No. 661,183. Patented Nov. 6, 1900.

S. LOUNT.

# RADIAL FLOW STEAM TURBINE ENGINE OR MOTOR.

(Application filed Apr. 10, 1899.)

(No Model.) 2 Sheets—Sheet 1.

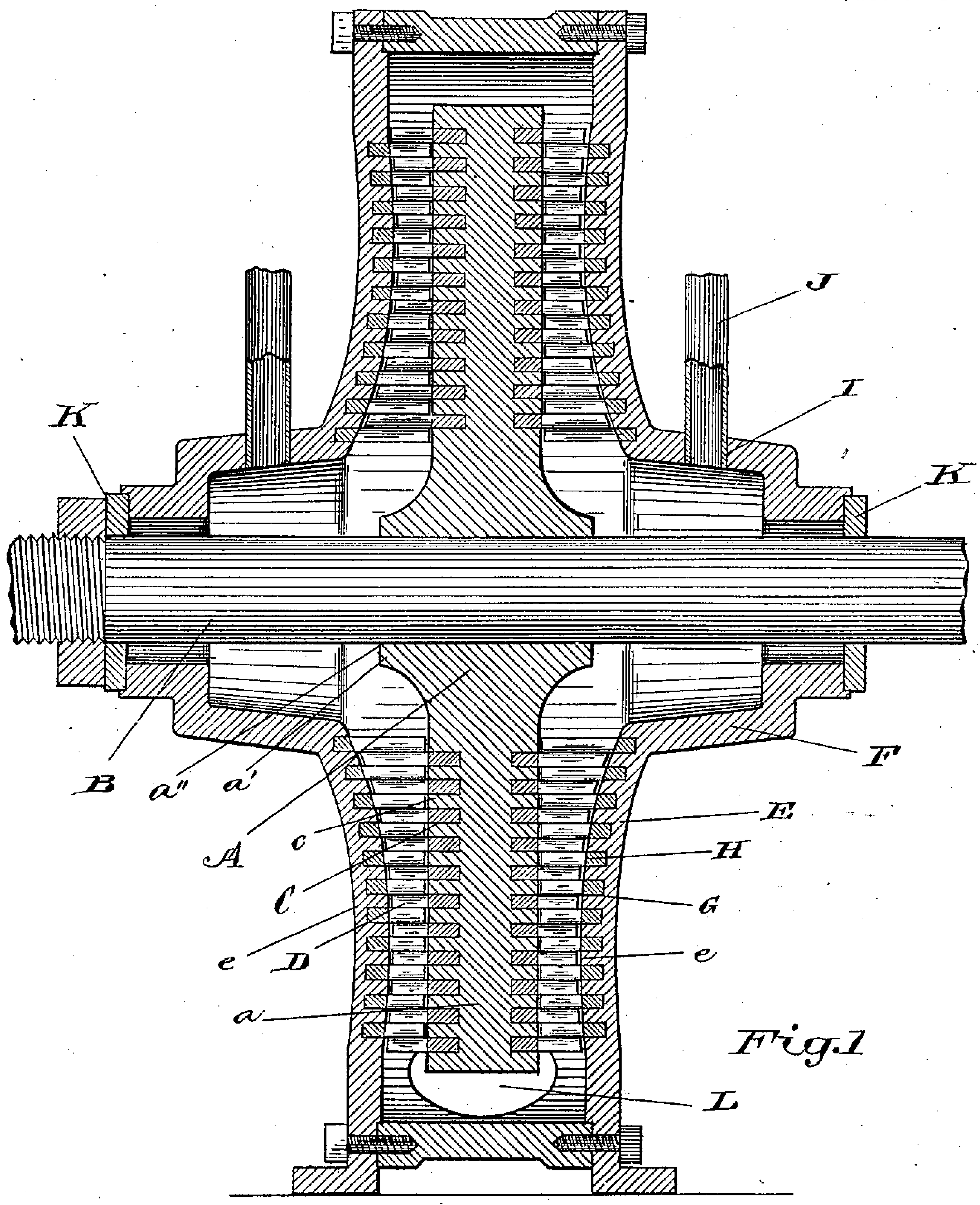


Fig.1

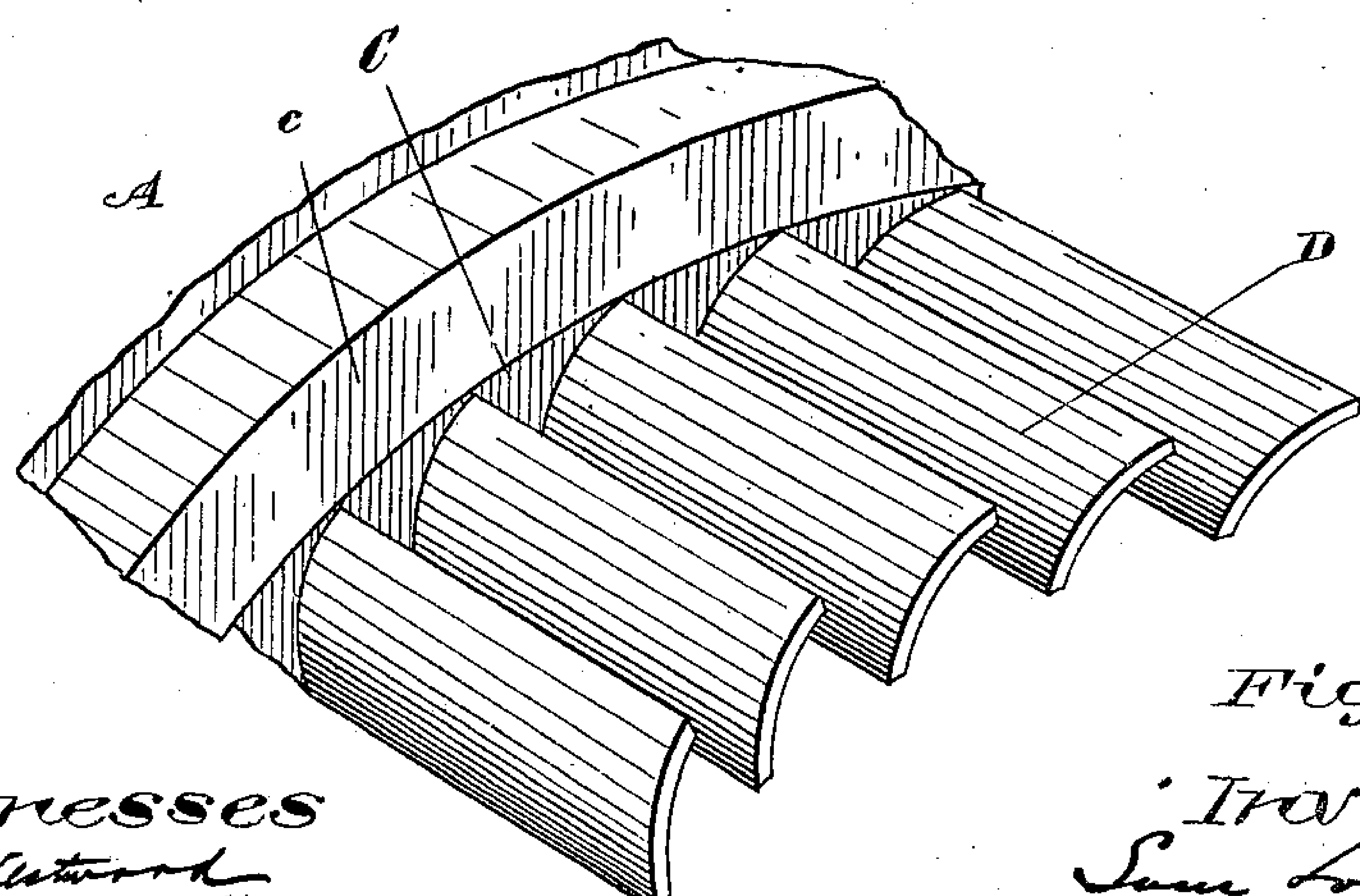


Fig.2

Witnesses

