E. ATWELL.

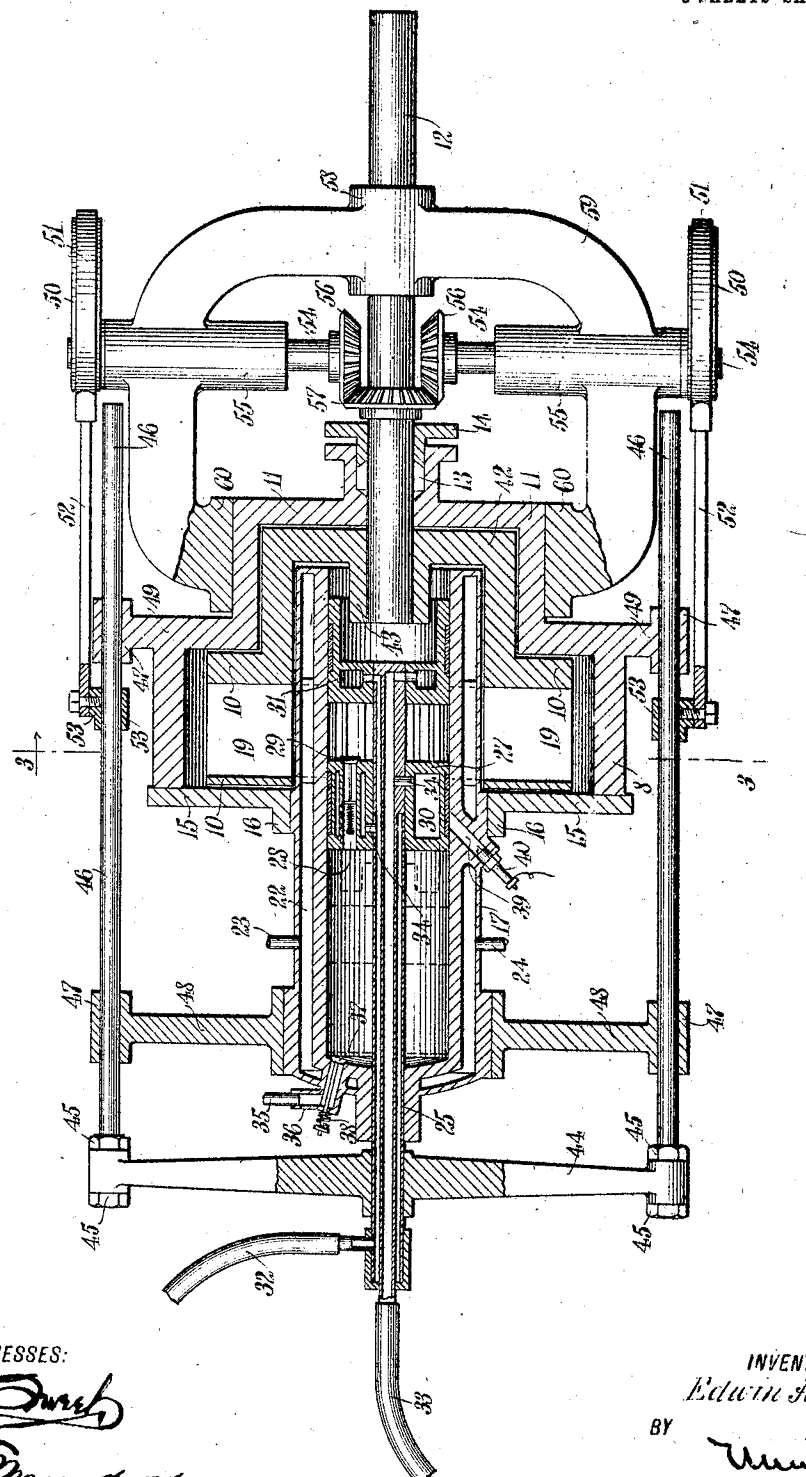
INTERNAL COMBUSTION GAS TURBINE ENGINE.

APPLICATION FILED AUG. 4, 1910. RENEWED JULY 1, 1911.

