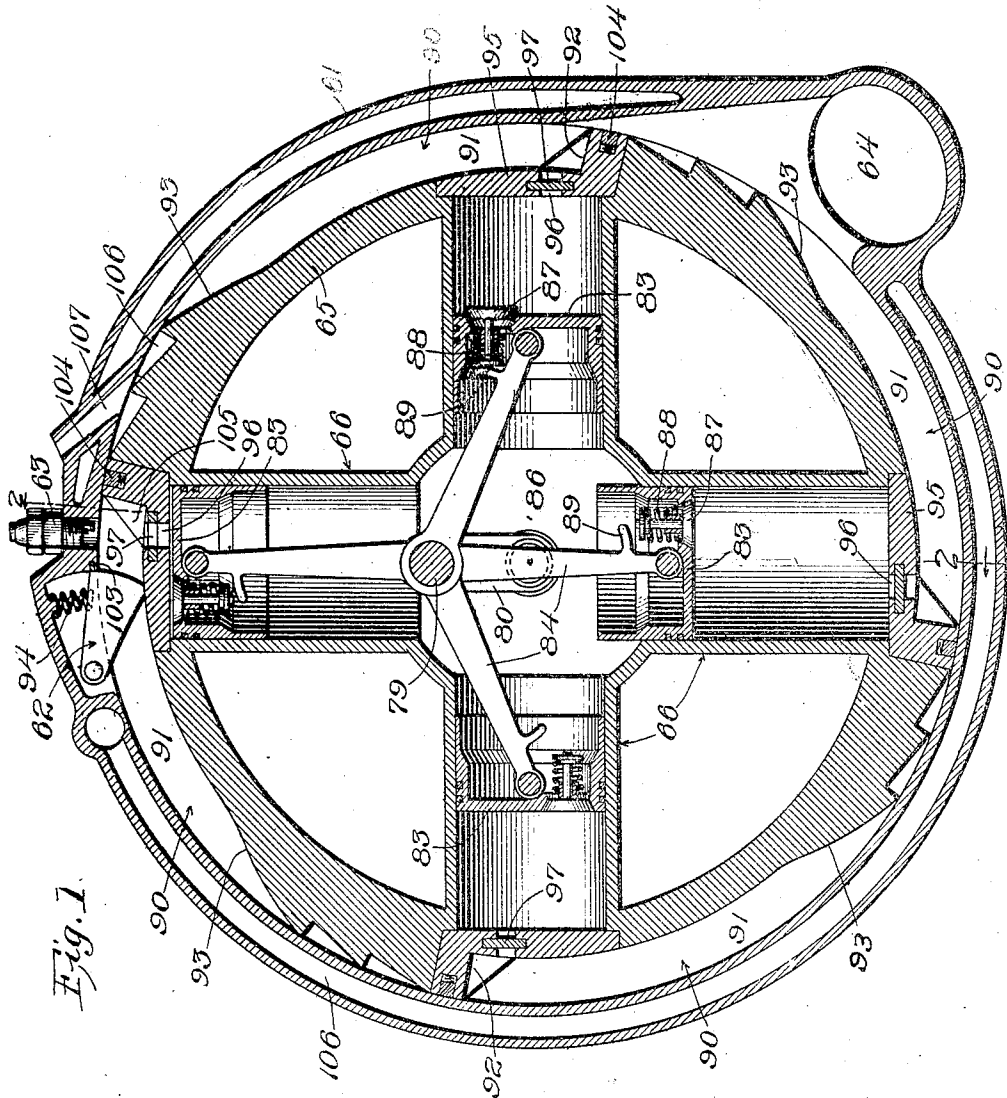


F. A. & O. M. VOILES.
GAS TURBINE.
APPLICATION FILED AUG. 14, 1911.

1,065,410.

