No. 898,127. PATENTED SEPT. 8, 1908.

M. R. MOORE.

TURBINE.

APPLICATION FILED JULY 22, 1904. 6 SHEETS—SHEET 1.

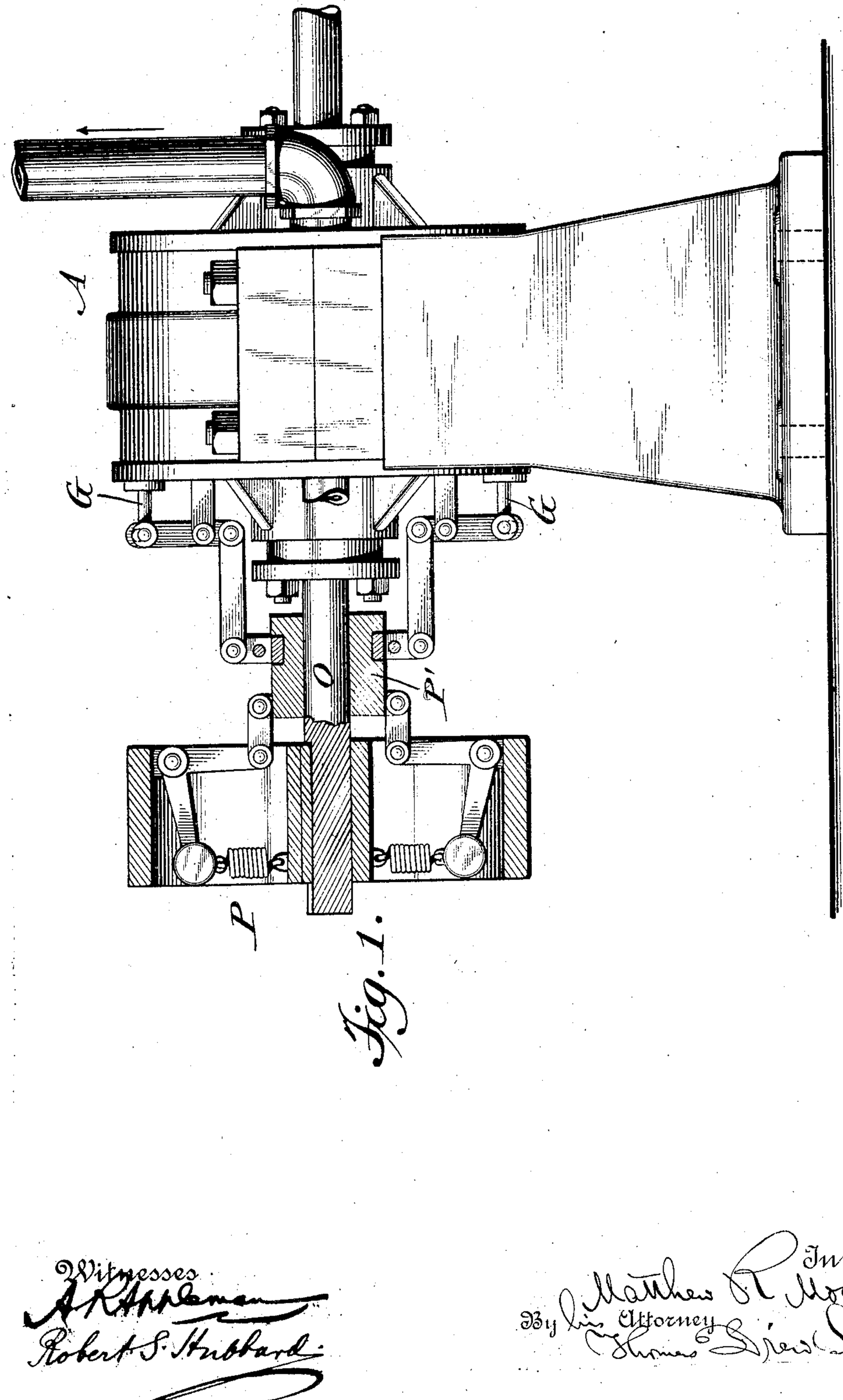


Fig. 1.

Witnesses
A. K. Stedman
Robert S. Stubbard.

Inventor
Matthew R. Moore
By his Attorney
Thomas Dyer Stetson

No. 898,127. PATENTED SEPT. 8, 1908.

M. R. MOORE.

TURBINE.

APPLICATION FILED JULY 22, 1904. 6 SHEETS—SHEET 2.

