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ROTATING COMBUSTION CHAMBER WITH CONTINUOUS REARWARD DISCHARGE

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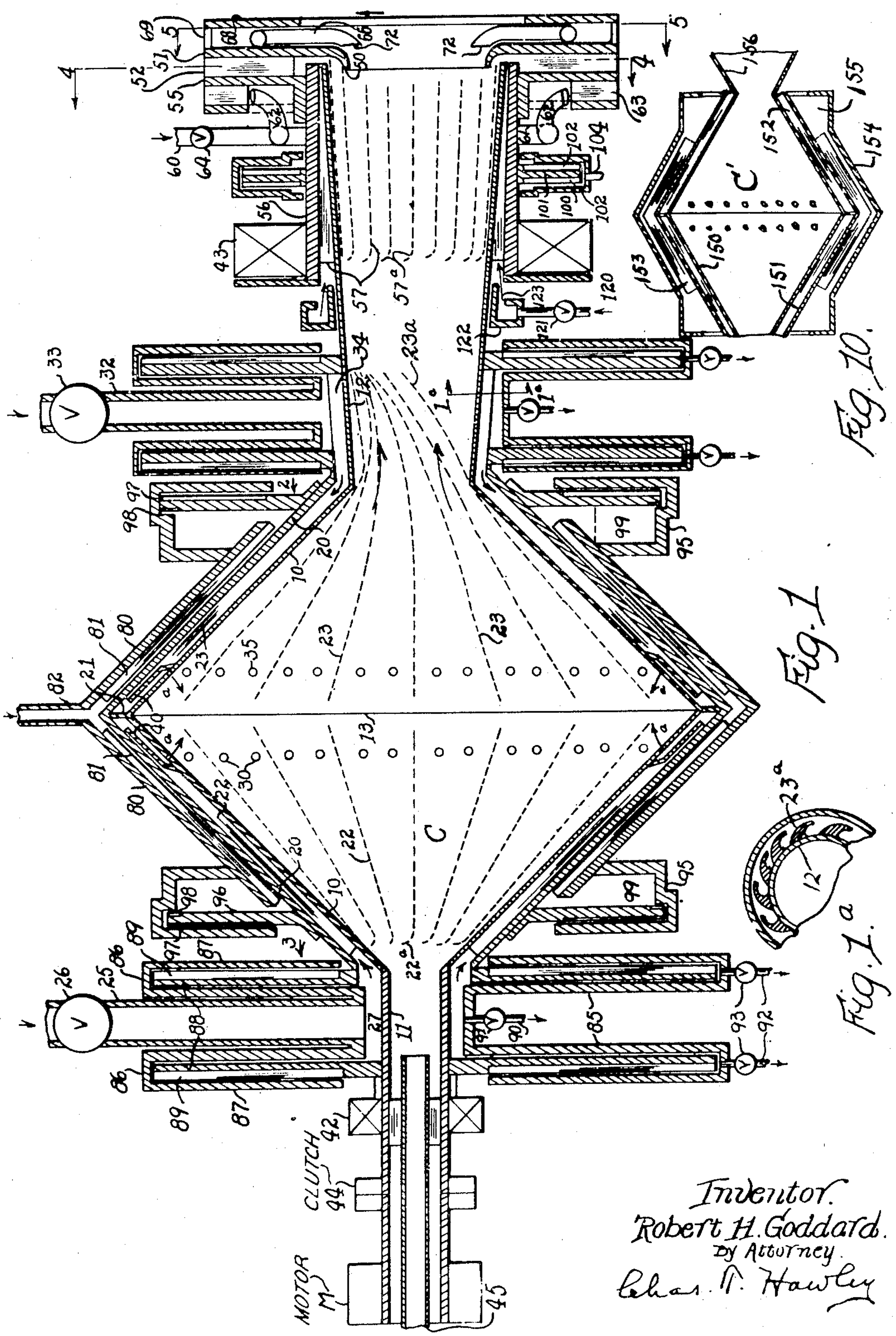