**1,000,882.** Patented Aug. 15, 1911.

3 SHEETS—SHEET 1.

Fig. 1



WITNESSES:

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3 SHEETS—SHEET 2.

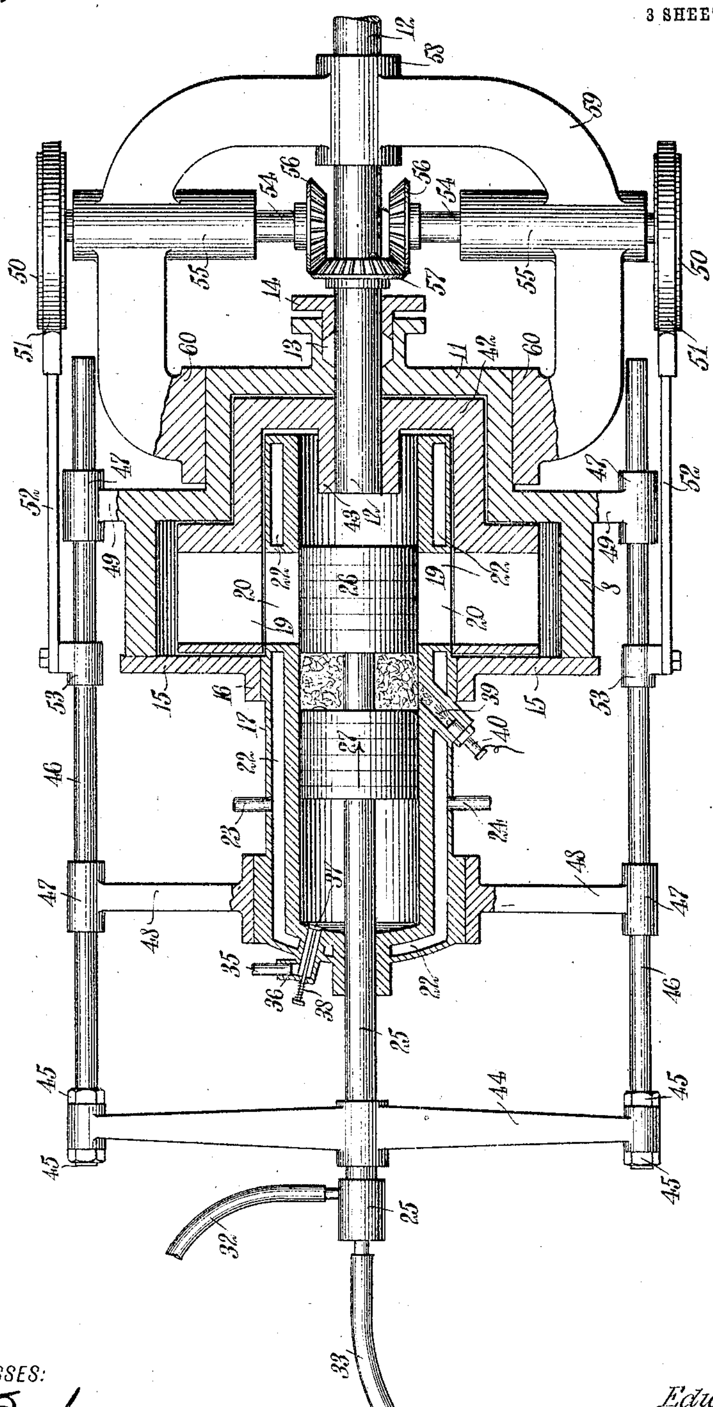


Fig. 2

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3 SHEETS—SHEET 3.

