E. F. HOPKINS.

INTERNAL COMBUSTION TURBINE.

APPLICATION FILED JAN. 11, 1910.

1,047,227.

Patented Dec. 17, 1912.

3 SHEETS—SHEET 1.

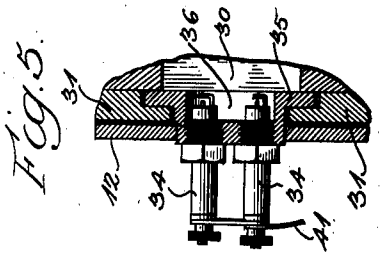

FIG. 5.

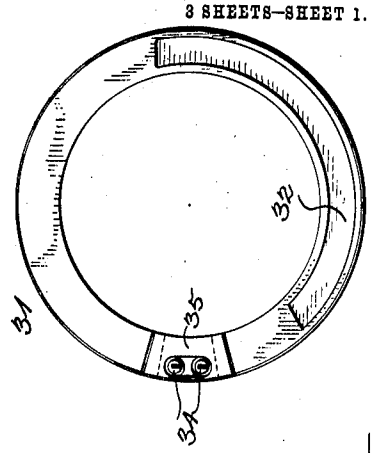

FIG. 6.

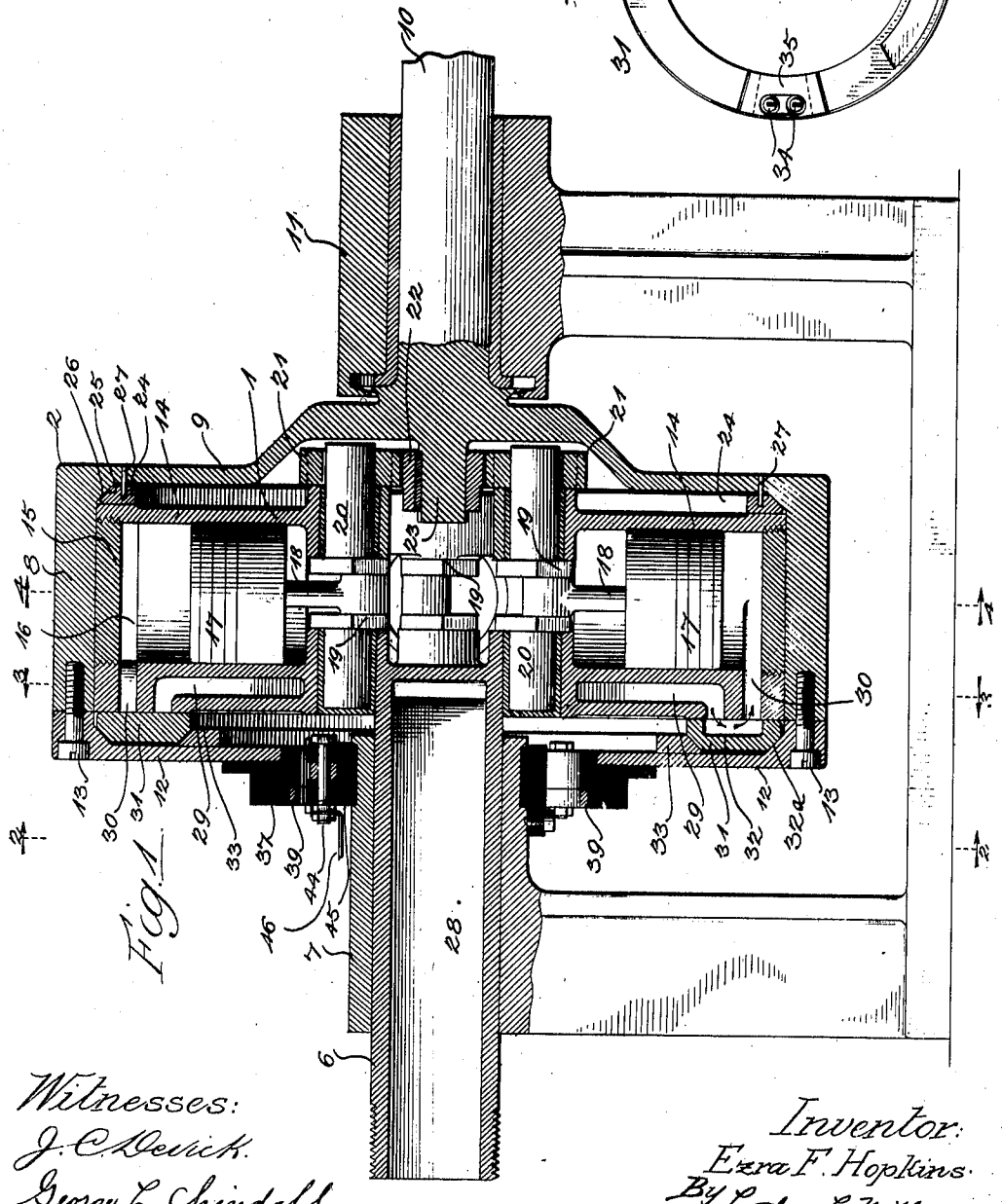