Fig. 1

Fig. 1a

Fig. 10

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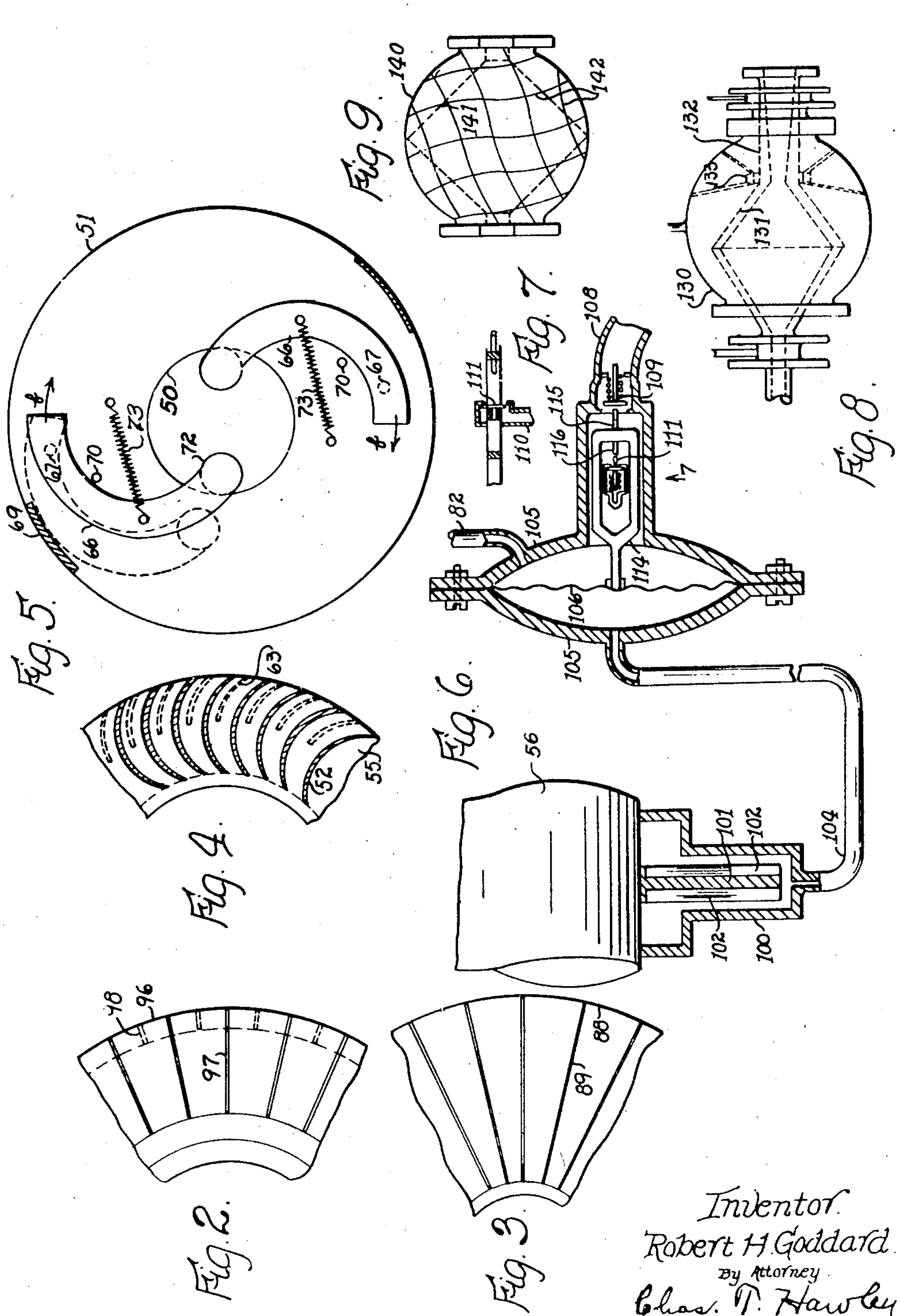