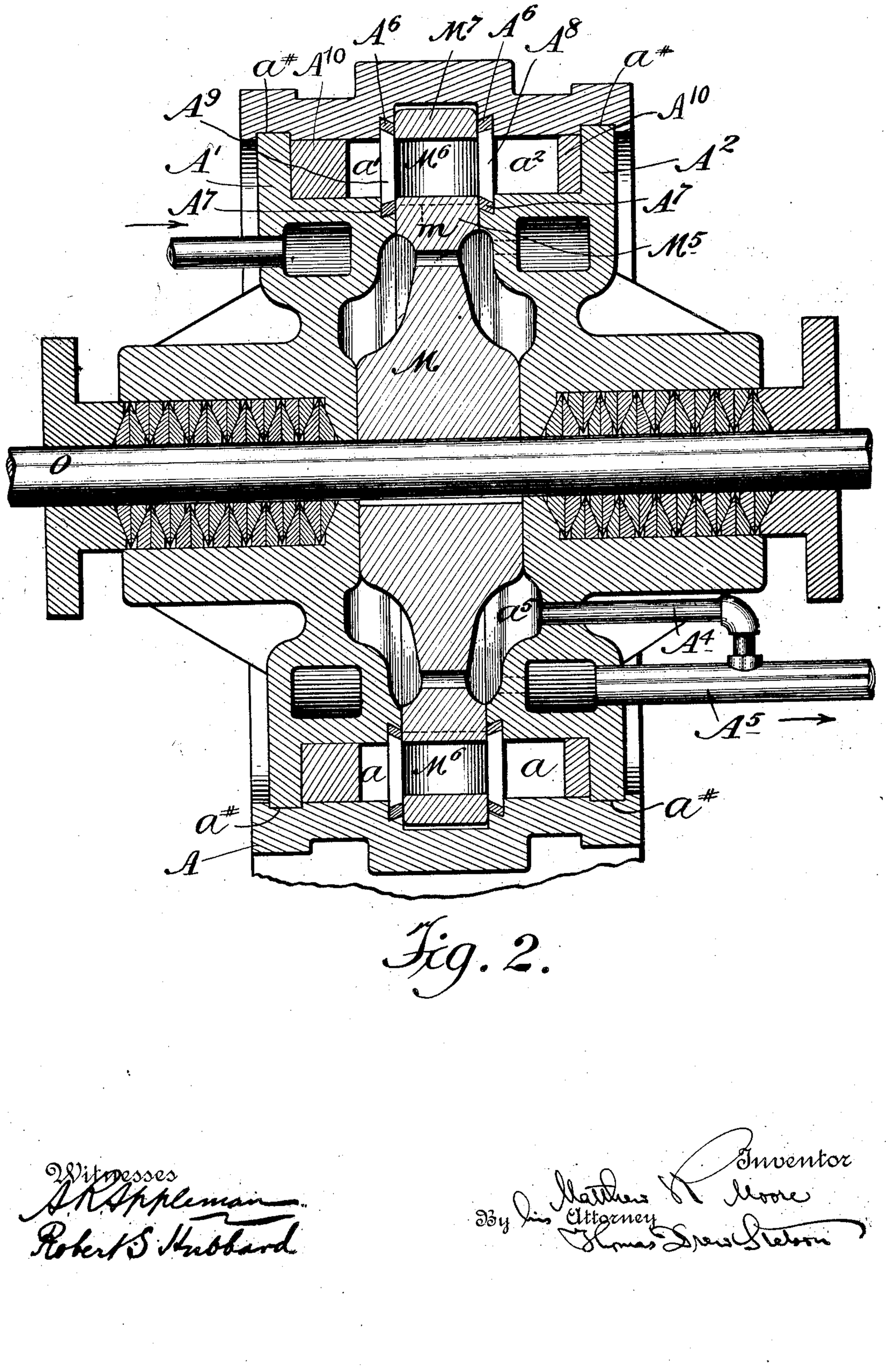


Fig. 2.

Witnesses
A. R. Appleman
Robert S. Hubbard

Inventor
Matthew R. Moore
By his Attorney
Thomas Drew Sloan

No. 898,127. PATENTED SEPT. 8, 1908.

M. R. MOORE.

TURBINE.

APPLICATION FILED JULY 22, 1904. 6 SHEETS—SHEET 3.

Fig. 2a.

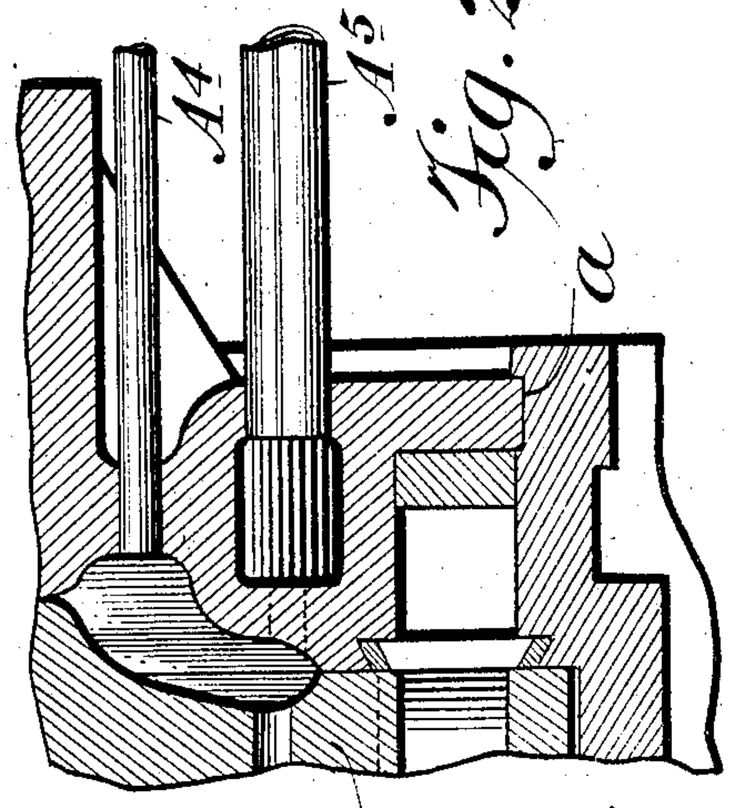
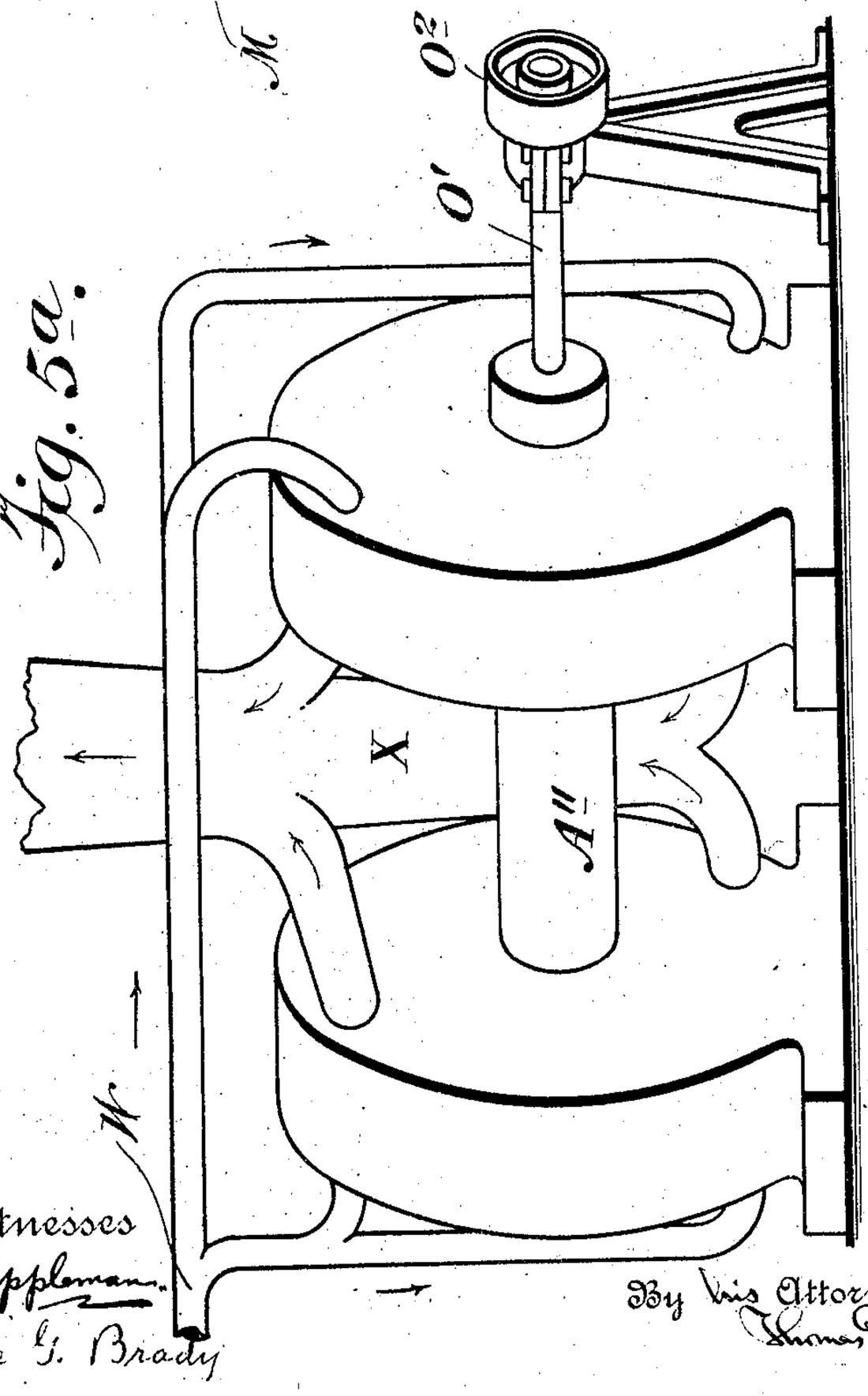


