

July 7, 1953

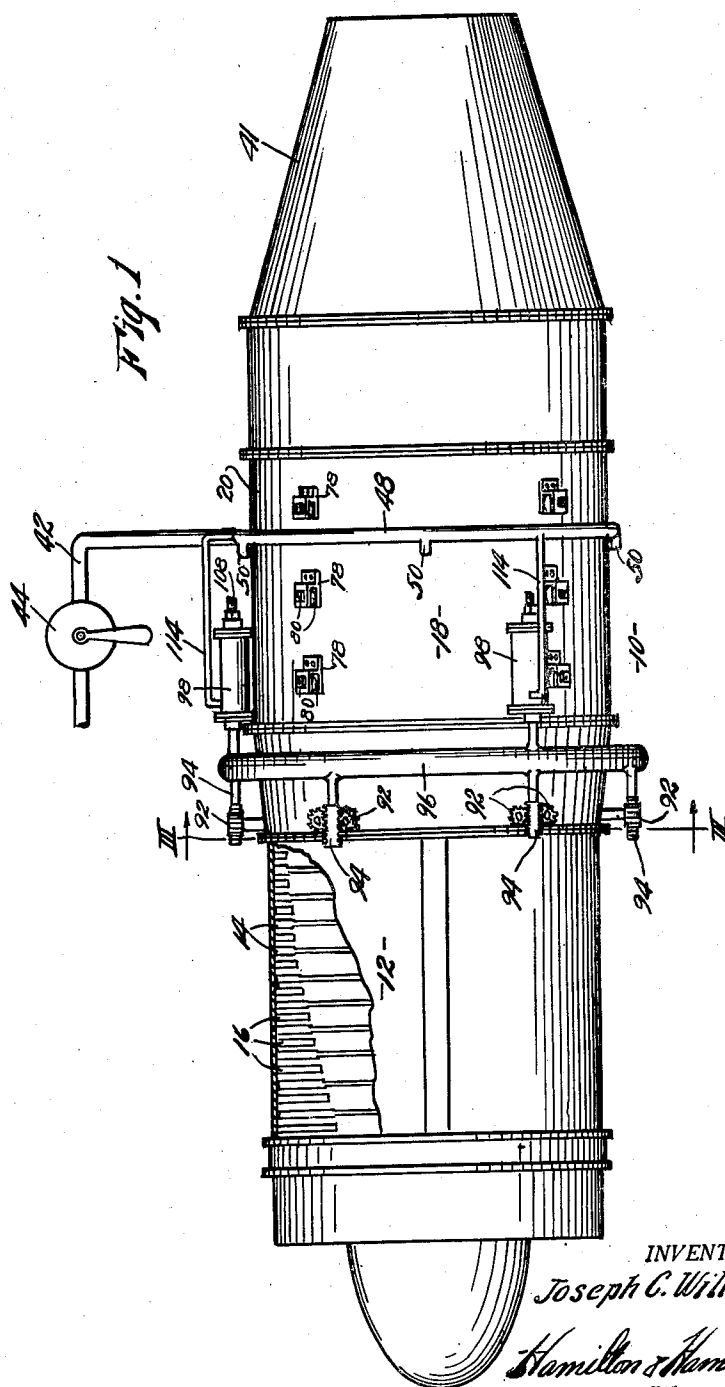
J. C. WILLIAMS

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JET PROPULSION