No. 725,184. PATENTED APR. 14, 1903.

W. L. WEBSTER.

STEAM TURBINE.

APPLICATION FILED JAN. 13, 1903.

NO MODEL. 2 SHEETS—SHEET 1.

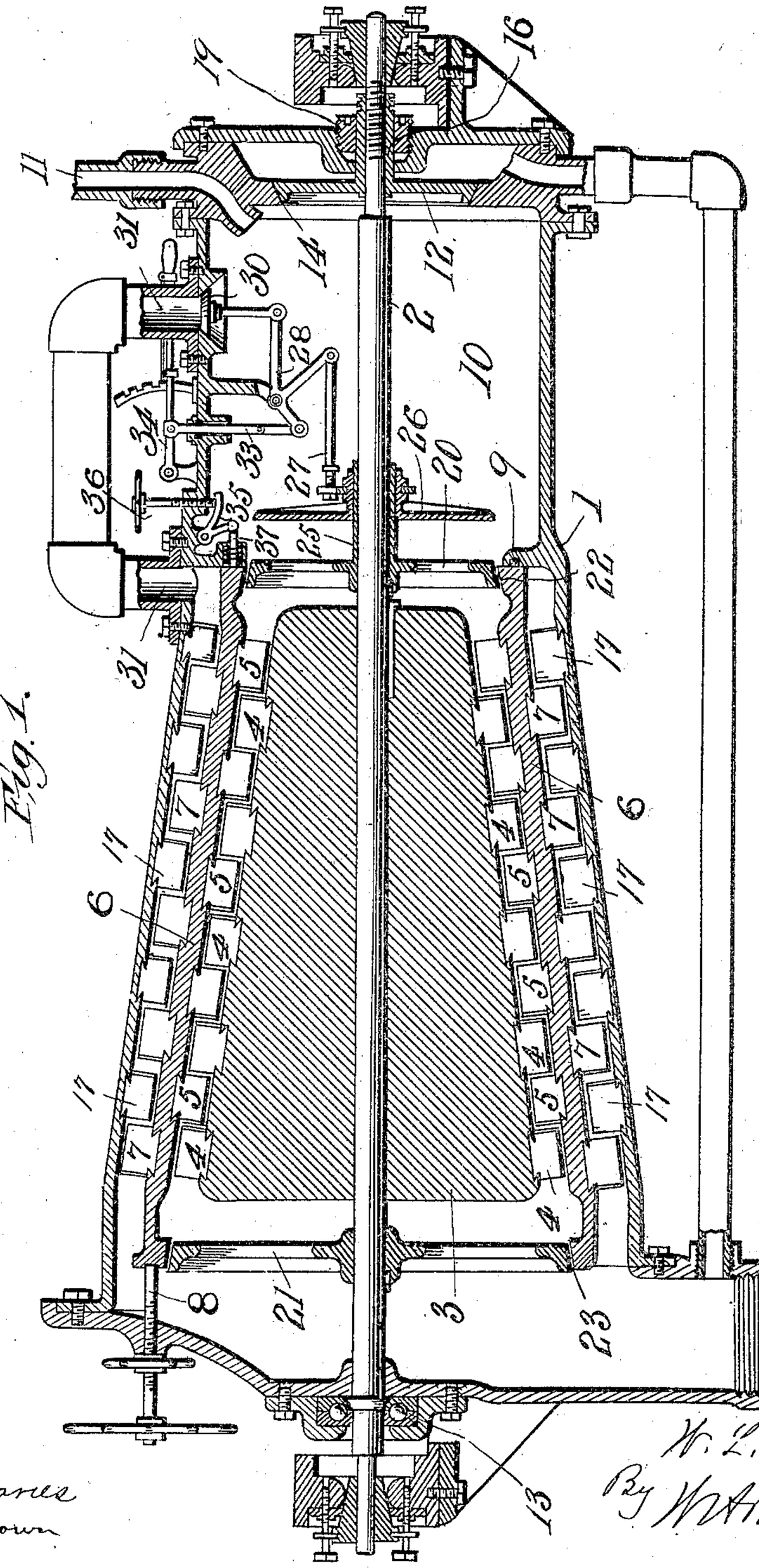

Fig. 1.

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NO MODEL. 2 SHEETS—SHEET 2.

