T. H. BROCKMAN.

INTERNAL COMBUSTION TURBINE.

APPLICATION FILED JAN. 20, 1919.

1,315,906.

Patented Sept. 9, 1919.

4 SHEETS—SHEET 1.

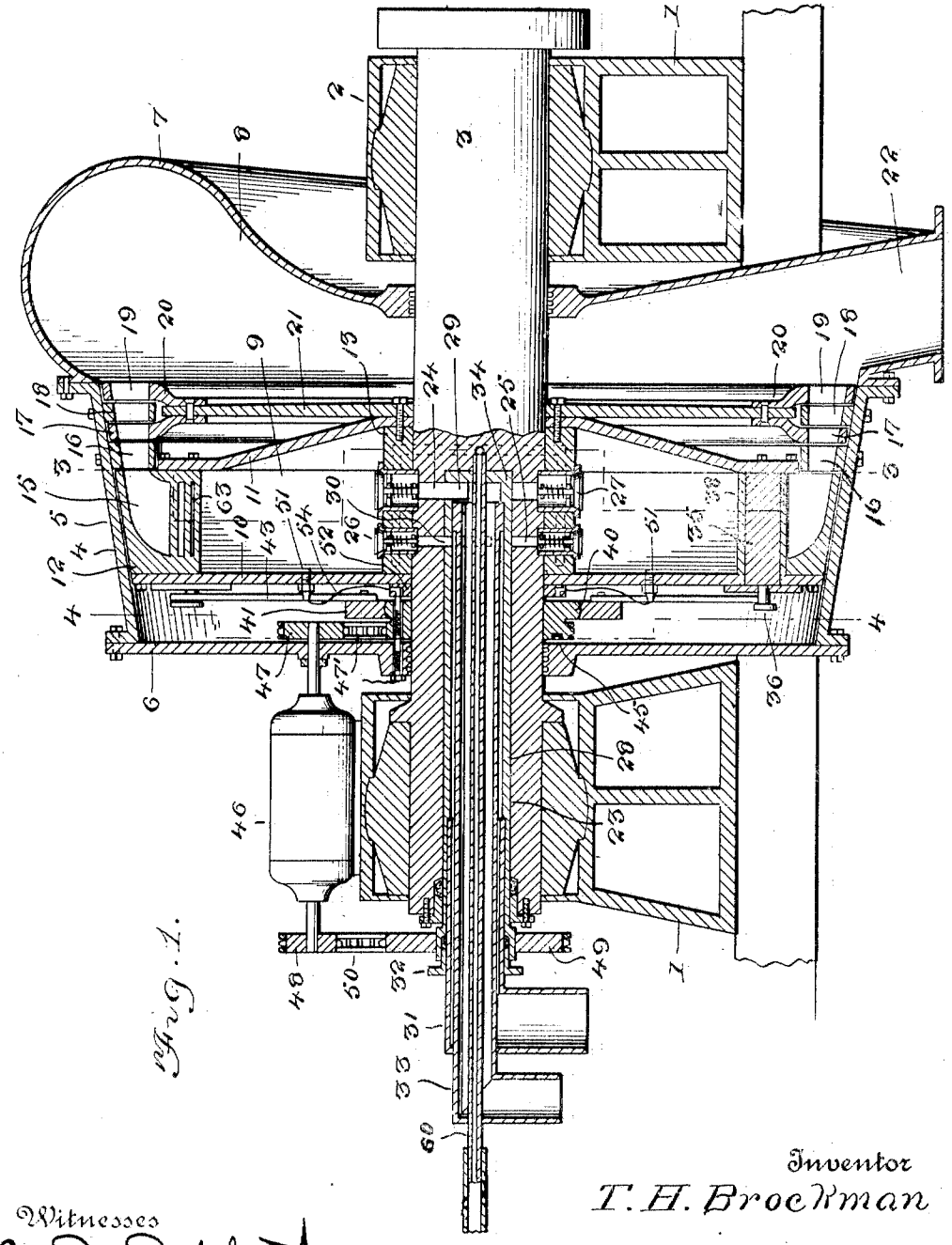


Fig. 1.

Witnesses

E. R. Rupfert

Inventor

T. H. Brockman

By Victor J. Evans

Attorney

T. H. BROCKMAN.

INTERNAL COMBUSTION TURBINE.

APPLICATION FILED JAN. 20, 1919.

1,315,906.

Patented Sept. 9, 1919.

4 SHEETS—SHEET 2.

Fig. 2.