Inventor

Sam Lount

by his atty

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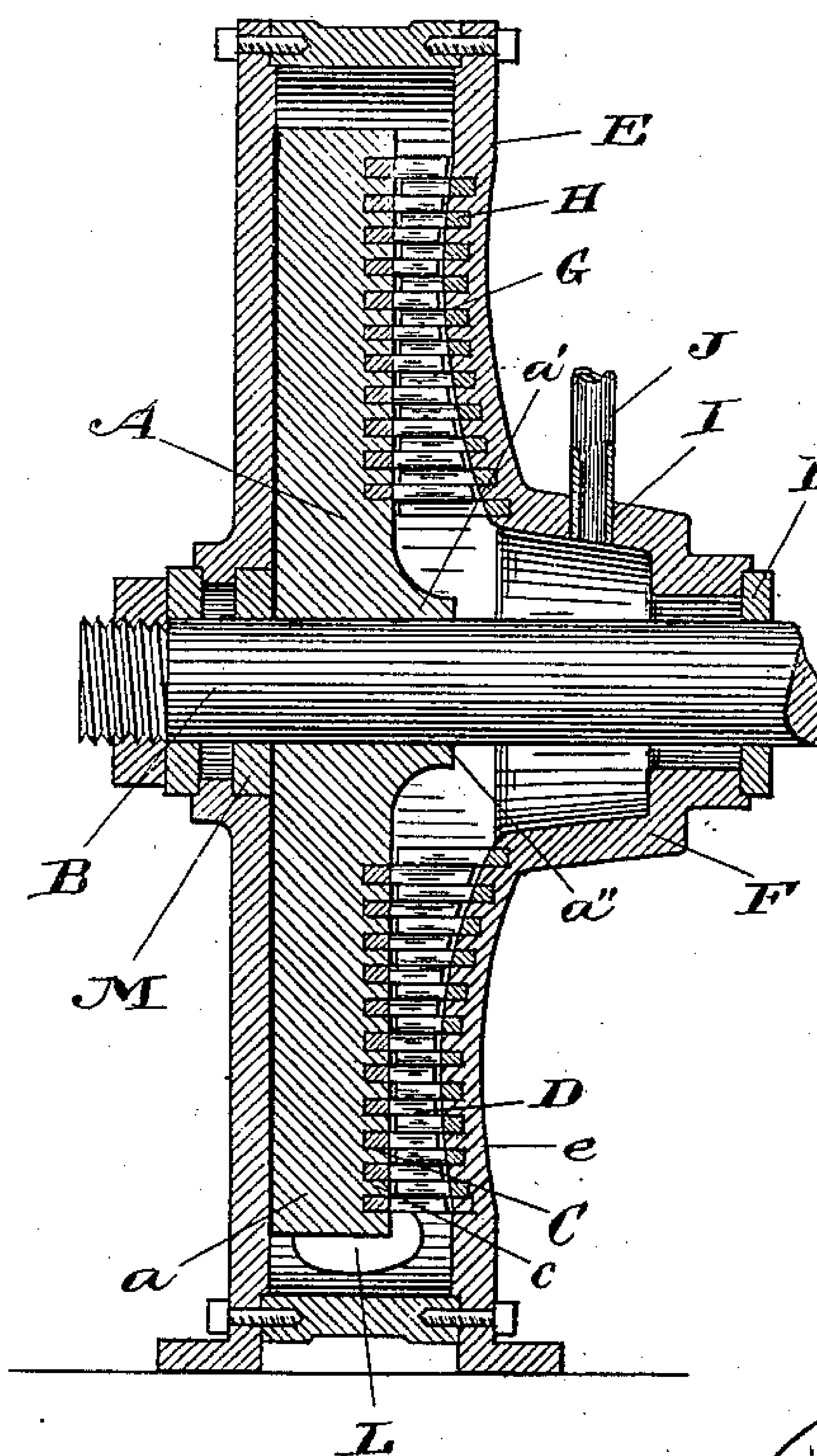