Patented June 24, 1913

2 SHEETS—SHEET 1.



Witnesses:

Harry S. Carter
Monte H. Sadler

Inventors
Frank A. Voiles
Oscar M. Voiles

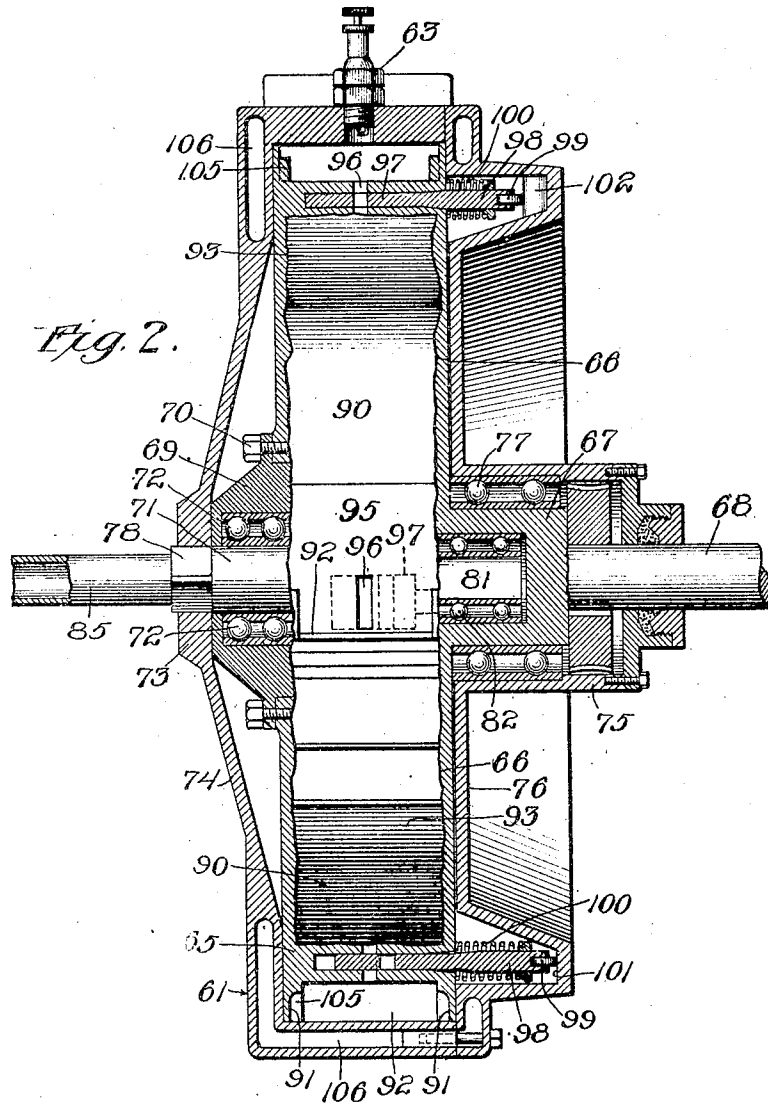
By *Lawrence B. Banning* Att'ys.

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2 SHEETS-SHEET 2.



Witnesses:

Harry S. Gaither
Monte H. Sadler

Inventors
Frank A. Voiles
Oscar M. Voiles

by Lawrence & Lawrence Attys

UNITED STATES PATENT OFFICE.

FRANK A. VOILES AND OSCAR M. VOILES, OF CHICAGO, ILLINOIS.

GAS-TURBINE.

1,065,410.

Specification of Letters Patent.

Patented June 24, 1913.

Application filed August 14, 1911. Serial No. 643,944.

To all whom it may concern:

Be it known that we, FRANK A. VOILES and OSCAR M. VOILES, both citizens of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Gas-Turbines, of which the following is a specification.

This invention relates to a new form of gas turbine in which the power is derived from a series of explosion impulses which take place in one or more pockets or notches in the periphery of one member to cause a relative rotation as between such member and another member. For convenience, the members are preferably mounted concentric with one another, so that a relative rotation may occur as between the two members. For purposes of convenience, we will hereafter term the rotating member the rotor and the stationary member the stator.