Fig. 5a.



Witnesses
A. R. Appleman.
Bessie G. Brady

Inventor
M. R. Moore
By his Attorneys
Thomas Drew Stetson

No. 898,127. PATENTED SEPT. 8, 1908.

M. R. MOORE.

TURBINE.

APPLICATION FILED JULY 22, 1904. 6 SHEETS—SHEET 4.

Fig. 3.

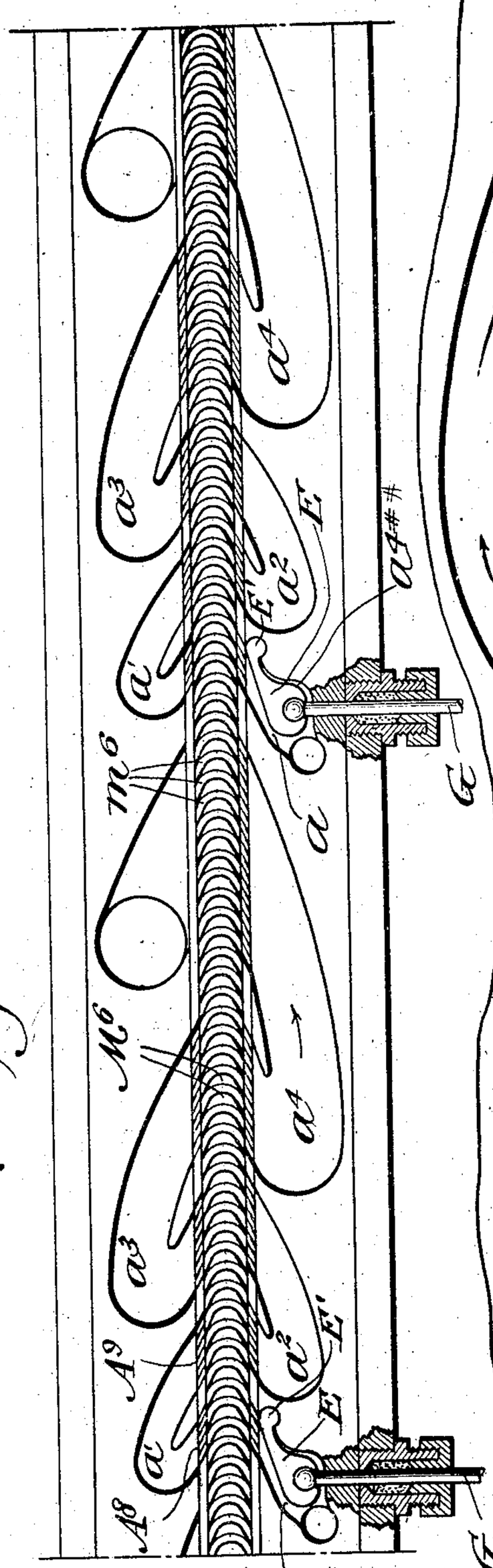
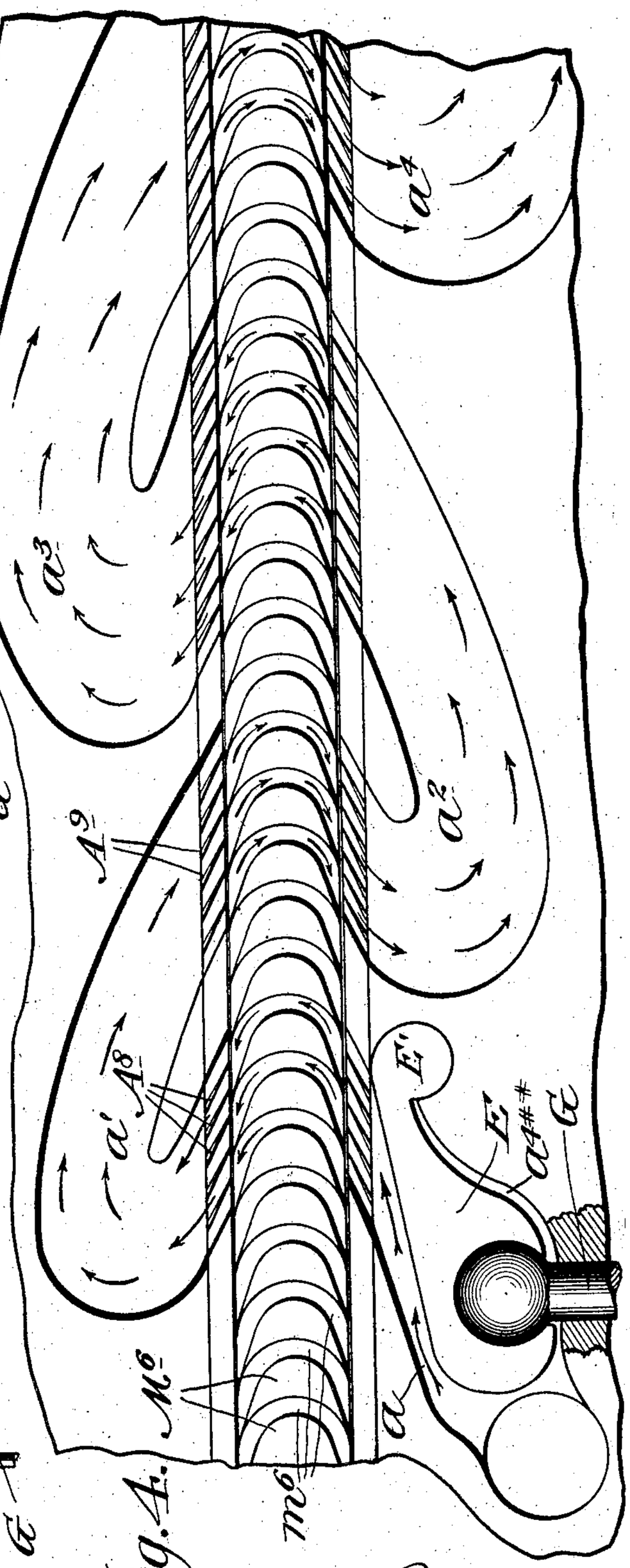


Fig. 4.



