No. 801,644. PATENTED OCT. 10, 1905.

J. C. BUCKBEE.

STEAM TURBINE ENGINE.

APPLICATION FILED SEPT. 30, 1904.

3 SHEETS SHEET 1

Fig. 6.

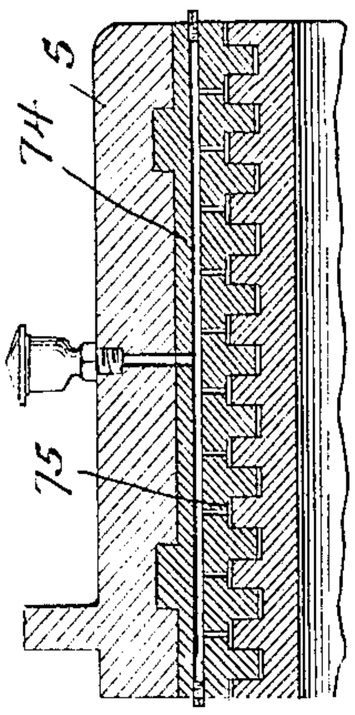
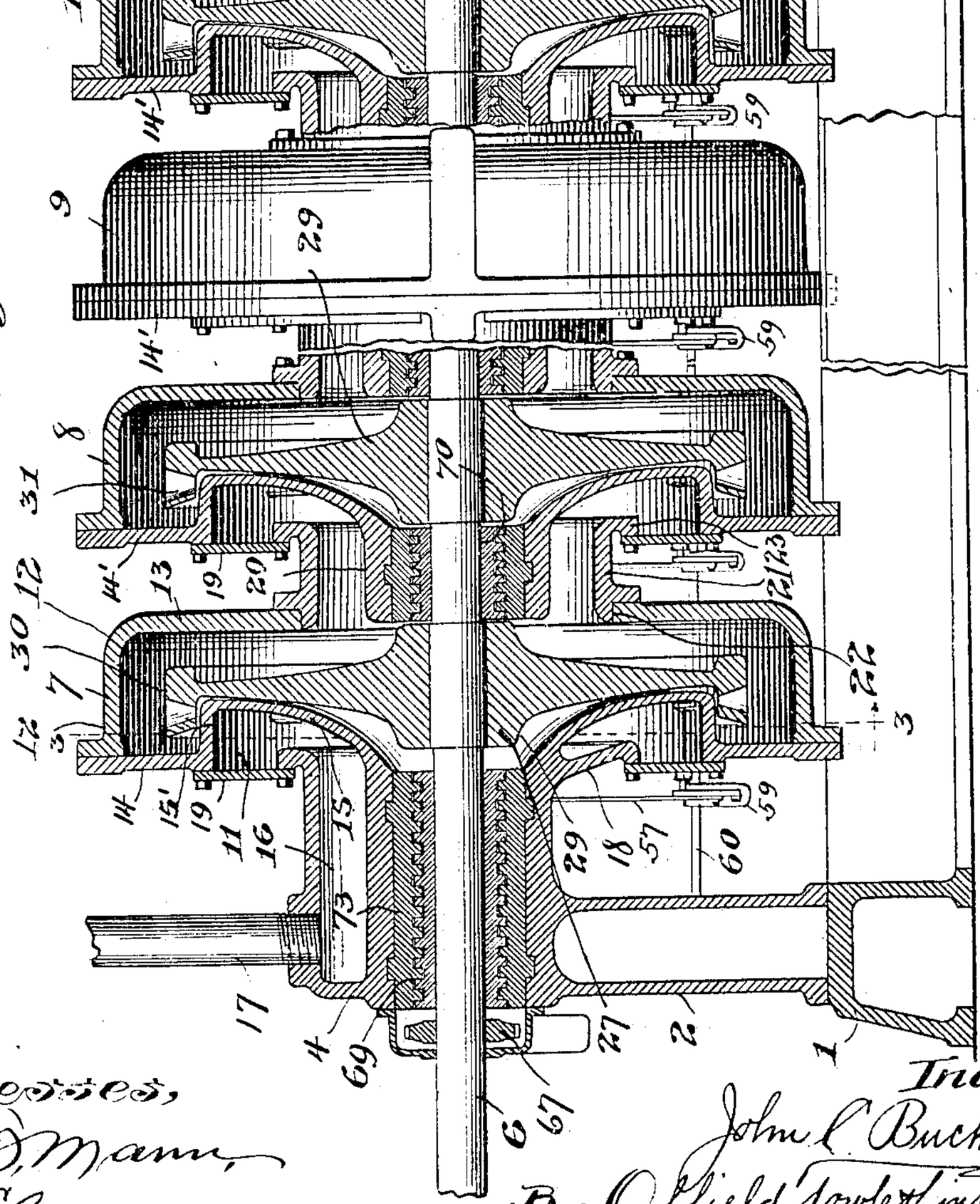


Fig. 1.



Witnesses,
F. D. Mann,
A. N. Graves

Inventor,
John C. Buckbee,
By Offield Towler & Linthicum,
Attys.

No. 801,644. PATENTED OCT. 10, 1905.

J. C. BUCKBEE.

STEAM TURBINE ENGINE.

APPLICATION FILED SEPT. 30, 1904.

3 SHEETS—SHEET 2.

Fig. 2.