FIG. 1.

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Fig. 11.

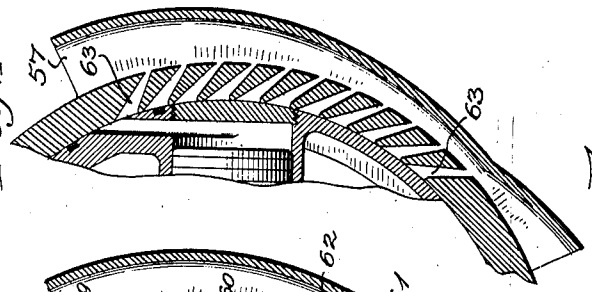


Fig. 10.

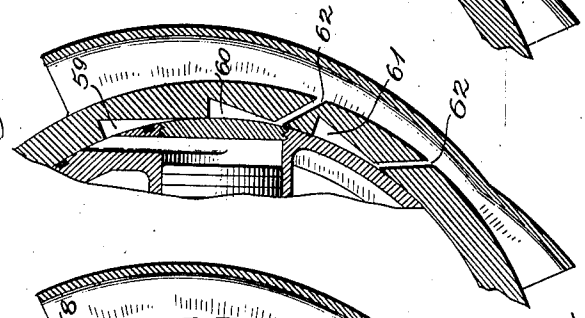


Fig. 9.

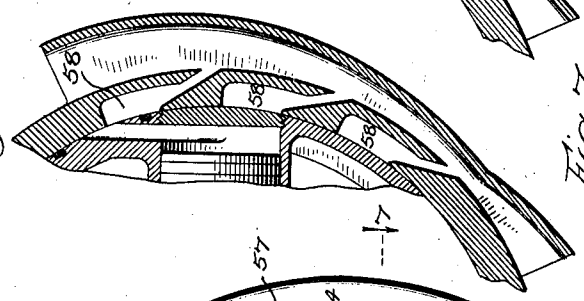


Fig. 8.

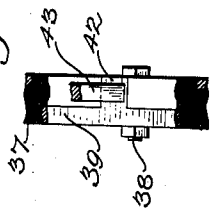


Fig. 7.

