D. KEMBLE.

STEAM TURBINE.

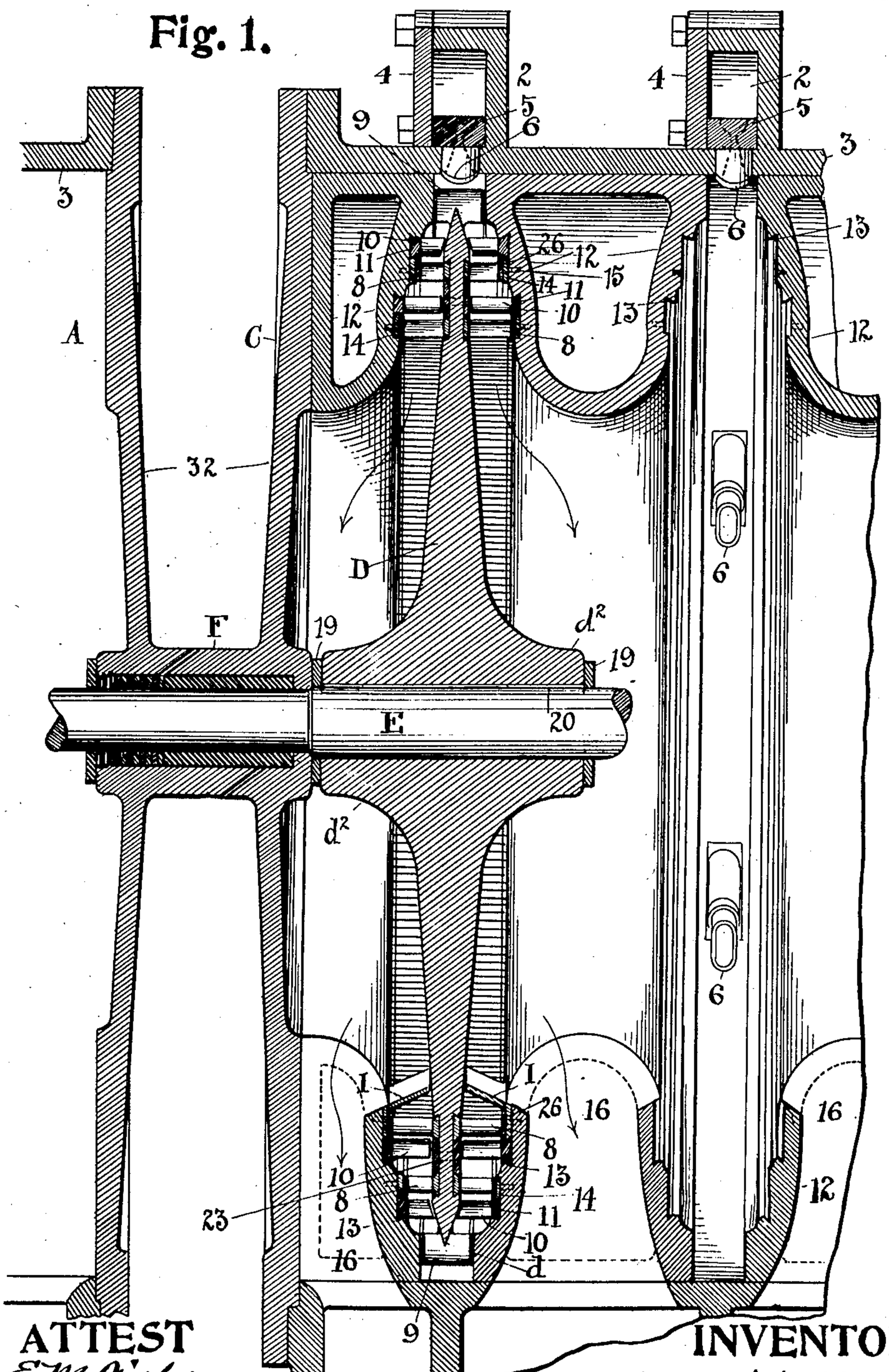
APPLICATION FILED FEB. 8, 1909.