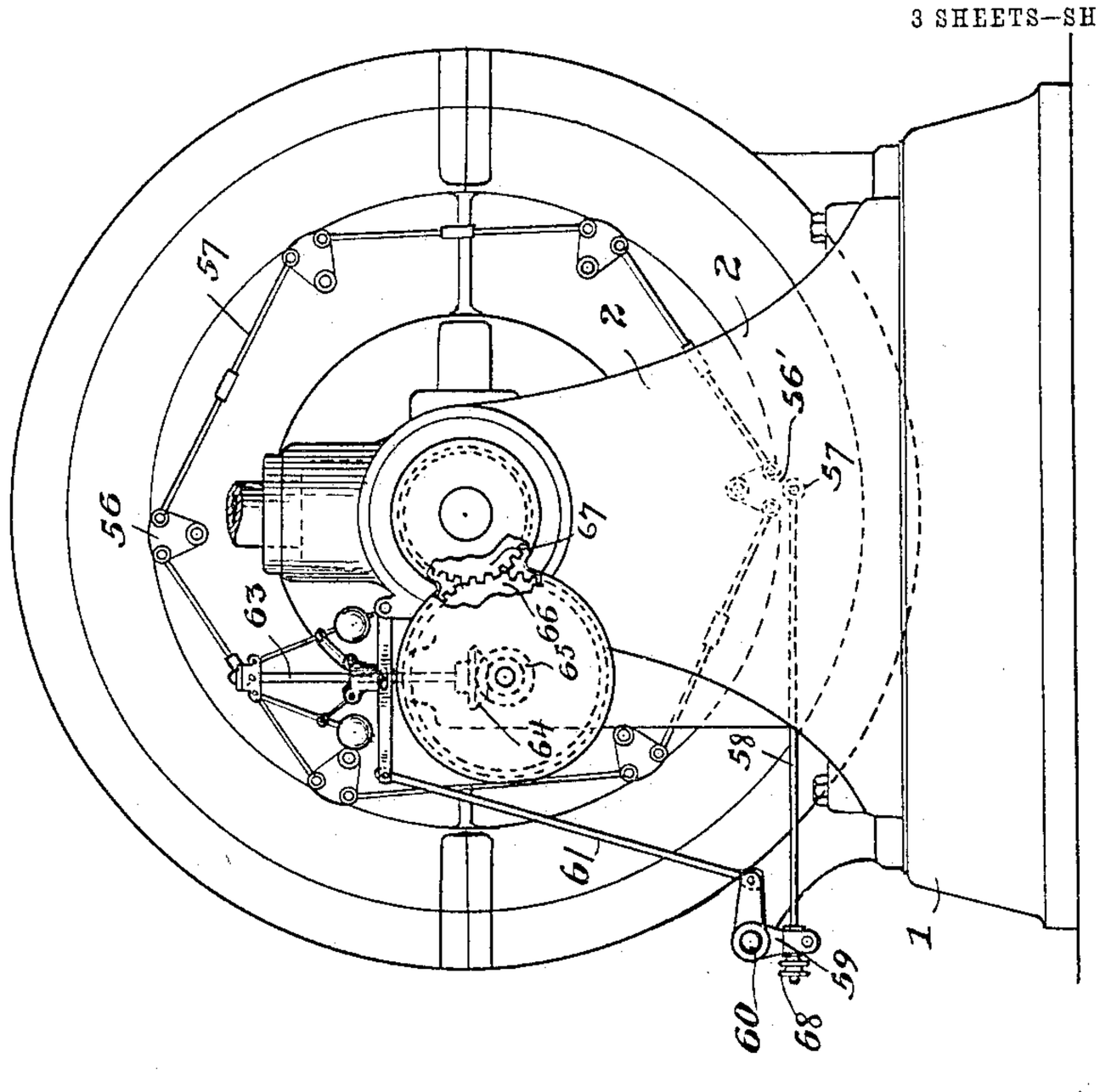
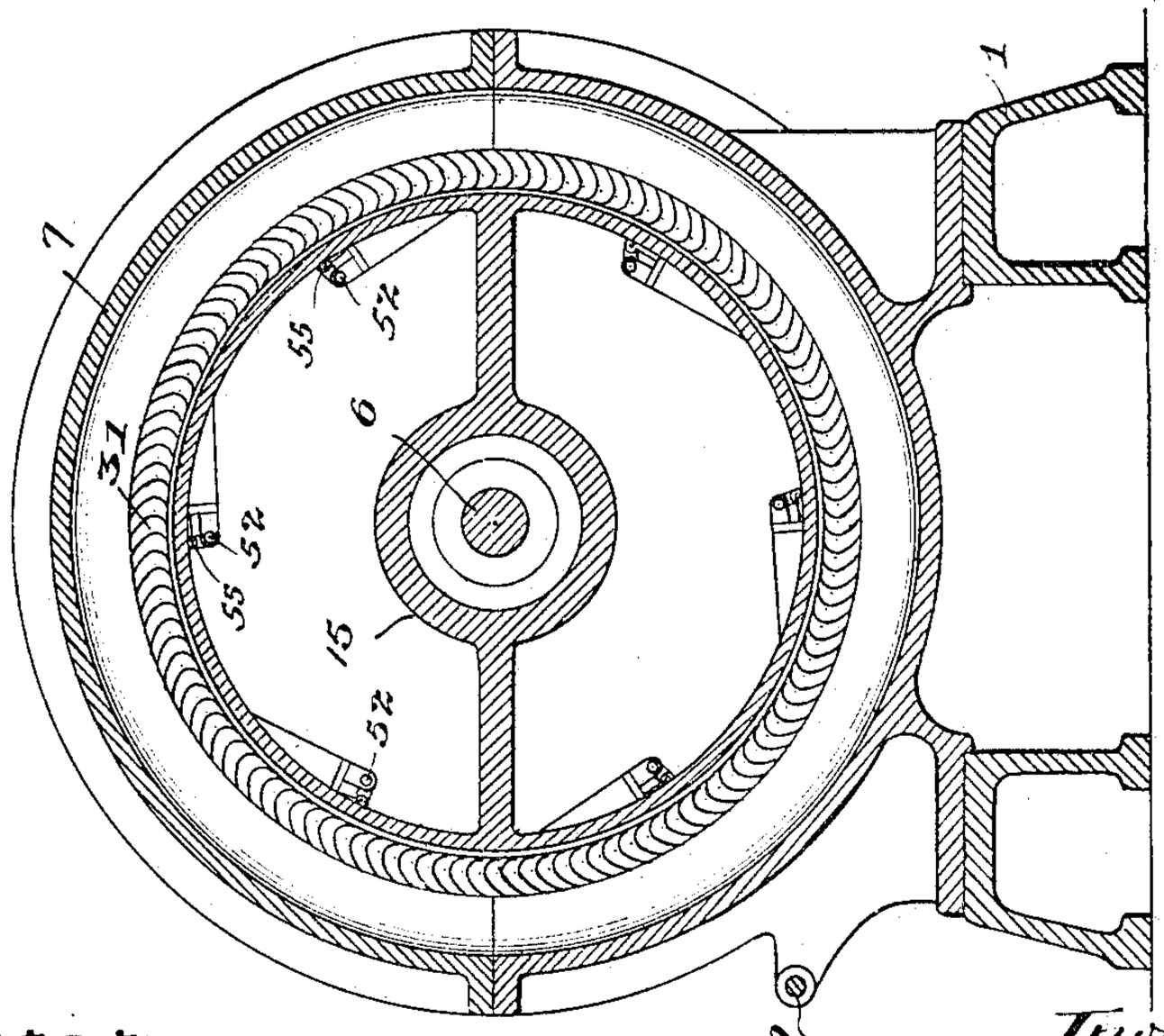


Fig. 3.