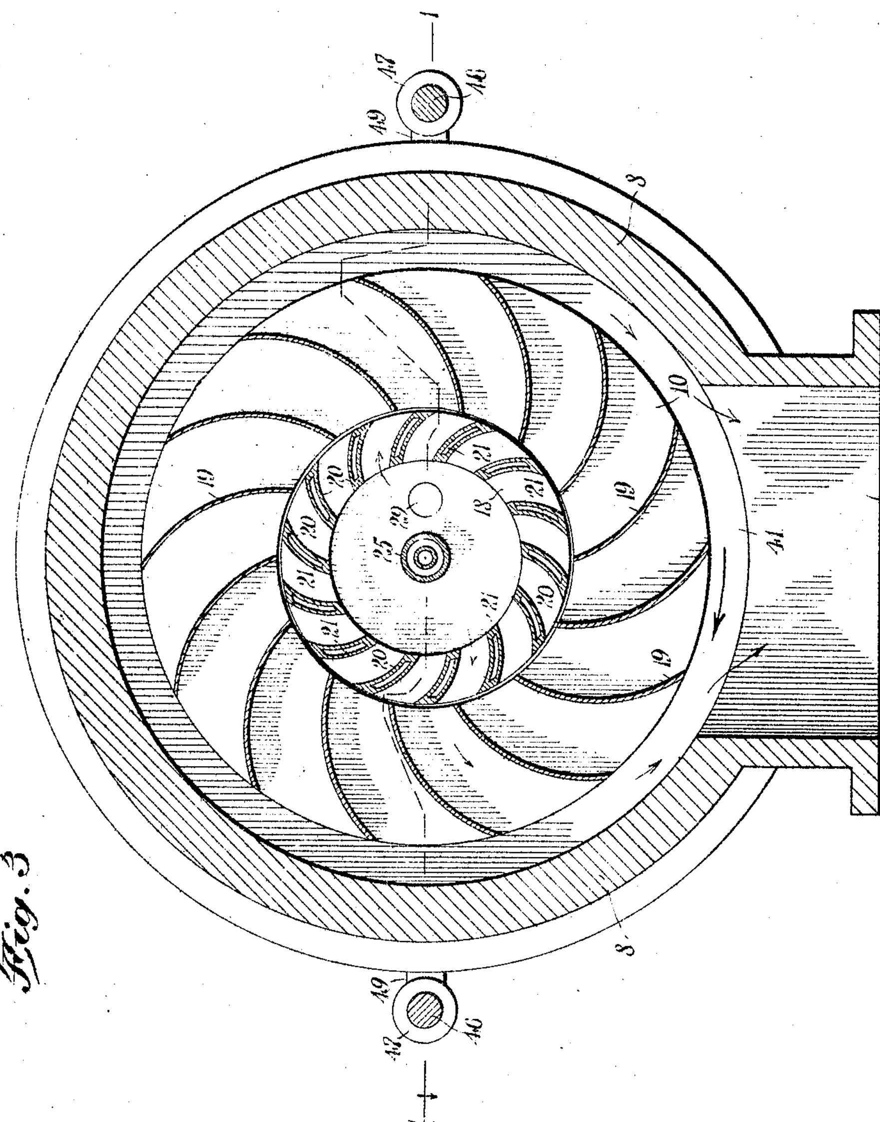


Fig. 3

WITNESSES:

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# UNITED STATES PATENT OFFICE.

EDWIN ATWELL, OF BALTIMORE, MARYLAND.

INTERNAL-COMBUSTION GAS-TURBINE ENGINE.

1,000,882. Specification of Letters Patent. Patented Aug. 15, 1911.

Application filed August 4, 1910, Serial No. 575,406. Renewed July 1, 1911. Serial No. 636,508.

*To all whom it may concern:*

Be it known that I, EDWIN ATWELL, a citizen of the United States, and a resident of Baltimore, in the State of Maryland, have invented a new and Improved Internal-Combustion Gas-Turbine Engine, of which the following is a full, clear, and exact description.

Among the principal objects which the present invention has in view are: to provide an engine of the character specified wherein the explosive mixture is primarily compressed and while so compressed is exploded; to provide an explosion chamber wherein is exploded the compressed charge of explosive mixture while establishing communication between the said explosion chamber and the turbine rotor; to provide a reciprocating mechanism for compressing and firing the explosive mixture as distinguished from the turbine or rotor mechanism; to provide a compression chamber wherein the gases are maintained at a low temperature; to provide an engine of the character set forth employing in mutual operative relation a reciprocating explosion chamber and a turbine shaft driving rotor; and to provide an engine of the character set forth, the construction and arrangement of which is simple, economical and durable.