Witnesses
A. R. Stoppleman
Robert S. Hubbard

Inventor
Matthew R. Moore
By his Attorney
Thomas Drew Sloteon

No. 898,127. PATENTED SEPT. 8, 1908.

M. R. MOORE.

TURBINE.

APPLICATION FILED JULY 22, 1904.

6 SHEETS—SHEET 5.

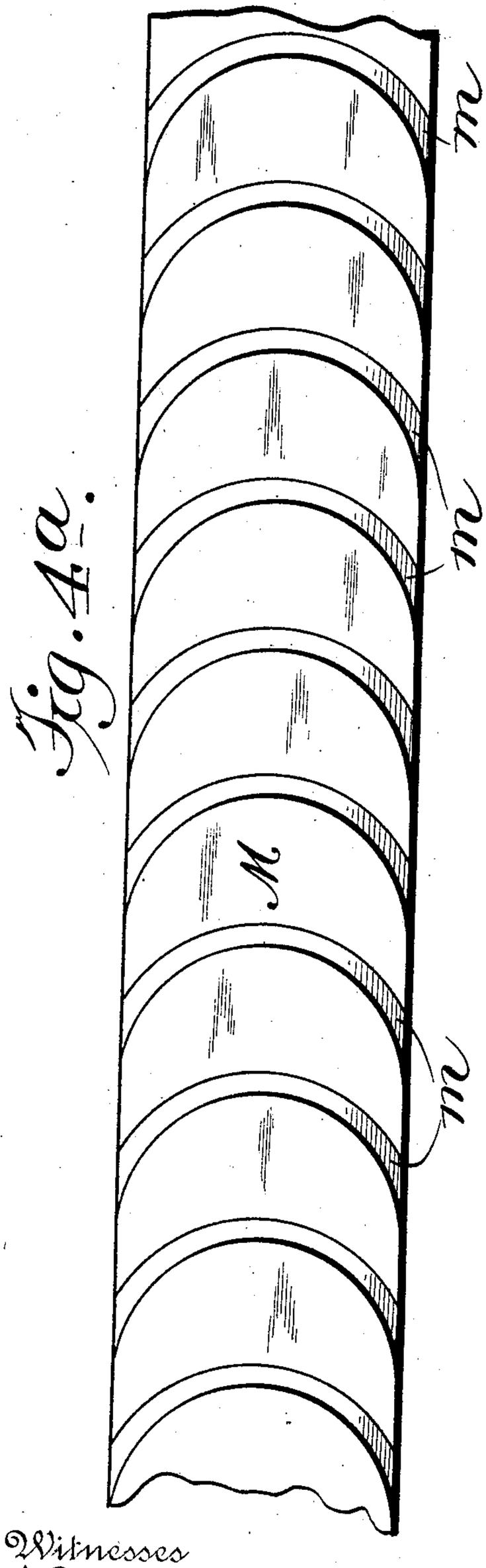


Fig. 4a.

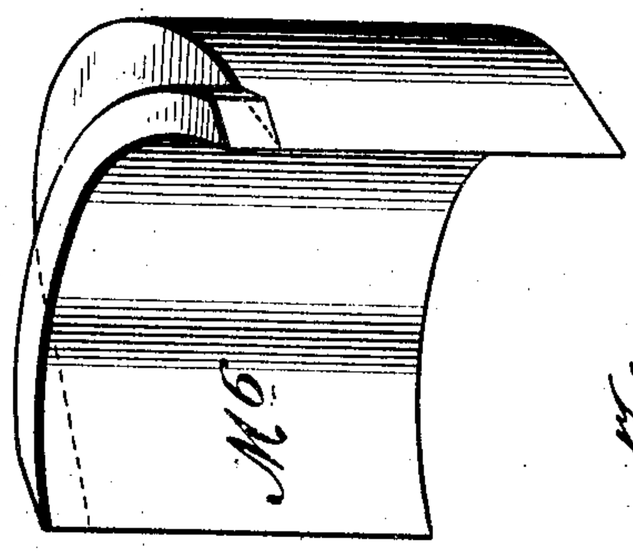


Fig. 4c.

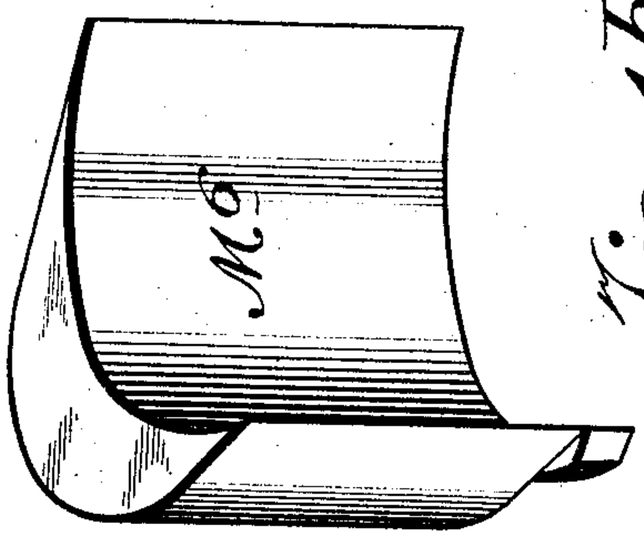


Fig. 4b.

Witnesses
A. R. Appleman
Wm. A. Bates

Inventor
Mathew R. Moore
By his Attorney
Thomas Drew Stetson

No. 898,127. PATENTED SEPT. 8, 1908.

M. R. MOORE.

TURBINE.

APPLICATION FILED JULY 22, 1904.