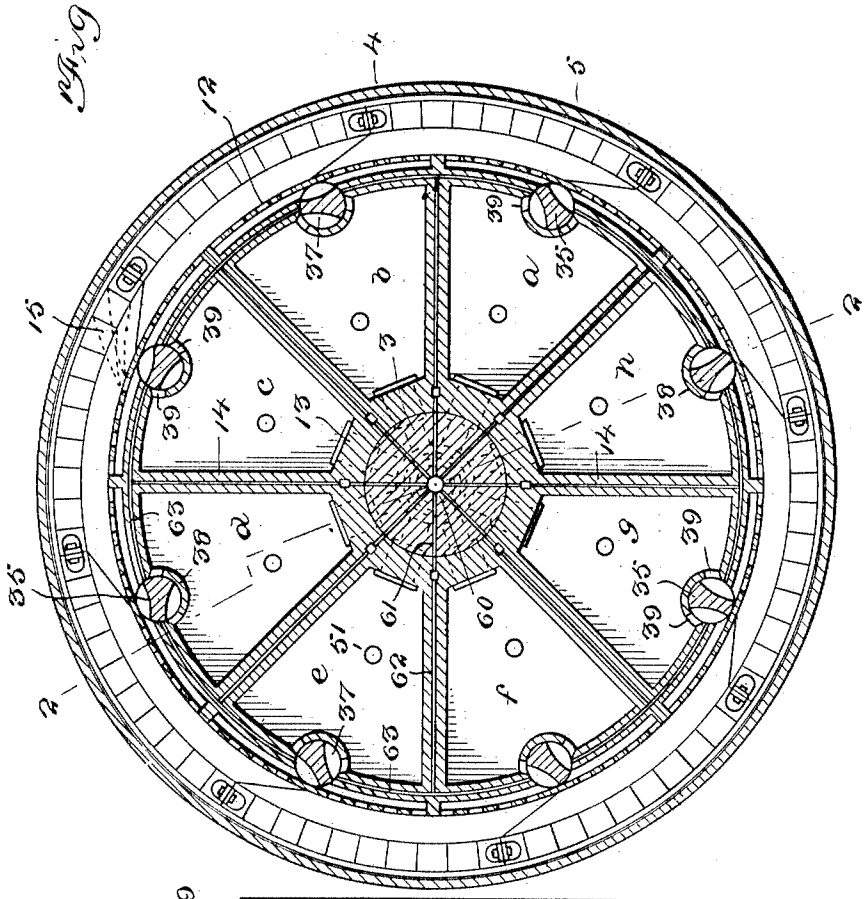
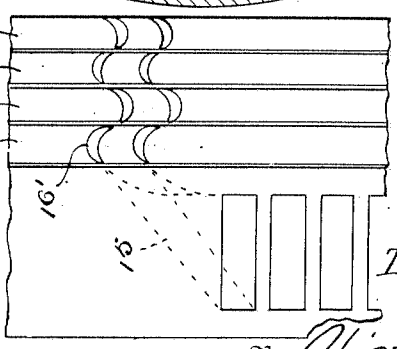


Fig. 6.



Witnesses

E. R. Ruppert.

Inventor

T. H. Brockman

By Victor J. Evans

Attorney

T. H. BROCKMAN.

INTERNAL COMBUSTION TURBINE.

APPLICATION FILED JAN. 20, 1919.

1,315,906.

Patented Sept. 9, 1919.