ENGINE WITH REGULATION OF AIR DISTRIBUTION

Filed Aug. 18, 1950

4 Sheets-Sheet 1



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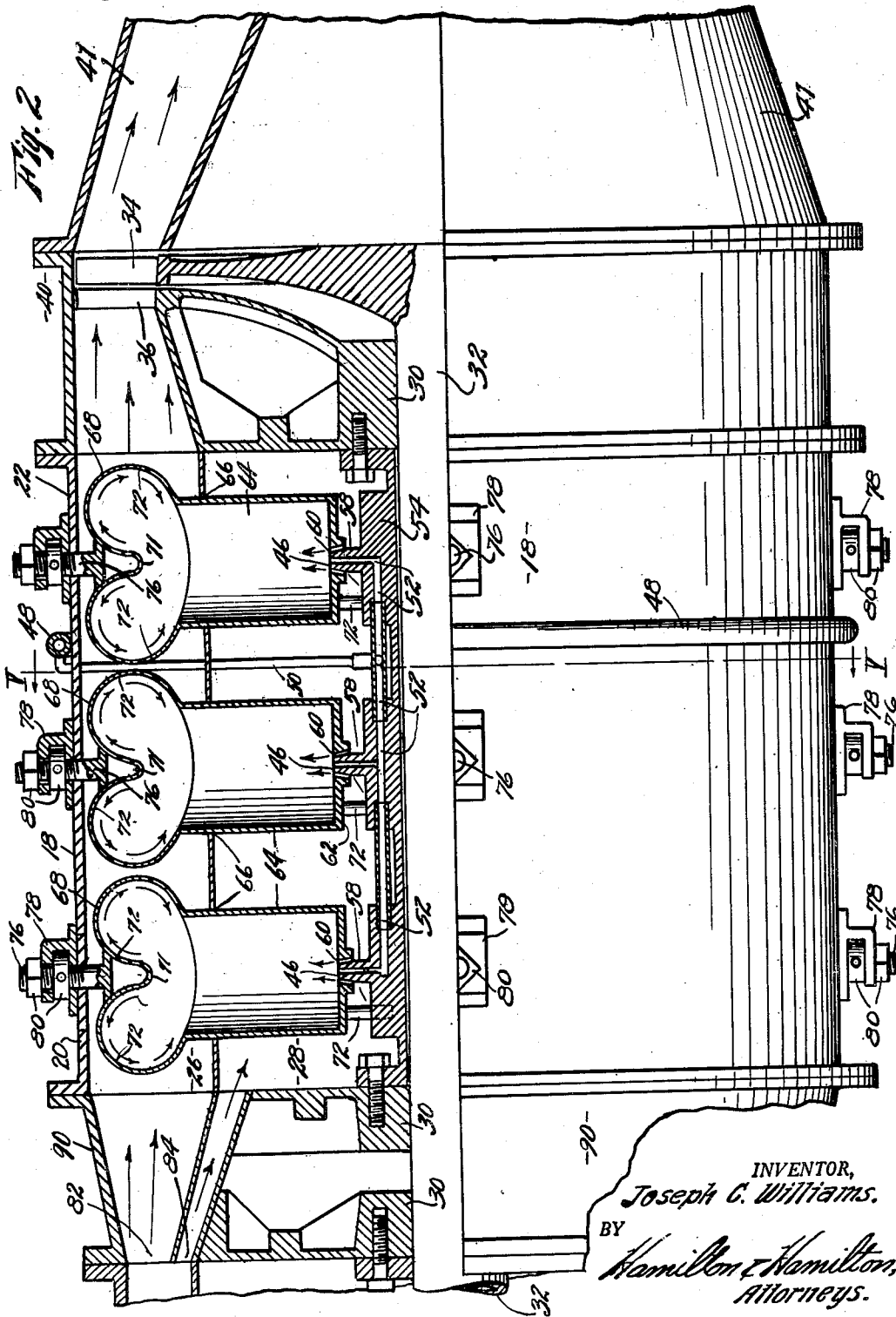
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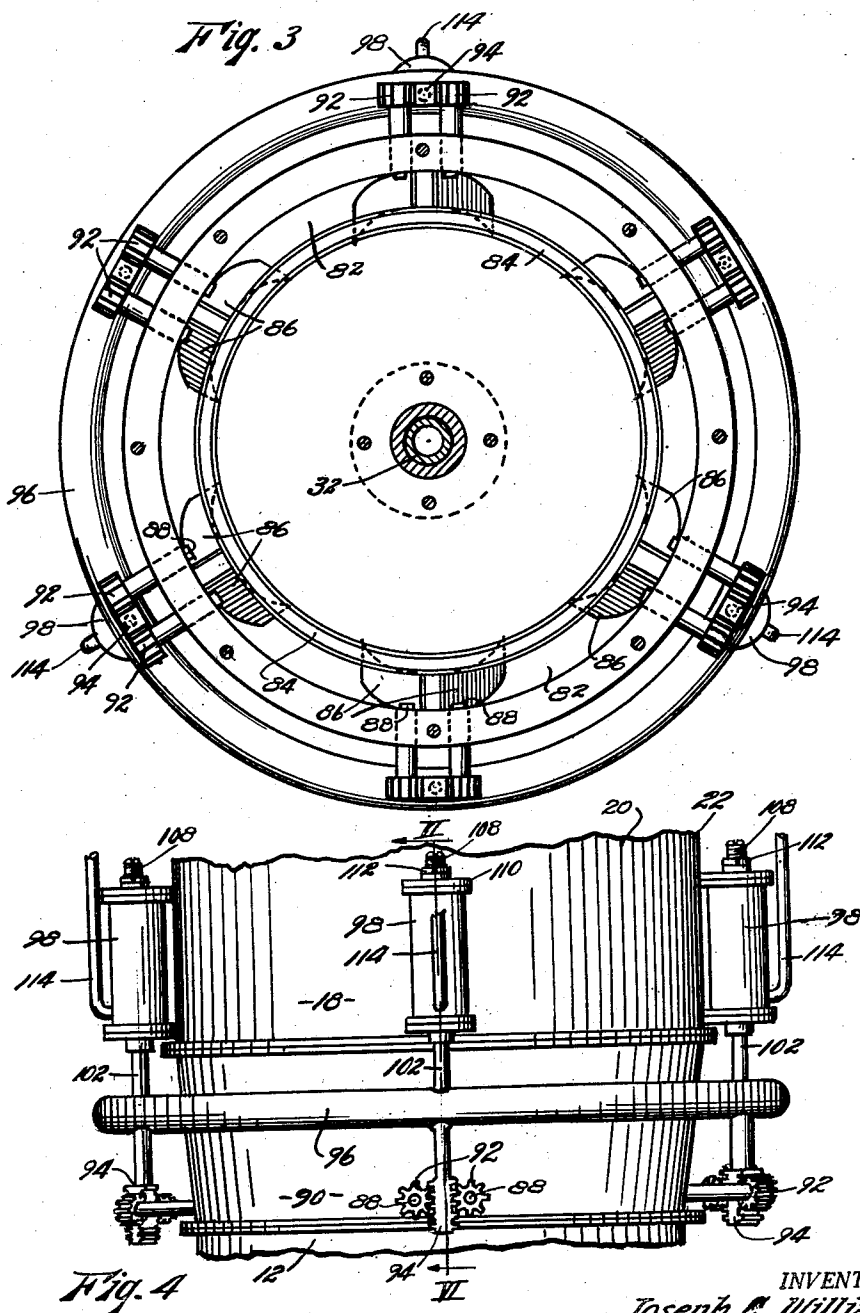
J. C. WILLIAMS