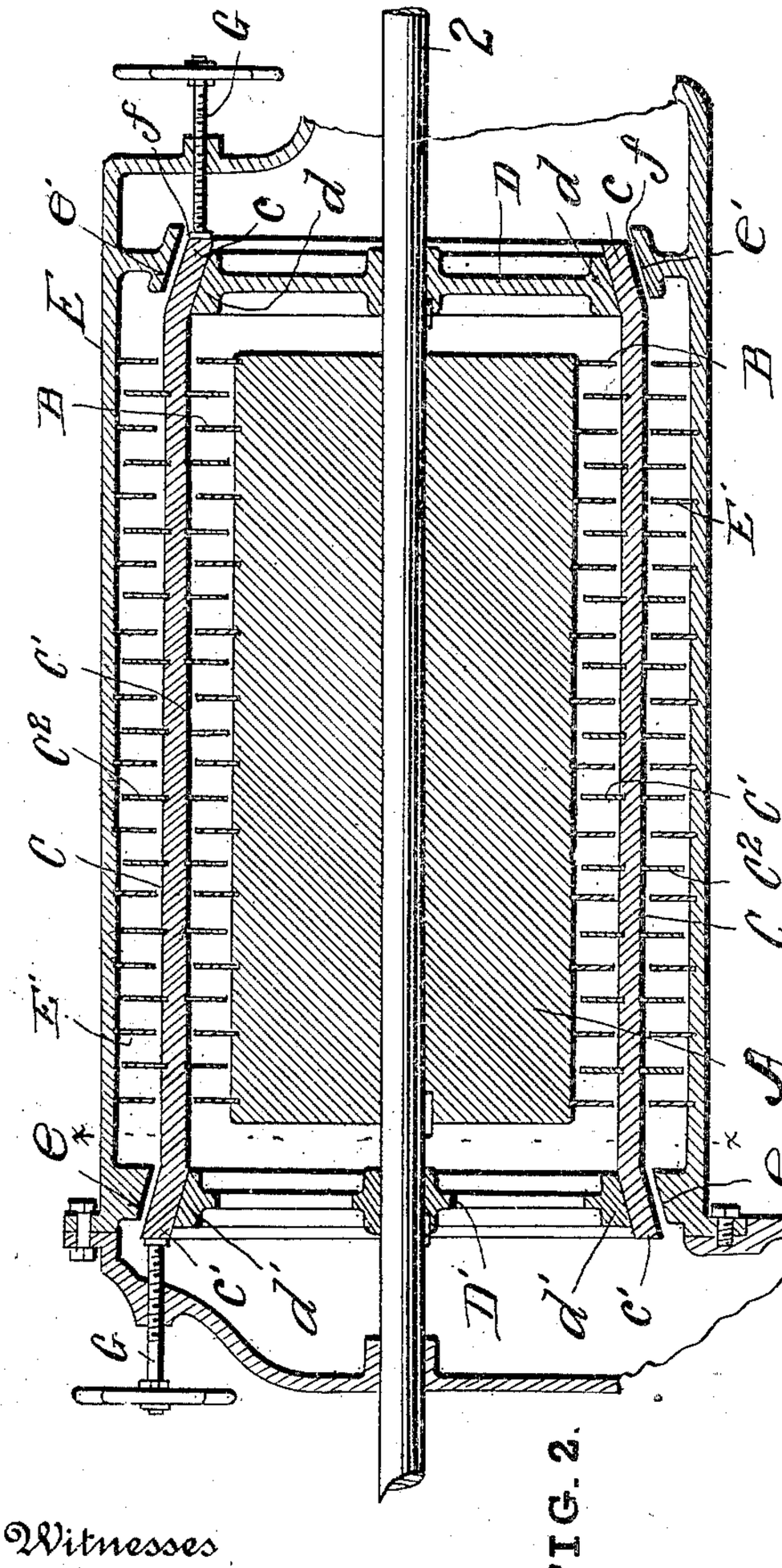

FIG. 2.