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ROTATING COMBUSTION CHAMBER WITH CONTINUOUS REARWARD DISCHARGE

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13 Claims. (Cl. 60—35.6)

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This invention relates to a rotating combustion chamber adapted for use in rockets or rocket-type aircraft, and in which chamber combustion gases are produced which are thereafter continuously discharged from a rearwardly directed nozzle. It is advantageous to rotate such a combustion chamber at a relatively high speed to thoroughly intermingle the combustion liquids, such as gasoline and liquid oxygen. Such high speed rotation, however, subjects the combustion chamber walls to strong centrifugal outward pressure, which pressure is increased by the pressure of the gases produced by combustion.

It is the general object of my invention to counteract these strong outward pressures by mounting the combustion chamber in a stationary jacket or casing and by applying sufficient gas pressure in the space between the jacket and the chamber casing to counteract said outward pressures.

Other features of my invention relate to the provision of improved means for supplying combustion liquids to a rotating chamber and to improved means for distributing and intermingling the combustion liquids in the chamber.

My invention further relates to arrangements and combinations of parts which will be hereinafter described and more particularly pointed out in the appended claims.

Preferred forms of the invention are shown in the drawings, in which

Fig. 1 is a sectional front elevation of my improved combustion chamber;

Fig. 1*a* is a partial detail section on the line 1*a*—1*a* in Fig. 1;

Figs. 2 and 3 are partial side elevations of certain sealing discs and vanes, looking in the direction of the arrows 2 and 3 in Fig. 1;

Figs. 4 and 5 are sectional end elevations, taken respectively along the lines 4—4 and 5—5 in Fig. 1;

Fig. 6 is a side elevation, partly in section, of centrifugally controlled means for regulating the valves which control the pressure in the jacket space;

Fig. 7 is a detail sectional side elevation, looking in the direction of the arrow 7 in Fig. 6;

Fig. 8 is a front elevation of a modified jacket construction;

Fig. 9 is a side elevation of a reenforced type of pressure container or jacket; and

Fig. 10 is a sectional front elevation of a further modification.

Referring particularly to Fig. 1, I have shown a combustion chamber C comprising an inner casing or wall 10 having a cylindrical entrance portion 11 and a slightly conical discharge nozzle 12. The casing 10 is shown as comprising a pair of reversely disposed hollow cones having their base edges joined along a line 13.

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The chamber C is provided with an outer wall 20, also formed of reversed hollow cones having their base edges joined at an annular partition 21 and spaced from the conical walls 10 of the chamber C by a series of ribs 22 and 23.

The ribs 22 are so disposed that, if extended, they would meet at the axis of the hollow cones. The ends of the ribs 22 adjacent the entrance portion 11 are curved forwardly in the direction of rotation, as indicated at 22*a* in Fig. 1, to facilitate entrance of a combustion liquid, such as gasoline.

The ends 23*a* of the ribs 23 extend along the discharge nozzle 12 and are curved forwardly as shown at 23*a* to facilitate entrance of a second combustion liquid, such as liquid oxygen. These ribs are also curved in cross-section as shown in Fig. 1*a*. The ribs 23*a* assist movement of the liquid oxygen towards the combustion chamber C by their propeller-like action, thus avoiding interference with the flow by centrifugal action at the nozzle surface.

The gasoline is introduced through a pipe 25 and shut-off valve 26 to an annular space 27, communicating with the radiating passages formed between the ribs 22 which space the inner chamber wall 10 from the outer wall 20. Each of these passages communicates through one or more small holes or feed openings 30 with the interior of the combustion chamber.

The liquid oxygen is similarly introduced through a pipe 32 and shut-off valve 33 to an annular space 34, communicating with additional radiating passages between the inner wall 10 of the chamber C and the outer wall 20 thereof. The oxygen is then delivered to the chamber through openings 35, corresponding to the openings 30 but substantially spaced axially therefrom.