4 SHEETS—SHEET 3.

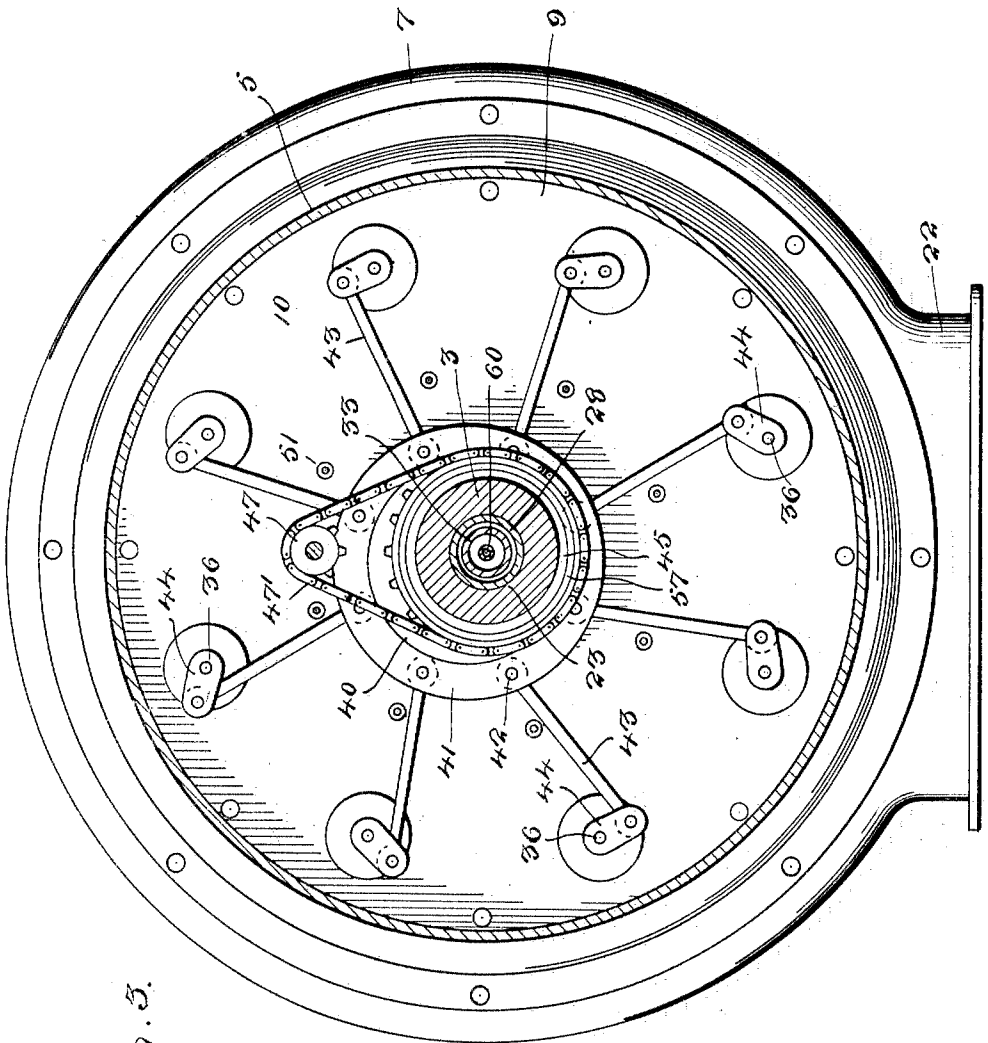


Fig. 5.

Witnesses

E. A. Ruhlpert.

Inventor

T. H. Brockman

By Victor J. Evans

Attorney

T. H. BROCKMAN.

INTERNAL COMBUSTION TURBINE.

APPLICATION FILED JAN. 20, 1919.

1,315,906.

Patented Sept. 9, 1919.

4 SHEETS—SHEET 4.

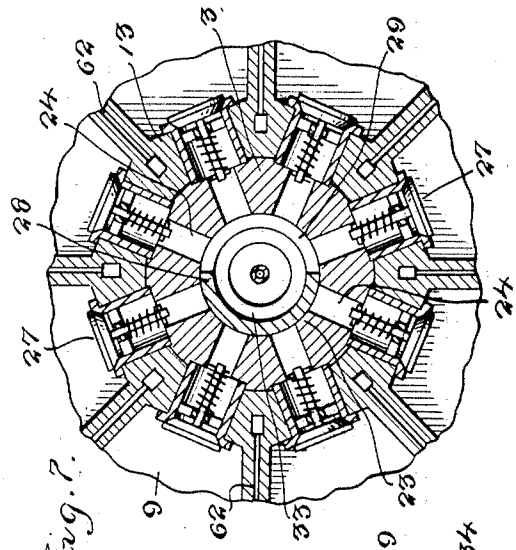


Fig. 7.

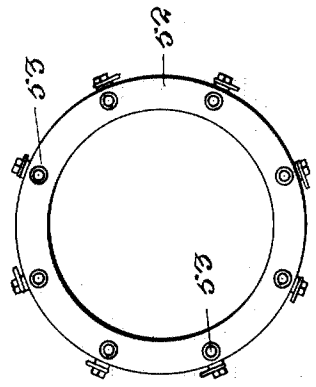


Fig. 8.