927,658.

Patented July 13, 1909.

3 SHEETS—SHEET 1.

Fig. 1.



ATTEST

E. M. Fisher

F. C. Upscomb.

INVENTOR

Weston Kemble

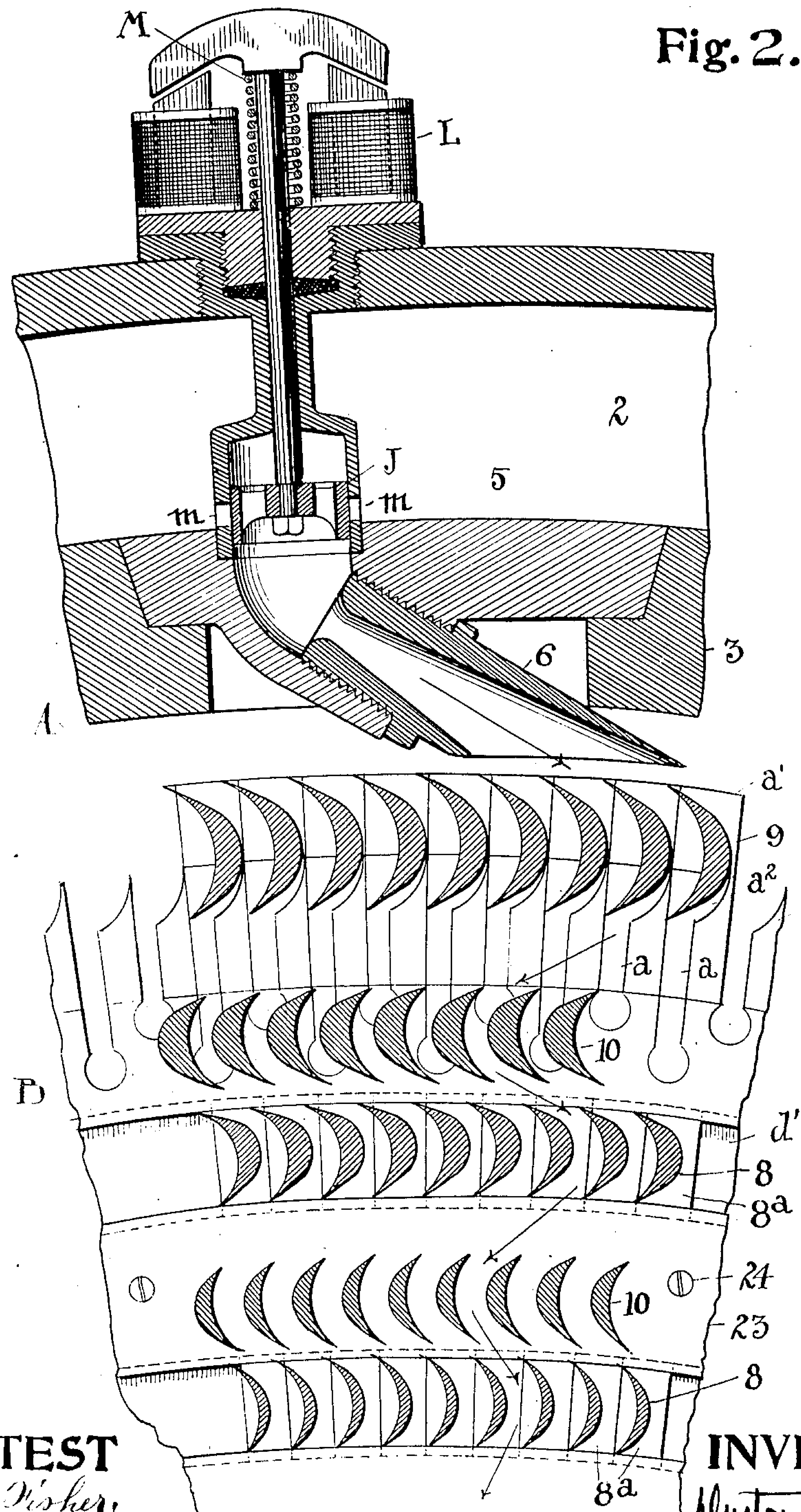
BY Fisher & Moser ATTYS.