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INVENTOR,
Joseph C. Williams.
BY
Hamilton & Hamilton,
Attorneys.

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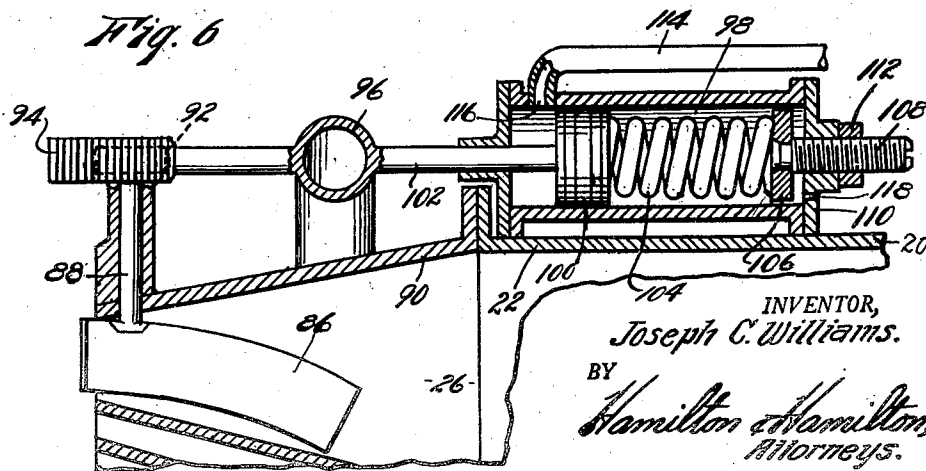
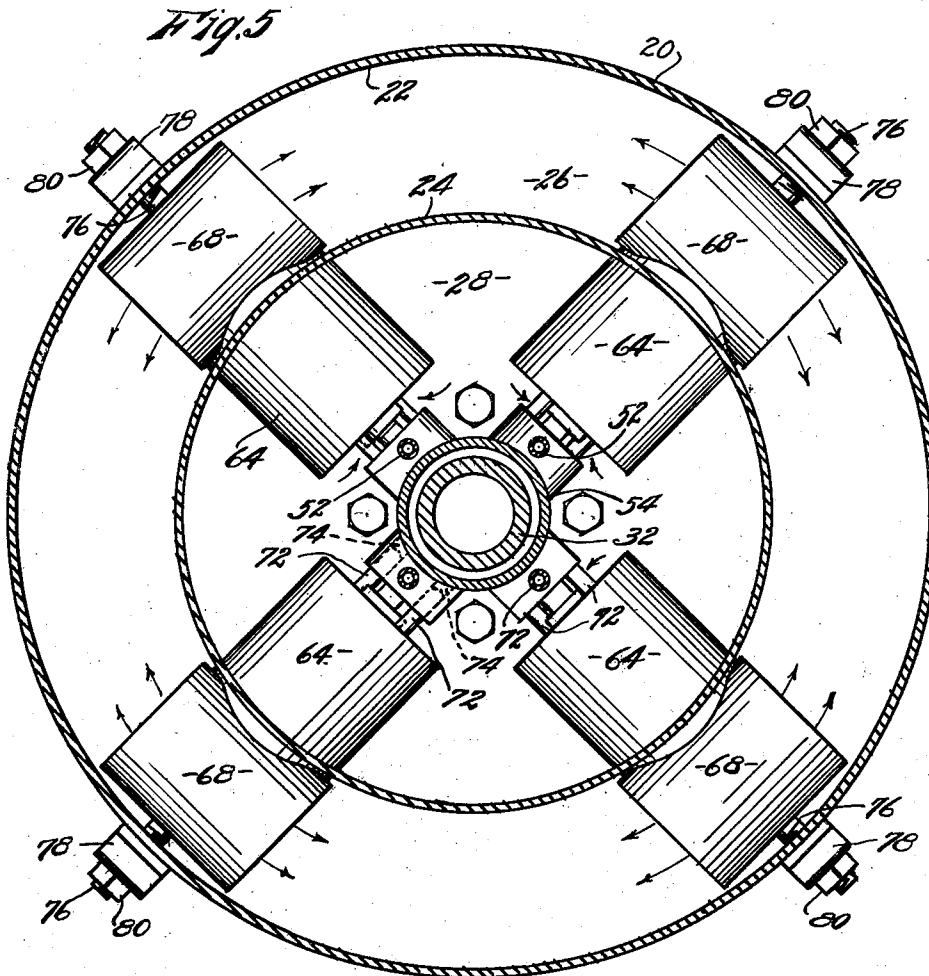
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UNITED STATES PATENT OFFICE

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JET PROPULSION ENGINE WITH REGULATION OF AIR DISTRIBUTION

Joseph C. Williams, Independence, Mo.

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4 Claims. (Cl. 60—39.23)

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This invention relates to improvements in jet propulsion engines or the like and has particular reference to jet propulsion engines wherein the amount of primary air supplied is in direct proportion to the power required, which in turn is in proportion to the fuel feed pressure.

The fuel feed pressure under different conditions varies over a wide range and in order to obtain the desired combustion under any particular condition it has been found that the supply of primary air should be regulated by the fuel feed pressure existing at that particular time.

In current practice the primary air is metered through a predetermined number and size of holes, and does not provide for any variation in the amount of primary air to the total air flow, regardless of the air output of the compressor in relation to the fuel flow.

During acceleration, due to the out-put time lag of the compressor, one extreme of the air fuel ratio exists, a rich, yellow and greasy flame is had, a tongue of flame is projected beyond the limits of the combustion chamber onto the turbine nozzles and buckets, sometimes causing flame blow-out, at all times is responsible for appreciably lowered thermal efficiency, shortens the useful life of the combustion chamber and turbine parts, reduces the possible maximum temperature of the turbine entrance air because of flame impingement heating the parts to a higher temperature than the air stream itself, the temperature differential being the reverse of what it should be for best efficiency, some of the air flow is heated by convection which is less efficient than heating air by radiation.

Proper air-fuel mixtures for acceleration assured by the high fuel feed pressure exerted upon the spring loaded air pistons to operate the air shutters toward the closed position, crowding a greater proportion of the total air flow into the primary air section, thus producing a higher flame temperature and heating a slightly reduced amount of secondary air to a higher temperature.