6 SHEETS—SHEET 6.

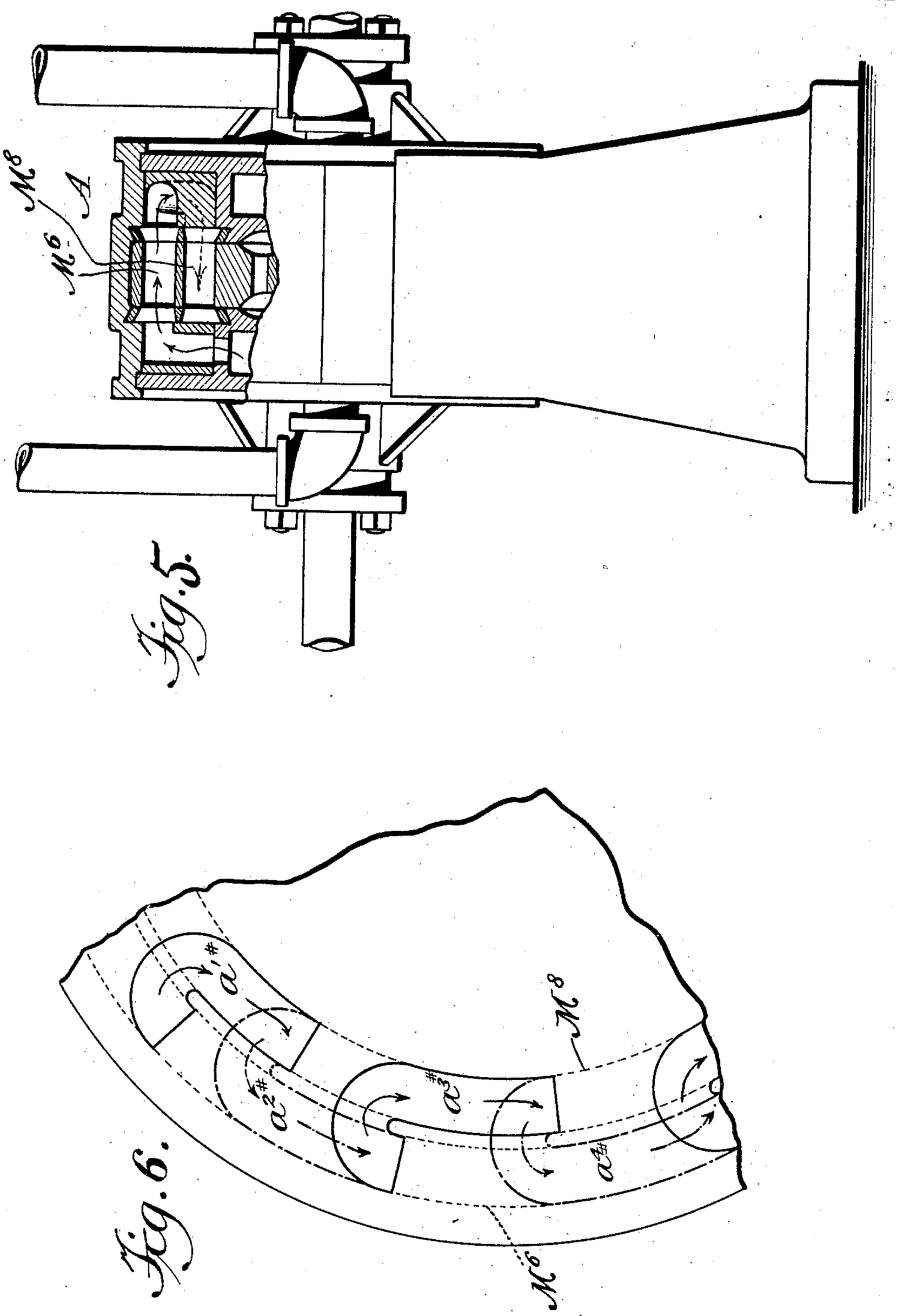


Fig. 5.

Fig. 6.

Witnesses
A. H. Hepburn
Robert S. Stubbard

Inventor
Matthew R. Moore
By his Attorney
Thomas Drew Stetson

UNITED STATES PATENT OFFICE.

MATTHEW R. MOORE, OF INDIANAPOLIS, INDIANA.

TURBINE.

No. 898,127. Specification of Letters Patent. Patented Sept. 8, 1908.

Application filed July 22, 1904. Serial No. 217,678.

To all whom it may concern:

Be it known that I, MATTHEW R. MOORE, a citizen of the United States, residing in the city of Indianapolis, in the county of Marion and State of Indiana, have invented a new and useful Improvement in Turbines, of which the following is a specification.

The improvement may be used with any elastic fluid, as air, but I will describe it as used with steam supplied from a boiler at high pressure. It is of the class known as compound, in which the pressure is let down by stages. In all turbines of this class, the area of the several passages must be enlarged at each of the several successive actions to allow for the expansion of the steam and the increase of volume as its pressure is lowered.

In the simplest form one wheel alone can be used. Such form is preferable for many purposes and is that which I will first describe.

In what I esteem the most completely developed form of the invention to avoid the necessity of a thrust bearing, I mount two wheels on a single shaft with the successive inductions and eductions reversely arranged, so that any end thrust in one will be balanced by an approximately similar end thrust in the other, and each of the wheels uses two or more separate and distinct streams of steam brought into the casing at opposite points. I will mainly use the word in the singular number "stream", referring to one stream alone, and will trace the action only of that; the others being similar. I effect the successive applications of the steam to the buckets by leading it after each passage forward and projecting it again against the wheel. I repeat this action several times, restraining the steam and allowing it to reduce its pressure by stages, as will be fully described further on.

In the form which I will first describe, I employ only one wheel and one series of buckets. Suppose the steam to be admitted at high velocity to the left face, it first acts upon the buckets of the wheel by impact, then traverses across the wheel in the spaces between the buckets from left to right and is delivered at the opposite face, the right face of the wheel, with the backward motion relatively to the wheel necessary to develop reactionary force. Emerging from the wheel it is received in a passage which deflects it again forward and delivers it again to the same series of buckets, through the spaces between which it traverses across the wheel in the opposite direction and is again thrown backward. On the second emergence, this time, on the same side on which entered, it is received in a passage and again deflected forward. It is from this passage again delivered into the same series of buckets and again traversed across the wheel through the spaces between the buckets in the same direction as at first. This is repeated further. I provide thin guides set obliquely in the passage where the steam emerges from the wheel, which makes the passage equivalent to a multiple nozzle, and insures that the motion is properly oblique, and I employ thicker guides all properly oblique to aid in its next presentation to the wheel. I make these latter also serve an important function in determining the restraint imposed on the steam, so as to let the pressure down to a proper amount at each passage.

I have devised a mode of constructing the wheel, which allows great perfection of form with facility for repairs, and a construction of the casing in separate parts with means for easily separating and reassembling. I effect the regulation by contracting and enlarging the small orifices close to the wheel, through which the steam is allowed to flow, in being introduced. I avoid friction by maintaining a partial or complete vacuum on a large portion of each face of the wheel.