D. KEMBLE.
STEAM TURBINE.
APPLICATION FILED FEB. 8, 1909.

927,658. Patented July 13, 1909.

3 SHEETS—SHEET 2.

Fig. 2.



ATTEST
E. M. Fisher
E. P. Museum

INVENTOR
Dunston Kemble

BY Fisher & Moser ATTYS.

D. KEMBLE.

STEAM TURBINE.

APPLICATION FILED FEB. 8, 1909.

927,658.

Patented July 13, 1909.

3 SHEETS—SHEET 3.

Fig. 3.

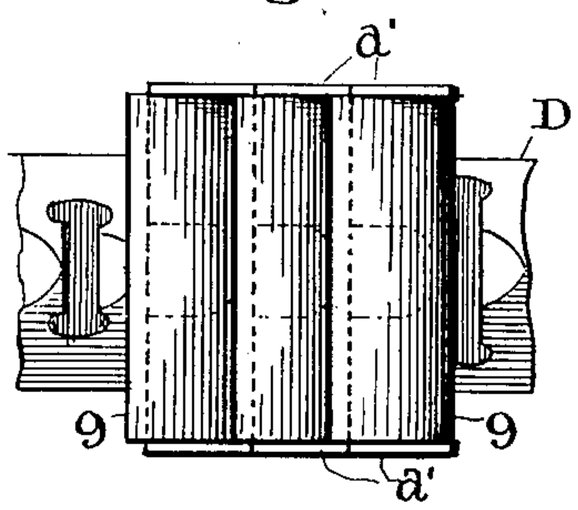


Fig. 4.

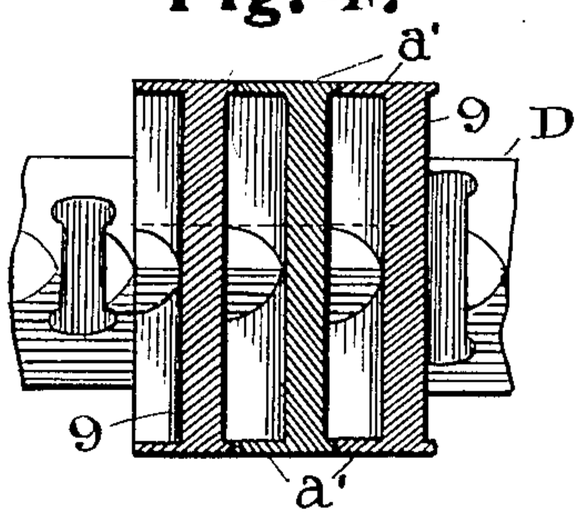


Fig. 5.