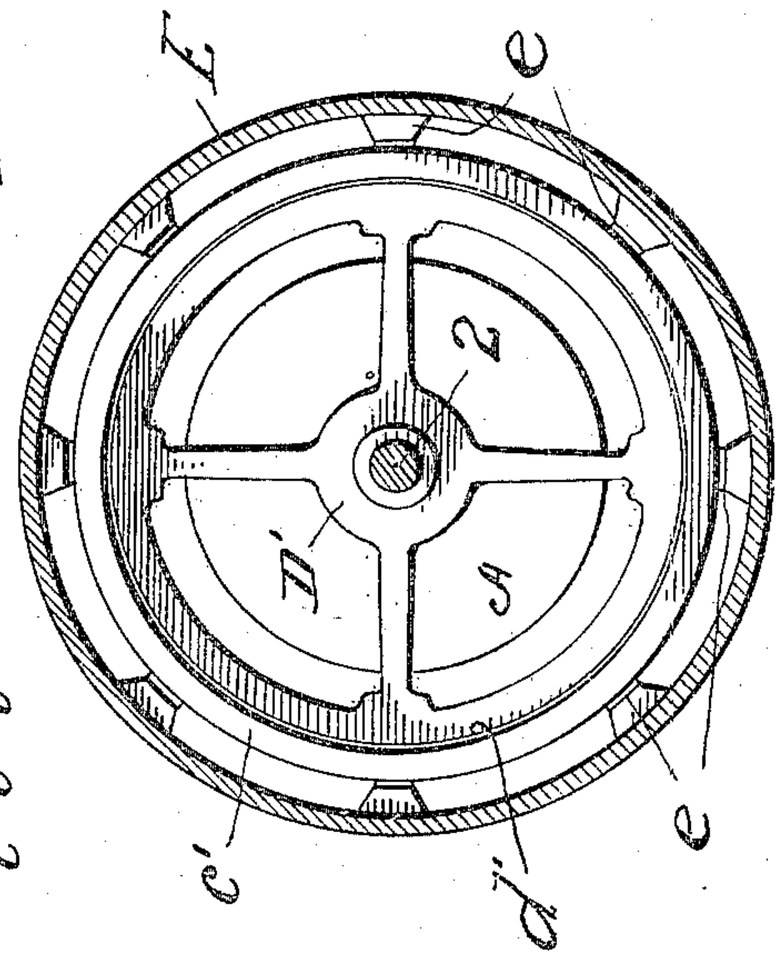

FIG. 3.

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UNITED STATES PATENT OFFICE.

WILLIAM LLOYD WEBSTER, OF NEW YORK, N. Y., ASSIGNOR OF ONE-HALF TO ALBERT CROMWELL, OF NEW YORK, N. Y.

STEAM-TURBINE.

SPECIFICATION forming part of Letters Patent No. 725,184, dated April 14, 1903.

Application filed January 13, 1903. Serial No. 138,891. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM LLOYD WEBSTER, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Steam-Turbines, of which the following is a specification.

This invention relates to that class of steam-engines known as "steam-turbines."

The object of the invention is to improve the construction and operation of such engines, and especially the reversing mechanism thereof; also to improve the valve-gear necessary to operate this class of engines and reversing mechanism.

The invention consists in certain constructions and combinations, which I believe to be carefully pointed out in the claims hereto annexed.

Figure 1 is a vertical longitudinal central section of an engine embodying my improvements. Fig. 2 is a diagrammatic section showing the relation of the more essential elements in a parallel-flow turbine. Fig. 3 is a cross-section of the engine on line $x\ x$.

The numeral 1 indicates the outer casing of a turbine-engine. 2 denotes the shaft, which passes through the casing lengthwise and is kept steam-tight by suitable packing, as usual. To the shaft 2 a frusto-conical hub 3 is held by key or other suitable means of attachment. The hub 3 has exterior projecting blades 4, arranged in circumferential rings or rows, the blades being at an incline relatively to the shaft, as is usual. Between the blades 4 there are blades 5, projecting inwardly from the frusto-conical shell 6, the blades 5 being inclined in opposite direction to the inclination of blades 4, as is usual in engines of this class. The shell 6 is, as I believe, a new feature in this class of engines. The shell under some conditions, as when the shell is locked and the engine running forward, serves the purpose of the usual casing of the engine. Under other conditions, as I will explain, the shell becomes an attachment of the hub and revolves therewith, but in the backward or reverse direction. The shell 6 is concentric with hub 2 and may be held against rotation by a screw 8, which passes through the end of the outer casing and presses said shell 6 tightly against a packing 9 at the small end of the casing, thus forming a steam-tight joint, and is held also by frictional contact between the blades 7, the casing, and blades 17 with the hub.