In a modification I employ two series of buckets, one concentric to the other in the same wheel.

In each form I use in the fullest development two wheels on the same shaft, and two streams of steam on each wheel but any given stream of steam acts only on one of the wheels, being returned to the same wheel as many times as is found expedient.

The following is a description of what I consider the best means for carrying out the invention.

The accompanying drawings form a part of this specification.

Figure 1 is a side view with certain portions in central vertical section. Fig. 2 is on a larger scale; it is a central vertical section in the plane of the axis. Fig. 2ª is an outline of a portion corresponding to Fig. 2, showing a modification. Fig. 3 is a diagram showing the parts projected on a plane; it is a section on a curved line extending quite around the wheel through the center of the buckets. Fig. 4 is a corresponding diagram showing a small portion on a larger scale. Fig. 4ª is an edge

view of a portion of the wheel body reduced to a plane. Figs. 5 and 6 show a modification in which two series of buckets are used one concentric to the other. Fig. 5 is an end view with a portion of the casing broken away, the break showing a vertical section in the plane of the axis, and Fig. 6 is a diagrammatic view of a portion at right angles thereto on a larger scale. Fig. 5[a] is an outline in perspective showing two wheels on one shaft with their respective inductions and eductions arranged to balance each other.

Similar letters of reference indicate corresponding parts in all the figures where they appear.

Referring to Figs. 1, 2, 3, and 4 I provide metal casings peculiarly chambered. These casings are formed with feet or bases by which they may be supported and rigidly bolted on a bed plate in the obvious manner. Only one-half of one of the casings will be minutely described. The casings are each formed in three parts, a main portion A made in separable parts firmly secured together and provided with grooves a^* a^* and heads A^1 A^2, provided with chambers or passages a a^1 a^2, etc., having curved outlines and equipped with sectional rings and guide plates to be described further on.

The steam is led at full pressure to a contracted throat a and thrown obliquely against the passing buckets M^6. The steam thus received at one edge of each bucket moves across the breadth of the wheel through the spaces m^6 between the several buckets, with the velocity due to its drop in pressure, and emerges with an obliquely backward motion on the opposite side of the wheel. I term this the first traverse. On its emergence it flows through a smoothly curved chamber a^1, first rearward and afterwards forward, and is again delivered at the proper angle into the buckets of the same wheel. In this second traverse the steam is received and passed through the spaces m^6 between the several buckets M^6, in the opposite direction to that in the first traverse, and is discharged with a rearward motion as before, but it is a weaker and larger stream and the passages allow it to act on a larger number of buckets. This operation is repeated several times.

Advantage is taken of the principle that steam under pressure when allowed to escape through an orifice or nozzle has its static pressure transformed more or less completely into kinetic energy or projectile force, capable of imparting motion to a movable obstacle by impact, or by reaction when rebounding therefrom; and also that such a jet of steam when projecting through a properly conditioned nozzle into a closed chamber will generate in such chamber a pressure commensurate with the velocity of the jet, kinetic energy being thus transformed into static pressure.

The several guide plates A^8 and A^9 are secured in rings A^6, A^7 (see Figs. 2, 3, and 4) each fitted firmly and tightly in a corresponding groove turned in the inner face of the proper head A^1 or A^2. When it becomes necessary to repair these parts, the holding bolts being removed, the heads are detached from the other parts and each laid with its inner face upward on the bench and the rings A^6, A^7 being in sections are taken out. After the damage is repaired the rings are again tightly replaced and the heads A^1 A^2 are again engaged with the rim or periphery of the body A and the bearings and packings and the several connections being adjusted, all is ready to serve again as before.

A^8 are guide-plates arranged to guide the stream of steam as it flows from the wheel into the chamber a^1. These have thin edges and act as receiving nozzles whereby the tendency to agitation and eddying in the pockets is resisted and the kinetic energy of the steam is transferred again into pressure.

A^9 are thicker sharp-edged guide-plates set at a uniform angle at the delivery from the chamber a^1 into the spaces m^6 between the buckets. They perform the two important functions, firstly, of directing the steam at the proper angle, preferably about 20 degrees, and secondly, inducing the drop in pressure and consequent retransformation of pressure into high velocity immediately adjacent to the face of the wheel. These plates are strongly set and their thickness and number are carefully determined so that the passages for the steam in flowing violently through between them, are just sufficiently contracted to induce a drop to the desired amount in the pressure.

If the pressure in the boiler is 160 pounds absolute pressure per square inch, the steam will in passing through the throat a in its first presentation to the wheel acquire a velocity of approximately 2330 feet per second; and it will during its passage across impart to the buckets of the wheel, which constitutes a movable obstruction, a certain velocity, twice the amount of such velocity being subtracted from the velocity of the steam. Supposing the speed of the buckets to be one-tenth that of the steam, the steam will lose in the passage one-fifth of its velocity and neglecting any loss through friction would flow into the chamber a at a velocity of but 1864 feet per second, corresponding to a static pressure of 128 pounds per square inch. Next its flow through the passages m^6 between the thick guides A^9 will induce a velocity of the steam of 2123 feet per second and to act again effectively to impel the wheel it must again lose 466 feet per second, and be received in a second chamber a^2 with a velocity of 1657 feet per second corresponding to a pressure of 102 pounds per square inch, and so on, through alternate conversions of pres-

sure into velocity and velocity into pressure until all available energy has been transferred to the wheel.

The precise sizes and forms of the several chambers or smoothly curved passages a^1 a^2 etc. must be determined from the increase in volume of the steam after each reduction of pressure, so that a^2 should always be longer and somewhat greater in cross-section than a^1, and a^3 still longer and larger and so on.

In the diagrammatic representation shown in Fig. 4 of a portion of a section through the wheel and casing, A^1 A^2 are parts of the casing, in which a^1 a^2 etc. are pockets in the fixed casings and M^6 are buckets carried on in the wheel. A^6 and A^7 are solid parts of the "nozzle rings" which are inserted into recesses in the casing. The openings between the parts A^6 A^7 etc. have grooves cut obliquely across their insides, into which are inserted plates, the portions of which inside the grooves are so shaped that the spaces between form tapering passages through which the steam is projected against and flows away from the wheel. Those plates A^9 through which the steam enters the wheel act as diverging or expanding nozzles. Those A^8 through which it flows away from the wheels M and into the pockets a' form converging nozzles. The distance apart or pitch of these nozzle openings should be the same as that of the buckets in the wheel. The bucket spaces have full opening to exit nozzles before and until after they are opened and closed to the receiving nozzles. The number and width of these nozzle openings in any one set determine the pressure of the steam in the pocket to which that set belongs, and the velocity with which it is projected from the pocket into the wheel.