Witnesses,
F. D. Mann,
A. N. Evans

Inventor,
John C. Buckbee,
By Offield Towle & Linthicum
Attys

No. 801,644. PATENTED OCT. 10, 1905.

J. C. BUCKBEE.

STEAM TURBINE ENGINE.

APPLICATION FILED SEPT. 30, 1904.

3 SHEETS—SHEET 3.

Fig. 4.

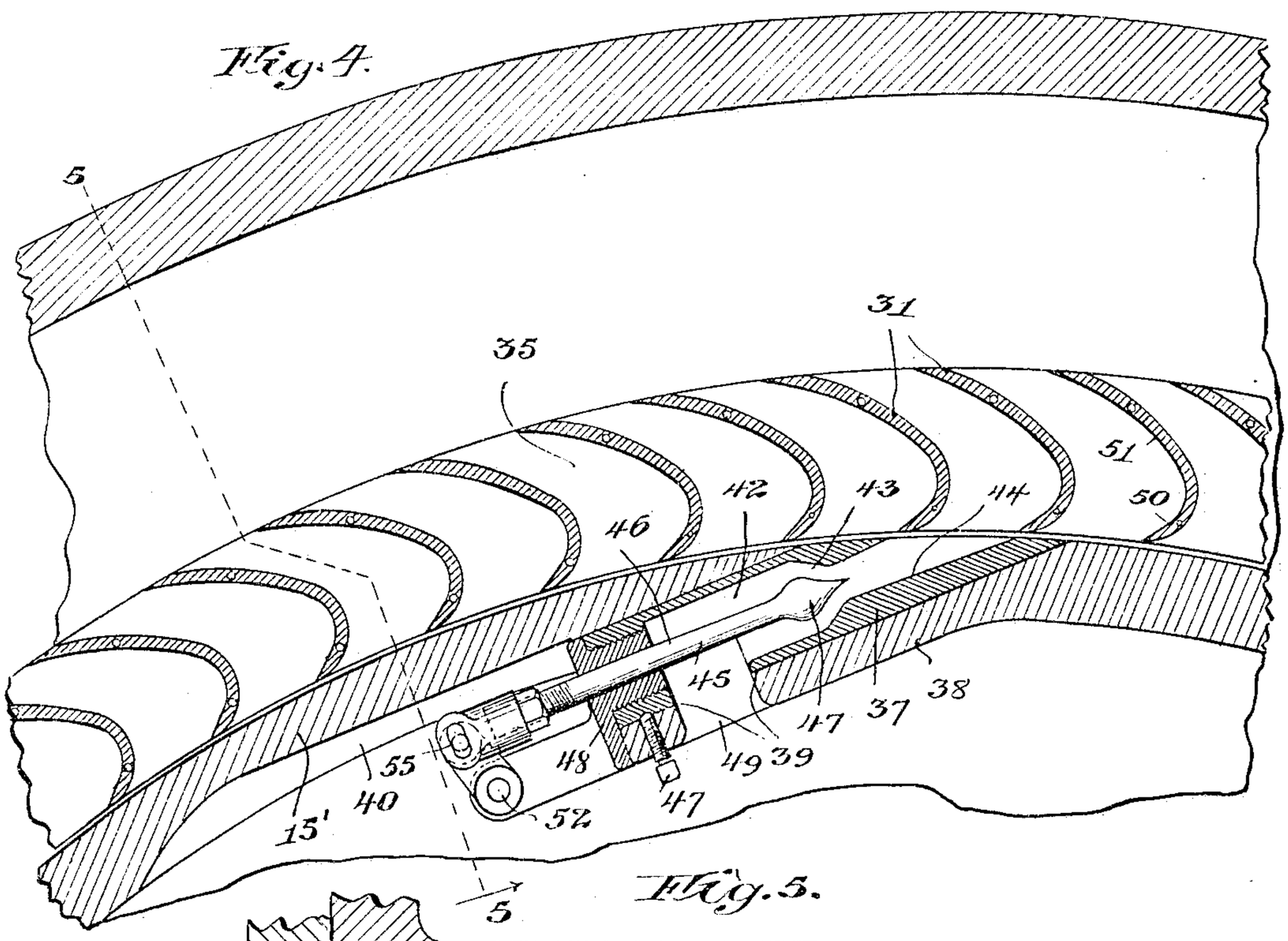
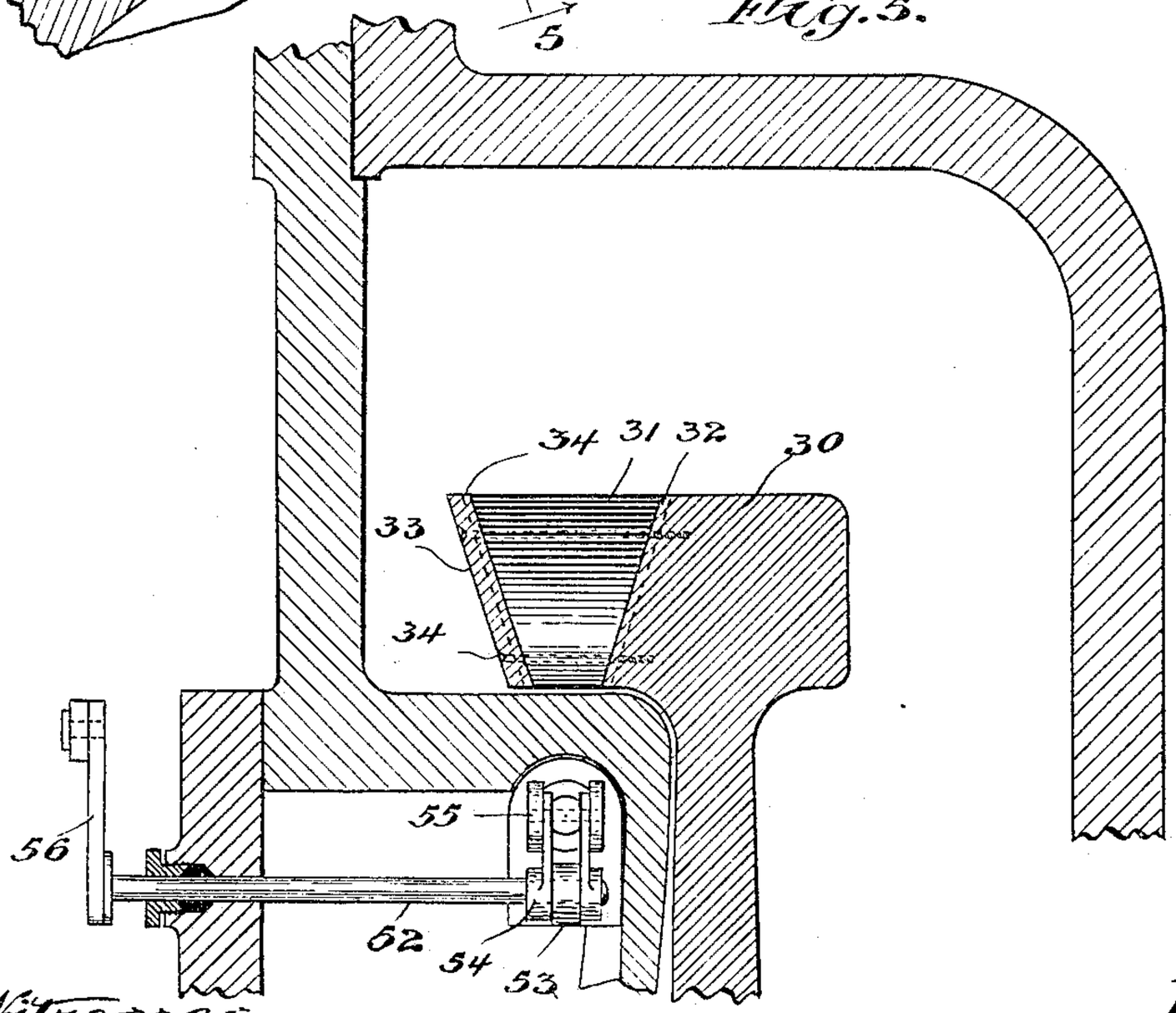