The openings 30 and 35 are so disposed that the liquids are discharged in converging directions, as indicated by the arrows *a* in Fig. 1. They thus intersect and are intimately intermingled at an annular area indicated generally by the line 13. Preferably, annular partitions or shields 40 are provided adjacent the openings 30 and 35. The combustion liquids must pass around these partitions as they are delivered from the rotating passages between the ribs 22 and 23 to the openings 30 and 35. Objectionable pumping action is avoided by omitting all ribs in the spaces within the annular partitions 40.

The combustion chamber C, entrance portion 11 and nozzle 12 are rotatably supported in bearings 42 and 43, and initial rotation of the chamber C may be produced by a motor M acting through a clutch 44 which may be disengaged when the chamber is rotating at a desired speed. An ignition tube 45 is mounted within the entrance portion 11 and is used to project a flame into the combustion chamber for initial combustion when starting up the apparatus.

As the combustion gases are discharged from the nozzle 12, an outer and cooler portion of the gases is engaged by the inturned lip 50 of a disc 51. The disc 51 is connected by a plurality of vanes 52 (Fig. 4) to a second disc 55 which is firmly supported on a sleeve 56. The sleeve 56 is connected to the nozzle 12 by a series of vanes 57 having curved entrance portions 57*a*. As the rotating combustion gases engage the lip 50 and are directed outward, they react with the curved vanes 52 to keep the chamber C and associated parts in continued rapid rotation.

For preliminary starting purposes, gas under pressure may be supplied through a pipe 60 (Fig. 1), annular connection 61 and stationary nozzles 62 to react against relatively short curved vanes 63 (Figs. 1 and 4) mounted on the disc 55 at the opposite side from the vanes 52. A valve 64 controls the admission of gas through the pipe 60. This turbine construction for initial starting may be used in addition to the motor M or in substitution therefor. After the chamber C is in full operation, the valve 64 may be closed.

As an aid to quick pick-up, two or more starting nozzles 66 (Figs. 1 and 5) are pivoted at 67 between a disc 68 and the outer face of the disc 51. The two discs are connected by segmental portions 69 which also act as outer stops for the nozzles 66. Pins 70 mounted in the discs 68 and 51 act as inner stops.

At their inner ends, the nozzles 66 have side inlet openings 72, directed toward the chamber C and positioned to receive portions of the exhaust gases as they are ejected at high speed through the nozzle 12. The gases which enter the side openings 72 pass outward through the curved nozzles 66 and are discharged as indicated by the arrow *b* (Fig. 5), thus producing a further reaction which tends to increase the speed of rotation of the combustion chamber and associated parts.

Springs 73 (Fig. 5) normally hold the starting nozzles 66 in inward position against the stop pins 70. As the speed of the chamber increases, the inner ends of the nozzles 66 are swung outward by centrifugal force to the inoperative positions shown in dotted lines in Fig. 5, where they are shielded between the discs 51 and 68.

An outer casing or jacket 80 (Fig. 1) surrounds the rotating combustion chamber but is spaced outwardly therefrom. Vanes 81 are provided on the inner face of the jacket 80 and extend closely adjacent the outer chamber wall 20 but do not engage therewith.

The jacket space thus formed is supplied with gas under pressure through a pipe 82. This gas is preferably a very light gas, such as hydrogen or helium, by which pressure may be applied to the exterior of the rotating combustion chamber C but with minimum frictional resistance.

Special sealing devices are provided to prevent escape of gasoline, liquid oxygen and the jacket gas at the junctures of rotating and non-rotating parts and these sealing devices will now be described.

The pipe 25 (Fig. 1) for gasoline is connected between stationary discs 85, joined by outer annular portions 86 to additional stationary discs 87. Movable discs 88 are mounted to rotate between each pair of stationary discs 85 and 87, and each disc 88 is provided with radiating vanes 89 (Fig. 3) which rotate in the outwardly closed annular space and with running clearance with respect to the disc 87.