Under ordinary conditions my wheel M revolves with only moderate velocity, but as there is always a possibility of excessive speed under some accidental conditions I adopt the form of cross-section of the parts shown in Fig. 2 the wheel having much thickness near the center to give great strength and having the thickness reduced near the periphery to reduce the centrifugal force. The necessary widening where the buckets are introduced I attain with only a moderate weight.

A small portion of each bearing matches approximately to the surface of the shaft. But the main portion of each bearing is attained by separately formed pieces of good anti-frictional material, as soft metal, applied in the form of sectional rings B C and filling with gentle pressure the space between the firm bearing and the shaft. These rings are made in separate sections, so that they may be easily applied and separated, each being wedge shaped in cross section. They are applied as shown, in reversed order, first two wedge bearings B with their widest edges inward, and then two C with their widest edges outward. These sectional rings are compressed axially by a gland or follower D which is adjusted delicately by ordinary studs and nuts. This bearing being well lubricated and the adjustment being tightened by small increments at intervals, the bearing is reliable, steam tight and nearly frictionless.

The cavity in the casing is made wider than the wheel against the idle portions of the latter as indicated by a^5, (see Fig. 2) and A^4 is a pipe or passage leading from such cavity to the exhaust pipe A^5. Through this pipe A^4 the air or steam is led freely away, so that there is little pressure and consequently little friction of the fluid on these extended surfaces. In cases where the exhaust pipe A^5 leads into the atmosphere and cannot induce a vacuum, I give the pipe A^4 another direction and lead it to a small condenser, in which a vacuum is induced by any convenient means, as a pump not shown, operated by the engine.

The buckets M^6 may be all alike. Each is of good steel drop-forged and highly finished in the form shown adapted to engage in a groove by its inner edge, and the remainder crescent-shaped in cross section. To set them, I treat the periphery or narrow outer face of the wheel body M^5 with a planing or splining tool and thus produce curved grooves m each adapted to tightly hold the inner edge of a bucket, and drive the several buckets M^6 into their places, each held by its inner edge tightly in its proper groove m^6. I afterwards true their positions. In order to do this, I oil their surfaces, fill the spaces between with plaster of paris and allow it to set, which will hold the buckets sufficiently firm so that I can then true the outer edges of all the series M^6 by a revolving grinder, and shrink on the ring M^7 by applying it in a heated condition, after which I remove the plaster.

When at any subsequent period it becomes necessary to separate the parts, the spaces between the buckets being again filled with plaster, this time mainly to retard the conduction of heat inward, heat may be applied by any suitable means, as a ring of gas flames directed rapidly and strongly on the ring M^7, and the expansion will allow it to be removed by gentle force applied axially.

There are important uses in which the speed should be governed. Such involves working ordinarily at less than the full power. It is common to obtain this by throttling. There is in such mode of regulating a disadvantage in that the steam thus used is by reason of its lower pressure used with reduced economy. It has long been common to attain the end without any considerable loss, by varying the aperture close to the wheel. I have devised improved

means of contracting and enlarging each throat *a* maintaining in all conditions a simple rectangular form. I make one side of each throat a movable block E having parallel sides fitting steam-tight in a chamber a^{4*}, having corresponding parallel sides and arranged to turn on a center E^1. I operate it by a rod G to change the position as required. In all conditions of contraction and expansion the jet exposes but little surface, and is delivered unruffled and in condition to develop the fullest force.

To govern automatically, I mount on the shaft O, a shaft-governor P, which may be that set forth in the patent to me dated May 6th, 1885, No. 318,482, or any other suitable construction and connect the collar P^1 thereof with the rod G. When the speed becomes too slow the heavy weights in this governor move inward in obedience to the strong springs therein and each rod G moves the corresponding block E outward and allows more steam to flow through the passage *a* and operate the wheel. Each of the several induction passages *a a* should be equally changed so that the pressures will be always balanced.

When the engine runs too fast and the governor weights move outward, the governor partially closes the passage *a* and reduces the flow of steam into the wheel.

I attach importance to the arrangement by which the steam is admitted at two directly opposite points in the casing and is exhausted at two opposite points, and by which all the several chambers and pressures therein are equal for each stream, because it contributes to make and maintain a balanced condition on the shaft. This reduces the strain and the liability of the wheel and the shaft to spring, and thus not only relieves the shaft from friction, but also contributes greatly to the reduction of friction on the extended surfaces which are in contact or nearly so on both faces and on the periphery of the wheel.

I attach importance to the pipe A^4 because it allows of maintaining in the chambers a^5, either the exhaust conditions or a higher or a lower pressure at will.

Modifications may be made without departing from the principle or sacrificing the advantages of the invention. The sizes and proportions of the parts may be varied within wide limits.

Other material than plaster can be used to support the buckets in the act of assembling and dismembering, but plaster is peculiarly serviceable, especially in the heating of the ring M^7 in preparing to separate the parts, by reason of the plaster giving off, at a high heat, water which is held under ordinary conditions, giving reliable assurance against any serious mischief from the heat traveling inward.

In Fig. 5^a, in which two of my wheels are mounted on the same shaft, A^2 indicates the casing which connects the two larger casings for the wheels, respectively, and O^2 is the pulley from which the power is taken. In this figure O^1 indicates the shaft, W the steam pipe properly branched and X the exhaust pipe correspondingly branched.

Parts can be used without the whole. I can when regulation is not important, omit the whole of the provisions for governing. I can adopt other means of constructing and assembling the separately formed portions of the wheels or wheel.

I propose in some cases to provide two series of buckets concentric to each other in the wheel or wheels, and to correspondingly modify the form and arrangement of the passages A^1 A^2 etc. Such modification is shown in Figs. 5 and 6. In this form of the invention the steam is not required to reverse its motion in the spaces between the buckets.

In the form first described, having only one series of buckets, the motion across the wheel is completely reversed at these short intervals. In the form now described, shown in Figs. 5 and 6 the motion will vary in velocity, but the movement of the steam in any given space *m* in either series of buckets is always in one direction. The description already given of the action applies to this form with additions. The steam on being introduced through the throat *a* is thrown obliquely against one series, as shown it is the outer series of the buckets. In this form of the invention, the steam on its emergence is received in a smoothly curved chamber a^{1*} and led not only obliquely backward and then smoothly turned around and led forward but is also led radially inward. After being thus moved inward sufficiently to present it to the inner series M^8 instead of the outer series M^6 from which it emerged, the steam is delivered in the required direction nearly tangentially into the inner series M^8 of the buckets of the same wheel.

