No. 746,388. PATENTED DEC. 8, 1903.

T. SCHEFFLER.

STEAM TURBINE.

APPLICATION FILED MAY 23, 1903.

NO MODEL.

Fig. 1.

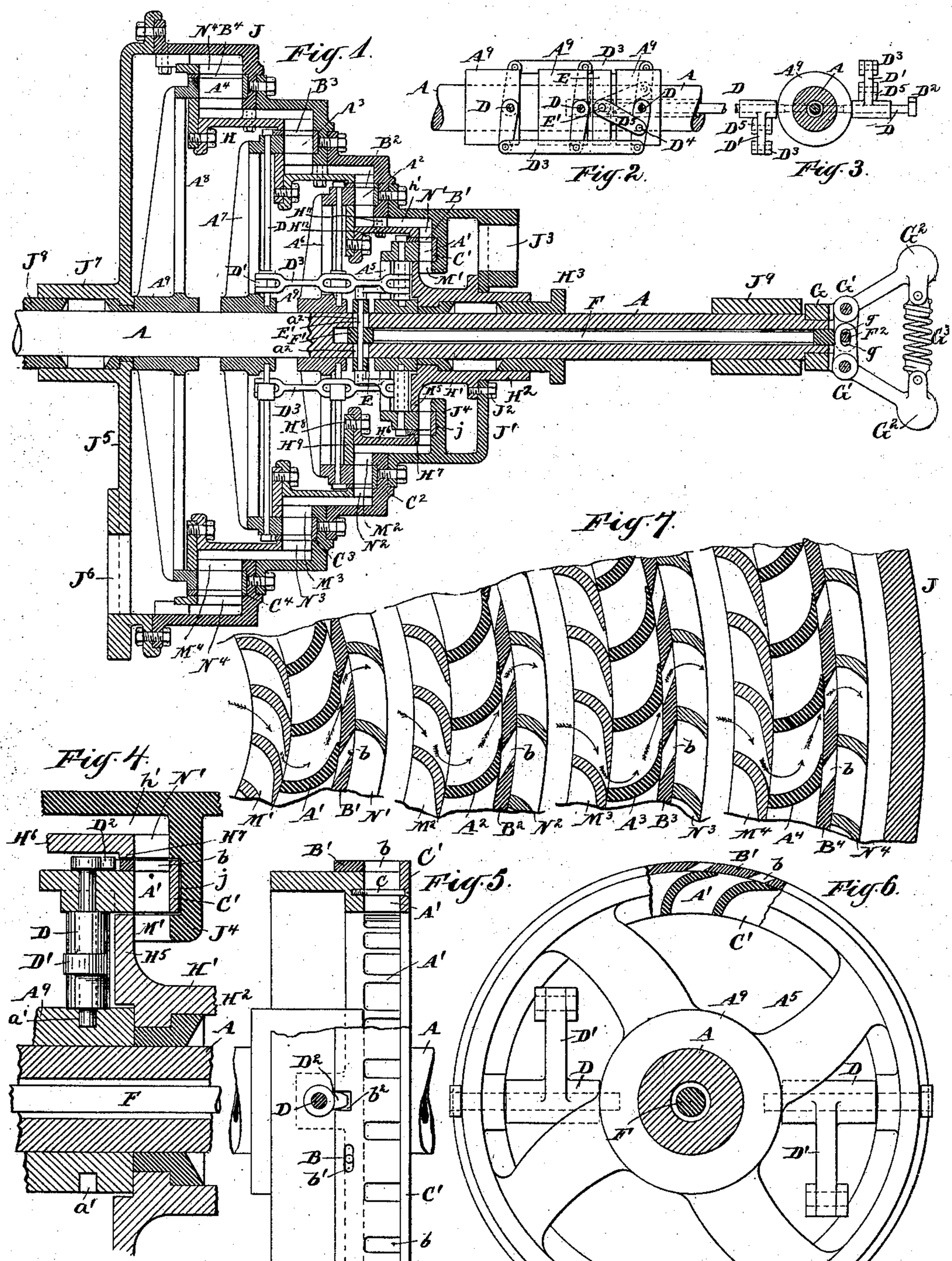

Fig. 2.

Fig. 3.

Fig. 7.

Fig. 4.

Fig. 5.

Fig. 6.

Witnesses:

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No. 746,388. Patented December 8, 1903.

UNITED STATES PATENT OFFICE.