One embodiment of the present invention is disclosed in the structure illustrated in the accompanying drawings, in which like characters of reference denote corresponding parts in all the views, and in which—

Figure 1 is a longitudinal section of a machine constructed and arranged in accordance with the present invention, the section being taken on the line 1—1 in Fig. 3, the engine being shown in position subsequent to the explosion; Fig. 2 is a similar view, showing the engine in position at the moment of explosion; and Fig. 3 is a vertical cross section taken on the line 3—3 in Fig. 1.

As illustrated in the accompanying drawings, the engine is provided with a casing 8, from which is extended an exhaust outlet 9. The outlet 9 is formed in proportions sufficiently ample to prevent any backing pressure on the blades of the rotor 10. The casing 8 is formed in any suitable shape, having a chambered extension 11 provided to receive the hub of the rotor 10, and to support a driving shaft 12 where the same passes through a stuffing box 13. The stuffing box 13 is closed by a gland 14 of usual construction. The casing 8 is preferably cast as a single unit to form the chambers for the blade extensions of the rotor 10 and the hub of the said rotor. The chambers are closed by a face plate 15, which is bolted or otherwise suitably secured to the casing 8. The face plate 15 is provided with a circular opening concentric with the opening in the extension 11 provided to receive the shaft 12. The circular opening in the face plate 15 is surrounded by an annular bolting flange 16. The bolting flange 16 is provided to receive a cylinder 17 to be held rigidly thereby. The cylinder 17 is provided with a series of passages 18 disposed in line with and registered with the blades 19 of the rotor 10.

The passages 18 are formed by curved vanes 20. The vanes 20, as shown in Fig. 3 of the drawings, are pitched in a direction set angularly to the blades 19 and in the direction of the rotary path of the rotor 10, as indicated by the arrow in said Fig. 3. It will be understood that the vanes 20 are integrally formed with and constitute a part of the cylinder 17. The vanes 20 are provided with open passages 21 to form connecting passages between the water jackets 22, 22 of the cylinder 17. The water jackets 22, 22 are provided for cooling the cylinder 17 and parts connected therewith as in the usual explosive engine construction. An inlet pipe 23 and an outlet pipe 24 are connected to the said jackets in the manner usual in such constructions. By means of the arrangement described the water is freely circulated and the temperature of the cylinders and parts connected therewith is maintained in working condition.

Slidably mounted in the cylinder 17 is a piston rod 25. At the end of the said rod 25 is mounted a piston head 26, and rigidly mounted on the rod 25 is a second piston head 27. Both piston heads are rigidly connected to the piston rod and separated from each other a distance designed to form the explosive chamber for the engine. Each of the pistons is provided with a guide wall upon which are suitably mounted packing devices of any approved form or type. Extended through the piston 27 is a passage 28 provided for the delivery of the explosive mixture into the space between the heads 26 and 27 or the explosive chamber of the present engine. The passage 28 is normally closed by a spring seated valve 29. The valve 29 is of the usual type, the stem of the said valve being guided within the said passage 28, and having a seating spring coiled thereon in position to normally seat the valve 29. The valve 29 lifts into the space between the heads 26 and 27.

The piston heads 26 and 27 are provided with circulating water spaces 30 and 31. The water spaces 30 and 31 are provided for the circulation of water which is introduced through the piston rod 25, which is constructed as shown in Fig. 1 of the drawings, of outer and inner tubes, one of which is connected with a flexible inlet pipe 32 and the other with a flexible delivery pipe 33. Passages 34, 34 connect the inner and outer tubes with the water spaces 30 and 31. By means of this arrangement it will be understood that water is forced into and delivered from the water spaces 30 and 31 during the operation of the engine, thereby maintaining the temperature of the pistons at a workable degree.

It will be seen that by means of the water cooling system for the cylinder 17 and the system for maintaining circulation in the piston heads 26 and 27, the cylinder and parts operating therein are maintained at working temperature.