Fig. 5.



Witnesses:

F. S. Mann,

A. N. Spates

Inventor,

John C. Buckbee,

By Offield Towler & Linthicum,

Attys.

UNITED STATES PATENT OFFICE.

JOHN C. BUCKBEE, OF CHICAGO, ILLINOIS.

STEAM-TURBINE ENGINE.

No. 801,644. Specification of Letters Patent. Patented Oct. 10, 1905.

Application filed September 30, 1904. Serial No. 226,644.

To all whom it may concern:

Be it known that I, JOHN C. BUCKBEE, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and recent Improvements in Steam-Turbine Engines, of which the following is a specification.

This invention relates to improvements in steam-turbines; and it has for its salient objects to produce an engine of the character referred to wherein the steam is delivered to the vanes of the rotary member or members in such manner as to flow radially outward during its traverse and action upon the blades, thereby combining the acquired centrifugal force of the steam with the force thereof due to impact and reaction; to provide in a steam-turbine such a construction and relative arrangement of the steam-nozzles and moving vanes that both the acquired centrifugal force of the steam and the impact and reactionary force thereof have a continuing action until the steam has fully traversed the vanes; to provide in such machine a construction and arrangement of the parts whereby the reactionary effect due to the discharge of the steam in a direction opposite that in which the moving vanes are traveling is likewise secured; to provide in such a machine a plurality of units each comprising a rotor and a separate chamber within which the rotor operates arranged in series, so that the steam is successively passed through the several units, thereby utilizing to increase the efficiency of the engine the known principle that steam in flowing through an orifice or nozzle from one chamber of greater pressure to another of lower pressure increases its velocity as the difference in pressure increases only up to a certain limit, beyond which limit the velocity of discharge remains practically the same regardless of increased difference in pressures; to provide in such a machine a plurality of units all acting upon a common shaft; to provide an improved automatic governor mechanism operating to regulate the engine by throttling or opening the several nozzle-openings; to provide an improved construction in the mountings of the main shaft and rotor elements carried thereby, enabling said main shaft to automatically assume a position in which its axis of rotation coincides exactly with the axis of the mass, the lateral movement of the shaft being provided for without the use of loosely-interposed parts, such as bushings and the like; to provide an improved construction in the form and mounting of the vanes and the rotor member upon which they are carried, whereby the vanes are held securely in position by the form of their seats and independently of the holding action of the securing bolts or rivets; to provide an improved form of rotor member in which the vanes radially overhang the inlet-nozzles, but in which, nevertheless, such overhanging parts of the rotor are counterbalanced, so as to prevent the bringing of bending stresses upon the rotor which would tend to break the latter under the action of centrifugal force; to provide a construction in which the bodily-lateral movement of the main shaft in accommodating itself to its gravity center of rotation does not interfere with the efficiency or correctness of relative position of the rotating and stationary parts, and, in general, to provide an extremely simple, compact, and highly-efficient engine of the character referred to.

To the above ends the invention consists in the matters hereinafter described, and more particularly pointed out in the appended claims.