The chamber 10 is supposed to receive steam from a supply-pipe 11. When the engine is in position for running forward, steam entering chamber 10 will pass between the hub 3 and the shell 6, impinging alternately on the blades 4 and 5 and driving the hub and shaft in usual manner. The clearance between the blades 4 and 5 is as little as practicable to secure best results from the steam admitted.

On the shaft 2 I firmly secure a balance-disk 12, which is nearly equal in diameter to the extreme diameter of hub 3. The back pressure of the steam on this disk nearly balances the end pressure or thrust of the steam on the hub, leaving only a small amount of end thrust to be taken up by thrust-bearings 13, which thrust-bearing may be of any approved form.

The casing 1 has a tapered or frusto-conical passage 14, in which the balance-disk 12 is placed, and the periphery of the disk 12 is on an incline, so that a very slight endwise adjustment of disk 12 serves to make a pretty close passage through which steam will not escape to much extent. The disk 12 is carried by a hub 16 on the shaft, which hub and disk can be adjusted lengthwise of the shaft, as by screw-thread 19.

The small amount of wasted steam which leaks past disk 12 can be exhausted by a pipe 44, leading to the exhaust of the engine.

On shaft 2 there are two wheels 20 and 21, keyed or otherwise secured firmly to the shaft, so as to rotate therewith, each having frusto-conical rims tapered in the direction of the taper of hub 2.

Shell 6 has outwardly-extending blades 7 arranged in annular groups, but inclined in reverse direction from the blades 4 on hub 2. The outer casing 1 has inwardly-projecting blades 17 arranged in annular series and inclined in opposite direction to the inclination of blades 7—that is, the inclined relation of the outwardly-projecting blades 7 of shell 6 to the inwardly-projecting blades 17 of casing

1 is the reverse of the inclined relation of the blades 4 of hub 2 to the inwardly-projecting blades 5 of shell 6.

When shell 6 is in its locked position, the outer ends of blades 7 are in contact with the inner surface of the hollow frusto-conical casing and the inner ends of blades 17 are in frictional contact with the tapered outer surface of the frusto-conical shell, thus forming a close-fitting friction-clutch between the parts.

Now assuming steam to cut off from the engine, the backward movement of screw 8 will permit the longitudinal shifting of shell 6. The tapered chambers 22 and 23 in said shell then close tightly on the tapered rims of wheels 20 and 21, locking the shell quite tightly on these wheels by frictional engagement. The same endwise shift of shell 6 frees the blades 7 and 17 from contact with the casing and shell, respectively, and causes the outer ends of blades 4 to make contact with the interior surface of shell 6 and the inner ends of blades 5 to make contact with the tapered hub 3. The shell 6 then becomes to all intents a part of hub 3, so far as its operation is concerned.

Wheel 20 has a hub 25 surrounding the shaft 2. On this shaft a disk valve 26 may be moved lengthwise to close the opening by which steam formerly passed from chamber 10 to the outer surface of hub 3. The closing of disk valve 26 against wheel 20 may be effected by pitman 27, connected to the disk valve in suitable manner to permit the rotation of said disk valve and also connected to a three-armed lever 28, which is pivoted within the chamber 10. One of the arms of lever 28 is connected to valve 30, and the movement of closing disk valve 26 opens the passage 31, by which steam can pass from chamber 10 to the space between shell 6 and casing 1. A draw-rod 33, connected to three-armed lever 28 within the steam-chamber and also connected to lever 34 outside the steam-chamber, passing through a suitable stuffing-box, serves as a means for operating the three-armed lever and connected valves.

The endwise shift of shell 6 heretofore referred to may be effected by means of a bell-crank lever 35, pivoted within the steam-chamber and operated by screw 36, passing through the wall of said chamber. Lever 35 bears on a push-pin 37, which is drawn or pressed back by a surrounding coiled spring in usual manner. The endwise shift of the shell should not be great enough to cause the blades on the shell to overlap the edges of those on the hub or casing.

When the shell 6 is shifted to reversal position and locked to hub 8, as described, and valve 26 is closed, steam from chamber 10 will pass through channel 31 to the space between shell 6 and casing 1, and by impinging on the blades 7 and 17 will drive the shell 6 and with it the hub and shaft in reverse direction from that of the proper forward movement of the hub and shaft when the shell is not so connected thereto. The disk valve 26 will rotate with the hub.