Less fuel feed flow reduces the pressure on the cylinders, allowing the shutters to open to a predetermined position for cruise conditions.

Minimum fuel feed pressure allows the shutters to open wide for idling conditions, which calls for the least proportion of the total air flow to the primary air section, guarding against flame blow-out due to lean mixtures.

Another object of this invention is the provision of a jet propulsion engine having a primary air chamber and a combustion chamber

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adapted to receive a supply of compressed air, manually controlled pressure fuel delivered to said engine and valves controlled by said pressure fluid to regulate the air flow to said air chambers.

A further object of the present invention is the provision of a jet propulsion engine having a combustion section including an oil atomizer positioned in a mixing chamber, adjustable means to vary the flow of pressure air to said atomizer and a tubular deflector combustion chamber having a tubular exit passage formed therethrough and being positioned to receive the gases from said mixing chamber.

Another object of this invention is the provision of an open combustion chamber constructed and adapted to heat a continuous stream of air to energize and drive an engine or a turbine.

Other objects are simplicity and economy of construction, ease and efficiency of operation and adaptability to maintain a substantially constant fuel-air ratio regardless of the varying power required.

With these objects in view as well as other objects which will appear during the course of the specification, reference will be had to the drawings wherein:

Fig. 1 is an elevation view partly in section of a jet propulsion engine embodying this invention.

Fig. 2 is a view partly in section and partly in elevation of the combustion section of the engine.

Fig. 3 is an enlarged sectional view taken on line III—III of Fig. 1.

Fig. 4 is a fragmentary elevational view of the air controlling portion of the engine, with parts omitted.

Fig. 5 is an enlarged sectional view taken on line V—V of Fig. 2 with some of the parts omitted.

Fig. 6 is an enlarged fragmentary view taken on line VI—VI of Fig. 4.

Throughout the several views like numerals refer to similar parts and the numeral 10 designates a jet propulsion engine of the turbojet type with axial compression. The air compressor 12 has rotary compressor blades 14 and stationary blades or buckets 16 and is of sufficient size and capacity to supply the maximum air supply required.

The combustion section 18, best shown in Fig. 2 includes a tubular housing 20 having an outer cylindrical wall 22. A partition 24 concentric with wall 22 serves to divide the combustion section into an outer combustion chamber 26 and an inner primary air chamber 28. Bearings po-

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sitioned concentrically in housing 20 serve to carry the turbine shaft 32 which is provided at its outer end portion with a series of rotary blades 34 which coact with stationary blades 36 to drive shaft 32 which carries rotary blades 14 of the compressor 12.

This turbojet engine operates by inducting air, compressing it, adding direct to the compressed air by burning an injected fuel in the combustion chamber and expanding the high pressure combustion products. The larger portion of the energy thus produced is utilized to compress the air, by the action of said turbine designated as 40. The remainder of the expansion takes place through the exhaust nozzle 41 where the energy appears as kinetic energy of the exhaust gases.

The fuel supply is considered to be an oil under pressure which is admitted into the feed system through a pipe 42 which is manually controlled by a throttle valve 44 which regulates the pressure of the flow of oil to the discharge nozzles 46. Oil under pressure is fed by pipe 42 into the ring manifold 48 which is carried by cylinder 22. A pipe 50 communicates with manifold 48 to deliver fuel oil to nozzles 46 through passage ways 52 formed in hub member 54 then to the passage way 56 formed in the nozzle tip 58. Tip 58 is frusto-conical in shape to fit into a frusto-conical hole or port 60 formed in the bottom 62 of the mixing chamber housing 64 disposed in the primary air chamber 28. This mixing chamber housing 64 extends through an opening 66 formed through partition 24 and terminates in combustion chamber 26 with an open transverse head 68 having a pair of arcuate inner deflecting surfaces 70 which extend from the upper portion of the head to a point where it joins the tubular mixing chamber housing 64. A transverse depending ridge 71 disposed above the center of the mixing chamber 64 serves to divide the fuel mixture from the mixing chamber to cause it to flow in opposite directions to the points of ignition. It will be noted that there is a plurality of like series of the heads 68 in the combustion chamber 26 and that they are transversely spaced apart to permit a free flow of compressed air therebetween (see Fig. 5).