The invention will be readily understood from the following description, reference being had to the accompanying drawings, forming a part thereof, and in which—

Figure 1 is a view chiefly in vertical axial section, but partly in side elevation, of an engine forming a preferred embodiment of my invention. Fig. 2 is an end elevation of the receiving or inlet end of the engine. Fig. 3 is a transverse vertical sectional view taken approximately on line 3 3 of Fig. 1 and looking in the direction of the arrows. Fig. 4 is a fragmentary transverse sectional view through one of the units, taken in the plane of the axis of the steam-nozzles. Fig. 5 is a sectional view taken on the indirect line 5 5 of Fig. 4 and looking in the direction of the arrows. Fig. 6 is an enlarged fragmentary view of the parts shown at the right-hand end of Fig. 1, showing particularly the construction and arrangement of the oil-ducts which supply lubrication to the main shaft.

In the steam-turbines of the prior art, so far as I understand the same, there has been no ostensible attempt to utilize the centrifugal force acquired by the steam in passing through the turbine as an auxiliary force to that due to the impact and reactionary forces. While it is true that in some instances the steam has been delivered in such manner as to flow ra-

dially outward or in that direction which centrifugal force would tend to carry it, nevertheless the shapes of the vanes and the relation of the nozzles or other parts which deliver the steam to the vanes have been such as to indicate a lack of appreciation of the factor of centrifugal force as a means of increasing the efficiency or economy of the engine and have failed to utilize such centrifugal force.

The impact forces and reactionary forces have apparently been well understood, and in my present invention I have endeavored to utilize these forces to the greatest practicable degree, but have at the same time combined therewith the force derived from centrifugal action. Furthermore, so far as I understand the prior art, no steam-turbine heretofore has been devised in which the steam is passed successively through separate units in such manner as to utilize for securing greater efficiency the known principle that the velocity of flow of steam through an orifice leading from one stage of pressure to a lower stage of pressure increases proportionately to the increase in difference between pressures only up to an approximately definite percentage of difference. With these several points in mind I have developed the engine which will now be described, and in making such development have made certain subsidiary improvements, as will hereinafter appear.

Referring to the drawings, 1 designates as a whole a suitable base-frame carrying at each end suitable frame-standards, as 2 and 3, the upper ends of which form journal-supports 4 5, within which is journaled a main shaft 6. Surrounding the main shaft and interposed between the journals 4 and 5 are a plurality of separate steam-cylinders, substantially similar in construction, and there being four in the present instance, (designated, respectively, 7, 8, 9, and 10.) These cylinders are so constructed as to provide two internal annular chambers—one for convenience designated the "inlet-chamber" 11 and a larger main chamber 12, within which the rotor operates. As convenient construction the peripheral wall 12 and the wall 13, forming the delivery side of each chamber, are made integral, while the opposed or receiving side wall 14 is made in the form of a disk, having a centrally-recessed portion 15, which forms the partition dividing the receiving-chamber from the main chamber. At the inlet end of the engine the casting 4, which forms the journal-support at that end, is chambered to provide a steam-inlet passage 16, through which communicates an inlet-pipe 17, and said casting is provided at its end adjacent to the first steam-cylinder with a radial extension or flange 18, extending outwardly in the plane of the main portion of the disk or end wall 14. An annular plate 19 is connected with said flange 18 and the outer face of the side wall 14, so as to form, in conjunction with said recessed side wall and the flange 18, the inlet-chamber 11, hereinbefore referred to.

The end wall 14 of the first cylinder is shown as formed integrally with the journal-casting 14 in the present instance; but a construction similar to that shown in the succeeding units may obviously be adopted, if preferred. The side walls 14′ of each of the succeeding cylinders are generally similar to that of the first unit, it being noted that the central portion of each such wall is integrally united with a journal portion 20, which surrounds the shaft and serves to carry the latter, as will hereinafter more particularly be described. Between the first cylinder and the second and between each of the succeeding units is interposed a trunk-like or tubular member 21, having its receiving end fitting into a central opening 22 in the one cylinder and its opposite end provided with a peripheral flange 23, corresponding in function to the flange 18 of the first unit, hereinbefore described. Plates 19 extend between these peripheral flanges 23 and the outer or main portions of the side walls 14′, as in the case of the first unit. It will be noted that the internal diameter of the trunk members 21 is such as to provide an annular steam-passage leading from the main chamber of each cylinder to the inlet-chamber of the succeeding cylinder.

With the delivery side of the last unit is connected a discharge-trunk 24, which is provided at one side—its lower side in the present instance—with a discharge extension 25, the end of this trunk 24 adjacent to the bearing-casting 5 being united with the latter by an overlapped joint, as indicated at 26. It will be understood from the foregoing description that the cylinder members and the parts which connect the same with each other and with the respective ends of the main frame together constitute a rigid non-rotative structure.

Describing now the rotor members of the several units, these being alike in all respects except that each succeeding rotor member is provided with vanes of somewhat larger area than the preceding one, which correspond in proportions to the cylinders, which are also successively of increasing capacity from the receiving end of the engine toward the discharge end, 27 designates as a whole a disk-like main body provided at its center with an enlarged hub portion 29, which is keyed or otherwise rigidly secured upon the main shaft and provided at its periphery with a rim portion 30, which overhangs the central web or main body at both sides of the latter.

Upon that side of each member 29 adjacent to the inlet-chamber of the cylinder is arranged a circumferential series of vanes 31, these vanes being arranged to overhang or extend in proximity to and radially outside of the

cylindric portion 15′ of the partition member 15 of the cylinder. The construction and arrangement of these vanes are best seen in detail, Figs. 4 and 5, by reference to which it will be seen that said vanes are of increasing width from their inner ends radially outward, being shown as wedge-shaped and each vane having one of its edges seated in a corresponding groove 32, formed in the rim of the rotor. Against the opposite edges of the vanes is secured a facing-ring 33, the abutting side of which is similarly provided with grooves 34 to receive the corresponding edges of the vanes. The set of vanes and the ring 33 are made rigid with the rim by means of screw-bolts 34, these bolts being desirably extended through the bodies of the vanes, as indicated clearly in Figs. 4 and 5, so as to avoid obstructing the throat-passages 35, formed between contiguous vanes.