Fig. 3

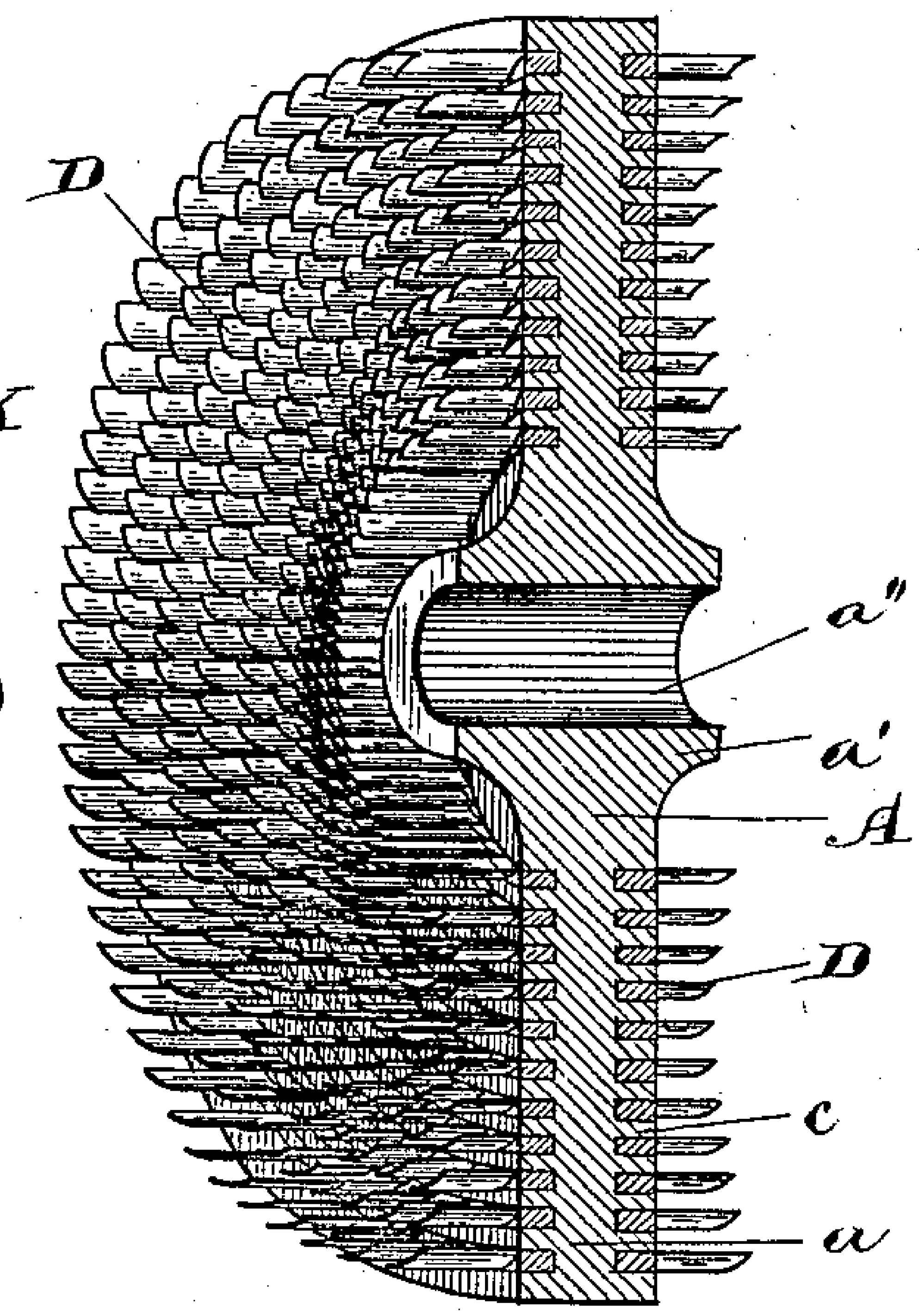


Fig. 4

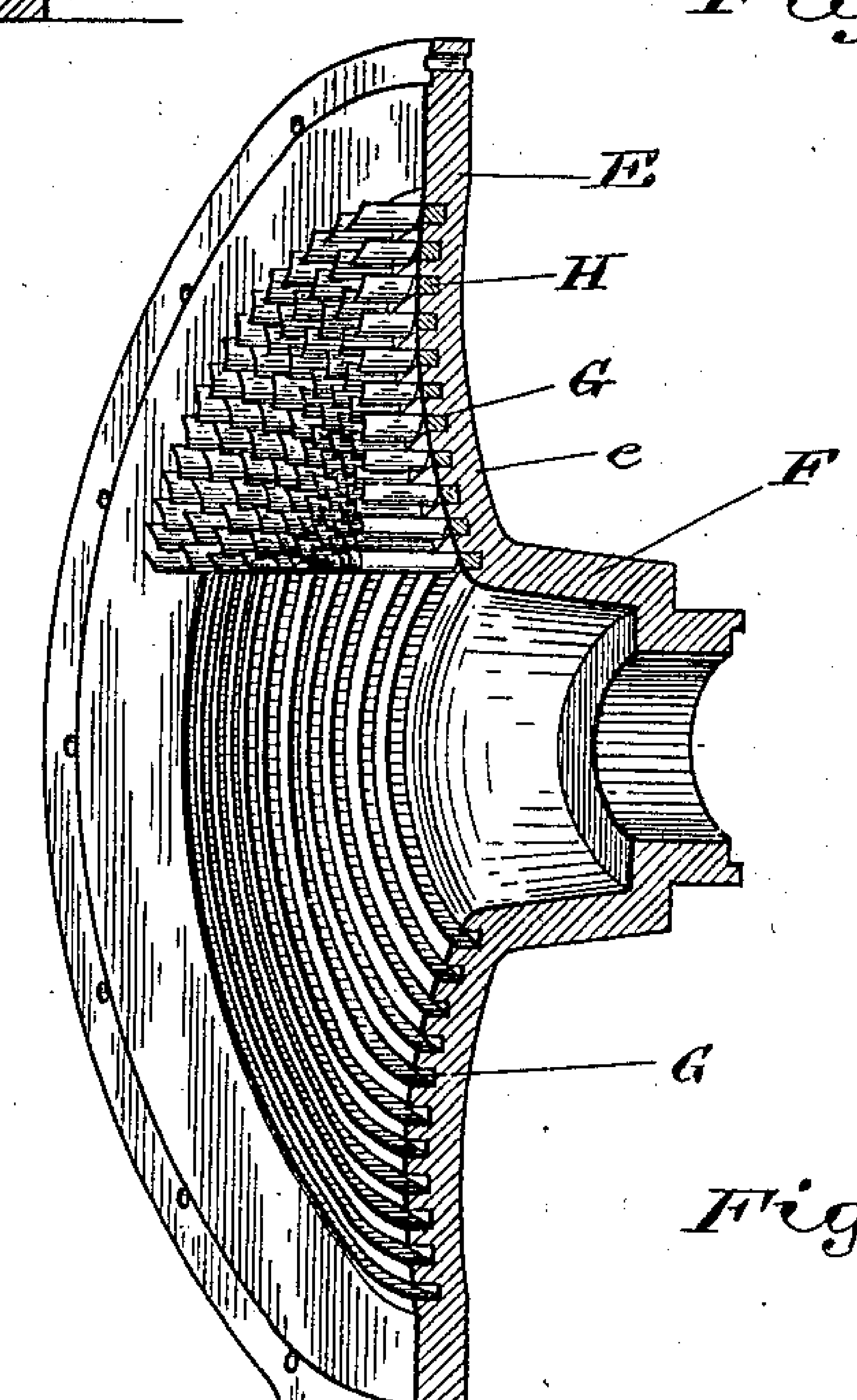


Fig. 5

Witnesses
M. A. Westwood
J. E. Cameron

Inventor
Sam Lount
by C H Riches
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# UNITED STATES PATENT OFFICE.

SAMUEL LOUNT, OF BARRIE, CANADA.

## RADIAL-FLOW STEAM-TURBINE ENGINE OR MOTOR.

SPECIFICATION forming part of Letters Patent No. 661,183, dated November 6, 1900.

Application filed April 10, 1899. Serial No. 712,558. (No model.)

*To all whom it may concern:*

Be it known that I, SAMUEL LOUNT, a subject of the Queen of Great Britain, residing in the town of Barrie, in the county of Simcoe and Province of Ontario, Canada, have invented certain new and useful Improvements in Radial-Flow Steam-Turbine Engines or Motors; and I hereby declare that the following is a full, clear, and exact description of the same.

This invention relates to a radial-flow steam-turbine engine or motor, and more particularly to the peculiar construction of its parts and the manner of admission, flow, and exhaust of the actuating fluid.

The object of the invention is to devise an economically-working motor in which the velocity of the steam while doing work on the motor shall be under complete control and the speed of the engine at best efficiency shall be within practicable limits.