This arrangement of heads 68 in chamber 26 with their open ends in circumferential alignment serves to present a structure wherein the desired air pressure to drive the rotor 34 and to also produce a jet propulsion force suitable to drive a plane, is provided. Each of the combustion units including mixing chamber housing 64 and head 68 is axially supported for radial adjustment by guide pins 72 fixed to the bottom 52 of mixing chamber housing 64, and which are slidably mounted in holes 74 formed in hub member 54. An axially disposed threaded stem 76 fixed to the upper side of head 68 extends outwardly through cylinder wall 22 and through a fixed bracket 78 which serves as a bearing for nuts 80 by means of which each of the combustion units is axially adjustable to regulate the opening of port 60 to admit the desired flow of primary air to the mixing chamber. These units are manually adjusted to obtain the proper mixture for each burner, and when adjusted may be set by means of nuts 80.

The fuel mixture passing from the mixing chamber 64 will be forced in the general direction indicated by the arrows, and the downwardly moving ignited fuel meeting the up traveling gases will ignite the upwardly moving gases. The products of combustion in head 68 will be grad-

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ually discharged into the continuous flowing air stream passing through combustion chamber 26 thereby increasing its heat and velocity.

The annular ring inlet ports 82 and 84 respectively to combustion chamber and the primary air chamber extend about the entire periphery thereof and communicate with the discharge opening of the compressor 12. The area of the inlet port to the primary air chamber is much smaller than the inlet port 82 to the combustion chamber.

Means are provided to vary the proportionate flow of compressed air to said compression and primary air chambers to obtain the proper amount of air to said chambers as the fluid fuel pressure to the burner is varied by manual adjustment of the throttle valve 40. This means consists in shutter means to vary the area of the inlet port to the compression chamber from the compressor, whereby more compressed air will be forced into the primary air chamber to feed air to the mixing chamber.

There is provided a series of spaced apart pairs of shutters or valve members 86 each pair being mounted on substantially parallel rotatably mounted shafts 88 carried by the extension housing 90 of wall 22, with the shutters secured on the inner ends of shafts 88 in the path of port 82. A pinion 92 is provided on the outer end of each shaft and so that the pinions of each pair of shafts are in operative relation with a double rack member 94 whereby when the rack is moved longitudinally the shutters will be moved in opposite directions to close or open said inlet port to the desired degree. Each of the racks 94 are rigidly attached to an annular ring 96 which is positioned about the housing 90.

Referring now to Figs. 1, 3, 4, and 6 it will be noted that there are a plurality of cylinders 98 provided with pistons 100, each having a piston rod 102 all of which are rigidly connected to ring 96.

Piston 100 is spring loaded by spring 104 which is positioned in cylinder 98 between piston 100 and a disc 106 which is adjustable to vary the tension against the said piston by means of screw 108 axially mounted in the end plate 110 of said cylinder. A lock nut 112 is provided to secure the disc in the desired position.

Fuel pressure oil from manifold 48 is delivered to each of the cylinders 98 through a pipe 114 which communicates with the front end of the cylinders at 116 in front of piston 100, thus determining the position of the piston in the cylinder and the position of the valve members 86 relative to the inlet port 82. Air port 118 is formed in head 110 to permit free action of spring 104.

When throttle valve 44 is opened wider the fuel pressure in cylinder 98 will be increased thus operating valves 86 to cause a partial closing of the inlet valves to combustion chamber 26, and causing a larger flow of compressed air to the primary air chamber. This adjustment of the parts will produce a proportionally greater flow of air to the mixing chamber 64 regulating the rate of combustion and the rate of heating of the stream of air through the combustion chamber.

Heretofore no means has been provided to proportion the amount of compressed air to the combustion chamber and to the primary air chamber, by the variation of fuel pressure being delivered through the throttle to the engine. This structure provides for the proportioning of the compressed air feed thus insuring a substantially uniform proportionate mixture of oil and air.