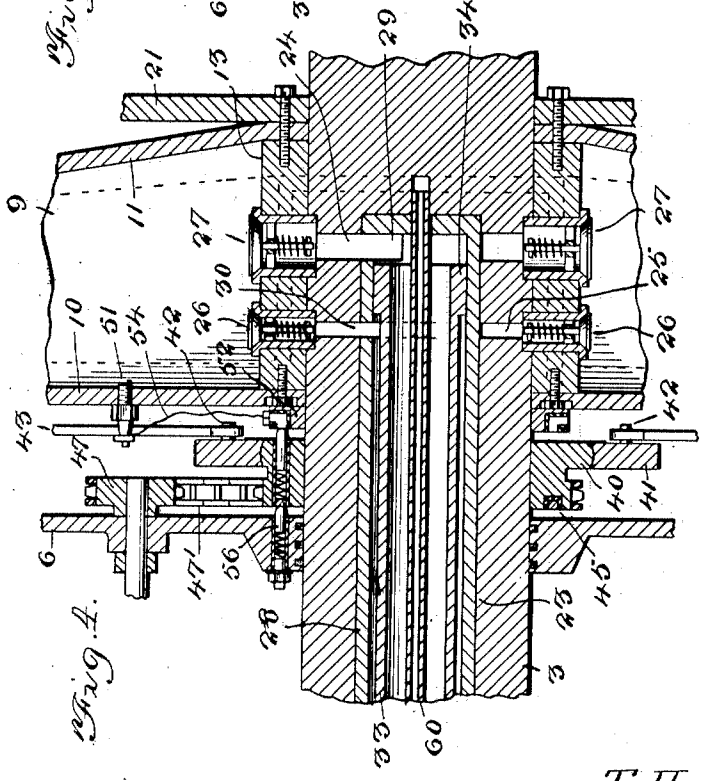


Fig. 4.

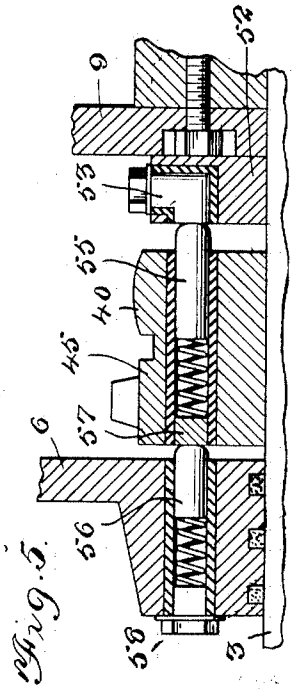


Fig. 5.

Witnesses

E. R. Ruppert.

Inventor

T. H. Brockman

By Victor J. Evans

Attorney

UNITED STATES PATENT OFFICE.

THOMAS H. BROCKMAN, OF NEW ORLEANS, LOUISIANA.

INTERNAL-COMBUSTION TURBINE.

1,315,906. Specification of Letters Patent. Patented Sept. 9, 1919.

Application filed January 20, 1919. Serial No. 272,095.

To all whom it may concern:

Be it known that I, THOMAS H. BROCKMAN, a citizen of the United States, residing at New Orleans, in the parish of Orleans and State of Louisiana, have invented new and useful Improvements in Internal-Combustion Turbines, of which the following is a specification.

This invention relates to improvements in internal combustion turbines and has particular application to an internal combustion turbine of the reaction type.

In carrying out the present invention it is my purpose to provide an internal combustion turbine of the reaction type whereby any grade of hydrocarbon fuel, or gas may be advantageously employed and the maximum power of the turbine delivered irrespective of the grade of fuel used, and wherein the formation of carbon will be reduced to a minimum.

It is also my purpose to provide a turbine of the class described which will be constructed in such manner as to occupy small space when compared with a steam motor or other power plant developing like horse power; and will weigh proportionately less, and which will involve compartively small expense both in installation and maintenance.

Another object of my invention is the provision of an internal combustion reaction turbine wherein the speed of the rotor may be regulated at will so that the power delivered by the turbine will be commensurate with the work to be performed, and wherein the explosion chambers, the reaction nozzles and the blade coöperating with such nozzles will be maintained at a proper working temperature in the operation of the turbine thereby preventing overheating and enabling the turbine to deliver its maximum power under all conditions.

A further object of the invention is the provision of a turbine of the class set forth wherein the component parts will be so arranged and correlated as to reduce the possibility of derangement to a minimum, and which will be simple, positive and reliable in operation.

With the above recited objects in view and others of a similar nature, the invention resides in the construction, combination and arrangement of parts set forth in and falling within the scope of the appended claims.

In the accompanying drawings:—

Figure 1 is a longitudinal vertical section of an internal combustion reaction turbine, constructed in accordance with my present invention.

Fig. 2 is a vertical transverse sectional view.

Fig. 3 is a similar view taken in a different plane.

Fig. 4 is an enlarged cross sectional view through the valve mechanism.

Fig. 5 is an enlarged detail view of the commutator and timing mechanism therefor.

Fig. 6 is a diagrammatic plan view of the rotors and stationary blades coacting therewith.

Figs. 7 and 8 are views of details of the invention.

Referring now to the drawings in detail, 1—1 designates pedestals suitably spaced apart, while 2—2 indicates bearings suitably mounted on the upper ends of the pedestals 1—1 respectively. Journaled in the bearings 2—2 is a shaft 3 adapted to rotate in the bearings. The bearings 2—2 are of any suitable or preferred construction.

Surrounding the shaft 3 concentrically thereof is a casing 4 arranged between the bearings 2—2 and composed of an annulus 5 having its respective ends flanged, end plates 6 bolted to one flange end of the annulus 5 and an end plate 7 bolted to the other flanged end of the annulus. The end plate 7 is formed in such a manner as to provide an exhaust chamber 8 of appropriate dimension.