An important feature of the present invention resides in so shaping the vanes and so arranging the discharge-nozzles relatively thereto as to secure the combined effect of impact-acquired centrifugal force and reaction of the steam. The steam-nozzles, of which there may be any desired number placed at suitable equal intervals apart, are arranged to communicate with the inlet-chamber 11 and to discharge through the cylindric wall 15′ in radial alinement with the series of vanes. In order to secure the greatest efficiency, I arrange the nozzles (each designated as a whole 37) so that their direction of discharge will be as nearly tangential to the radially outer surface of the cylindric wall 15′ as practicable. To accommodate the nozzles in this position, the wall 15′ is provided with inwardly-projecting thickened portions 38, through which are formed straight slightly-tapered bores 39, within which the discharge ends of the nozzles are seated and secured. In order that said nozzles may lie as nearly tangential as practicable and yet be capable of being withdrawn, the wall 15′ is cut away in continuation of the bore 39, as indicated at 40, for a sufficient distance to permit the nozzle to be retracted until its end is disengaged from the bore proper. The nozzle is conveniently locked in position by means of a set-screw 41.

The bore of the nozzle (designated 42) is enlarged at its receiving end, contracted at a point intermediate its length to form a tapered seat 43, and beyond this seat made very slightly flaring, as indicated at 44.

While I preferably employ the slightly-flaring expansion-nozzle, yet this feature is not of the essence of the invention, and jet-passages may be employed.

45 designates a throttle-valve arranged to coöperate with the seat 43 to control the flow of steam through the nozzle, said valve taking the form of a stem 46, arranged to reciprocate through a closure 48, seated in the end of the nozzle and provided with a pointed approximately pear-shaped head 47, the sides of which are shaped to fit seat 43. With the valve and seat thus formed it will be obvious that a very uniform or regular increase or decrease of inlet area may be had by approaching the valve toward or retracting it from its seat, while at the same time the friction resistance or obstruction to the flow of the steam through the nozzle is minimized to the greatest practicable extent. The interior of the nozzle communicates with the interior of the inlet-chamber 11 through a port 49. The vanes 31 are so shaped that their rear or impact faces are at the receiving edges of the vanes nearly in alinement with the axis of the discharge-nozzle, the forwardly-inclined inner end portion 50 of each vane merging rapidly and smoothly into a rearwardly-extending curved portion 51. The curvature of that part of the vane extending from its most advanced point to its discharge edge is approximately parabolic with the flatter portion of the curve at the outer edge of the vane. It will be seen by reference to Fig. 4 that the shape of the vanes is in cross-section such that the throats therebetween are actually narrower at the delivery end than at the receiving end; but on account of the outwardly-flaring or broadened form of the vanes the actual area of these throat-passages is not decreasing outwardly. By adopting this construction, in which the steam delivered from the nozzles impinges against a pocket-like surface, which surface immediately merges into a rearwardly-extended relatively long surface inclined in its general direction at an angle of somewhat more than forty-five degrees from a radius of the rotor, I secure first the greatest practicable impact effect and thereafter the action of the acquired centrifugal force of the steam acting upon the inclined surface referred to, tending to impel the rotor forwardly. By reason of the fact that the discharge ends of the throats 35 extend in a general direction closely approximating the tangential to the periphery of the rotor it will be obvious that the steam in passing through and out from between the vanes into the main chamber exercises a very pronounced and effective reactionary force, which of course also tends to impel the rotor forwardly.

The steam discharged into the main chamber passes through the connecting-trunk to the inlet-chamber of the next unit, and in this connection it is to be noted that while the succeeding main chambers are shown as of successively-increased capacity, nevertheless this is not essential because it is the relative capacity of the inlet-nozzles or steam-passages which determine the amount of expansion from one unit to the next. Inasmuch as the pressures in the succeeding units are lower and the volume of steam passing therethrough correspondingly larger, the several sets of noz-

zles for the several cylinders are made of proportionately larger capacity, and the area of the vanes is likewise greater in each succeeding unit. The construction, arrangement, and principle of operation of those units succeeding the first are the same, it being understood that there may be any preferred practicable number of such units. Obviously an increase in number of steam-jet inlets in successive units instead of an increase in the size of the same would be an equivalent arrangement to that shown, wherein the number of nozzles is the same; but they are made of larger size successively. I have not in the drawings accompanying this specification attempted to show exact proportions; but it will be understood that the relative sizes of the successive units may be varied widely without departing from that principle of securing greater efficiency which consists in causing the steam to act successively in rotor elements arranged in separate chambers and in expanding from each chamber to the succeeding one, so as to increase the velocity of the steam, but expanding in each successive step to such extent only as is well within the limits of differences in pressure which increase the velocity of flow proportionately to such expansion.

As a further feature of the invention I provide means for automatically regulating the engine by means of throttling the flow of steam through the nozzles. In carrying out this phase of the invention I connect the valve-stems 45 operatively with a suitable governor. In the preferred embodiment shown a rock-shaft 52 is journaled to extend through the side plate 19 of each cylinder and through a bearing-lug 53 adjacent to the rear end of each valve-stem 45. At its inner end said rock-shaft carries a duplex crank 54, which at its free end is connected with the end of the stem by means of a slot-and-pin connection, as indicated at 55. Upon the outer end of the shaft 52 is mounted a crank-arm 56, and the several crank-arms of each unit are connected together in train by a series of rods 57, as seen clearly in Fig. 2, so that the throttle-valves of each unit move in unison. In order to actuate the train of rock-shafts, one of the crank-arms (designated 56′) is provided with an extension 57, with which is connected an actuating-rod 58, extending substantially at right angles thereto and connected with a rocking lever 59, mounted between its ends upon a rock-shaft 60, journaled in a series of suitable brackets or extensions of the main frame. The opposite end of the lever 59 is connected by means of a rod 61 with the actuating-lever 62 of an ordinary ball-governor, (designated as a whole 63.) The spindle of the governor carries a miter-gear 64, which intermeshes with a corresponding gear 65, and with this gear 65 is connected a larger gear 66, which intermeshes with a gear 67 upon the main shaft 6 of the engine. The operation of the governor thus geared to the main shaft is as usual and need not, therefore, be more specifically described. The rock-shaft 60 extends throughout the principal length of the engine, and it will be understood that each cylinder is provided with a controlling mechanism for the throttle-valves similar to that just described and that each train of said valves is connected with the rock-shaft 60 by means of an actuating-rod 58 in substantially the same manner as that shown in Fig. 2, the single rod 61 of course serving to actuate the rock-shaft 60, and thus control all the valves. The end of each actuating-rod 58 is provided with a set of adjusting-nuts 68, so that the several sets of valves pertaining to each unit may be independently adjusted.