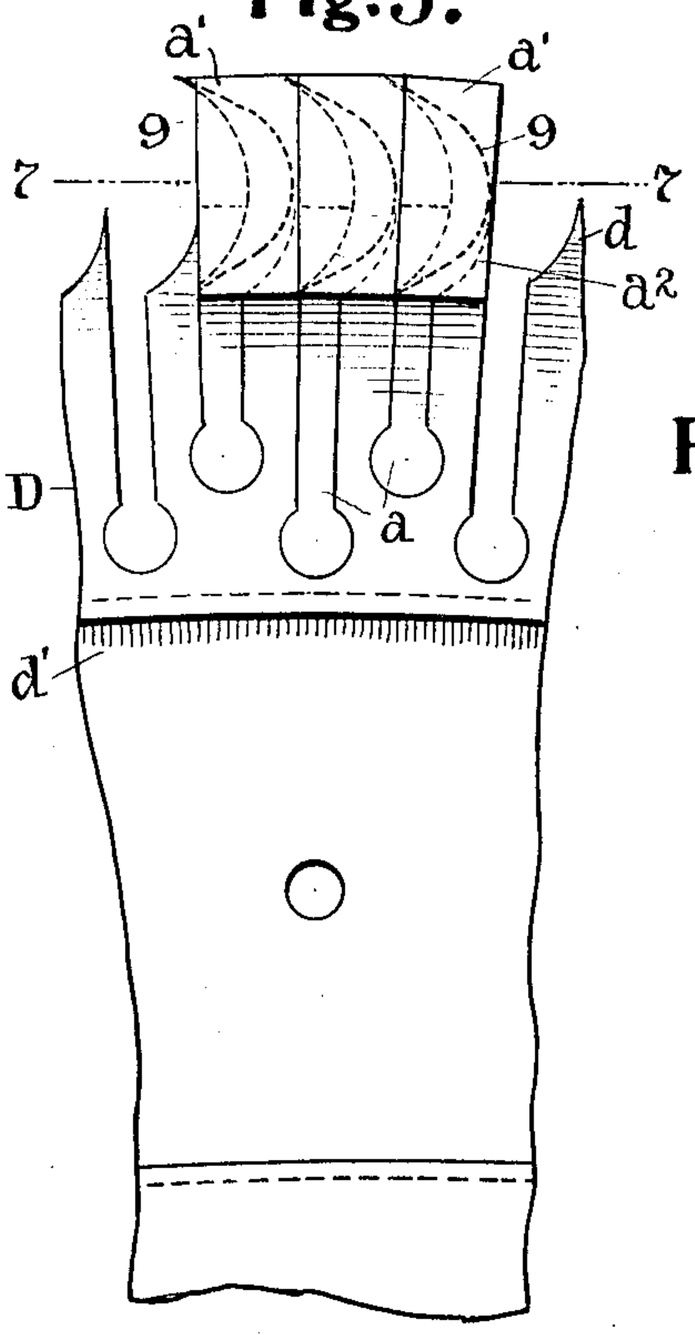


Fig. 6.