In the operation of the present engine, the piston rod 25 and the heads 26 and 27 connected therewith are reciprocated in timed relation with the driving shaft 12, within the cylinder 17. The extent of the reciprocation is indicated in Fig. 1 of the drawings. The extreme position of the piston heads 26 and 27 at the outward or delivery stroke of the piston rod is shown in full lines in said Fig. 1, while the position of the pistons at the extreme of the inner or charging stroke of the said piston rod and piston heads is indicated by dotted lines in the said figure at the outer end of the said cylinder 17. The cylinder 17 is connected with the carbureter or supply of explosive mixture by means of a supply pipe 35, which delivers into a valve controlled nipple 36. The passage formed by the nipple 36 through the head of the cylinder 17 is closed by means of a valve 37 of the usual type and construction. The valve 37 is spring seated, a spring 38 being employed to normally seat the said valve to close the passage through the nipple 36. By the operation of the valves 29 and 37, when the piston 27 is carried away from the head of the cylinder 17 toward the rotor 10, the valve 29 is closed and the valve 37 is drawn upon by the rarefication within the chamber of the cylinder 17. This rarefication causes a suction to draw the explosive mixture into the upper portion of the cylinder 17. Attention is called to Fig. 1 wherein is shown the relative dimensions of the chamber in the cylinder 17 between the piston 27 and the head of the said cylinder, and the explosion chamber formed between the pistons 26 and 27. When the pistons 26 and 27 are moved from the position shown in full lines in Fig. 1 to the position shown in dotted lines in said figure, the compression of the gas in the chamber of the cylinder 17 between the head thereof and the piston 27 opens the valve 29 and closes the valve 37. It will be noticed that when the face of the piston 26 passes the ends of the vanes 20 all exit from the space between the pistons 26 and 27 is closed, and the further continuance of the travel of the pistons 26 and 27 to the position of the said pistons shown in dotted lines, operates to transfer the quantity of gas drawn into the chamber of the cylinder 17 to the space between the pistons 26 and 27. This operation results in imparting to the explosive mixture between the said pistons the desired compression.

Formed in the walls of the cylinder 17 is a passage 39, in the outer end of which is mounted a spark plug 40. The passage 39 opens into the cylinder 17 at near the edge of the passages 18 formed between the vanes 20. In the travel of the pistons 26 and 27, the space between the said pistons is alined with the passage 39 immediately prior to the face of the piston 26 passing the end of the said passages 18. By this arrangement is accommodated the timing of the sparking device with which the engine is provided. The sparking mechanism connected with this engine is of any usual and approved type. Under preferred conditions the ignition spark is caused to operate at the short interval between the passage of the face of the piston 26 into alinement with the vanes 20. In this manner the full effect of the explosion of the explosive mixture between the pistons is obtained and transferred expansibly outward through the passages 18, 18 between the vanes 20, 20. When the rapidly expanding gases are thus delivered laterally through the passages 18, 18, they are deflected in conformity with the curvature of the vanes 20, 20, which causes the gases to impinge upon the blades 19, 19 of the rotor 10. The blades 19, 19 are arranged and disposed substantially as shown in the drawings, delivering outward into an annular passage 41 which is connected with the outlet or exhaust 9, as seen in Fig. 3 of the drawings. The impingement of the gases thus controlled and directed, imparts to the rotor 10 a rotary motion, which is in turn imparted to the shaft 12. The rotor 10 is provided with a body extension 42 having formed thereon a boss 43 arranged to receive the driving shaft 12, and to be rigidly and permanently mounted thereon. The driving shaft 12 is provided with a suitable driving pulley, or other driving device as dictated by the use to which the engine is placed.

The piston rod 25 is reciprocated from and in timed relation to the driving shaft 12. For this purpose the piston rod 25 is rigidly connected to a cross head 44. The outer ends of the cross head 44 are secured by nuts 45, 45 to guide rods 46, 46. The guide rods 46, 46 are mounted in sleeves 47, 47 formed in the ends of bracket arms 48 and 49, the latter being extended from and preferably cast with the casing 8. The guide rods 46, 46 are operatively connected with eccentric driving disks 50, 50 by means of collars 51, 51 and pitmen 52, 52. The pitmen 52, 52 are pivotally mounted on pivot blocks 53, 53 adjustably and fixedly mounted upon the rods 46, 46.