The invention consists of the following construction: To a shaft passing through the casing of the engine and journaled in bearings at either side is attached a disk-like driving-wheel, both sides of which are provided with three or more circular concentric sets of blades or vanes, the inner ends or bases of which are securely fastened in concentric grooves channeled in the side faces of the disk. These blades are preferably stamped out of thin sheet metal and are so formed that when secured in place they will project from the face of the disk parallel to the axis of revolution and be inclined as to their width secant to the circle of revolution. The blades of each set are of exactly the same length; but they vary in length in the different sets, decreasing or increasing from the central set outward as requisite to regulate the port area of the various sets, and so control the effluent velocity of the steam in its passage between the blades. As the blades are intended to extend to the face of the casing, (without actual contact,) this decrease or increase in their length is obtained by curving radially the face of the casing toward or from the face of the disk, between which faces the blades project. To the curved inner face of the opposite sides of the casing of the engine are fixed three or more concentric sets of stationary blades secured in concentric channeled grooves corresponding in location with the spaces between the sets of blades on the revolving disk in order that when the parts are assembled in position the stationary and moving sets of blades will intermesh. The stationary blades or vanes are made and secured in place in a similar manner to the moving blades or vanes and project to the face of the disk (but without actual contact therewith) parallel to the axis of revolution of the wheel, but inclined as to their width in a direction opposed to the inclination of the moving blades. The intervening space between the sets of stationary blades and between the sets of moving blades is sufficient only to allow of the free revolution of the latter without interference between the parts. The two sides of the driving-wheel with their blades attached are exact counterparts of each other, and the two sides of the casing with their blades attached are also counterparts. By this method of construction an engine is obtained evenly balanced as to the pressure of the actuating fluid and capable of most efficiently utilizing the mechanical energy of the steam in its passage through the engine; but while it is preferable to use, still it is not desirable to confine the invention to the above construction, as primarily the system may be limited by providing one face of the driving-wheel and the opposed face of the casing with blades or vanes and admitting the steam to such face only, whereas in the former case the steam is admitted simultaneously to both faces of the driving-wheel for the purpose of obtaining equilibrium of pressure.

When using high-pressure steam operating through a wider range of expansion than can be conveniently utilized in a single motor, the motor can be compounded by employing two or more suitably-constructed driving-wheels operating in separate casings on the same or different shafts, the steam being exhausted through the terminal port of the first motor to the admission-port of the second and so on until exhausted from the last motor of the series.

The rotational force of the engine is obtained as follows: The steam is admitted centrally to the motor and, expanding radially between the central ring of stationary blades, strikes with the force of its momentum the central ring of moving blades on the driving-wheel, reacts through them against the next outwardly ring of stationary blades, which in turn deflect the fluid against further outwardly-moving blades, and so on from ring to ring until the external space between the wheel and casing is reached, whence by means of an exhaust-pipe it is conducted to the next motor or to the air or a condenser.

By slightly modifying the construction and applying rotational force to the shaft the engine may be used as an elastic-fluid compressor.

In the drawings, Figure 1 is a sectional view of the steam-turbine motor, showing the relative positions of the various parts. Fig. 2 is a perspective view of a section of the driving-wheel and several of the blades or vanes. Fig. 3 is a sectional view of a modification of the steam-turbine motor, showing the blades or vanes on one side only. Fig. 4 is a sectional perspective view of the driving-wheel. Fig. 5 is a sectional perspective view of one of the sides of the casing.

Like letters of reference refer to like parts throughout the specification and drawings.

The driving-wheel A consists of a disk-like body or web $a$ and a hub $a'$, integrally formed with the body or web, having a central bore $a''$, through which passes the shaft B, keyed or otherwise fastened to the hub in order that it will rotate unitedly with the driving-wheel. Formed in each side face of the web $a$ are a series of concentric channels or grooves C, each of which is adapted to receive a set of blades or vanes D. Each set of blades or vanes consists of a ribbon of thin sheet-steel (though any other metal suitable for the purpose may be used) cut and bent to the requisite shape to form the blades or vanes which project outwardly from the body of the ribbon in such a manner that when they are in position on the driving-wheel they will curve in a line secant to the circle of revolution. Although a specified number of sets of blades or vanes have been shown in the drawings, it is not intended that the invention should be confined to any particular number, as the driving-wheel may be provided with any number of sets to meet the requirements for which the motor is intended.

Inclosing the driving-wheel and a portion of the shaft is the body E of the casing, the inner faces of which are arched or convexed toward the side faces of the driving-wheel, and projecting equally beyond both sides of the body E is a central enlargement F. The inner face of each of the opposite sides $e$ $e$ of the casing is provided with concentric channels G, similar to the channels in the side faces of the disk and so arranged as to be opposed to the spaces $c$, intervening between the channels C.