THEODORE SCHEFFLER, OF PATERSON, NEW JERSEY, ASSIGNOR TO HIMSELF, AND FREDERICK A. SCHEFFLER, OF GLENRIDGE, NEW JERSEY.

STEAM-TURBINE.

SPECIFICATION forming part of Letters Patent No. 746,388, dated December 8, 1903.

Application filed May 23, 1903. Serial No. 158,389. (No model.)

To all whom it may concern:

Be it known that I, THEODORE SCHEFFLER, a citizen of the United States, residing in Paterson, in the county of Passaic and State of New Jersey, have invented a certain new and useful Improvement in Steam-Turbines, of which the following is a specification.

The invention relates to turbine-motors of the type known as "radial," in which steam reacts on a plurality of turbine-wheels each carrying an annular series of peripheral vanes coacting with one or more series of stationary buckets and delivering its steam in an expanded condition to the next succeeding wheel; and the object of the invention is to increase the efficiency and economy of the motor by arranging the vanes, buckets, and passages to present the steam favorably and by automatically controlling the steam in its passage from one wheel to the next by a speed-governor.

The invention consists in certain novel features and arrangements of parts by which the above objects are attained and also in certain details of construction to be hereinafter described.

The accompanying drawings form a part of this specification and show a preferred form of the invention.

Figure 1 is a diametrical section, partly in plan view. Fig. 2 is a side view of a portion detached; and Fig. 3 is a corresponding end view, partly in transverse section. The remaining figures are on a larger scale. Fig. 4 is a diametrical section through a portion. Fig. 5 is a side view, partly in section, showing the first turbine-wheel and the adjacent parts. Fig. 6 is a corresponding face view, partly in section. Fig. 7 is a transverse section diagrammatically arranged to show the course of the steam through all the vanes and buckets.

Similar letters of reference indicate the same parts in all the figures.

In my improved engine steam admitted to the casing passes through an annularly-arranged series of stationary leading buckets to the first turbine-wheel and is delivered from the latter through apertures in a controlling-ring to an annular series of reaction-buckets. The steam is then led through an annular passage to a second annular series of leading buckets of larger diameter and between the vanes of the second turbine-wheel, controlling-ring, and stationary buckets, and so on through as many sets as may be found desirable. I have shown four such sets each of larger diameter than the next preceding. The several controlling-rings inclosing the turbine-wheels are moved relatively thereto by connections from a governor, and thus automatically regulate the speed by varying the size of the discharge-channels through which steam passes from the wheels to the stationary reaction-buckets.

The shaft is marked A and carries a number of wheels or spider-frames A^5 A^6 A^7 A^8, secured thereto by the hubs A^9 and each having a peripheral flange, upon which is formed a series of suitably-curved vanes (marked, respectively, A′, A^2, A^3, and A^4) arranged in a manner analogous to the the teeth of a crown-wheel and serving by the reaction of the current to revolve the shaft. Encircling each flange or rim and revolving with the wheel is a controlling-ring (marked, respectively, B′, B^2, B^3, and B^4) having angular apertures or notches *b* inclined in the same general direction as the vanes and of a width the same as or a little less than the peripheral faces of such vanes.

The rings are held against axial movement on the wheels by steady-pins B, extending through short circumferential slots *b*′ in the rings and into the rims of the wheels, but are free to rotate to the limited extent allowed by the slots and control the passage of steam through the openings between the vanes by varying the positions of the apertures *b*′ relatively to the faces of the vanes, and thus correspondingly varying the area of the delivery-channels.

C′ C^2 C^3 C^4 are annular plates fitting upon the plane faces of the vanes of the several wheels and also upon the plane faces of the ring and serving as covers for the openings between the vanes and for the apertures *b*. The plates are held in place by screws C, extending through them into the rims of the wheels, of which, in effect, they form a part, but are not joined to the rings. The construc-

tion is the same for each of the turbine-wheels, except the last, A^4, in which the ring B^4 may be understood to be adjusted to produce the required area of opening for the apertures and then fastened in such position by its steady-pins against further movement relatively to its wheel.