What I claim is:

1. An engine of the class described including a cylindrical combustion section having an outer annular combustion chamber, an inner annular primary air chamber, and a plurality of radially extending mixing chambers extending between and interconnecting said primary air and combustion chambers, said combustion and primary air chambers terminating in concentric annular air inlet openings at one end of said combustion section, an air compressor adapted to receive and compress air and to deliver it simultaneously to the air inlet openings of said combustion section, means for injecting fluid fuel under pressure into the inner ends of said mixing chambers together with air from said primary air chamber, manual means for regulating the pressure and hence the flow rate of said fuel, a plurality of annular segmental vanes disposed in the air inlet opening to said combustion chamber to control the flow of air therethrough, means responsive to the fuel pressure for operating said vanes, whereby said vanes are closed in a degree substantially directly proportionate to said fuel pressure, thereby deflecting a greater or less proportion of the compressor air to the air inlet opening of said primary air chamber, and a gas turbine disposed at the end of said combustion section opposite from said compressor, said turbine being operable by the products of combustion and operably connected to said compressor to drive the same.

2. An engine of the class described including a cylindrical combustion section having an outer annular combustion chamber, an inner annular primary air chamber, and a plurality of radially extending mixing chambers extending between and interconnecting said primary air and combustion chambers, said combustion and primary air chambers terminating in concentric annular air inlet openings at one end of said combustion section, an air compressor adapted to receive and compress air and to deliver it simultaneously to the air inlet openings of said combustion section, means for injecting fluid fuel under pressure into the inner ends of said mixing chambers together with air from said primary air chamber, manual means for regulating the pressure and hence the flow rate of said fuel, a plurality of annular segmental vanes disposed in the air inlet opening to said combustion chamber to control the flow of air therethrough, a hydraulic cylinder carried by said combustion section, a piston carried operably by said cylinder, said cylinder being interconnected with the fuel supply, and said piston being movable by fuel under pressure, means interconnecting said piston with said vanes, whereby the latter are closed in a degree substantially directly proportionate to the fuel pressure, and a gas turbine disposed at the end of said combustion chamber from said compressor, said turbine being operable by the products of combustion and operably connected to said compressor to drive the same.

3. An engine of the class described including a cylindrical combustion section having an outer annular combustion chamber, an inner annular primary air chamber, and a plurality of radially extending mixing chambers extending between and interconnecting said primary air and combustion chambers, said combustion and primary air chambers terminating in concentric annular air inlet openings at one end of said combustion section, an air compressor adapted to receive and

compress air and to deliver it simultaneously to the air inlet openings of said combustion section, means for injecting fluid fuel under pressure into the inner ends of said mixing chambers together with air from said primary air chamber, manual means for regulating the pressure and hence the flow rate of said fuel, a plurality of annular segmental vanes disposed in the air inlet opening to said combustion chamber to control the flow of air therethrough, a hydraulic cylinder carried by said combustion section, a piston carried operably by said cylinder, said cylinder being interconnected with the fuel supply, means interconnecting said piston with said vanes whereby movement of said piston in opposite directions will respectively open or close said vanes, said piston being movable in a direction to close said vanes by fuel pressure in said cylinder, a spring urging said piston in a direction to open said vanes, whereby the degree of closure of said vanes is rendered substantially directly proportionate to the fuel pressure, and a gas turbine driven by the products of combustion and operably connected to said compressor to drive the same.

4. An engine of the class described including a cylindrical combustion section having an outer annular combustion chamber, an inner annular primary air chamber, and a plurality of radially extending mixing chambers extending between and interconnecting said primary air and combustion chambers, said combustion and primary air chambers terminating in concentric annular air inlet openings at one end of said combustion section, an air compressor adapted to receive and compress air and to deliver it simultaneously to the air inlet openings of said combustion section, means for injecting fluid fuel under pressure into the inner ends of said mixing chambers together with air from said primary air chamber, manual means for regulating the pressure and hence the flow rate of said fuel, a plurality of annular segmental vanes disposed in the air inlet opening to said combustion chamber to control the flow of air therethrough, a hydraulic cylinder carried by said combustion section, a piston carried operably by said cylinder, said cylinder being interconnected with the fuel supply, means interconnecting said piston with said vanes whereby movement of said piston in opposite directions will respectively open or close said vanes, said piston being movable in a direction to close said vanes by a fuel pressure in said cylinder, a spring urging said piston in a direction to open said vanes, whereby the degree of closure of said vanes is rendered substantially directly proportionate to the fuel pressure, means for adjusting the tension of said spring, and a gas turbine driven by the products of combustion and operably connected to said compressor to drive the same.

JOSEPH C. WILLIAMS.

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