Contained in each channel G is a set of blades or vanes H, respectively corresponding with the blades or vanes connected to the side faces of the driving-wheel, but projecting in the reverse direction and inclined as to their width in a direction opposed to the inclination of the moving vanes. The blades or vanes of the first sets connected to the sides of the casing are interposed between the hub and first sets of blades or vanes connected to the driving-wheel, the second sets of blades or vanes connected to the casing being interposed between the first and the second sets of the driving-wheel, and so on outwardly to the last successive sets, with sufficient clearance only between them to allow of the free rotation of the moving blades or vanes.

Formed through the enlargement F on each side of the body E is an opening I, communicating with a steam-pipe J, and formed in the sides of the enlargement F are bearings K for the shaft B. Steam is admitted to the center of the enlargement F on each side of the driving-wheel with a comparatively high initial pressure and expanding radially acts upon the fixed blades or vanes of the first set, from which it is deflected against the first set of moving blades or vanes with sufficient force and velocity to cause their rotation, and so on outward against each set of fixed and moving vanes in succession until it has passed the last set, after which it is exhausted through the exhaust-pipe L, connected to the outer part of the casing E.

In the modification shown in Fig. 3 the motor would be subjected to a force having a tendency to move the driving-wheel laterally and cause an end movement of the shaft. In order to check this end thrust, the shaft is provided with thrust-collars M, which act against the bearings for the shaft.

As the velocity with which an elastic fluid under compression will flow from one vessel into another depends upon the density of the fluid in the discharging vessel and the difference in pressure between the vessels, it may be conceived that in a series of connected vessels discharging from one to another if the pressure in the first and last vessels of the series be kept constant and the area of the discharge-orifices of all the vessels be properly adjusted the flow of fluid through the series of vessels from the highest pressure to the lowest may be maintained at an even rate, or, if desired, at a constantly-increasing velocity. In the application of this principle to the engine which is the subject of this invention the central steam-space of the engine is the first vessel of the series whose discharge-orifice is the port area at the tips of the central ring of stationary blades. The space occupied by the central ring of rotating blades is the next vessel of the series, that occupied by the next outwardly ring of stationary blades the third vessel, and so on to the external space between the periphery of the wheel and the casing, which is the last vessel of the series, the port area at the tips of each ring being the discharge-orifice of the vessel whose space the ring occupies.

To preserve equality of action of the steam on the blades in the different concentric circles, one of two sets of conditions must exist. Either the inclination of the blades must approach more and more nearly a right angle to the disk radii passing through them as the distance of the blades from the center of the disk increases and the velocity of flow of steam be uniform at all points or the velocity of the flow of steam must increase as it gets farther away from the center of the disk and the inclination of the blades be uniform throughout or the two conditions may coexist to a modified extent. This increase in the velocity of the steam must be brought about by having the ratio between the area of the port-openings between the blades of the successive circles and the volume of steam passing through them decrease as the steam gets farther and farther from the center of the disk. The area of these port-openings may be controlled by making the blades in the successive circles thicker or thinner and so reducing or increasing the space between them or by varying the length of the blades and bringing the opposing faces of disk and casing nearer together or farther apart.

I have illustrated a construction in which the inclination of the blades is uniform throughout—that is to say, all the blades set in the rotating disk have a common angle of inclination and all those set in the stationary disk also have a common angle of inclination. Consequently the speed of flow of the steam from center to circumference must increase as the distance from the center increases if the result sought for is to be secured—that is to say, if the radius of the first circle of blades is ten inches and that of another circle of blades is twenty inches the steam must travel past the blades of the second circle with a radial velocity double that with which it travels past the blades in the first circle.