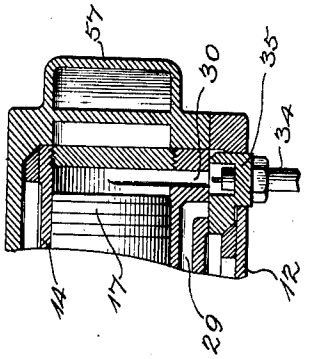
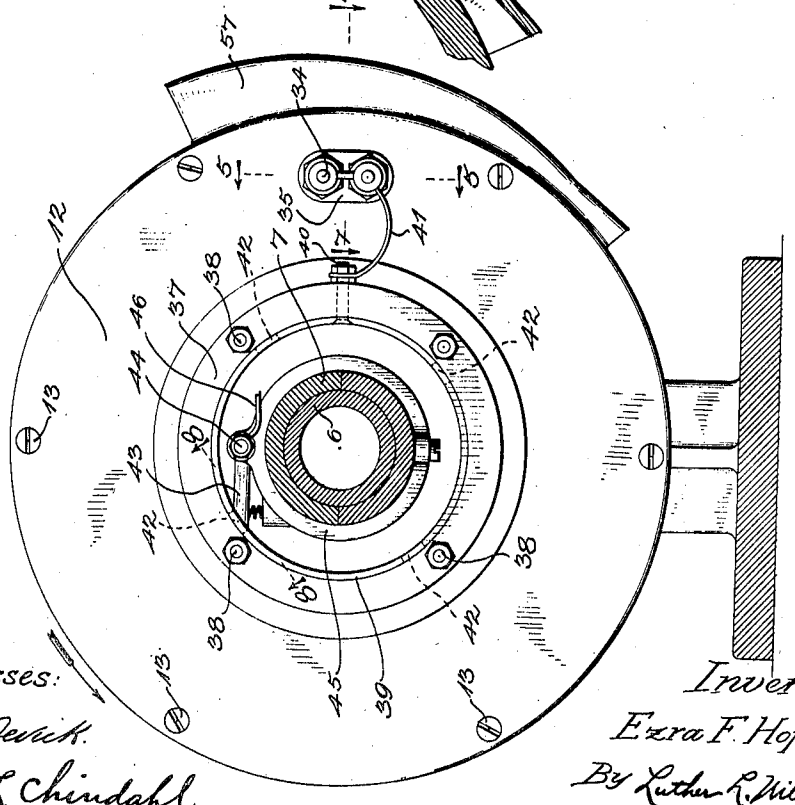


Fig. 12.



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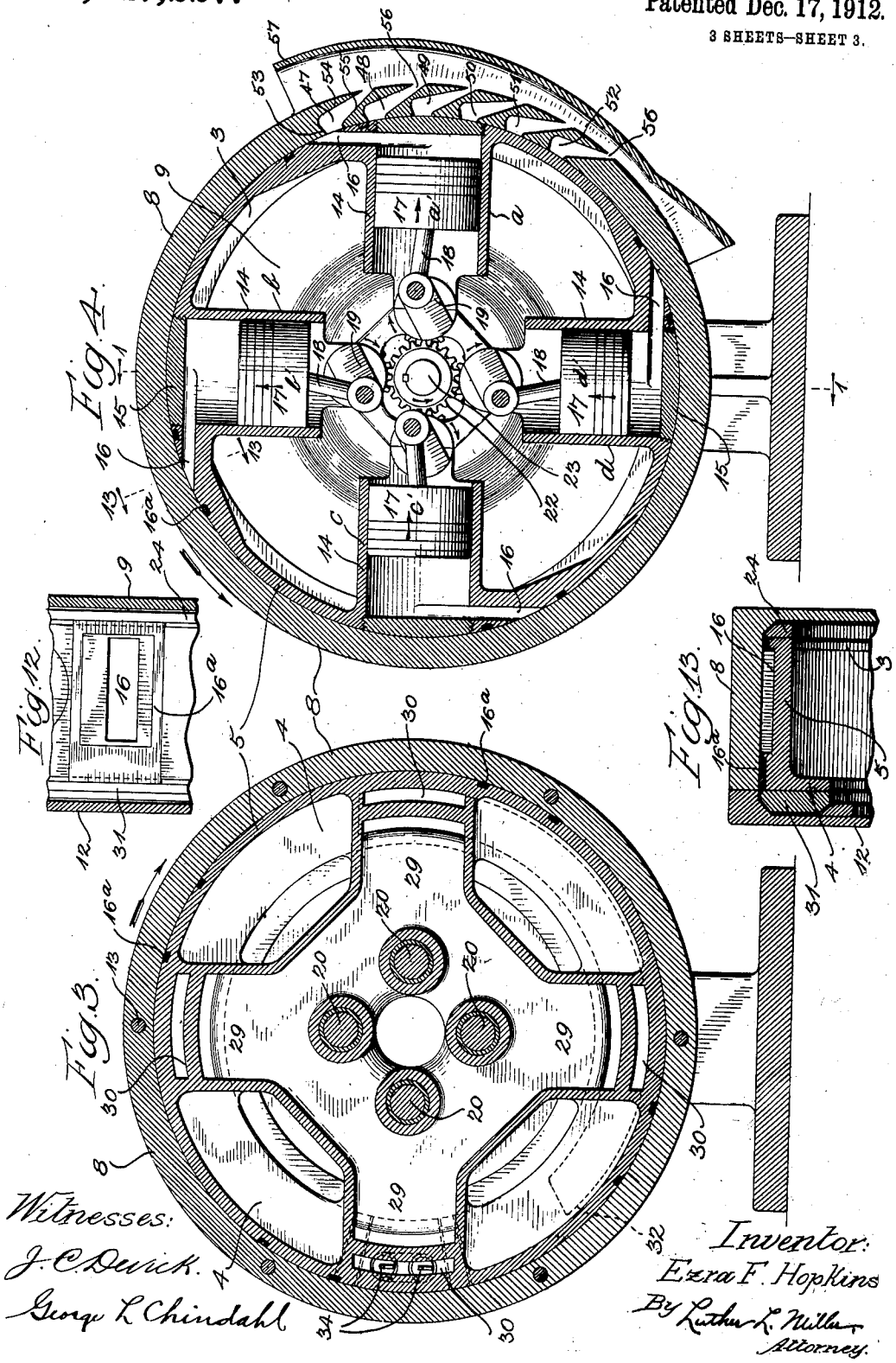
3 SHEETS—SHEET 3.



