

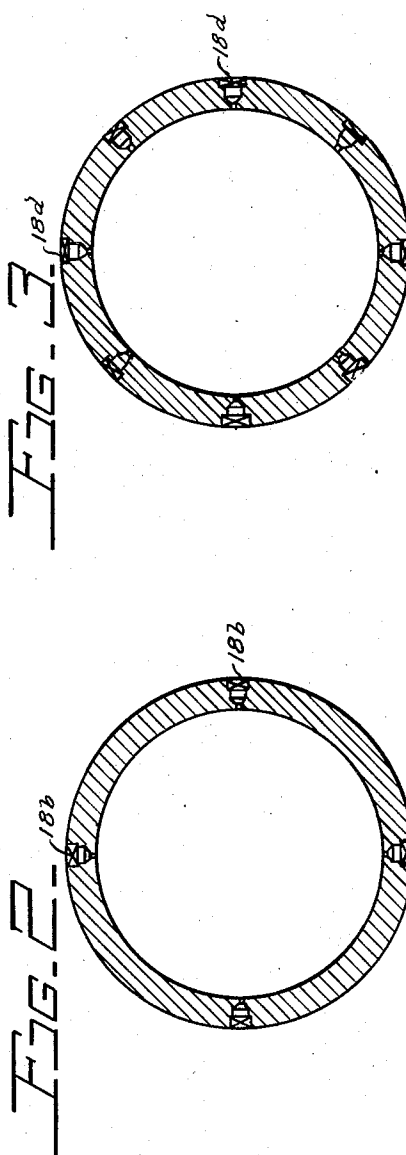
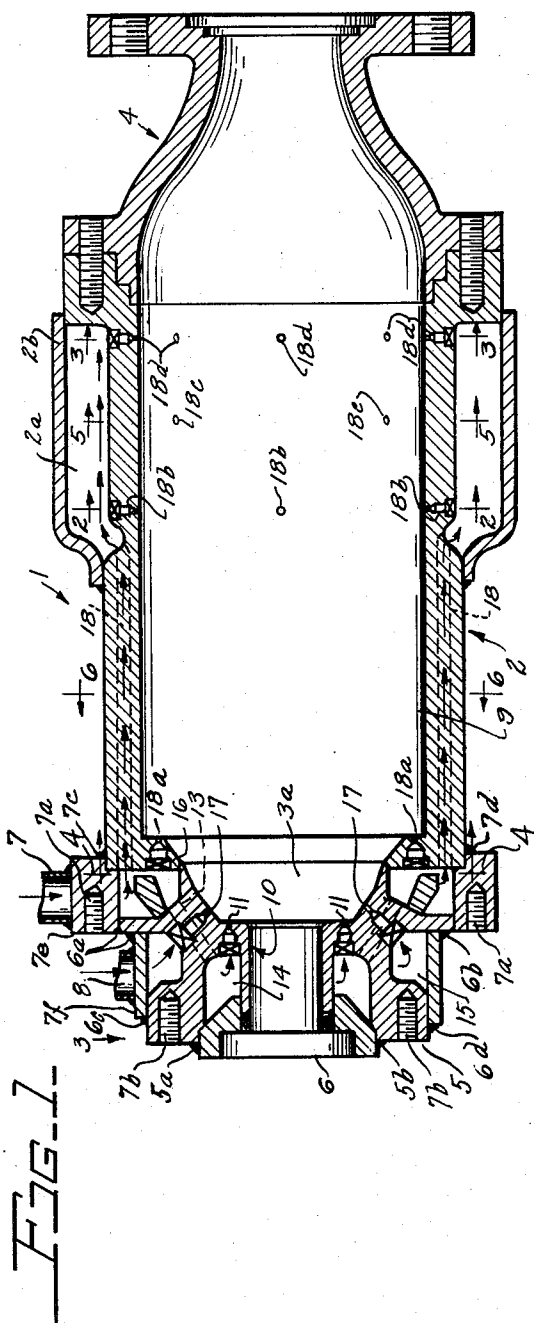
Sept. 8, 1959

C. E. WAGNER
DESIGN FOR A STAINLESS STEEL OR ALUMINUM GAS
GENERATOR WALL SPRAYING SYSTEM FOR
COMBUSTION CHAMBER

2,902,823

Filed Nov. 21, 1956

2 Sheets-Sheet 1



INVENTOR
CLARENCE E. WAGNER
BY *Wade Rountree*
ATTORNEY
Arthur R. Parker and
AGENT

Sept. 8, 1959

C. E. WAGNER
DESIGN FOR A STAINLESS STEEL OR ALUMINUM GAS
GENERATOR WALL SPRAYING SYSTEM FOR
COMBUSTION CHAMBER

2,902,823

Filed Nov. 21, 1956

2 Sheets-Sheet 2

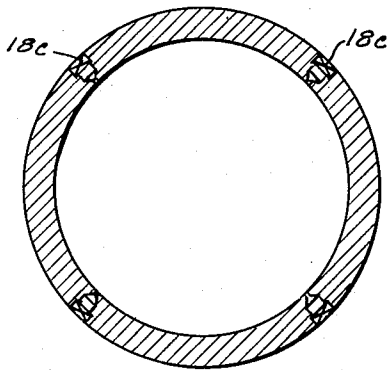


FIG. 5.