The eccentric disks 50, 50 are each fixedly mounted on a short shaft 54, 54. The shafts 54, 54 are suitably mounted in elongated bearing boxes, 55, 55, and are each provided at the inner end with equal bevel gears 56, 56. The bevel wheels 56, 56 are each meshed with a bevel gear 57 rigidly mounted upon the driving shaft 12. The ratio of the diameters between the bevel gear 57 and the bevel gears 56, 56 controls the time relation of the rotation of the shafts 54, 54 and disks 50, 50 connected therewith, with the rotation of the driving shaft 12. The reciprocations of the piston rod 25 and pistons mounted thereon are synchronized with the rotation of the shafts 54, therefore the reciprocations of the pistons 26 and 27 may be adjusted in timed relation with the rotation of the driving shaft 12. It is obvious that by the introduction of a plurality of varying sized bevel gears mounted rigidly on the shaft 12 and meshed with loose clutch controlled gears mounted on the shafts 54, the speed of the shaft 12 could be varied without requiring invention further than here pointed out.

The bearings 55, 55 for the shafts 54, 54 and a bearing 58 are formed in a loop bracket 59, which is provided with bolting pads 60, 60 to be rigidly secured upon the extension 11 of the casing 8, substantially as shown in the drawings.

While I have herein shown the engine as constructed for single unit work, it will be understood that two rotors 10, cylinders 17 and operating mechanisms connected therewith, could be mounted upon the shaft 12 and at both ends thereof, in which instance the driving pulley, or other driving device with which the shaft 12 is provided, would be located between the two engines. It has been considered unnecessary to illustrate this duplication of the construction in the drawings.

From the explosion chamber between the heads 26, and 27, all dead air or burned fuel is drawn by the suction naturally produced by the rapid rotation of the vanes 19. Further the rapid succession of outward explosions produces an equal number of inward impulses of the surrounding air which circulation of air it is found is sufficient to maintain the temperature of the rotor at working height.

It will be understood that while I have herein shown the flexible pipes 32 and 33, as supplying the water cooling system I do not wish to be understood as limiting myself to such construction.

I am well aware that more than one spark plug may be used on an engine of this type.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. An internal combustion gas turbine engine, comprising a rotor having a plurality of radially disposed open-ended spiral passages; a driving shaft fixedly connected with said rotor; an elongated cylinder extended within said rotor in line with said driving shaft, and having a series of open-ended radially disposed passages arranged in line with the passages of said rotor; a piston rod slidably mounted on said cylinder; a plurality of piston heads fixedly mounted on said rod in separated relation; a valve controlled inlet for said cylinder; a valve controlled passage in open communication between the space between said piston heads and the receiving end of said cylinder; means for igniting the explosive material in said space between said piston heads in timed relation with the movement of said piston rod; and a translating mechanism connecting said driving shaft and piston rod for reciprocating the said piston rod in timed relation with the rotation of said driving shaft.

2. An internal combustion gas turbine engine, comprising a rotor having a plurality of radially disposed open-ended spiral passages; a driving shaft fixedly connected with said rotor; an elongated cylinder extended within said rotor in line with said driving shaft, and having a series of open-ended radially disposed passages arranged in line with the passages of said rotor; a piston rod slidably mounted on said cylinder; a plurality of piston heads fixedly mounted on said rod in separated relation; a valve controlled inlet for said cylinder; a valve con-

trolled passage in open communication between the space between said piston heads and the receiving end of said cylinder; an ignition system embodying a spark plug; a passage opening from said cylinder in communication with said spark plug, said passage opening into said cylinder adjacent to the said radially disposed passages therein; a counter-shaft having mounted on the end thereof a cranking device; means for operatively engaging said cranking device and said driving shaft to operate in unison; and a pitman connecting said cranking device on said counter-shaft and said piston rod for reciprocating the said piston rod.