In the second traverse, the steam is received and passed through the spaces *m* between the several buckets in the inner series M^8 and is discharged with the proper oblique rearward motion as before, the passages a^{2*} shown leading it forward and being so varied from the form shown in Fig. 1 that the steam is in this stage of its progress led outward from the inner series to the outer series. This operation is repeated several times, the steam always moving in one direction, as from the left to the right, in the outer series of buckets, and in the opposite direction, as from the right to the left, in the inner series of buckets. There will be fluctuations in the velocity at different points, the elastic quality of the fluid allows this, but the flow through any given space between the buckets in either series is always in one direction.

In the use of the words, "apply the steam

at two opposite points" I mean arranging the induction of the steam on the opposite edges of the wheel, so that the lateral pressure on the shaft due to the receipt of one jet, is balanced by corresponding pressure in the opposite direction received from a jet diametrically opposite. There may be more than two such inductions opposed to each other. With a large and relatively slow wheel, it will be desirable to have four or more. They are preferably always arranged opposite to each other.

I claim as my invention:

1. In an elastic fluid turbine, the combination with an annular set of movable vanes, of passages conducting the elastic fluid through the movable vane spaces two or more times in succession, the main portion of each such passage being smoothly curved and each end thereof being divided, forming a sectional nozzle, all of the nozzles at each point of delivery being of substantially the same form and angle of delivery, substantially as set forth.

2. In an elastic fluid turbine, a wheel having radially projecting and laterally curved buckets confined by an encircling tire, rotatably mounted in a casing having on each side facing the buckets of the wheel, a series of pockets or chambers and between the open sides of the pockets and the wheel a septum in the form of a flat ring, through which is formed a series of inclined tapering openings, the orifices next to the wheel being of the same size as the spaces between the buckets of the wheel, the partitions between the orifices being tapered to sharp edges, and the openings near the pocket side converged, not radially, but laterally, to a width of approximately six-tenths that of the orifices next to the wheel, and the edges of the partitions on the pocket side rounded over so as to form smooth debouchures, the inclination of the openings to be approximately 20 degrees to the faces of the septum; the sizes of the pockets and the number of openings through the septum opposite them being progressively enlarged to allow of the increase in volume of the stream of fluid as it loses pressure and motion.

3. A steam turbine wheel having a series of separately formed, crescent-shaped buckets, in combination with a casing having passages arranged to apply the steam at two opposite points, throwing each stream of steam several times in succession against the end faces, to flow axially across through the spaces between the buckets, substantially as herein specified.

4. A steam turbine wheel having a series of separately formed, crescent-shaped buckets, in combination with a casing having passages arranged to apply the steam at two opposite points, throwing each stream of steam several times in succession against the end faces, having the successively enlarged chambers and the several reductions of pressure equal on the opposite sides of the axis, all substantially as herein specified.

5. A steam turbine wheel having a series of separately formed, crescent-shaped buckets, in combination with a casing having passages arranged to introduce and exhaust two streams at opposite points, and to apply each stream of steam several times in succession against the end faces, to flow axially across through the spaces between the buckets, and with nearly tangential guide plates A^8, all arranged to serve substantially as herein specified.

6. A steam turbine wheel having a series of separately formed, crescent-shaped buckets, in combination with a casing having passages arranged to introduce and exhaust two streams at opposite points, and to apply each stream of steam several times in succession against the end faces, to flow axially across through the spaces between the buckets, and with thick guide plates A^9, arranged as shown, so as to serve the double function of guiding the steam to insure the proper direction and of restraining it to obtain the required drop in pressure all substantially as herein specified.

7. A steam turbine wheel having a series of separately formed, sectional, crescent-shaped buckets, in combination with a casing having passages arranged to introduce the steam nearly tangentially and to apply each stream several times in succession to flow across through curved spaces between the buckets, and with guide plates A^8, and separately formed rings A^6 A^7 carrying such plates, set in heads A^1 A^2, the parts being engaged by interlocking, all substantially as herein specified.

8. In a turbine operated by steam or gas the chambers a^5 on opposite idle portions of the faces of the wheel and provisions by an independent pipe A^4 leading from such spaces adapted to allow such spaces to be put in connection with the exhaust passages or to be otherwise conditioned as preferred for maintaining low pressure in such chambers, all substantially as herein specified.

9. A steam turbine wheel having a series of separately formed, crescent-shaped buckets, in combination with a casing having passages arranged to introduce each stream of steam several times in succession to flow across through curved spaces in planes parallel to the axis, and with blocks E arranged to turn on the centers E^1 adjacent to the wheel and with a shaft governor and connections, all substantially as herein specified.

10. In a steam turbine wheel the construction comprising a center M having recesses in its periphery, and having a series of curved buckets M^1, with their inner edges shaped to match and tightly forced in such re-

cesses and their outer edges trued in combination with each other and with a stout ring M^2 shrunk on the exteriors of such buckets, all substantially as herein specified.

11. The combination with a bucketed wheel, and a passaged casing arranged for an axial flow of the fluid with successive actions, of pockets and inclined wedge-shaped plates interposed between the wheel and such pockets, presenting their small edges to said wheel on each side, substantially as described.

12. A passaged casing for a motor wheel, composed of a middle portion in sections with grooves a^* in its inner periphery, and two heads whose edges fit in said grooves, respectively, substantially as described.

13. A casing composed of a middle portion in sections with grooves a^* in its inner periphery, and two heads whose edges fit in said grooves, respectively, in combination with a motor wheel mounted between said heads and inclosed at the periphery by said middle portion, substantially as described.

14. A casing for a motor wheel having rings recessed to form passages for the motor fluid, and also having annular seats in which said rings are located, substantially as described.

15. A casing for a motor wheel having a head, a middle portion, and rings located in annular seats between said head and said middle portion, said rings being recessed to form passages for the motor fluid, substantially as described.

16. The combination with a motor wheel provided with buckets having openings at the side of said wheel, of a casing provided with annular seats adjacent to said buckets on each side and rings shaped to form passages for the motor fluid located in said seats, substantially as described.

17. The combination with a bucketed wheel, and a casing, of two rings shaped to form passages for the motor fluid and located in annular seats in said casing opposite the buckets of said wheel and on the same side thereof, one ring being interposed between said wheel and the other ring and projecting radially beyond the latter, substantially as described.

18. The combination with a bucketed wheel, and a casing which contains a passage whose ends are presented to said wheel at different points, of plates located adjacent to said wheel in the delivery end of said passage and occupying not less than about one-half the delivery opening, said plates dividing the passage for a short distance only next said wheel, substantially as described.

In testimony that I claim the invention above set forth I affix my signature, in presence of two witnesses.

MATTHEW R. MOORE.

Witnesses:
R. M. COFFIN,
E. K. MARQUIS.