, flanges, dividing the spaces between the sides of the disk and the sides of the case into annular chambers, grooves in the edges of the flanges, ducts through the case for supplying liquid to the grooves in the flanges, annularly-arranged blades extending from the sides of the disk into the chambers between the flanges, annularly-arranged blades extending from the sides of the case into the annular chambers between the flanges in opposition to the disk-blades, passages connecting the annular chambers, inlet-ports opening to the annular chambers near the hub, and an outlet-port opening from the annular chamber about the periphery, substantially as specified.

ALFRED WELLS CASE.

Witnesses:
H. R. WILLIAMS,
ELLA T. SHEA.