With this construction, gasoline may work outward between the stationary discs 86 and the rotating discs 88 but will be prevented from passing around the discs 88 and working inward by the centrifugal action of the vanes 89. Leakage is thus prevented without the use of packing and without metal-to-metal contact of any relatively movable parts. A drip pipe 90 and valve 91 may be used to draw off surplus gasoline from the annular space 27, and similar drip pipes 92 and valves 93 may be used to drain the outer portions of the sealing casings. Leakage is avoided, on stopping, by opening the valve 90 while idling speed is maintained by the motor M, after which the valves 93 are opened and the sealing liquid is drained.

An exactly similar construction is provided for preventing leakage of liquid oxygen introduced through the pipe 32 and valve 33 to the annular chamber 34. The explanation already given applied directly thereto.

In order to prevent leakage of the jacket gas, fixed casings 95 are mounted on the jacket 80, and coacting discs 96 are mounted on the rotating outer chamber wall 20. The discs 96 are provided with relatively long radiating vanes 97 (Fig. 2) on one side and with relatively short vanes 98 on the other side. A relatively large annular space 99 in each casing 95 is partially filled with a sealing liquid, preferably mercury. Some of this will be forced around the outer edge of each disc 96 by the jacket gas pressure but is prevented from thereafter escaping toward the axis by the centrifugal action of the long radiating vanes 97. An effective seal is thus maintained during the operation of the rotating chamber.

It is desirable that the gas pressure in the outer jacket be applied only when the combustion chamber is rotating at substantial speed, and that the pressure be relieved when the speed of the chamber substantially decreases. At any lower speed, the mercury seal will become ineffective and the jacket gas will escape. I accordingly provide the special gas control devices best shown in Figs. 6 and 7. These devices comprise an outer stationary annular casing 100 (Figs. 1 and 6) within which a disc 101 is supported on the rotating nozzle sleeve 56. The disc 101 is provided with radiating vanes 102 on each side, which vanes tend to force the sealing liquid, as mercury, outward from the annular casing 100 through a pipe 104 to the interior of a control casing 105 having a diaphragm 106 mounted therein. The pipe 82 previously described connects the jacket space about the combustion chamber C with the interior of the control casing 105 but at the opposite side of the diaphragm 106.

High pressure jacket gas is supplied through a pipe 108 but any flow of this gas is commonly prevented by a supply valve 109 which acts as a check valve. An exhaust pipe 110 is similarly normally closed by a check valve 111. A sliding frame 114 is mounted on the diaphragm 106 or is movable therewith, and this frame is provided with pins 115 and 116, adapted to alternately engage and open the valves 109 and 111.

When a predetermined amount of pressure is built up by the rotating disc 101, the diaphragm 106 and frame 114 will be moved to the right in Fig. 6, engaging and opening the supply valve 109 and allowing gas under pressure to flow from the pipe 108 through the connection 82 to the pressure jacket 80 which encloses the rotating combustion chamber. When the chamber slows down, the pressure against the diaphragm 106 will be reduced and the diaphragm 106 and frame 114 will move to the left to allow the supply valve 109 to close and to engage and open the exhaust valve 111, thus relieving the gas pressure in the jacket 80.

It is desirable to reduce the temperature of the gases collected by the disc 51 and flowing outward along the vanes 52. For this purpose, water is supplied through a pipe 120 and valve 121 (Fig. 1) to a casing 122 having an annular outlet 123. Water is thus supplied to the axial passages between the rotating vanes 57 in the annular space between the nozzle 12 and the nozzle casing 56. This water acts to lower the temperature of the rear end of the nozzle 12 and at the same time the water is turned into steam which mingles with that portion of the exhaust gases which is diverted by the lip 50 and thus directed outward against the vanes 52.