I have described an operative mechanism for shifting the shell, valves, &c.; but I do not intend to limit myself to the particular construction and arrangement of mechanisms shown and described, as numerous mechanical elements have been or may be devised as equivalents or substitutes for mechanisms herein shown and described.

In Fig. 2 the mere essential elements which go to make up a steam-turbine are shown. The shaft 2 supports a hub A of cylindrical form, having blades B, which are merely shown in section, as any of the known forms of blades may be used. The cylindrical shell C has blades C′ and C², projecting inwardly and outwardly, and has concavo-convex sections *c c′* near its ends, which sections can close against correspondingly-shaped shoulders *d d′* on the pulleys D D′, secured to the shaft, or against inclined shoulders *e* and lugs *e′* in the casing E, accordingly as the shell is shifted in one direction or the other. If pulley D be a close disk, the shifting of the shell C to the position shown will close the opening around said disk D and at the same time open the passage at *f*, providing for the entrance of steam between the shell and casing E. A reverse movement of the shell will of course close the opening outside the shell and open that between the shell and hub, so that the steam from chamber F may enter outside or inside the shell, according to its position. Casing E has blades E′. I have shown the screws G G as means for shifting the shell. These are merely illustrative, as other suitable means can readily be devised for the purpose of shifting the shell. So other steam-passages can be provided than the openings between the shell and casing or shell and hub, as of course the mechanism of Fig. 1 for supplying steam is equally adapted to this form of engine.

I have not intended to go largely into minor details of construction which are merely matters of mechanical skill, but have confined my description largely to the features involving the essential principles of my invention.

What I claim is—

1. In a steam-turbine, the combination with the hub and casing, having respectively outwardly and inwardly projecting blades, of an intermediate shell having outwardly and inwardly projecting blades, and means for connecting said shell to the casing, and means for connecting the shell to the hub.

2. In a steam-turbine, a shaft, a frusto-conical hub thereon provided with inclined blades, a frusto-conical shell surrounding the same and provided with outwardly and inwardly projecting blades, a frusto-conical casing around said shell having inwardly-projecting blades, means for connecting the shell to the hub, and means for connecting the shell to the casing, all combined.

3. In a steam-turbine, the combination of a fixed casing and a rotating hub, each provided with blades for the impact action of steam, and an intermediate piece provided with blades, and adapted to be connected to either the shell or the hub, and thereby serve to reverse the normal action of the engine.

4. The combination with the outer tapered casing having internally-projecting blades, the inner tapered hub having outwardly-projecting blades, and an intermediate tapered shell having both inwardly and outwardly projecting blades, and means for shifting the shell lengthwise, so that its inner set of blades may make contact with the hub, or its outer set of blades may make contact with the casing.

5. In a steam-turbine, a rotating shaft and its hub having blades, an intermediate shell having outwardly and inwardly projecting blades, an outer casing having inwardly-projecting blades, and movable valves for closing the entrance between shell and hub while opening the entrance between shell and casing, or vice versa, substantially as described.

6. In a steam-turbine, the combination with the shaft, bladed hub, and bladed casing, of a balance-disk on the shaft at the end of the casing remote from the hub.

7. In a steam-turbine, the combination with the shaft, bladed hub and bladed casing, of a balance-disk on the shaft at the opposite side of the steam-entrance from the hub, and of less diameter than the hub, and a thrust-bearing to support the excess of pressure.

8. In a steam-turbine, the shaft having a wheel thereon with tapered rim, and the shell longitudinally removable with reference to said wheel and having a tapered chamber which tightly closes on said rim when longitudinally shifted.

9. The combination with the bladed casing, bladed shell having tapered chambers, and shaft having wheels with tapered rims, of means for shifting the shell so that its tapered chambers may close onto or move away from said tapered wheel-rims.

10. The combination of a casing having interiorly-projecting blades and a seat against which the shifting shell may close, a shaft having a bladed hub thereon and a seat against which the shell may close, and an intermediate shell having both outwardly and inwardly projecting blades, and surfaces which close against the seat on the casing or on the shaft.

In testimony whereof I affix my signature in presence of two witnesses.

WILLIAM LLOYD WEBSTER.

Witnesses:

FRED J. STARR,

J. D. BROWER.