The several turbine-wheels are successively of larger diameters and greater width of face. The radial depth or thickness of the rims may be the same in all and are so represented. The wheels are mounted one behind the other on the shaft to which they are secured by the hubs A^9, in which in all but the last are produced oppositely-placed holes or radial sockets a' a', coinciding in direction with similar holes a a in the rim behind the vanes and receive short shaft or arbors D D, arms having D′ D′, extending at right angles and lying with their free ends in the spaces between adjacent arms or spokes of the wheels. The outer end of each arbor carries a tooth or lug D^2, which engages in a corresponding notch b^2 in the adjacent rear edge of the controlling-ring and serves to move the latter circumferentially upon its rim by the partial rotation of the arbor D through motion imparted to its arm D′. By employing two oppositely-placed arbors arranged to be moved simultaneously and to turn the ring in the same direction the free movement of the ring on its wheel is insured; but it will be understood that a single arbor may be used alone.

D^3 D^3 are links, one connecting all the arms D′ on one side of the shaft and the other all the oppositely-extending arms. The foremost arms, those belonging to the wheel A′, are provided each with a pin D^4, carrying one end of a short link D^5, extending parallel with the shaft and pivoted at the opposite end to the projecting end of a pin E′, protruding from a ring or annular slide E, encircling the shaft and arranged to be moved axially thereon. The shaft A is hollow and is slotted longitudinally at a^2 a^2 on opposite sides to receive the pin E′, extending diametrically through the shaft and slide and permitting the axial movement of the latter while compelling it to revolve with the shaft and wheels. As before stated, the overhung ends of the pin E′ serve as trunnions or pivots for the links D^5, and the body of the pin passes through a head F′ on a rod F, lying in the axial line of the bore in the shaft and carrying at its protruding outer end a transverse pin F^2, engaged in slots g g in the short arms of a pair of bell-crank levers G′ G′, fulcrumed in a ring G, secured to the end of the shaft and forming part of a governor. The longer arms extend angularly outward in a plane parallel with the axis of the shaft and are each provided at its end with a weight or governor-ball G^2, drawn normally inward toward its companion by the force of a helical spring G^3, attached at its ends to the two balls.

The rotation of the shaft tends to separate the balls by centrifugal force as the speed increases, and the spring draws them together as the speed is lessened, the movements thus produced by the short arms being transmitted through the rod F and pin E′ to the slide E and from the latter through the short links D^5 D^5 to the arms D′ D′ and arbors D D, and through the partial rotation of the arbors and their teeth D^2 D^2 the several controlling-rings are correspondingly moved circumferentially on the turbine-wheels and vary the effective areas of the apertures b. The parts are so arranged that an increase of speed moves the rings in the direction to diminish the delivery area and lessen the speed, and the reverse.

The casing in which the turbine-wheels revolve and which carry the stationary leading and reaction buckets, comprises, in effect, an outer shell J and an inner shell H, each built up of a number of annular sections bolted or otherwise joined together in the process of assembling.

The smallest section of the inner shell is marked H′ and has a stuffing-box H^2 and gland H^3 and a flange H^4, to which is secured the smallest section J′ of the outer shell by the bolts J^2. This portion of the outer shell has the steam-inlet passage J^3 receiving steam through a pipe (not shown) from a boiler and has also an inner flange J^4, in which is formed an annular groove j, receiving the cover C′ for the first series of vanes A′ and ring B′, matching closely therein. The main portions of the vanes and ring revolve in a close-fitting annular groove formed by the space between a flange H^5 on the inner end of the first section H′ of the inner shell and a similar but shorter flange H^7 on a second annular portion H^6 of the inner shell secured by studs H^8 to a flange H^9 on the next succeeding section H^{10} of which the flange H^9 performs a function corresponding to that of the flange H^5, but receiving the second series of vanes A^2 and its ring B^2.

The first series of leading buckets M′ is formed on the annular flange H^5 and lies close within the inner faces of the vanes A′, and the first series of reaction-buckets N′ are formed on the flange H^7 and lie close to the outer face of the first ring B′. The arrangement of the succeeding fixed leading and reaction buckets M^2, M^3, and M^4 and N^2 N^3 N^4 is the same for the succeeding turbine-wheels, the only difference being a corresponding increase in size.

The cylindrical portion H^6 of the inner shell is held away from the inclosing outer shell by bolts H^{12}, extending through radial bosses H^{11}, set at intervals in a circumferential line and bridging the annular passage h', through which expanded steam from the first series of reaction-buckets N′ is led to the second series of leading buckets M^2. The several sections of the inner and outer shells are similarly formed and assembled by bolting together and provide annular passages for the

steam from the reaction-buckets to the succeeding leading buckets until the last of the sets is reached, from which the expanded steam flows freely to the interior of the inner casing and is lead away through an exhaust-pipe (not shown) received in the opening J^6 in the head J^5, forming part of the outer shell.