Fixed upon the shaft 3 in the casing or housing 4 and arranged concentrically of the shaft is a rotor 9 comprising a side plate 10 spaced apart a short distance from the end plate 6 of the casing, a side plate 11 spaced apart a great distance from the end plate 7 of the casing and an annular ring 12 arranged between the plates 10 and 11 at the outer edges of the latter and suitably bolted or otherwise fastened to such side plates 10 and 11.

In the present instance, the annulus 5 increases in diameter from the end plate 6 toward the end plate 7 and the outer surface of the annular ring 12 is similarly

formed so as to conform to the shape of the annulus 5. In this form of my invention I have shown the side plate 11 of the rotor as substantially saucer-like in shape with the outer or peripheral edge straight to accommodate the bolts or other fastening means so that this plate may be fastened to the ring 12. The center portions of the side plates 10 and 11 of the rotor are bolted or otherwise connected to the respective ends of a sleeve 13 that is arranged concentrically of th main shaft 3 and forms, in effect, the hub of the rotor.

The rotor 9 is divided into the circular series of explosion chambers and in order to form these explosion chambers I employ a number of partition plates 14 that radiate from the hub 13 and have the side edges thereof in engagement with the respective side walls 10 and 11 of the rotor, and the outer edge fastened to or integral with the inner wall of the annular ring 12. In the present instance the partition plates 14 are spaced apart equal distances around the hub of the rotor to provide a plurality of explosion chambers. In the present instance I have shown eight of such chambers and these are designated by the letters *a*, *b*, *c*, *d*, *e*, *f*, *g*, and *h* respectively.

The annular ring 12 of the rotor is formed to provide a plurality of reaction nozzles 15 that are arranged at the outer ends of the explosion chambers respectively. In the present instance each reaction nozzle is arranged approximately centrally of the distance between the partition plates forming the particular explosion chamber and the inner end of the nozzle is adapted for communication with such chamber, while the outer end of the nozzle opens onto the exhaust side of the ring 12 of the rotor. Bolted or otherwise fastened to the inner surface of the annulus 5 contiguous to the exhaust side of the ring 12 is a stator 16 in the form of a ring provided with inwardly projecting impact blades 16′ that are adapted to receive the impact of the gases issuing from the reaction nozzle so that such gases may react upon the nozzles and drive the rotor.

The present embodiment of my invention is shown as a multiple stage turbine. Therefore a rotor 17 is shown adjacent to the exhaust side of the stator 16, a stator 18 contiguous to the exhaust side of the rotor 17, and a rotor 19 contiguous to the exhaust side of the stator 18. In other words, the stators and rotors alternate with one another as is usual in multiple stage turbine constructions. The stator 18 is identical in construction with the stator 16 embodying inner and outer rings and an annular series of blades between the rings spaced apart equal distances around the stator. The rotors 17 and 19 alternate with the stators 16 and 18 each embodying inner and outer rings and an annular series of blades between such rings spaced apart equal distances around the rotor. The inner rings of the rotors 17 and 19 form depending flanges or ears 20 that are arranged at the opposite sides of and bolted to a circular plate or disk 21 that is arranged concentrically of the shaft 3 and bolted or otherwise fastened to the side plate 11 of the rotor at the center of the latter. By means of the construction and arrangement of the rotors and stators just described, it will be seen that the gases issuing from the reaction nozzles impact upon the blades of the stators and react against the blades of the rotors with the effect to drive the rotors in one direction. As the rotors 17 and 19 are fixed to the plate 21 and the latter secured to the rotor 9, it will be seen that the rotor 9 is subjected to the full expansion of the gases so that the maximum power may be taken from the fuel. After the gases leave the rotor 19 they are discharged into the exhaust chamber 8 and from the exhaust chamber 8 through the exhaust port 22 therein.

In the present instance, the shaft 3 is formed with a longitudinal bore 23 that extends from one end of the shaft to a point slightly beyond the center of the rotor and formed in the shaft 3 contiguous to the inner end of the bore 23 is an annular series of air ports 24 and an annular series of hydro-carbon ports 25 arranged along side of the respective ports 24 in outer communication therewith. The ports 24 correspond in number to the explosion chambers and open into the inner ends of the latter, while the ports 25 also correspond in number with the explosion chambers and open into the inner ends of such chambers respectively. Fixed in the hub 13 at the inner end of each explosion chamber are valve casings carrying puppet valves 26 and 27 respectively that control communication between the explosion chamber and the corresponding air and hydro-carbon ports 24 and 25 in the shaft 3.