In practising our invention, we provide one or more pockets or notches in the periphery of one member, preferably the rotor, the same co-acting with the other member, so that each time an explosion takes place in one of these pockets a relative force will be exerted between the members, tending to cause a relative rotation. Means are provided for periodically delivering charges of explosive gas under compression to the pocket or pockets and for firing the charges at the proper intervals.

The main objects of the invention are: to provide a prime-mover, the principle of operation and the construction of which are such that its parts may be compactly assembled so as to reduce its size and weight as much as possible; to provide a machine of the class described, in which the gases may expand to a considerable degree after each explosion, thus giving a greater efficiency of operation; to provide a construction in which a positive reaction of one element with respect to the other will occur each time a charge of explosive is fired; to provide means for initially compressing the gas a sufficient amount to insure complete and instantaneous ignition of the charge when fired; to locate and arrange such compressing means with respect to the explosion pockets, so that the gas can be directly delivered to each pocket, thereby securing quicker

operation and reducing the loss of compression; to provide positively actuated valve mechanisms for delivering the charges of gas to the pockets at the proper times; to provide means for starting the prime mover with compressed air or other compressed fluid; to provide a construction such that a number of impulses may be obtained during each rotation of the rotor; and in other ways and manners to provide an economical and satisfactory machine of this class.

Other objects and uses will appear from a detailed description of the invention, which consists in the features of construction and combination of parts hereinafter described and claimed.

Referring to the drawings, Figure 1 shows a cross section taken through a machine embodying the features of our invention, in which the rotor is provided with a plurality of pockets, and carries compressing cylinders for delivering the charges of explosive gas to the pockets; and Fig. 2 shows a vertical cross section taken on line 2—2 of Fig. 1, looking in the direction of the arrows, the periphery of the rotor being shown partly in elevation.

In the drawings the stator is designated by the numeral 61. It is provided with a single dog 62, a single spark plug 63, and a single exhaust port 64. The rotor comprises an outer rim 65 carried by a number of cylinders 66 which serve as spokes in addition to performing their compressing function. In Fig. 2, practically the entire machine is shown in cross section with the exception of a portion of the periphery of the rotor. The cylinders have their inner ends mounted on a hub 67 which in turn is secured to a shaft 68. At their other sides they are secured to a sleeve 69 as by means of bolts 70, which sleeve in turn rotates on a fixed shaft 71 through the medium of ball-bearings 72. At this side of the machine, the stator carries a bearing 73 through the medium of a side wall 74 which may be perforated for purposes of ventilation should that be desired. At the other side of the machine, the stator carries a bearing 75 through the medium of a side wall 76 which may likewise be perforated. A ball-bearing journal 77 is provided between the bearing 75 and the hub of the rotor. From the above it is ap-