In the apparatus illustrated the blades on each disk are all of the same thickness. Consequently the area of port-openings for different circles of blades will vary as the products of the circumference of each circle into the length of the blades in that circle. The length of the blades is determined by the distance between the opposing faces of the rotating disk and of the inclosing casing. If the distance between these faces be the same at all points, the area of port-openings of the second circle of blades above selected would be double that of the first. In such case if the speed of radial flow of steam is also to be doubled four times the volume of steam must pass through the port-openings between the second circle of blades as entered through the first circle. As a matter of fact, however, my calculations show that with an initial pressure of twenty pounds to the square inch at the first circle and an initial velocity of three hundred feet per second a given quantity of steam would be expanded to only about double its volume by such a drop in pressure as would create a difference of pressures sufficient to have doubled its velocity by the time it reached the twenty-inch circle of blades. Consequently if under the conditions thus assumed the speed is to be doubled the volume of steam that must pass through the ports having been doubled by expansion the area of port-openings must be the same in the second circle as in the first. Since one dimension of the port-openings—the one in the direction of the circumference of the circle—is necessarily doubled on the second circle by the conditions of construction, the only way in which the area of the ports can be maintained equal is by reducing the other dimension—the distance between disk and casing—by one-half. By doing that the result of equal action of steam on the two sets of blades is secured. The same process of calculation applied to the other circles of blades produces a curvature of the surfaces of one or both disks and consequent varying length of blades of the character shown in the drawings. While the equation of the curve varies for engines of different proportions and for steam at different initial pressures and velocities, its distinguishing characteristic is that starting at the innermost circle it approaches the opposing face for a certain distance, reaching its nearest point at about the circle of double radius, and from that point on begins to recede from the opposing face, the distance between the opposing faces increasing as the perimeter is approached.

The mode of operation of the invention is clear from the foregoing description and explanation. Steam being admitted at the hub through pipe J flows to the perimeter at a velocity increasing as the radii of the successive circles of blades. As the successive sets of blades travel across the line of motion of the steam at a circumferential velocity, also increasing as the radii of their respective circles, the action of the steam will be the same on all the blades and the highest efficiency will result. The required uniform increase of speed of steam is secured in the apparatus illustrated by so varying the distances between the opposing faces of the disk and the casing at different distances from the center that the ratio of the various volumes of expanded steam to the area of port-openings through which each particular volume passes shall increase also as the distance from the center of the disk increases. This may be expressed in different terms by saying that the area of the port-openings in the successive circles varies as the ratio of the coefficient of expansion of the steam passing that point to the circumference or the radius of that circle, this being a mere transformation of the equation $\frac{E}{A} = R$ to $E = A \times R$ and $A = \frac{E}{R}$, where E represents the coefficient of expansion, A the area of the port-openings in any one circle, and R the radius of that circle.

Having therefore described my invention, what I claim is—

1. In a turbine motor the combination of the shaft, a driving-disk thereon, a series of blades set in concentric circles on said disk parallel to the driving-shaft and each inclined at a uniform angle to the radius of the disk passing through it, a casing for said disk in which the driving-shaft is journaled, a corresponding series of blades of opposite inclination set in the inner face of the casing, each circle of blades set in the disk running between two circles of blades set in the casing, a steam-inlet at the center of the casing, and a steam-outlet at the perimeter of the casing, the disk and casing being so shaped that the distances between them at different points shall vary so as to produce such port-openings at the various circles of blades that at every point the ratio of expansion of the steam to the area of port-opening shall vary as the distance from the center of the disk varies.

2. In a turbine motor, the combination of the shaft, a driving-disk thereon, a series of blades set in concentric circles on said disk parallel to the driving-shaft and each inclined at a uniform angle to the radius of the disk passing through it, a casing for said disk in which the driving-shaft is journaled, a corresponding series of blades of opposite inclination set in the inner face of the casing, each circle of blades set in the disk running between two circles of blades set in the casing, a steam-inlet at the center of the casing and a steam-outlet at the perimeter of the casing, the disk and casing being so shaped that the distance between them decreases in a curve which begins at the inner circle of blades, reaches its minimum at an intermediate circle of blades, and then increases as the perimeter of the disk is approached.

3. In a turbine motor, the combination of the shaft, a driving-disk thereon, a series of blades set in concentric circles on said disk parallel to the driving-shaft and each inclined at a uniform angle to the radius of the disk passing through it, a casing for said disk in which the driving-shaft is journaled, a corresponding series of blades of opposite inclination set in the inner face of the casing, each circle of blades set in the disk running between two circles of blades set in the casing, a steam-inlet at the center of the casing and a steam-outlet at the perimeter of the casing, the area of the port-openings in the successive circles of blades varying from the inner to the outer circle as the ratio of the coefficient of expansion of steam at any one circle of blades to the radius of said circle.

Barrie, Canada, March 30, A. D. 1899.

SAM. LOUNT.

In presence of—
HENRY HARPER,
GEO. W. LOUNT.