Mounted in the bore 23 is a sleeve valve 28 capable of rotation within the bore and having its inner end closed. The sleeve valve 28 adjacent to its inner end is formed with an elongated air port 29 and a similar hydro-carbon port 30. These ports 29 and 30 are adapted to register with the series of air ports 24 and the series of hydro-carbon ports 25 respectively incidental to rotation of the shaft 3 and the sleeve valve 28, so that communication may be established between the interior of the sleeve valve and the series of explosion chambers in the rotor 9. In the present structure, the outer end portion of the sleeve valve 28 is counter-bored and fitted into such counter-bored portion is the inner end of a hydro-carbon conveying tube

or pipe 31, the outer end of such tube or pipe 31 extending downwardly so that a connection may be made between the tube and a source of hydro-carbon fluid supply. A packing gland 32 encircles the tube 31 adjacent to its outer end and is carried by the outer end of the sleeve valve so as to effect a fluid tight connection between the sleeve valve and the hydro-carbon fluid conducting tube. This packing gland permits the sleeve valve to revolve while the hydro-carbon conducting tube remains stationary. Extending through the tube 31 and the sleeve valve and spaced apart from the tube and the valve is an air conducting tube 33 whose inner end terminates short of the inner closed end of the sleeve valve and is formed with a boss 34 that engages the inner wall of the sleeve valve at a point between the series of ports 24 and 25 so as to prevent intercommunication between such ports thereby preventing the air from entering the hydro-carbon port in the shaft and the hydro-carbon liquid or fuel from entering the air port. In practice, the hydro-carbon liquid or gas traverses the space between the sleeve valve 28 and the air conducting pipe 33, while the air traverses the interior of the pipe 33; thus air may be delivered through the proper port to the explosion chambers and the hydro-carbon liquid or gas delivered to the explosion chambers through the ports 25, both sets of ports being controlled by the sleeve valve 28.

Communication between the reaction nozzles 15 and the respective explosion chambers is controlled by means of valves and operating mechanism for such valves. In the present instance, each valve is of the rocking or oscillatory type and comprises a plug or body 35 extending across the inner end of the corresponding reaction nozzle 15 having its ends journaled in the respective end walls of such nozzle. The end of each plug 35 adjacent to the side plate 10 of the rotor is formed with a stub shaft 36 that projects beyond the plate 10, while the sides of the valve plug or body are cut out to provide ports 37. Integral, or otherwise connected, to the inner side of the annulus 12 and surrounding the inner portions of the respective valve bodies or plugs are semi-circular casings 38 formed, at their opposite sides, with ports 39 that coöperate with the ports 37 to facilitate the discharge of the gases from the explosion chambers when the valves are opened.

In the present instance the valve operating mechanism embodies an eccentric 40 loosely mounted upon the main shaft 3 between the plates 6 and 10 and a strap 41 encircling the eccentric 40 and equipped with laterally projecting pins 42 corresponding in number with the number of valves. Each pin 42 is connected with the corresponding valve by means of a rod 43, the inner end of which is mounted upon the pin, while the outer end is pivotally connected with a rocker arm 44 secured to the stub shaft 36 of the particular valve. By means of this construction it will be seen that when the eccentric is held stationary upon the main shaft 3, or revolved at a speed less than the speed of the main shaft, motion will be transmitted from the eccentric strap 41 through the rod 43 to the rocker arms of the stub shafts of the valves, thereby rocking or oscillating the valves in the inner ends of the reaction nozzles. Also surrounding the shaft 3 adjacent to the eccentric 40 and integral with such eccentric or otherwise connected thereto is an annulus 45 having its periphery formed with spur teeth or sprocket teeth.

In the present instance I have shown an electric motor 46 mounted upon the bearing tube at the inlet side of the turbine and one end of the armature shaft of the motor 46 extends through the plate 6 and is equipped with a pinion 47 over which and the toothed annulus 45 is trained an endless chain 47' whereby motion may be transmitted to the eccentric 40. On the other end of the armature shaft of the motor 46 is a pinion 48, while fixed upon the projecting end of the sleeve valve 28 is a gear 49 and over the pinion 47 and the gear 49 is trained an endless chain 50 whereby motion may be transmitted from the armature shaft of the motor to the sleeve valve to revolve the latter.