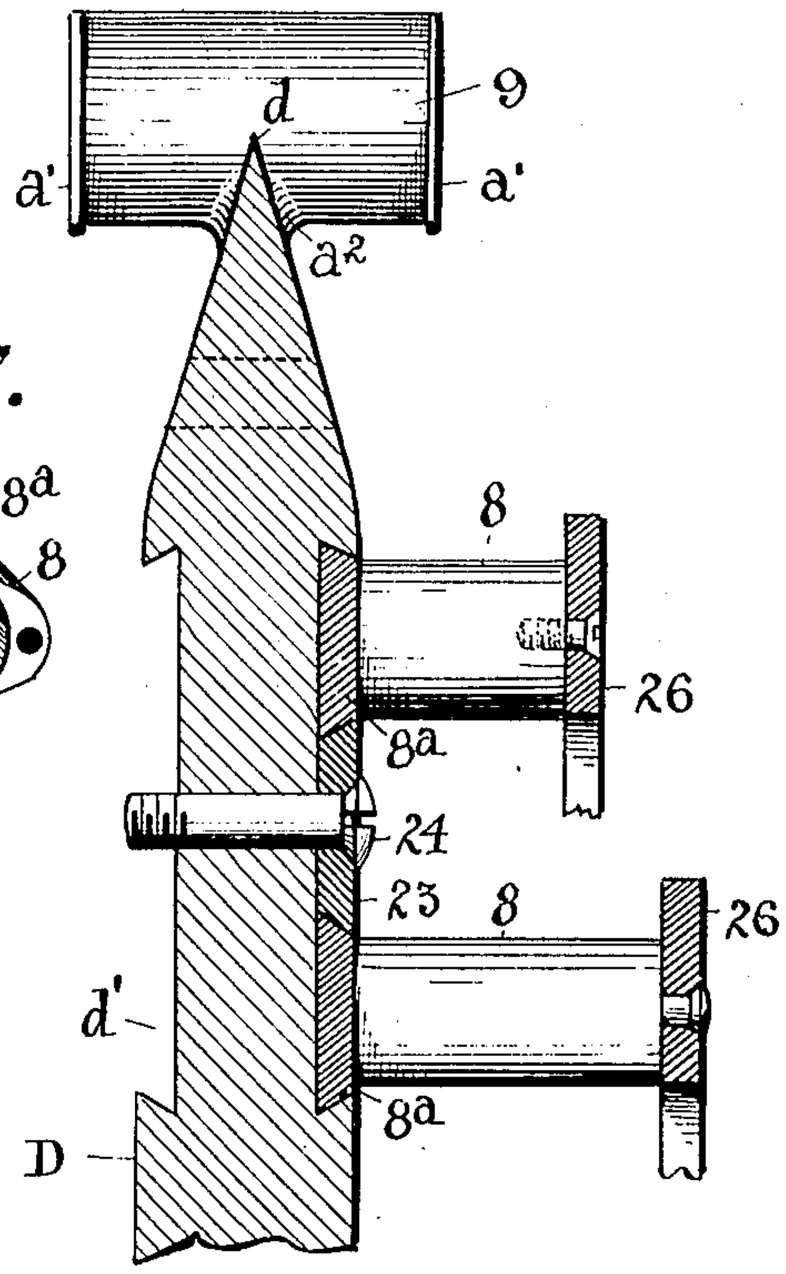
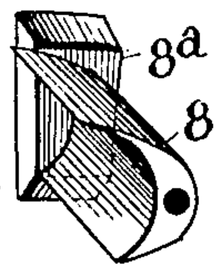


Fig. 7.



ATTEST

E. M. Fisher

F. C. Mussmus.

INVENTOR

Huston Kemble

BY Fisher & Moore ATTYS.

UNITED STATES PATENT OFFICE.

DUSTON KEMBLE, OF LAKEWOOD, OHIO.

STEAM-TURBINE.

No. 927,658. Specification of Letters Patent. Patented July 13, 1909.

Application filed February 8, 1909. Serial No. 476,833.

To all whom it may concern:

Be it known that I, DUSTON KEMBLE, citizen of the United States, residing at Lakewood, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvement in Steam-Turbines, of which the following is a specification.

My invention relates to steam turbines and is an improvement in the steam turbine disclosed in my application of August 17, 1908, Ser. No. 448,780, in which I applied the actuating steam by means of a set of expanding nozzles arranged circumferentially about a series of peripheral vanes set across the edge of a double beveled vane disk with inward radial flow; but exhausting from the wheel chamber through enlarged spaces in the chamber wall on both sides of the lower part of the vane disk. The original plan of this turbine was for one, two, or more pressure stages, as might be desired, with two or more vane disks arranged to run in parallel for each of the lower stages, and each disk having a separate set of steam nozzles arranged about its vanes circumferentially. To that general plan I now propose several modifications, and chiefly for the following aims and practical objects. First. To provide a plan of construction that will enable me to diminish the vane velocities employed without serious loss of steam economy, and thus to diminish the circumferential dimensions of the vane wheels without changing the rate of rotational speed per minute. Second. To secure greater flexibility of the general design for adaptation of the same to varying (various) sizes and powers of turbines without special changes of circumferential dimensions or rotational speed per minute, thus avoiding also special changes in the forms of vanes and nozzles. Third. To abridge the number of pressure stages that may be necessary to secure an economical steam consumption at a given rotational speed, and at the same time to provide means for a thorough regulation of the steam supply in due proportion to varying loads on the driven machine, which is supposed to be usually an electric generator.

In addition to the foregoing, other objects are also embodied in other details of construction all as hereinafter more specifically described.