In Fig. 8 I have shown an alternative form of jacket casing 130 which is of spherical contour for greater strength, and which is of sufficient size to enclose the combustion chamber 131 and a substantial portion of the nozzle 132. The portion of the nozzle enclosed is that which is subjected to the heaviest gas pressure. In this construction, an additional bearing 133 may be provided for the combustion chamber within the jacket 130, but otherwise the construction is substantially as previously described.

In Fig. 9 I have indicated a spherical jacket casing 140 of such size as to enclose only the double conical combustion chamber 141. I have also indicated that this jacket casing 140 may be desirably wire bound, as indicated at 142, for increased strength. Obviously, the jacket casing 130 in Fig. 8 may be similarly reenforced.

Having described the details of construction of my improved combustion chamber, the method of operation will be readily apparent. In starting up the apparatus, the chamber C is started in rotation, either by the motor M or by the starting nozzles 62, or both. When a sufficient speed of rotation has been reached, gasoline and liquid oxygen are admitted by opening the valves 26 and 33.

Combustion is then produced by injection of a flame through the ignition tube 45, started just prior to the admission of the two liquids. The speed of rotation will be increased by the action of the exhaust gases against the vanes 52 and also by discharge of exhaust gases through the curved nozzles 66. Further increase in speed of rotation causes the mercury or other liquid in the control casing 100 to act through the device 105 and diaphragm 106 to open the gas valve 109 and admit gas under pressure to the jacket casing 80 to offset the outward pressures in the rotating combustion chamber.

The nozzles 66 will move out of the path of the exhaust gases and become inoperative as normal speed is attained. The supply of gas under pressure through the nozzles 62 may then be discontinued, or the motor M may be unclutched from the combustion chamber.

The apparatus will then continue in satisfactory operation for as long a period as may be desired. To stop the apparatus, the valves 26 and 33 are closed. As combustion ceases and the speed induced by the vanes 52 drops off, the gas valve 109 will be automatically closed and the exhaust valve 111 will be automatically opened, thus relieving the pressure within the jacket 80.

In Fig. 10 I have shown a modified construction in which the pressure on the combustion chamber is supplied by a liquid rotating within a stationary jacket. The combustion chamber C′ may be similar to that shown in Fig. 1, with an inner wall 150 and outer wall 151, and with vanes 152 disposed between the inner and outer walls and holding them in definite spaced relation. Additional vanes 153 are mounted on the outer surface of the outer wall 151 and rotate inside of a stationary jacket casing 154. Water or any other suitable liquid is provided in the jacket casing 154 and fills the lower part of the jacket and also the annular recesses 155 when the combustion chamber C′ is at rest. When the chamber is rotated, the water or other liquid is also rotated by the outer vanes 153 and builds up pressure between the outer chamber wall 151 and the jacket casing 154, which pressure counteracts the outward centrifugal force exerted on the rotating chamber as well as the gas pressure within the chamber. A portion of the nozzle is indicated at 156.

This construction induces more friction than the preferred construction using gas within the stationary jacket but is simpler in design and is suitable for moderate speeds of chamber rotation.

Having thus described my invention and the advantages thereof, I do not wish to be limited to the details herein disclosed, otherwise than as set forth in the claims, but what I claim is:

1. In a rocket-type combustion apparatus, a rotatable structure comprising a combustion chamber and means to supply fuel and oxidizing elements to said chamber, means to rotate said structure during operation of said chamber, a stationary jacket surrounding said rotatable structure, and separate means to maintain gaseous pressure between said jacket and said rotatable structure to offset the outward pressures developed in said rotatable structure.

2. In a rocket type combustion apparatus, a combustion chamber, means to rotate said chamber during operation thereof, a stationary jacket surrounding said chamber, means to maintain gaseous pressure between said jacket and said chamber to offset the outward pressures in said chamber, and speed-responsive means by which the admission of gas to the jacket space is made dependent on the speed of rotation of said chamber.