3. An internal combustion gas turbine engine, comprising a rotor having a plurality of radially disposed open-ended spiral passages; a driving shaft fixedly connected with said rotor; an elongated cylinder extended within said rotor in line with said driving shaft, and having a series of open-ended radially disposed passages arranged in line with the passages of said rotor; a piston rod slidably mounted on said cylinder; a plurality of piston heads fixedly mounted on said rod in separated relation; a valve controlled inlet for said cylinder; a valve controlled passage in open communication between the space between said piston heads and the receiving end of said cylinder; an ignition system embodying a spark plug; a passage opening from said cylinder in communication with said spark plug, said passage opening into said cylinder adjacent to the said radially disposed passages therein; a plurality of counter-shafts mounted in the frame of the said engine, said counter-shafts having mounted at the outer ends thereof driving eccentrics and at the inner ends thereof equal driven gears; a driving gear fixedly mounted on said driving shaft and held in engaged relation with said driven gears; and a plurality of pitmen connected with said driving eccentrics and said piston rod for reciprocating said rod in timed relation with the rotation of said driving shaft.

4. An internal combustion gas turbine engine, comprising a rotor having a plurality of radially disposed open-ended spiral passages; a driving shaft fixedly connected with said rotor; an elongated cylinder extended within said rotor in line with said driving shaft, and having a series of open-ended radially disposed passages arranged in the same plane with the spiral passages of said rotor; a piston rod slidably mounted on said cylinder; a plurality of piston heads fixedly mounted on said rod in separated relation to form in conjunction with said cylinder an explosion chamber between said piston heads; a valve controlled inlet for said cylinder; a valve controlled passage in open communication between the space between said piston heads and the receiving end of said cylinder; an ignition system embodying a spark plug; a passage opening from said cylinder in communication with said spark plug, said passage opening into said cylinder adjacent to the said radially disposed passages therein; a plurality of counter-shafts mounted in the frame of said engine, said counter-shafts having mounted at the outer ends thereof driving eccentrics and at the inner ends thereof equal driven gears; a driving gear fixedly mounted on said driving shaft and held in engaged relation with said driven gears; a plurality of guide rods slidably mounted in the frame of said engine and connected with said piston rod; and a plurality of pitmen operatively connected with said driving eccentrics and adjustably connected with said guide rods for reciprocating the said rods and said piston rod connected therewith in timed relation with the rotation of said driving shaft.

5. An internal combustion gas turbine engine, comprising a rotor having a plurality of radially disposed open-ended spiral passages; a driving shaft fixedly connected with said rotor; an elongated cylinder extended within said rotor in line with said driving shaft, and having a series of open-ended radially disposed passages formed by longitudinally disposed partitions connecting the end sections of said cylinder, said end sections and said partitions being hollow and connected to form a circulating water jacket for said cylinder and partitions; a plurality of piston heads disposed in spaced relation each to the other, each of said heads having a hollow construction to form a water circulating cooling system; a piston rod fixedly connected with said piston heads and having passages communicating with the water spaces in said heads introducing and drawing from said spaces water for cooling said heads and rod; and a water circulating system separately connected with the passage in said rod for ejecting and drawing off the water employed for cooling said piston heads.

6. An internal combustion gas turbine engine, comprising a rotor having a plurality of radially disposed open-ended spiral passages; a driving shaft fixedly connected with said rotor; an elongated cylinder extended in line with said driving shaft and provided with a valve controlled fuel-intake port; a plurality of pistons spaced apart, said pistons being slidably mounted in said cylinder; a partition having a plurality of radially disposed delivery passages adapted to aline with the passages in said rotor; means operatively connected with said driving shaft for reciprocating the said pistons

into and out of alinement with said rotor; means for transferring fuel from said cylinder to the space between said pistons; and means operatively timed with the movement of said pistons for igniting said fuel between said pistons coincident with the passage of said pistons in alinement with the spiral passages in said rotor.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

EDWIN ATWELL

Witnesses:
HERMAN N. ENGELBRECHT,
V. A. THOMPSON.