Figure 1 is an enlarged sectional view longitudinally of the shaft of one end of the low pressure chamber and a vane wheel therein and showing the shaft bearing and a portion of the high pressure chamber. Fig. 2 is an enlarged cross sectional view of the high pressure chamber on the line of the valve controlled nozzles and showing a portion of a vane wheel and the vanes, both movable and stationary. Fig. 3 is a plan or edge view of a portion of a vane wheel and its peripheral vanes thereon, and Fig. 4 is a sectional view of the vanes taken on line 7—7, Fig. 5. Fig. 5 is a side view of a vane wheel with three peripheral vanes in place thereon, and Fig. 6 is a sectional view of a vane wheel with the side vanes at the right in place and the vanes on the opposite side removed. Fig. 7 is a perspective view of one of the side vanes alone.

As in my former turbine machine, I provide a high pressure chamber A having a single vane wheel B, and a low pressure chamber C having a series of vane wheels D, all the said vane wheels being mounted and secured in any suitable manner on a central shaft E having bearings F of such size, form and number as the size and capacity of the machine requires, and these bearings may be the same as shown in my application herein referred to or may be constructed variously and with special reference to the work to be done.

Now referring to the construction of my improved machine in detail, it will be noted that I now provide a circumferential channel 2 in the metal casing 3 part of the way around each vane wheel, with a detachable cap 4 of curved form to close one side of said channel, and mount removable blocks 5 of metal in seats in said channels, said blocks being provided with suitable removable nozzles 6 for carrying live steam to the nearest portions of the vane wheels inside of the wheel chamber. In the case of a single chamber containing a plurality of vane wheels, and likewise having a plurality of steam conducting pipes or channels to supply steam from a common source to the several circular sets of nozzles, it is evident that these channels in the metal casing might be made to run parallel with the shaft instead of circumferentially as described. Instead of limiting the several vane wheels to a single series of vanes placed about their periphery and extending beyond it in a radial direction as in my former arrangement, I now place one or more additional series of vanes 8 concentrically on each side of each

vane wheel to receive one or more further impulses from the steam particles after these have flowed through the peripheral set of vanes 9, thus enabling me to utilize the full kinetic energy of the steam with a less vane velocity than when only a single series of vanes is employed. Then, while still using nozzles that shall permit the steam particles to expand to the greater part of the volume and velocity that may be obtained by their passage from the higher to the lower pressures respectively existing in the feed channels and inside of the wheel chamber, yet to provide for the greater space that must be occupied by the said steam particles after their passage through each series of moving vanes, whether on account of further expansion or merely by reason of the loss of a portion of their velocity, I make the successive series of concentric moving vanes 8 longer and the spaces leading to them wider, as we proceed toward the wheel center, and in order to turn the steam particles after issuing from the first or second circle of moving vanes so that they shall strike the next circle of moving vanes at a proper angle to do their work most effectively, I interpose between the successive circles of moving vanes suitably formed circles of stationary guide vanes 10 that are firmly secured to annular pieces of metal 11 removably mounted on the inside of the removable sub-division walls 12, or possibly to integral walls of the wheel chamber itself. Usually, I shall prefer to employ, as a support for the circles of guide vanes, the said annular pieces of metal 11, and make the guide vanes of such shape and form in cross section so that they will dovetail or fit undercut portions 13 in the walls 12, and secure said pieces 11 further by flat rings 14 bolted in place upon the walls by screw bolts 15. Walls 12 are suitably grooved and fitted for holding the guide vanes 10 and rings 14. These annular pieces 11 may be employed in halves only in the end sections of each wheel chamber, whether in high or low pressure stages. The peripheral vanes 9 may be further described as having the axis of their outer and inner curved surfaces always substantially at a right angle with the plane of revolutions. And, in order to avoid excessive losses in the first impact, either by friction of the steam particles against the vane at a very high velocity, or by the shock of concussion when the radius of vane curvature is very short, I make the peripheral vanes 9 relatively large and of a wide radius of curvature, while both the stationary guide vanes 10 and moving vanes 8 for the second impact are narrower and of different curve radius; also the guide and moving vanes for the third impact are made of still different form and curvature.