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INTERNAL-COMBUSTION TURBINE.

1,047,227. Specification of Letters Patent. Patented Dec. 17, 1912.

Application filed January 11, 1910. Serial No. 537,447.

To all whom it may concern:

Be it known that I, EZRA F. HOPKINS, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Internal-Combustion Turbines, of which the following is a specification.

The object of this invention is to produce a simple and efficient motor of the rotary type in which the energy due to the expansion of the products of combustion may be utilized.

In the accompanying drawings, Figure 1 is a sectional view of an internal-combustion turbine embodying the features of my invention, the view being taken substantially in the plane of dotted line 1 of Fig. 4. Figs. 2, 3 and 4 are sectional views taken in the planes of dotted lines 2 2, 3 3 and 4 4, respectively, of Fig. 1. Fig. 5 is a section on line 5 5 of Fig. 2 illustrating the spark plugs. Fig. 6 is a detail view of the valve ring and the spark plugs moving with said ring. Fig. 7 is a section on line 7 7 of Fig. 2. Fig. 8 is a section on line 8 8 of Fig. 2. Figs. 9, 10 and 11 are fragmental detail sections illustrating various forms of buckets or blades. Fig. 12 is a fragmental detail illustrating one of the packing rings for the outlet ports. Fig. 13 is a section on line 13 13 of Fig. 4.

The embodiment which I have selected for illustration comprises a stator 1 (Fig. 1) containing a suitable number of chambers in which an explosive mixture is compressed and ignited, and a rotor 2 carrying buckets or blades adapted to be acted upon by the expanding products of combustion. As herein shown, the stator consists of a casing having the general form of a disk and comprising the parallel annular side flanges 3 and 4 and the peripheral wall 5. The stator has an axial stem 6 by means of which it is supported and held against rotation, the stem being fixed in a bearing 7 of the supporting frame.

The rotor is in the form of a casing which incloses the stator and consists of an annular flange 8 surrounding and fitting upon the periphery of the stator, said flange being connected by a web 9 with a shaft 10 which is rotatably mounted in a bearing 11 of the supporting frame. The rotor further comprises an annular inwardly extending flange 12 secured by suitable means, as screws 13, to the flange 8.

Within the stator is a plurality of cylinders 14, in this instance four cylinders being provided. The outer end of each cylinder is closed by a head 15. Each cylinder is provided with an outlet port 16 extending from the closed outer end of the cylinder to the periphery of the stator, said port having its major axis coincident with the major plane of the rotor and extending in a forward direction from the cylinder. As indicated in Figs. 4 and 13, the port 16 is relatively narrow in the direction of the length of the cylinder, but in the direction at right angles thereto the width of said port is preferably equal to the diameter of the cylinder.

If it be deemed desirable to provide special means for preventing leakage of gases between the rotor and the stator, some such means as that illustrated in Figs. 12 and 13 may be provided. In said views I have illustrated a rectangular packing member 16^a movably seated in a correspondingly shaped recess in the stator. The ends of the packing member 16^a are beveled and overlie the beveled edges of the rings 24 and 31, as shown in Fig. 13. Expansion of said rings will tend to keep the packing member 16^a in fluid-tight contact with the inner periphery of the rotor.