3. In a rocket type combustion apparatus, a combustion chamber, means to rotate said chamber during operation thereof, a stationary jacket surrounding said chamber, means to maintain gaseous pressure between said jacket and said chamber to offset the outward pressures in said chamber, and speed-responsive means to admit gas to the jacket space only when said chamber is rotating at or above a predetermined speed.

4. In a rocket type combustion apparatus, a combustion chamber, means to rotate said chamber during operation thereof, a stationary jacket surrounding said chamber, means to maintain

gaseous pressure between said jacket and said chamber to offset the outward pressures in said chamber, and speed-responsive means to admit gas to the jacket space only when said chamber is rotating at or above a predetermined speed and to connect said jacket space to exhaust below a predetermined speed of rotation.

5. In a rocket type combustion apparatus, a combustion chamber, means to rotate said chamber during operation thereof, a stationary jacket surrounding said chamber, a supply pipe and exhaust pipe connected to said jacket, valves normally closing said pipes and controlling the supply of a pressure fluid thereto, a device operative to open a selected valve, and means to move said device in accordance with the speed of rotation of said chamber.

6. The combination in combustion apparatus as set forth in claim 5, in which the latter means comprises a fluid pressure operated device, and in which the fluid pressure is produced by centrifugal force proportionate to the speed of rotation of said chamber.

7. In a rocket type combustion apparatus, a combustion chamber, means to rotate said chamber during operation thereof, a stationary jacket surrounding said chamber, and means to maintain gaseous pressure between said jacket and said chamber to offset the outward pressures in said chamber, and said jacket being provided with vanes to prevent rotation of the jacket gas with the rotating chamber.

8. In a rocket type combustion apparatus, a combustion chamber, means to rotate said chamber during operation thereof, a stationary jacket surrounding said chamber, means to maintain gaseous pressure between said jacket and said chamber to offset the outward pressures in said chamber, and liquid sealing devices to prevent escape of the jacket gas at the edges of said jacket and between said jacket and chamber.

9. In a rocket-type combustion apparatus, a rotatable structure comprising a combustion chamber and means to supply fuel and oxidizing elements to said chamber, means to rotate said structure during operation of said chamber, a stationary jacket surrounding said rotatable structure, and separate means to produce and maintain fluid pressure between said jacket and said rotatable structure to offset the outward pressures developed in said rotatable structure.

10. In a rocket type combustion apparatus, a combustion chamber, means to rotate said chamber during operation thereof, a stationary jacket surrounding said chamber, and means to provide liquid under pressure between said jacket and said chamber to offset the outward pressures in said chamber, said jacket having open ends and having adjacent recessed portions of sufficient capacity to contain the pressure liquid when the chamber is at rest.

11. In a rocket type combustion apparatus, a combustion chamber, means to rotate said chamber during operation thereof, a stationary jacket surrounding said chamber, and means to produce and maintain liquid pressure between said jacket and said chamber to offset the outward pressures in said chamber, said latter means comprising vanes on said rotating chamber having running clearance with said jacket and means to supply liquid to said vanes when the chamber is rotated and to store said liquid when said chamber is at rest.

12. In a rocket type combustion apparatus, a combustion chamber, means to rotate said chamber during operation thereof, a stationary jacket surrounding said chamber, and centrifugal means operative within said jacket and effective to produce liquid pressure between said jacket and said chamber to offset the outward pressures in said chamber, said centrifugal means being associated with said chamber and being operative only during rotation thereof.

13. In a rocket type combustion apparatus, a combustion chamber, means to rotate said chamber during operation thereof, a stationary jacket surrounding said chamber, means to maintain fluid pressure between said jacket and said chamber to offset the outward pressures in said chamber, means to supply a combustion liquid at each end of said rotating chamber, liquid sealing means for said chamber including rotated discs and stationary enclosing casings, means to drain the space between said discs, and additional means to drain said casings when said chamber is brought to rest.

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