To economize floor space and also the better to carry off the water of condensation, I locate the exhaust ports 16 in the low pressure wheel chamber at the very lowest part of the chamber, where the exhaust steam is to pass down through the supporting base of the machine by a more or less rectangular channel and thence directly to the condensing apparatus, (not shown but as in other turbines). The exhaust outlets 16 are preferably positioned at either side of the vane wheel at and through the bottom portion of the sub-division wall members 12, see Fig. 1, although not necessarily at this radial point of the circle, and I further support inwardly extending segments of baffle or guard plates I upon these walls adjacent to exhaust passages 16 and overlapping the vanes on the wheels at this point to deflect the escaping steam from the central area of the chamber away from the wheels and into said passages.

For simplicity of design, I use a solid wheel D having a double beveled peripheral edge d and annular undercut side channels d' within either side face at or near said edge, and each wheel has hubs d^2 which are spaced and separated on the shaft by metal washers 19, and each hub is secured to the shaft by splines 20 or small wedges of metal driven into channels symmetrically disposed on the shaft so as to preserve the most perfect alinement and balance of all the parts.

As herein shown, the peripheral vanes 9 have each a supporting shank a, but of different lengths with heads which alternate at unequal distances from the axis, thus preserving the stock at the edge of the disk from being cut away and weakened too much.

The moving vanes 8 are shown as dovetailed into the sides of the wheel by their keystone shaped supporting bases 8^a which are set into corresponding circular channels d' and are locked therein by light locking rings 23 having screws 24 to fasten the same to the wheel or disk. Or, the moving vanes may be set in short radially formed dovetailed channels in the wheel, if necessary on account of high velocity.

In this design I have shaped the peripheral vanes 9 with a flange a' on each side and with a central rib a^2 in the convex surface of each vane extending from about the middle of the vane measured radially down into the shank portion, or in other words, said rib is an extension of the shank-head a. This construction also provides for free sharp edges on the bottom side of the vanes toward the shaft in order to avoid any interference with the passing steam. It will also be seen that flanges a' on each side of vanes 9 abut edge to edge and close all exit of the steam at the sides thereof.

The side circles of moving vanes 8 and

also the circles of stationary guide vanes 10 may each be provided with a circular shroud or metal ring, with the ends of the vanes suitably secured thereto by means of screws or rivets, so as to afford them mutual support against the effects of centrifugal force or the impact of the live steam; but in such case, the guide and moving vanes must be matched as to steam surfaces to avoid needless interference with the passage of the steam at the ends of the vanes. Only the moving vanes 8 are shown as thus equipped with a ring 26, see Figs. 1 and 6.

What I claim is:

1. In a steam turbine, a vane wheel having individually removable peripheral vanes and individually removable side vanes, combined with stationary vanes individually and removably mounted intermediate of said wheel vanes.

2. In a steam turbine, a vane wheel having individually removable peripheral vanes, and a set of individually removable expanding nozzles mounted opposite thereto, combined with circles of laterally extending vanes mounted on said wheel at the side thereof, and circles of laterally extending vanes stationarily mounted intermediate of said wheel vanes.

3. In a steam turbine, a turbine casing and a vane wheel therein, said casing having a steam channel opposite said wheel combined with a nozzle member removably seated within said channel and adapted to be held to its seat by the pressure within said channel.

4. In a steam turbine, a disk wheel having a double-beveled outer edge and peripheral vanes thereon having dove-tailed bases, said wheel having an undercut circular channel on each side thereof in which to set the dovetailed bases of the side vanes, and a suitable locking ring on each side set in the said channel and engaged with said vane bases to secure the latter firmly in place.