In each of the cylinders 14 is a piston 17 which is connected by means of a rod 18 to a crank 19 upon a shaft 20. The four shafts 20 are connected by means of gear wheels 21 to a gear wheel 22 fixed upon a stud 23 forming an axial extension of the shaft 10. The gear wheels 21 and 22 are of equal size, therefore it will be seen that each piston will make two strokes (or one reciprocation) in each revolution of the rotor.

Contacting with the flange 3 of the stator is a ring 24, the beveled edge 25 of said ring contacting with the beveled surface 26 of the rotor. The ring 24 is caused to rotate with the rotor by any suitable means, as pins 27.

The explosive mixture is drawn into the cylinders 14 upon the inward stroke of the pistons 17. In the construction herein shown, the means for admitting the combustible mixture to the cylinders comprises a passage 28 formed in the stem 6 and

leading from a carbureter or other suitable source of supply (not shown) to radial channels 29 formed in the stator. The outlet ends of the channels 29 open upon the flange 4 of the stator, adjacent to the cylinders, and each of the latter is provided with an intake port 30 communicating with the outer end of the cylinder and opening upon the flange 4 at a point adjacent to the outlet end of one of the channels 29. Rotating with the rotor is a valve ring 31 (Fig. 6) having an arcuate groove or port 32 therein which is arranged to connect the channels 29 with the intake ports 30. The edges of the valve ring 31 upon the outer side thereof are beveled, as indicated in Fig. 1, and bear upon the beveled surface 32^a upon the flange 12 and against the beveled edge of a ring 33. The valve ring 31 in this instance is caused to travel with the rotor by reason of the fact that the spark plugs 34 extend through the flange 12 and said valve ring. For convenience in manufacture, the spark plugs 34 may be seated in a section 35 formed separate from the remainder of the valve ring. Said section extends through the flange 12, as shown in Figs. 2, 5 and 7. The inner ends of the spark plugs lie within a chamber 36 formed in the inner face of the section 35, said chamber being arranged to communicate in succession with the intake ports 30. I have, in this instance, provided two spark plugs, the one offering the least resistance operating until in need of cleaning or replacement, when the other automatically goes into service.

Any suitable means may be provided for connecting the spark plugs in circuit at the proper times. I have herein shown a ring 37 of suitable insulating material, said ring being attached to the flange 12 by suitable means, such as bolts 38. Upon the inner periphery of said ring is a ring 39 of conducting material which is connected by means of a binding post 40 and a wire 41 with the spark plugs 34. Upon the ring 39 are four contact projections 42 (Fig. 8) arranged to be brought successively in contact with a spring-pressed contact brush 43 pivoted at 44 upon a collar 45 of insulating material fixed on the bearing 7. The brush 43 is connected by the wire 46 to a suitable source of electrical energy.

In the present embodiment a charge is exploded in each of the cylinders in succession, one explosion taking place in each cylinder during each revolution of the rotor. The rotor is provided with buckets, blades, or equivalent devices positioned so as to come into operative relation with each cylinder as the charge in said cylinder is ignited. The buckets or blades may take various forms, a few practical constructions being illustrated in Figs. 4, 9, 10 and 11. In Fig. 4 are shown six buckets 47, 48, 49, 50, 51 and 52 formed in the peripheral flange 8 of the rotor, each being of the same width as the outlet ports 16, as shown in Fig. 7. Each bucket comprises a wall 53 which may be radial, or approximately so, a wall 54 extending substantially at right angles with the wall 53, and a wall 55 inclined with relation to the wall 54 so as to make the bucket slightly tapering with its smaller or exhaust end 56 opening upon the periphery of the rotor.

In order to muffle the noise of the exhaust through the openings 56 and cause a strong outward flow or suction through the last two or three buckets to reach the port 16, I place upon the periphery of the rotor an elongated hood 57 open at its forward and rear ends. Said hood is restricted in size toward its rear end, being of smallest cross-section at a point rearwardly of the exhaust opening of the last bucket, and rearwardly of said point being of increasingly larger cross-section, as indicated in Fig. 4. The hood 57 causes a rapid flow of air past the outlet ends of the buckets, thus causing a free and quick exhaust from said buckets, especially from the rearmost bucket. The hood 57 serves four purposes: It acts as a muffler; it accelerates the exhaust from the buckets and the cylinder; it cools that portion of the rotor which requires cooling, the extensive superficial area of the hood facilitating the rapid radiation of heat; and it balances the rotor by compensating for the metal removed in forming the buckets.