parent that the rotor may rotate with respect to the stator, the shaft 68 turning with it, but the shaft 71 remaining stationary. The shaft 71 is keyed to the bearing 73 of the stator by having its end portion 78 squared. Referring to Fig. 1, this non-rotatable shaft carries a stationary crank 79, the opposite arm 80 of which is journaled at the point 81 in the hub 67 of the rotor by means of the ball-bearings 82. Each piston 83 is connected to the stationary crank by a connecting rod 84 so that as the rotor rotates, the pistons will be operated back and forth in the cylinders with an action similar to that which takes place in a rotating cylinder engine. The stationary shaft 71 is hollow and into it is introduced a pipe or duct 85 which supplies combustible mixture to the space 86 inclosed by the pistons of the cylinders. Each piston is provided with a puppet valve 87 which opens upwardly into the cylinder to permit gas to be taken in through the pistons. A stiff spring 88 tends to close each of the valves 87. Each connecting rod is provided with a finger 89 in position to actuate the corresponding puppet valve, such actuation being insured each time the connecting rod swings over as the piston starts on its down stroke. Shortly before the piston reaches the lower end of its stroke, a complete charge of gas having been taken into the cylinder, the connecting rod will start to swing in the other direction and the puppet valve will remain closed while the gas is compressed on the up stroke. It will be understood that a centrifugal force will be exerted on the puppet valves, but by making the springs stiff enough they will be held closed except when forced open by the fingers 89. Above each cylinder there is provided a pocket 90 having side walls 91, a rather abrupt forward end 92, and a sloping rear end 93. The dog seats into each one of these pockets in succession, a spring 94 tending to throw it into such position. The outer end of each cylinder is formed as a block 95 which carries the forward end of the notch, and which is provided with a slide valve port 96, the slide valve of which is designated by the numeral 97. Each of these slide valves is provided with an arm 98 which carries a roller 99 and is normally held in outward or closed position by means of a spring 100. An annular trackway 101 is provided in the stator, the rollers of the slide valves being adapted to travel in the same, and a cam elevation 102 is provided in such trackway at a proper position with respect to the dog 62. At the proper instant, each slide valve will be thrown inwardly to open the port 96 and temporarily establish communication between the corresponding cylinder and pocket. The gas previously compressed in such cylinder

will then be transferred to that portion of the pocket in advance of the dog, and immediately thereafter the port will be closed, and the charge fired. The several parts should be relatively so placed and proportioned that the last portion of the stroke of the piston will take place while the valve is open, and communication existing between the cylinder and the pocket in advance of the dog. As soon as the piston has completed its upward movement, the valve should close, and the charge should then be fired.

In order to improve the operation of the mechanism a packing rod 103 is provided to prevent the escape of gas past the dog, and a packing rod 104 prevents the escape of gas forwardly past the forward end of the pocket. At each side of the forward end of the pocket there is provided a sloping portion 105 which allows the dog to descend easily and reduces the vibration, thus increasing the smoothness and effectiveness of operation. These surfaces should be so proportioned as to allow the dog to drop easily into the pockets.

From the above description, the operation of this form of machine will be apparent. As the rotor rotates, each piston in turn will start to travel downward in its cylinder. At the same time its connecting rod will swing toward the left, thus forcing open the valve and allowing gas to suck up into the upper portion of the cylinder during practically the entire down stroke of the piston. When approximately a half revolution has been made, the valve will again close, and as the piston starts to travel upward to compress the gas, the connecting rod will swing in the other direction, thus allowing the valve to remain closed and insuring a proper compression of the gas. Shortly before the piston reaches the upper end of its stroke, but after the dog has dropped into the corresponding pocket, the corresponding valve will open to establish communication from the cylinder to that pocket, and the past portion of the stroke will be performed while the valve is open. This will insure a practically complete transfer of gas to the pocket. Thereupon the valve will quickly shut and immediately afterward the charge will be fired. The charge will then expand in the pocket as the rotor rotates, until finally the rear end 93 will raise the dog, and afterward the pocket will come into communication with the exhaust port and the burnt gases will pass away. There are provided a number of smaller notches 106 as in the previous case, these serving to effectively clear the last traces of burnt gases from around the spark plug before the next pocket comes into action. Also a compressed air port 107

is provided for admitting compressed air into the notches in order to start the machine.

The above described embodiment of our invention is such that any number of impulses may be secured during each rotation of the rotor. In the particular construction illustrated, only four pockets are provided, but evidently their number can be increased indefinitely depending upon the size of the machine and the requirements. In this way, a very smooth operation is secured and one in which a practically uniform torque is exerted. Furthermore, the amount of expansion of the burnt gases may be as large as desired, depending upon the relative volume of the pocket at the instant of explosion as compared to the total volume of the pocket. Furthermore, in this present construction, the combustible gas is transferred directly with the shortest possible path from the cylinder to the pocket. In this way, the gas will be delivered to the pocket, at practically an undiminished compression, any loss by leakage will be minimized, and in general the operation of the machine will be improved.