I will now proceed to describe the ignition system which is used in connection with my present form of the turbine. This mechanism or system, in the present instance, embodies spark plugs 51 secured in the side plate 10 of the rotor and projecting into the respective explosion chambers of the rotor. Fixed to the main shaft 3 is a commutator ring 52 arranged contiguous to the side plate 10 and embedded in the outer face or side of the ring 52 are contact studs 53 corresponding in number with the number of explosion chambers in the rotor. Each contact stud 53 is connected by means of a wire 54 with the central electrode of the corresponding spark plug 51, the other electrode of the spark plug being grounded upon the plate 10. Mounted in a transverse bore formed in the casting composing the annulus 45 and eccentric 40 is a spring pressed brush 55 that bears, at all times, against the outer face of the commutator ring 52 so as to engage the contact studs 53 successively in the operation of the turbine. A second spring pressed brush 56 is slidably mounted within a bore in the end plate 6 and the end of the brush 56 at the inner side of the plate 6 engages or presses against a conducting ring 57 embedded in the annulus 45 and insulated therefrom and electrically connected with the brush 55. The outer end of the brush 56 is connected

with a binding post 58 to which one terminal of the ignition circuit wire may be connected, the other terminal of the ignition circuit being grounded so that current may flow through the particular plug in connection with the contact stud 53 that is engaged by the brush 55, thereby enabling the plug to produce the necessary spark to explode the mixture in the particular explosion chamber.

In practice, the air port in the sleeve valve 28 is arranged in advance of the hydro-carbon port 30 so that the explosion chamber at the beginning of a cycle will receive a charge of air prior to the delivery of the hydro-carbon fluid thereto. As shown in Fig. 3 of the drawing, the explosion chamber *a* is at the beginning of a cycle and is receiving the charge of air through the air pipe 33, the port 29, the port 24 and the puppet valve 26. At the beginning of the cycle the valve controlling communication between the explosion chamber and the reaction nozzle is completely closed so that the air will be prevented from passing through the nozzle. When the explosion chamber *a* reaches the position of the chamber *b* the port 30 in the sleeve valve 28 establishes communication between the port 25 in the shaft 3 and the oil conducting tube 31 so that a charge of oil or other hydro-carbon fluid will be delivered to the explosion chamber through the valve 27, the exhaust valve, in this position of the explosion chamber, remaining closed. When explosion chamber *a* moves from the position of the chamber *b* to the position of chamber *c*, the port 30 in the sleeve valve continues to establish communication between the hydro-carbon supply and the explosion chamber and the exhaust valve remains closed. When the explosion chamber *a* reaches the position of the chamber *d*, the brush 55 engages the contact stud 53, the spark plug of such explosion chamber to the effect to explode the charge of air and the hydro-carbon fuel or fluid mingled in the explosion chamber *a*. When the chamber *a* reaches the position of the chamber *e*, the pressure in such chamber due to the explosion has risen to the maximum degree and when the position of chamber *f* is reached, the expanding gases are delivered to the reaction nozzle by the way of the open exhaust valve, the exhaust valve opening when this position is reached. When the chamber *a* reaches the position of the chamber *g* the gases continue to flow through the reaction nozzle and when the position of the chamber *h* is reached, the air port 29 is the sleeve valve again establishes communication between the source of air supply and the particular explosion chamber while the exhaust valve of such chamber remains open thereby enabling the scavenging charge of air to be drawn through the explosion chamber to drive out the burned product of combustion that may remain in the chamber.

From the time that the explosion takes place in a particular explosion chamber, communication between the source of air supply and the source of hydro-carbon supply is cut off by means of the sleeve valve 28 and this communication is not opened until the particular explosion chamber reaches the position of the chamber *a* in Fig. 3 of the drawing, at which time the above cycle of operation again takes place in the continued operation of the turbine. It will be seen that the explosion chambers will pass through the above cycle of operation successively thereby enabling the power of the rotor to be delivered to the shaft 3 continuously and uninterruptedly.

By slowing down the motor 46 approximately one-half of the speed of the turbine rotor, the above cycle of operation will be repeated at every two revolutions of the turbine rotor, while, if the rotary valve 28 is speeded up by the motor 46 so that such rotary valve revolves at the same speed as the rotor of the turbine, the turbine will cease operating owing to the fact that the relative position of the sleeve valve and the rotor remain the same thereby breaking up the cycle of operation and bringing the rotor to a stop. On the other hand, the sleeve valve 28 may be speeded up by the motor 46 to such an extent that a relatively heavy charge is admitted in the combustion or explosion chamber thereby enabling more power to be developed. Again, the motor 46 may be cut out of operation and in this event the sleeve will be held stationary likewise, the brush 55, the ignition system and the eccentric of the valve mechanism. When this occurs, the previously described cycle of operation takes place at every revolution of the rotor. From this, it will be seen that the speed of the rotor, or the amount of power delivered by the rotor, may be controlled by varying the speed of the motor 46.

When the speed of the motor 46 is changed the spark is advanced or retarded according to the speed of the rotor and the operation of both the inlet and exhaust valves is changed so that the rotor will operate at the desired speed thereby enabling the desired power to be taken from the shaft 3 of the turbine.