The construction illustrated in Fig. 9 comprises three buckets 58 of the same general form as those shown in Fig. 4, but the inlet ends of the buckets 58 are proportionately larger than as shown in Fig. 4.

In Fig. 10 I have represented three buckets 59 60 61, each having a radial wall and a wall tangential to the periphery of the stator, said walls forming a triangular bucket having one of its apexes directed rearwardly. The rear ends of the buckets 60 61 are provided with exhaust ports 62.

Fig. 11 illustrates a rotor provided with eleven similar buckets 63 each having its smaller or exhaust end opening upon the periphery of the rotor. The inlet ends of the buckets 63 are proportionately smaller than those of the buckets shown in Figs. 4, 9 and 10.

In explaining the operation of the present embodiment of the invention, the several cylinders will be indicated in Fig. 4 by the letters *a b c d*, and the pistons by the characters *a' b' c' d'*, and the direction of piston travel by arrows. In cylinder *a* a charge is being ignited, in cylinder *b* a charge is being compressed, in cylinder *c* a charge has been nearly drawn in, and in cylinder *d* the draw-

ing in of a charge has recently begun. The cranks are so set that each piston will be thirty degrees from the outer end of its stroke and will be moving outwardly when the charge is ignited. As the charge in cylinder *a* is ignited the bucket 47 is brought into communication with the outlet port 16 of said cylinder, the pressure of the expanding products of the combustion being exerted upon the walls 53 and 54 of said bucket. The buckets 48, 49 and 50 successively come into register with said outlet port 16 and receive the pressure of the expanding gases. By the time the buckets 51 and 52 reach the port 16 the force of the gases has been substantially spent and the larger part of the gases remaining in the cylinder *a* is exhausted through the openings 56 of said buckets 51 and 52 by the action of the air current flowing through the hood 57. While expansion is taking place in the cylinder *a*, the port 16 and the buckets of the rotor, the piston *a'* is moving outwardly. Just before the last bucket passes the port 16, the piston *a'* begins its inward stroke and the inlet port 32 in the valve ring comes into register with the intake port 30 of the cylinder *a*, whereby a fresh charge is drawn into said cylinder during the inward stroke of said piston. The suction begins just before the last bucket passes the port 16 and while the burnt gases are being exhausted through said port, hence the incoming charge follows the burnt gases into said port and assists to clear the cylinder of the products of the preceding explosion. Before the inner end of the stroke is reached, the port 32 has passed the intake port 30, and the valve ring has blanked said intake port. Upon the succeeding outward stroke of the piston the new charge is compressed, the spark plugs again reaching the port 16 when the piston *a* is thirty degrees from the outer end of its stroke. The cycle just described as taking place in cylinder *a* occurs in each cylinder in succession, whereby as many impulses are imparted to the rotor in each revolution as there are cylinders,—in this instance, four impulses.

It will be understood that the invention is not limited to the precise construction shown and described, for various modifications will occur to persons skilled in the art.

I claim—

1. In an internal combustion turbine, in combination, a stator comprising a plurality of radially disposed cylinders, each cylinder having an outlet port, a piston for each cylinder, a rotor having an element which is concentric to the stator and bears a surrounding relation thereto, said element having a portion of its extent characterized by a bucket formation arranged to traverse the outlet ports, and the remaining portion of its extent imperforate, and a gear connection operatively interposed between the rotor and the pistons.

2. In an internal combustion turbine, in combination, a stator comprising a plurality of radially disposed cylinders, each cylinder having an outlet port and an intake port, a piston for each cylinder, a rotor having an element which is concentric to the stator and bears a surrounding relation thereto, said element having a portion of its extent characterized by a bucket formation arranged to successively traverse the outlet ports, and the remaining portion of its extent imperforate, fluid-admission means including a device common to the cylinders and carried by the rotor, for causing the admission of gas successively to the intake ports, and gear connections operatively interposed between the rotor and pistons.