It was previously stated that a removable head 95 is provided for each cylinder. This permits the cylinders to be easily bored, thus making it possible to cast them all as one piece, reducing the cost of construction, and providing a more rigid and durable machine. Although we have shown this construction as having a stator frame which completely encircles the rotor, still it is evident that only a comparatively small portion of it is active, being the portion immediately to the right of the dog and spark plug in Fig. 1. During practically three-fourths of a revolution the pockets are not being used so that the remaining portion of the stator might be cut away should that be desired in order to reduce the weight and cost of the machine. In any case, however, it would probably be desirable to provide a light framing around the entire machine in order to keep out dust and protect the rotating member. It will be understood, however, that this machine is one having certain inherent characteristics which permit it to be lightly and cheaply built and permit a practically uniform torque to be secured. Furthermore, the number of strokes per revolution can be increased almost indefinitely, and thus the strokes per minute also increased. For example, in the construction just described, four strokes per revolution are secured. If the machine were running a thousand revolutions per minute this would give four thousand strokes per minute while an ordinary four cylinder four cycle engine running at a thousand revolutions a minute would give only two

thousand strokes during the same time. In other words, the effectiveness per cylinder is practically doubled.

In the construction shown, a water jacket 106 is provided around practically the entire stator, although such jacket might perhaps be eliminated from a portion of the same.

We claim:

1. In a machine of the class described, the combination of a stator, a rotor adapted to co-act therewith and provided with a plurality of explosion pockets, a member on the stator adapted to successively seat within the pockets to cut off portions of them, a stationary crank, a cylinder mounted within the rotor corresponding to each pocket of the same, and having its piston connected to the stationary crank, a valve in each piston to permit a transfer of gas through the same, a valve for controlling the transfer of gas from each cylinder to its pocket, means for actuating such valves to effect the transfer of gas under compression to each pocket after the dog has seated therein, and means for firing such charges of gas in the pockets.

2. In a machine of the class described, the combination of a stator, a rotor adapted to co-act therewith and provided in its periphery with an explosion pocket, a member on the stator adapted to seat within the pocket to cut off a portion of the same, a cylinder for introducing charges of gas under compression into the pocket, a valve in the piston of the same, a spring for closing such valve, a finger on the connecting rod of the piston for actuating the valve, a valve for controlling the transfer of gas from the cylinder to the pocket, and means for firing the charges of gas within the pockets.

3. In a device of the class described, the combination of a stator, a rotor, provided with a plurality of explosion pockets, a member on the stator adapted to successively seat within the pockets, a cylinder carried by the rotor corresponding to each pocket thereof, a piston within each cylinder, a stationary crank, a connecting rod from each piston to the stationary crank, a valved connection from each cylinder to its pocket, and means for firing the combustible gas in each pocket, substantially as described.

4. In a device of the class described, the combination of a stator, a rotor adapted to coact therewith, and provided with a plurality of explosion pockets, a cylinder on the rotor to correspond with each pocket thereof, a member on the stator adapted to successively seat within the pockets, a stationary crank, a piston within each cylinder, a connecting rod from each piston to the crank, a valved connection from each cylinder to its pocket, and means for successively actuating the valves of such connections to permit a flow of gas from each cyl-

inder to its pocket after the member has seated within such pocket, and means for firing the explosive gas within the pocket, substantially as described.

5 5. In a machine of the class described, the combination of a stator, a rotor rotatably mounted adjacent the same, and provided with a plurality of explosion pockets, compression cylinders carried by the rotor corresponding to each pocket thereof, there being a valved connection from each cylinder to the corresponding pocket, a stationary crank, a piston within each cylinder, a connecting rod from the stationary crank to each piston, whereby as the rotor rotates the pistons are successively actuated, a member on the stator adapted to successively seat within the pockets to cut off portions of them, and means for successively actuating the valves of the valved connections to successively place the cylinders in communication with their respective pockets after the member is seated within them, substantially as described.