J^7 is a stuffing-box for the rear end of the casing, and J^8 is a portion of the gland.

Bearings for the shaft are provided, only one, J^9, being shown, which may be understood to be on arms forming part of the casing, and the whole is secured to the floor or foundation by lugs (not shown) on the casing.

The annular spaces between the shells, serving as steam-passages, are shut off from the interior of the inner shell by the close fit between the revolving and stationary parts; but, as above stated, the inner shell is open to the exhaust, so that any leakage of live steam through such joints can escape easily and the pressure on the interior of the inner shell will be exhaust only and may be easily controlled without excessive stuffing-box friction. The pressure of live steam in the several buckets, vanes, and passages is practically balanced, and end thrust on the shaft is avoided.

The governing rings are preferably of wrought-iron and are first fitted circumferentially to their respective wheels and their positions marked. The apertures *b* are then carefully marked directly from the vanes and the apertures then produced. When finished, the rings are returned to the marked positions, insuring that the apertures shall lie in proper relation to the vanes even though the latter may not be exactly spaced.

By varying the area of the apertures in the rings the volume of steam passing through the engine is increased or diminished automatically by the governor in accordance with the load; but it will be observed that the steam is not throttled before entering the vanes and also that it acts with full pressure against the reaction-buckets through channels of greater or less area as required by the conditions, the pressure acting on the first series of vanes being practically constant; but the volume of escape is varied. The rings may be set to allow the passage of just sufficient steam to give the required speed of revolution when the engine is running light and to increase the area of the channels automatically as required to maintain speed with a corresponding increase in load.

It is believed the reaction due to this construction is much greater than in engines in which the steam is throttled before entering the turbine-wheel, and therefore acting in an expanded condition in the latter and against the reaction-buckets.

An important feature of the invention is in providing each series of vanes with independent stationary leading and reaction buckets, thus permitting each to be shaped to perform properly its own function of directing the incoming current and receiving the escaping current.

Modifications may be made in the forms and proportions of the parts within wide limits without departing from the principle of the invention or sacrificing its advantages.

A greater or less number of turbine-wheels may be employed, and the forms of the leading buckets, vanes, and reaction-buckets may be varied.

Although I have described the engine as using steam for the motive power, it will be understood that any elastic fluid may serve.

Other types of governors may be substituted for the governor herein shown.

I claim—

1. In a turbine-engine, a turbine-wheel having a series of vanes and openings between them, a governing-ring carried by said wheel and movable thereon and having apertures arranged to register with said vanes and to be closed or partially closed thereby, and serving with said openings as channels for the passage of steam from said wheel.

2. In a turbine-engine, a turbine-wheel having a series of vanes and openings between them, a governing-ring carried by said wheel and movable thereon and having apertures arranged to register with said vanes and to be closed or partially closed thereby, and serving with said openings as channels for the passage of steam from said wheel, and means for moving said ring and wheel relatively to each other whereby the area of said channels is varied and the flow of steam controlled.

3. In a turbine-engine, a turbine-wheel having a series of peripheral vanes and openings between them, a governing-ring encircling said wheel and carried by the latter, the said ring having peripheral apertures arranged to register with said vanes and to be closed or partially closed thereby and serving with said openings as channels for the passage of steam from said wheel, and means for moving said ring circumferentially on said wheel whereby the area of said channels is varied and the flow of steam controlled.

4. In a turbine-engine, a turbine-wheel having a series of peripheral vanes and openings between them, a governing-ring encircling said wheel and carried by the latter, the said ring having peripheral apertures arranged to register with said vanes and to be closed or partially closed thereby and serving with said openings as channels for the passage of steam from said wheel, and means controlled by the speed of revolution of said wheel for moving said ring and wheel relatively to each other, whereby the area of said channels is automatically varied and the flow of steam controlled.

5. In a turbine engine, a turbine-wheel having a series of vanes and openings between them, a shaft carrying said wheel, a governing-ring carried by said wheel and having a series of apertures arranged to register with

said vanes and to be closed or partially closed thereby and serving with said openings as channels for the passage of steam from said wheel, a governor actuated by said shaft and wheel, and connections from said governor through said shaft to said ring, whereby the latter is moved relatively to said wheel.