5. In a steam turbine, a cylindrical turbine casing adapted to provide a wheel chamber having one or more annular pieces of metal substantially triangular in cross section fitted and suitably secured to its inner surface and provided with undercut circular channels and guide vanes seated therein, and locking rings for holding the circles of guide vanes in place, said annular pieces being used in halves only at the ends of the casing.

6. In a steam turbine, a plurality of disk-wheels, each having a single circle of peripheral vanes and other circles of vanes on the sides of the disk, in combination with a turbine casing and all adapted to provide a common wheel chamber and having a common main shaft therethrough for all said disk wheels, and a series of sub-division walls between the respective disk wheels open centrally thereto, and guide vanes on said walls opposite said disk wheels.

7. In a steam turbine, a plurality of disk wheels, each having a single circle of peripheral vanes and other circles of vanes on the sides of the disk, and said wheels having a common main shaft, in combination with a turbine casing having a common chamber for said wheels, and said casing sub-divided by annular walls adapted to provide separate circular recesses open centrally of the chamber at either side of said wheels, and guide vanes supported on the sides of said walls opposite said wheels.

8. In a steam turbine, a turbine casing having annular sub-division walls open centrally to provide a common wheel chamber, and a plurality of disk wheels, each having a single circle of peripheral vanes, in combination with other circles of vanes on the sides, and all said wheels being set on said shaft in said wheel chamber and divided by said annular walls, and guide vanes on the sides of said walls, and all the said wheels adapted to be operated in parallel by separate sets of feed nozzles mounted on said casing opposite said wheels.

9. In a steam turbine, a cylindrical turbine casing adapted to provide a wheel chamber and a series of vane wheels therein, said casing having an inner curved surface divided by removable annular metal supports for guide vanes into two or more circular recesses open toward the axis for the several disk wheels set to rotate therein, and the said turbine casing being provided with suitable fluid exhaust ports through its curved sides, and also through certain unutilized parts of the annular guide vane supports at points opposite the open spaces at the sides of the disk wheels or between the disk wheels.

10. In a steam turbine, a cylindrical casing having removable division walls of annular shape adapted to form a circular recess with a centrally disposed exhaust space, and said division walls having an exhaust outlet radially therethrough at the side of said chamber, combined with a vane wheel and steam nozzles arranged centrally between said division walls.

11. In a steam turbine, a cylindrical casing having a series of removable division walls of annular shape spaced apart at intervals to provide circular vane wheel chambers open centrally to pairs of vane wheels for the exhaust therefrom and provided with radial exhaust outlets through said walls, combined with vane wheels mounted to rotate in said chambers, and a series of steam nozzles mounted on said casing opposite each vane wheel.

12. In a steam turbine, a cylindrical casing having a vane wheel chamber therein and a concentric steam channel opposite

thereto on the outside of said casing, a removable plate to close said channel, a nozzle holding member removably seated upon the bottom of said channel, and a nozzle removably mounted in said member, combined with a vane wheel mounted to rotate in said vane wheel chamber opposite said nozzle.

13. In a steam turbine, a cylindrical casing having removable division walls of annular shape and stepped formation adapted to provide a circular vane wheel chamber of graduated width narrowest at its extreme circumference, and each succeeding step of said walls being formed by an annular channel concave in cross section, combined with a vane wheel having peripheral vanes and side vanes of varying lengths adapted to rotate within said chamber, and an expanding nozzle for said wheel.

14. A steam turbine having central steam spaces for the used steam and exhaust outlets leading therefrom, and a vane wheel having vanes at its peripheral edge and at both sides thereof, and baffle plates for said side vanes within said steam spaces to divert the used steam to said exhaust outlets.

15. In a steam turbine, a cylindrical turbine casing and a vane wheel rotatably mounted therein having peripheral vanes and side vanes, said casing having spaces at each side of said wheel for the used steam and exhaust outlets open thereto, and segmental baffle plates mounted opposite said exhaust outlets to divert the used steam from said side vanes at those points.

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

DUSTON KEMBLE.

Witnesses:
E. M. FISHER,
R. B. MOSER.