25 6. In a machine of the class described, the combination of a stator, a rotor rotatably mounted adjacent the same, there being a plurality of explosion pockets in the periphery of the rotor, compression cylinders carried by the rotor corresponding to each pocket thereof, a stationary crank, a piston within each cylinder, a connecting rod from each piston to the stationary crank whereby as the rotor rotates the pistons are successively actuated, a member on the stator substantially in line with the center of rotation and the stationary crank, and adapted to successively seat within the pockets to cut off portions of them, there being a valved connection from each cylinder to its corresponding pocket, and means for successively actuating the valves of the valved connections to successively establish communication between the cylinders and the cut off portions of their respective pockets, substantially as described.

7. In a machine of the class described, the combination of a stator, a rotor rotatably mounted adjacent the same, there being an explosion pocket in the rotor, a compression cylinder carried by the rotor, there being a valved connection from said cylinder to the pocket, a member on the stator adapted to seat within the pocket and cut off portions of the same, a stationary crank, a piston within the cylinder, a connecting rod from the stationary crank to the piston, an outwardly opening valve in the piston for establishing communication from the crank case to the interior of the cylinder above the piston, means tending to force said valve inwardly to close the same, a member on the connecting rod adapted to engage a portion of said valve to force the same outwardly

and open the same on the down stroke of the piston, and means for actuating the valve of the valved connection from the cylinder to the pocket to establish communication from the cylinder to the pocket after the member on the stator is seated within the pocket, substantially as described.

8. In a machine of the class described, the combination of a stator, and a rotor co-acting therewith to provide a plurality of pockets between the stator and rotor, a device on the stator adapted to successively seat in the pockets thus formed to cut off portions of them, a plurality of compression cylinders carried by the rotor corresponding to the number of pockets thus formed, a valved passageway between each cylinder and its corresponding pocket, a valve in each of said passageways, means for retaining said valves in closed position, and a cam track-way on the stator, the cam whereof serves to throw the valves in succession, to place the compression cylinders successively in communication with their respective pockets, substantially as described.

9. In a machine of the class described, the combination of a stator, a rotor mounted for rotation within the same, there being a plurality of explosion pockets in the periphery of the rotor, a device on the stator adapted to seat successively in the pockets of the rotor, a plurality of compression cylinders carried by the rotor corresponding to the several pockets thereof, the inner ends of all of said cylinders communicating with a common source of gas supply, a valved piston mounted for reciprocation in each compression cylinder, the valve whereof is adapted to control the flow of gas from the aforementioned common source of gas supply to the space in said cylinder above the piston thereof, means for actuating the several pistons to throw them into proximity with their several pockets when the aforementioned member on the stator has seated in such pockets, a valved passageway between each cylinder and its pocket, and means for successively actuating the valves of such passageways to place the cylinders in communication with their respective pockets immediately after the aforementioned member of the stator has seated in such pockets, substantially as described.

10. In a machine of the class described, the combination of a stator, a rotor mounted for rotation with respect to the stator there being a plurality of explosion pockets in the periphery of the rotor, and there being a plurality of drainage notches in the periphery of the rotor behind each explosion pocket, a member on the stator adapted to successively seat in the explosion pockets, to thereby cut off portions of them, means for firing gases in the cut-off portion of each

pocket, and means for introducing a charge of gas under compression to the cut-off portion of each pocket preparatory to firing such gas, whereby the exploded charge in each explosion pocket drives the rotor forward, and whereby the aforementioned drainage notches remove the burnt gases

left after the passage of the corresponding explosion pocket, substantially as described.

FRANK A. VOILES.
OSCAR M. VOILES.

Witnesses:

THOMAS A. BANNING, Jr.,
EPHRAIM BANNING.