3. In an internal combustion turbine, in combination, a stator comprising a cylinder having an outlet port; a piston in said cylinder; a rotor having a bucket arranged to be brought into communication with said outlet port; a connection between the rotor and the piston for moving the latter; a spark plug mounted on said rotor adjacent to said bucket; a contact member mounted on said rotor and electrically connected with said spark plug; and a contact device mounted on the stator and arranged to engage the first mentioned contact in the revolution of the rotor.

4. In an internal combustion turbine, in combination, a stator comprising a cylinder having an outlet port and an intake port; a rotor having a bucket arranged to be brought into communication with said outlet port; a piston in said cylinder; a connection between the rotor and the piston for moving the latter; charge-conducting means; a valve ring attached to said rotor for alternately blanking said intake port and connecting said intake port with said charge-conducting means; a spark plug attached to said valve ring at a point adjacent to said bucket; and means for periodically operating said spark plug.

5. In an internal combustion turbine, in combination, a stator having an annular marginal outline and comprising a cylinder having an outlet port opening upon the periphery of the stator, and an intake port opening upon one side of the stator; a piston in said cylinder; a rotor inclosing the stator and fitting upon the periphery of the latter, said rotor having a bucket arranged to be brought into communication with said outlet port; a connection between the rotor and the piston for moving the latter, said stator having a channel therein for an explosive mixture, which channel opens upon one side of the stator adjacent to said intake port; means traveling with the rotor for alternately blanking said intake port and con-

necting said intake port with said channel; and charge-igniting means.

6. In an internal combustion turbine, in combination, a stator having an annular marginal outline and comprising a cylinder having an outlet port opening upon the periphery of the stator and an intake port opening upon one side of the stator; a piston in said cylinder; a rotor inclosing the stator and comprising an annular flange fitting upon the periphery of the stator, and an annular inwardly-extending flange secured to said peripheral flange, said rotor having a bucket upon its periphery arranged to be brought into communication with said outlet port; a connection between the rotor and the piston for moving the latter, said stator having a channel therein for an explosive mixture, which channel opens upon one side of the stator adjacent to said intake port; a valve ring lying in contact with the intake-port side of the stator and attached to said inwardly-extending annular flange upon the rotor, said valve ring being arranged to alternately blank said intake port and connect said intake port with said channel; and charge-igniting means.

7. In an internal combustion turbine, in combination, a stator having an annular marginal outline and comprising a plurality of cylinders having outlet ports and intake ports; a rotor inclosing the stator and having buckets arranged to be brought successively into communication with the outlet ports of said cylinders; a piston in each of said cylinders; a connection between the rotor and the pistons for moving the latter, said stator having channels therein for the explosive mixture, which channels have outlet openings adjacent to the respective intake ports of the cylinders; an axial supporting stem for the stator, which stem is tubular and communicates with said channels and forms a conduit for the explosive mixture; means traveling with the rotor for alternately blanking each intake port and connecting such port with the adjacent channel; and charge igniting means.

8. In an internal combustion turbine, in combination, a stator having an annular marginal outline and comprising a plurality of cylinders having outlet ports opening upon the periphery of the stator, and intake ports opening upon one side of the stator; a piston in each cylinder; a rotor inclosing the stator and fitting upon the periphery of the latter, said rotor having a bucket in its periphery arranged to be brought successively into communication with said outlet ports; a connection between the rotor and the pistons for moving the latter, said stator having channels therein for an explosive mixture, which channels open upon one side of the stator at points adjacent to the respective intake ports; an axial supporting stem for the stator, said stem being tubular and communicating with said channels and forming a conduit for the explosive mixture; a valve ring traveling with said rotor and contacting the intake-port side of the stator, said ring being adapted to alternately blank each intake port and connect said intake port with the adjacent channel; and charge-igniting means.

9. In an internal combustion engine, in combination, a stator comprising a plurality of radially disposed cylinders, said stator having on its periphery a plurality of outlet ports and a continuously unobstructed channel connecting each of said cylinders respectively with one of said ports; a piston in each cylinder; a rotor having an element which is concentric to the stator and bears a surrounding relation thereto, the element having a bucket arranged to be brought into communication with said outlet ports; a shaft driven by said rotor; and means connecting said shaft and each of said pistons whereby said pistons are reciprocated in the rotation of the rotor.