As a further feature of improvement I have provided means permitting the main shaft to assume a position in which its axis of rotation coincides with the center of the mass of the revolving members considered as a unit. To this end the bearing portions of the main shaft are each inclosed in a bushing, as 69, 70, and 71, closely fitting the shaft and provided exteriorly with circumferential ribs 72, having parallel sides, which sides are perpendicular to the axis of the shaft. The bushings 69, 70, and 71 are respectively fitted within outer bushings 73 and 74, seated in the respective journal members and having upon their inner faces grooves 75, corresponding in width and form to the ribs of the inner bushings. The depth of the grooves 75 is such as to permit a substantial bodily lateral movement of the inner bushings, and the sides of the grooves and ribs are constructed to fit as accurately as practicable, so as to form steam-tight joints preventing the escape of steam through the joints between the bushings, the lubricating-oils of the bearing also contributing to such sealing effect. In order that the shaft may thus move laterally, the sets of vanes mounted upon the rotor members are spaced slightly away from the cylindric wall 15′, which they overhang, as indicated clearly in Figs. 1 and 4, thereby affording necessary clearance.

The operation of an engine constructed and arranged as described has been fully indicated in connection with the description of the mechanism and need not, therefore, be repeated. It will be seen that the several objects of the invention hereinbefore stated are secured and that the engine is of extremely simple and practical construction throughout. It will also be understood that the invention may be otherwise embodied and that some of the features of the invention may be utilized independently of the others and especially that the details of construction may be modified without in any sense departing from the invention. I do not, therefore, limit myself to the details of construction shown and de-

scribed herein except to the extent that such details are made the subject of specific claims.

I claim—

1. In a steam-turbine engine, the combination of a plurality of engine units, each unit comprising a main chamber, a rotor therein provided with a series of circumferentially-disposed vanes, an admission-chamber located concentrically with the main chamber and extending radially within the vanes of the rotor therein, said admission-chamber being provided with a series of nozzle-passages delivering radially outward and approximately tangentially against the vanes of the rotor, a main shaft extending axially through the series of units and upon which the several rotors are mounted, trunk connections affording communication between each main chamber of one cylinder and the admission-chamber of the succeeding cylinder, the diameters of the several rotors at the vanes being similar and the aggregate area of the nozzle-passages of each unit being increasing as to successive units.

2. In a steam-turbine engine, the combination of a plurality of engine units, each unit comprising a main chamber, a rotor therein provided with a series of circumferentially-disposed vanes, an admission-chamber located concentrically with the main chamber and extending radially within the vanes of the rotor therein, said admission-chamber being provided with a series of nozzle-passages delivering radially outward and approximately tangentially against the vanes of the rotor, a main shaft extending axially through the series of units and upon which the several rotors are mounted, trunk connections affording communication between each main chamber of one cylinder and the admission-chamber of the succeeding cylinder, the diameters of the several rotors at the vanes being similar and the aggregate area of the nozzle-passages of each unit being increasing as to successive units but within the limits of differences which increase the velocity of flow proportionately to the expansion permitted by such increased nozzle area.

3. In a steam-turbine engine, the combination of a plurality of engine units, each unit comprising a main chamber, a rotor therein provided with a series of circumferentially-disposed vanes, an admission-chamber located concentrically with the main chamber and extending radially within the vanes of the rotor therein, said admission-chamber being provided with a series of nozzle-passages delivering radially outward and approximately tangentially against the vanes of the rotor, a main shaft extending axially through the series of units and upon which the several rotors are mounted, trunk connections affording communication between each main chamber of one cylinder and the admission-chamber of the succeeding cylinder, the diameters of the several rotors at the vanes being similar and the aggregate area of the nozzle-passages of each unit being increasing as to successive units but within the limits of differences which increase the velocity of flow proportionately to the expansion permitted by such increased nozzle area, throttle-valves arranged to control the nozzle-passages of the several units and automatic governing mechanism operatively connected with said throttle-valves.

4. In a steam-turbine engine, the combination of a plurality of engine units, each unit comprising a main chamber, a rotor therein provided with a series of circumferentially-disposed vanes, an admission-chamber located concentrically with the main chamber and extending radially within the vanes of the rotor therein, said admission-chamber being provided with a series of steam-passages delivering radially outward and approximately tangentially against the vanes of the rotor, a main shaft extending axially through the series of units and upon which the several rotors are mounted, said units being spaced apart as to their main chambers to provide intervening spaces, and trunks arranged concentrically around the main shaft and affording communication between each main chamber of one cylinder and the admission-chamber of the succeeding cylinder, substantially as described.

5. In a steam-turbine engine, the combination of a plurality of steam cylinders or casings arranged concentrically with relation to each other and spaced apart as to their main bodies, a main shaft extending axially through the series, a rotor mounted upon the main shaft within each cylinder, an admission-chamber forming a part of each cylinder and provided with a series of steam-passages delivering into the main chamber of the cylinder and against the vanes of the rotor therein, adjustable valves, one for each passage, controlling said steam-passages, operative connections connected with said several valves and extending out through the side walls of the cylinders into the spaces intervening between the successive units, and means connecting the set of valves of each unit to move in unison, for the purpose set forth.

6. In a steam-turbine engine, the combination of a plurality of steam cylinders or casings arranged concentrically with relation to each other and spaced apart as to their main bodies, a main shaft extending axially through the series, a rotor mounted upon the main shaft within each cylinder, an admission-chamber forming a part of each cylinder and provided with a series of steam-passages delivering into the main chamber of the cylinder and against the vanes of the rotor therein, valves controlling said steam-passages, operative connections connected with the several valves, extending out through the side walls of the re-

spective cylinders into the spaces intervening between the successive units, an automatic governor and outside connections between the several valve connections and said automatic governor.