6. In a turbine-engine, a plurality of turbine-wheels each having a series of vanes and openings between them, a shaft on which said wheels are carried, a plurality of governing-rings mounted one on each of said wheels and having each a series of apertures arranged to register with the vanes of its wheel and be closed or partially closed thereby and serving with said openings as channels for the passage of steam from said wheel, a governor actuated by the revolutions of said shaft, and connections from said governor through said shaft to said rings, whereby the latter are all moved simultaneously relatively to the said wheels.

7. In a turbine-engine, a turbine-wheel having a series of vanes in its rim and openings between them, a shaft to which the hub of said wheel is secured, a governing-ring encircling said wheel and free to move circumferentially thereon having a series of apertures arranged to register with said vanes and to be closed or partially closed thereby and serving with said openings as channels for the passage of steam from said wheel, a governor actuated by said shaft, a slide on the latter moved axially thereon by variations in the speed of said shaft, an arbor journaled in said rim and hub, connections from said slide to said arbor for inducing partial revolutions of said arbor, and connections from said arbor to said ring whereby the movements of said arbor are transmitted to said ring.

8. In a turbine-engine, a plurality of turbine-wheels each having a series of vanes in its rim and openings between them, a shaft to which the hubs of said wheels are secured, a plurality of governing-rings encircling said wheels each free to move circumferentially on its wheel and having each a series of apertures arranged to register with said vanes and serving with said openings as channels for the passage of steam from said wheel, a governor actuated by said shaft, a slide on the latter moved axially by variations in the speed of said shaft, an arbor journaled in the rim and hub of each wheel, an arm on each arbor and connections from said slide to said arms for inducing partial revolutions of all of said arbors, and connections from said arbors to their respective rings, whereby the movements of said arbors are transmitted to said rings.

9. In a turbine-engine, a plurality of turbine-wheels each having a series of vanes in its rim, a shaft to which the hubs of said wheels are secured, a casing for said wheels comprising an inner and outer shell, annular openings in said inner shell receiving the rims of said wheels, an annular series of leading buckets carried by said casing interiorly of each of said rims, an annular series of reaction-buckets carried by said casing exteriorly of each of said rims, and annular passages leading from each series of reaction-buckets to the next succeeding series of leading buckets, a steam-inlet passage leading to the first series of leading buckets, and an exhaust-passage from the last series of reaction-buckets to the interior of said inner shell, and an exhaust-passage therefrom.

10. In a turbine-engine, a plurality of turbine-wheels, each having a series of vanes in its rim and openings between them, a shaft to which the hubs of said wheels are secured, a plurality of rings encircling said wheels, each free to move circumferentially on its wheel and having a series of apertures arranged to register with said vanes and serving with said openings as channels for the passage of steam from said wheels, means controlled by the speed of revolution of said shaft for moving said rings relatively to their respective wheels, a casing for said wheels comprising an inner and outer shell, annular openings in said inner shell receiving the rims of said wheels and their rings, an annular series of leading buckets for each wheel, carried by said casing, an annular series of reaction-buckets for each of said wheels, carried by said casing, and annular passages between said shells leading from each series of reaction-buckets to the next succeeding series of leading buckets, an annular passage from the last series of reaction-buckets to the interior of said inner shell, a steam-inlet passage to the first series of leading buckets, and an exhaust-passage from the interior of the casing.

11. In a turbine-engine, a turbine-wheel having a series of vanes in its rim and openings between them, a shaft to which the hub of said wheel is secured, a governing-ring encircling said rim and free to move circumferentially thereon, having a series of apertures arranged to register with said vanes to be closed or partially closed thereby and serving with said openings as channels for the passage of steam from said wheel, an arbor journaled in said hub and rim, a tooth carried by said arbor and engaged in a notch in said ring, and connections to said arbor through said shaft from a governor, whereby variations of said governor move said ring relatively to said wheel.

12. In a turbine-engine, a plurality of turbine-wheels each having a series of vanes in its rim and openings between them, a shaft to which the hubs of said wheels are secured, a plurality of governing-rings each encircling one of said rims and free to move circumferentially thereon, having a series of apertures arranged to register with said vanes and to be closed or partially closed thereby and serving with said openings as channels for the passage of steam from said wheel, a plurality of arbors each journaled one in the rim and hub of each wheel, a tooth carried by each

arbor and engaged in a notch in its ring, an arm on each arbor, a link connecting the several arms, a slide on said shaft adapted to move axially thereon, a link from said slide to one of said arms, a governor on said shaft, and connections from said governor to said slide.

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

THEODORE SCHEFFLER.

Witnesses:

JAMES H. COCKER,

JOSEPH HOPPER.