In the present embodiment of my invention, a pipe 60 of relatively small diameter extends through the air conducting pipe 33 and the outer end of this pipe 60 projects beyond the air conducting pipe 33 while the other end of the pipe 60 is fixed in the shaft 3 beyond the inner end of the sleeve valve 28. The inner end of the pipe 60 communicates with passages 61 formed in the shaft 3 radially of the latter and these

passages 61 open into the chamber 62 formed in the respective partition plate 14 of the rotor, the chamber 62 communicating with an annular chamber 63 formed in the annular ring 12. The outer end of the pipe 60 is adapted for connection with a source of water, steam or other tempering agent and this tempering agent passes through the passages 61, the chamber 62 and the chamber 63 commingles with the products of combustion issuing through the reaction nozzles 15 thereby preventing overheating of the turbine in the operation thereof.

While I have herein shown and described one particular form of my invention by way of illustration, I wish it to be understood that I do not limit or confine myself to the precise details of construction herein described and delineated, as modification and variation may be made within the scope of the claims and without departing from the spirit of the invention.

I claim:—

1. In an internal combustion turbine, a main shaft formed with a longitudinal bore and with transverse ports communicating with said bore, means for delivering fuel to said bore, a sleeve valve in said bore, controlling communication between the bore and said transverse ports, a rotor on said shaft formed with explosion chambers communicating with said ports and adapted to receive fuel charges through the ports from said valves and also formed with reaction nozzles in communication with said chambers, means for exploding the charges in said chambers, means acted upon by the discharges from the reaction nozzles to drive said rotor, and means for rotating said valve at different speeds to control the speed and power output of said rotor.

2. In an internal combustion turbine, a casing, a main shaft formed with a longitudinal bore and with transverse ports communicating with said bore, means for delivering fuel to said bore, a sleeve valve in said bore controlling communication between the bore and said transverse port, a rotor on said shaft formed with explosion chambers communicating with said ports and adapted to receive fuel through said ports from said valve, means for exploding the charges in said combustion chambers, means acted upon by said exploding charges to drive said motor, means for rotating said valve at different speeds to control the speed and power of said rotor, said means including a driving connection exterior of the casing, and means connecting said first-named means to said last-named means whereby the time of the spark may be varied in accordance with the speed of the engine.

3. In an internal combustion turbine, a main shaft formed with a longitudinal bore and with transverse ports communicating with said bore, means for delivering fuel to said bore, a sleeve valve in said bore controlling communication between the bore and said transverse ports, a rotor on said shaft formed with explosion chambers communicating with said ports respectively and adapted to receive fuel charges through said ports from said valves, means for exploding the charges in said combustion chambers, means acted upon by said exploding charges to drive said rotor, and means for rotating said valve at different speeds to control the speed and power output of said rotor.

4. In an internal combustion turbine, a main shaft formed with a longitudinal bore and with transverse ports communicating with said bore, means for delivering fuel to said bore, a sleeve valve in said bore controlling communication between the bore and said transverse port, a rotor on said shaft formed with explosion chambers communicating with said ports respectively and adapted to receive fuel charged through said ports from said valve, means for exploding the charges in said combustion chambers, means acted upon by said exploding charges to drive said rotor, and means for rotating said valve at different speeds to control the speed and power of said rotor, and means connecting said first named means to said last named means whereby the time of the spark may be varied in accordance with the speed of the engine.

5. In an internal combustion turbine, a rotor formed with a circular series of explosion chambers, reaction nozzles at the outer ends of said chambers respectively, stationary blades communicating with said nozzles to receive the impact of the gases issuing from the nozzles whereby the gases may react on said nozzles to drive said rotor, means for feeding an explosive mixture to said chambers, and means for exploding said mixture within said chambers, valves controlling communication between said chambers and nozzles respectively, a valve operating mechanism comprising an eccentric, a strap encircling said eccentric, connections between said strap and valves, and a motor connected with said eccentric to revolve the same, change the speed thereof and hold the same stationary in the rotation of the rotor whereby the speed of the rotor may be varied.

6. In an internal combustion turbine, a rotor formed with a series of explosion chambers, reaction nozzles at the outer ends of said chambers respectively. stationary blades communicating with said nozzles to receive the impact of the gases issuing from the nozzles whereby the gases may react on said nozzles to drive said rotor, means for feeding an explosive mixture to said chambers, and means for exploding said mixture within said chambers, valves con-

trolling communication between said chambers and nozzles respectively, a valve operating mechanism comprising an eccentric, a strap encircling said eccentric, connections between said straps and valves, and a motor connected with said eccentric to revolve the same, change the speed thereof and hold the same stationary in the rotation of the rotor whereby the speed of said rotor may be varied, and mechanism connecting said mixture exploding means with said motor whereby the action of the ignition mechanism will be advanced and retarded to vary the time of spark in accordance with the speed of the engine.

In testimony whereof I affix my signature.

THOMAS H. BROCKMAN.