7. In a steam-turbine engine, the combination of a plurality of steam cylinders or casings arranged concentrically with relation to each other and spaced apart as to their main bodies, each cylinder comprising a main chamber, an admission-chamber arranged concentrically within said main chamber and having a radially outer cylindric peripheral wall portion provided with a series of steam-passages delivering into the main chamber, a rotor arranged in said main chamber and provided with a series of vanes overhanging the said peripheral wall of the admission-chamber, endwise reciprocatory throttle-valves arranged to control said several steam-passages, a rock-shaft journaled adjacent to each throttle-valve and having crank-arm connections therewith, said rock-shafts being arranged to extend out through the side wall of the admission-chamber, crank-arms upon the outer ends of said several rock-shafts, a series of links connecting the outer crank-arms of each cylinder in a circumferential series and operative connections between each set of links, and an automatic governing mechanism, substantially as described.

8. In a steam-turbine, the combination with a suitable cylinder or casing and a rotor element therein provided with a circumferential series of impact-vanes, of a steam-inlet arranged to discharge into said cylinder and against the vanes of the rotor therein, said inlet being located radially inside of the series of vanes and having a fixed direction of discharge which is radially outwardly and approximately tangentially to the inner perimeter of the series of vanes, and said vanes being each constructed with a concave impact-surface at its receiving end arranged in direct alinement with the axis of the steam-inlet and with a rearwardly-extending outer continuation of said concave portion, which continuation extends throughout its principal length in a general direction approximating forty-five degrees from a radius of the rotor passing therethrough.

9. In a steam-turbine, the combination with a suitable cylinder or casing and a rotor element therein provided with a circumferential series of impact-vanes of similar shape and uniformly spaced to provide steam-passages therebetween, of a steam-jet inlet arranged to discharge into said cylinder and against the vanes of the rotor therein, said inlet being located radially inside of the series of vanes and arranged to discharge radially outwardly and approximately tangentially to the inner perimeter of the series of vanes, said vanes being each constructed with a concave impact-surface at its receiving end arranged in direct opposition or alinement with the axis of the steam-inlet and with a rearwardly-extending outer continuation of said concaved portion extending in a general direction approximating forty-five degrees from a radius of the rotor passing therethrough and said vanes being so spaced apart that the width of the steam-passages therebetween, measured in a direction circumferentially of the rotor, is less at the delivery end of the passage than at the impact-point and said vanes being of increasing width from their inner toward their outer ends, whereby the passages therebetween are of undiminished capacity from the receiving end outwardly.

10. In a steam-turbine, the combination with a suitable cylinder or casing and shaft extending therethrough, of a rotor element therein comprising a wheel provided with a circumferential series of vanes forming a peripheral portion which overhangs one side of the main plane of the wheel and provided at its opposite side with an overhanging peripheral portion constituting a counterbalance for the series of vanes, whereby breaking stress upon the rotor in a direction transverse to the general plane thereof is substantially avoided.

11. In a steam-turbine engine, a steam-cylinder or suitable casing, a rotor arranged therein provided with a series of impact-vanes, one or more steam-jet inlets communicating with the source of steam-supply at one side and discharging into said cylinder against the vanes of the rotor therein, and throttling mechanism controlling said steam inlet or inlets, each throttling mechanism comprising a valve-stem of restricted size provided at its end with an enlarged approximately pear-shaped forwardly-tapered valve-plug member, mounted to reciprocate longitudinally in the axis of the steam-inlet, and a constricted portion in the steam-jet passage constituting an annular valve-seat with which said valve member coöperates.

12. In a steam-turbine engine, a steam-cylinder or suitable casing, a rotor arranged therein provided with a series of impact-vanes, an annular support arranged to underlie or extend radially within said series of vanes, one or more steam-inlets arranged to extend approximately tangentially through said annular support, corresponding throttle-valves arranged to reciprocate longitudinally within said steam-inlets, a rock-shaft mounted to extend through the wall of said steam cylinder or casing, transversely to the axis of, and contiguous to each throttle-valve, operative connections between each rock-shaft and its corresponding throttle-valve, an automatic governor operatively connected with and driven by the engine and operative connections between the several rock-shafts and said governor, whereby the several throttle-valves are moved in unison.

13. In a steam-turbine engine, the combina-

tion of a plurality of units each comprising an internally cylindric casing interiorly divided to form a main chamber, and an inlet-chamber arranged concentrically within one side of said main chamber, a main shaft extending concentrically through the axes of said several cylinders, a rotor upon said main shaft in each of said main chambers and each provided with a circumferential series of impact-vanes arranged to radially overhang the peripheral portion of the partition-wall separating the inlet from the main chamber, a series of tangentially-disposed steam-passages leading from each inlet-chamber through said peripheral portion of the partition-wall, that part of the partition-wall which extends radially and divides the main chamber from the inlet-chamber of each cylinder being extended inwardly toward the center of the cylinder and merged into a cylindric bearing member inclosing and supporting the main shaft, and that part of the cylinder which forms the outer radially-extending wall of the inlet-chamber being united at its inner edge with a cylindric admission-trunk of larger internal diameter than, and surrounding, that part of said inner wall of the inlet-chamber which forms the said shaft-support.

14. In a steam-turbine engine, the combination with a suitable cylinder or casing and a rotor element therein, provided with a circumferential series of impact-vanes, a series of steam-inlets arranged to discharge into said cylinder and against the vanes of the rotor therein, said inlets being located radially inside of the series of vanes and arranged to discharge radially outwardly and approximately tangential to the inner perimeter of the series of vanes, and said vanes being each constructed with a concave impact-surface at its receiving end and with a rearwardly-extending outer continuation of said impact-surface, which continuation extends throughout its principal length in a general direction approximating forty-five degrees from a radius of the rotor passing therethrough and is extended to a length not less than twice the length of the receiving-limb of the vane, measured from the center of the concavity forming the impact portion.

15. In a steam-turbine engine, the combination with a suitable cylinder or casing, of a rotor element therein comprising a main wheel, a circumferential series of vanes, each having one of its lateral edges seated in the side face of the main body, a facing-ring applied to the opposite lateral edges of the vanes, and through-bolts connecting the facing-ring with the main wheel.

JOHN C. BUCKBEE.

Witnesses:
ALBERT H. GRAVES,
FREDERICK C. GOODWIN.