10. In an internal combustion turbine, in combination, a stator comprising a cylinder having an outlet port; a piston in said cylinder; a rotor having a plurality of buckets arranged to be brought into communication with said outlet port; a connection between the rotor and the piston for moving the latter; and means having an ejector-like action for accelerating the exhaust from one of said buckets.

11. In an internal combustion turbine, in combination, a stator comprising a cylinder having an outlet port; a piston in said cylinder; a rotor having a plurality of buckets arranged to be brought into communication with said outlet port; a connection between the rotor and the piston for moving the latter; and a hood carried by said rotor and extending over one of said buckets for accelerating the exhaust from said bucket.

12. In an internal combustion turbine, in combination, a stator comprising a cylinder having an outlet port; a piston in said cylinder; a rotor having a bucket arranged to be brought into communication with said outlet port; a connection between the rotor and the piston for moving the latter; and a hood fixed upon and rotating with said rotor and extending over the outlet from said bucket for muffling the exhaust.

13. In an internal combustion turbine, in combination, a stator comprising a cylinder having an outlet port; a piston in said cylinder; a rotor having a group of buckets arranged to be brought into communication with said outlet port; a connection between the rotor and the piston for moving the latter; and a muffler hood fixed to said rotor and extending over said group of buckets

and serving to balance the rotor by compensating for the metal removed in forming the buckets.

14. In an internal combustion turbine, in combination, a stator having an annular marginal outline and comprising a peripheral flange and radially disposed cylinders having outlet ports opening upon said peripheral flange; a rotor inclosing the stator and fitting upon said peripheral flange and having a bucket arranged to be brought into communication with said outlet ports, said rotor serving of itself to blank said outlet ports when said bucket is not in communication therewith; a piston in each cylinder; and a connection between the rotor and the pistons for moving the latter.

15. In an internal combustion turbine, in combination, a stator having an annular marginal outline and comprising a peripheral flange, an annular side flange, and cylinders having outlet ports opening upon said peripheral flange and intake ports opening upon said side flange; a rotor comprising an annular peripheral flange fitting upon the periphery of the stator and an annular inwardly-extending flange secured to the peripheral flange of the rotor, the peripheral flange of the rotor having a group of buckets therein adapted to be brought into communication with said outlet ports, the peripheral flange of the rotor serving to blank said outlet ports when said group of buckets is not in communication therewith; a piston in each cylinder; a connection between the rotor and the pistons for moving the latter, said stator having channels therein for an explosive mixture, which channels open upon the side flange of the stator at points adjacent to the respective intake ports; an axial supporting stem for the stator, said stem being tubular and communicating with said channels and forming a conduit for the explosive mixture; a valve ring fixed to the inwardly-extending flange of the rotor and contacting the side flange of the stator, said ring being adapted to alternately blank each intake port and connect said intake port with the adjacent channel; a spark plug carried by the inwardly-extending flange of the rotor and arranged to be brought into operative relation with the successive intake ports; and means for operating said spark plug.

16. In an internal combustion turbine, in combination, a stator comprising a plurality of cylinders, each cylinder having an outlet port and an intake port, a piston for each cylinder, a rotor including an element which has a bucket formation to traverse the outlet ports, fluid-admission means including a device common to the cylinders and carried by the rotor for causing the admission of gas successively to the intake ports, and gear connections operatively interposed between the rotor and the pistons.

17. In an internal combustion turbine, in combination, a stator comprising a plurality of cylinders, each cylinder having an outlet port and an intake port, a piston for each cylinder, a rotor including an element which has a bucket formation to traverse the outlet ports, fluid-admission means including a device common to the cylinders and carried by the rotor for causing the admission of gas successively to the intake ports, ignition means including a spark plug carried by said device and adapted to be moved successively into relation to the respective cylinders, and gear connections operatively interposed between the rotor and the pistons.

18. In an internal combustion turbine, in combination, a stator comprising a plurality of cylinders, each cylinder having an outlet port and an intake port, a piston for each cylinder, a rotor including an element which has a bucket formation to traverse the outlet ports, means operated by the rotor for causing the admission of gas to the cylinders, ignition means including a spark plug which is associated with the rotor for rotation therewith and is brought thereby successively into relation to the cylinders, and gear connections operatively interposed between the rotor and the pistons.

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