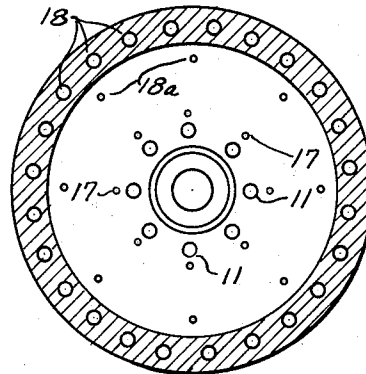


FIG. 6.

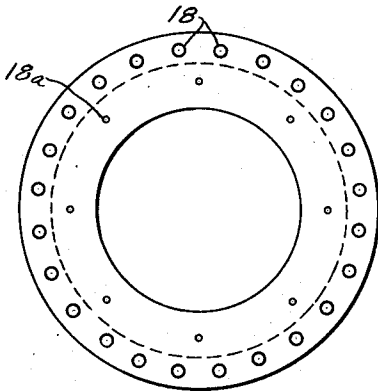


FIG. 4.

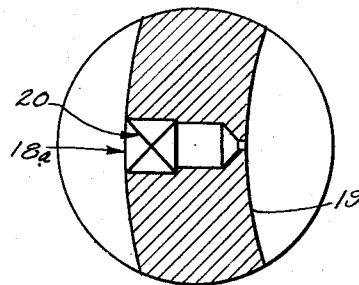


FIG. 7.

INVENTOR.
CLARENCE E. WAGNER
BY *Wade L. Lutz*
ATTORNEY
Arthur R. Parker
AGENT

1

2,902,823

DESIGN FOR A STAINLESS STEEL OR ALUMINUM GAS GENERATOR WALL SPRAYING SYSTEM FOR COMBUSTION CHAMBER

Clarence E. Wagner, Snyder, N.Y., assignor to the United States of America as represented by the Secretary of the Air Force

Application November 21, 1956, Serial No. 623,716

6 Claims. (Cl. 60—35.6)

This invention relates to a gas generator for driving a turbine or the pressurized tanks of a rocket power plant. More particularly, the invention relates to a wall spraying system utilized in the gas generator combustion chamber.

In the development of rocket type power plants, it has been found necessary to control the temperature of combustible products within predetermined limits to attain the most efficient burning. The use of additional nozzles to spray additional fuel into the combustion chamber axially against the wall thereof and radially downstream to cool said combustion products to a workable temperature has, heretofore, involved the disadvantage of a substantial formation of free carbon on the chamber walls and in the nozzle openings and piping and thereby substantially reducing the cooling effect thereof.

It is an object of this invention, therefore, to provide a gas generator incorporating a wall spraying system that is effective to cool the combustible products to a workable temperature.

It is a further object of the invention to provide a wall spraying system having nozzles formed in the walls of the gas generator to substantially reduce the effect of the formation of free carbon produced by the injection of additional fuel into gas generator combustion chamber.

Another object of the invention resides in the injection of fuel at a plurality of positions circumferentially arranged around the combustion chamber to cool the combustible products and thereby effect efficient burning characteristics.

An additional object of the invention provides a plurality of nozzles integral with the combustion chamber wall to effect multiple spray patterns and even distribution of the propellant and good combustion.

Other objects and advantages of the invention will become apparent from the following description, taken in connection with the accompanying drawings in which like reference characters refer to like parts in the several figures:

Figure 1 is a longitudinal sectional view of the gas generator utilized in the invention illustrating the relationship between the injector assembly and the gas generator assembly.

Figure 2 is a sectional view taken along 2—2 of Figure 1, illustrating the arrangement of spray nozzles at a particular location in the combustion chamber wall.

Figures 3 and 5 are additional sectional views taken along 3—3 and 5—5, respectively, of Figure 1, illustrating the arrangement of other spray nozzles at different locations in the combustion chamber wall.

Figure 4 is an end view taken about on line 4—4 of Figure 1 illustrating the arrangement of cooling tubes and other spray nozzles utilized in the invention with the forward inlet closure removed.

Figure 6 is a sectional view taken about on line 6—6 of Figure 1 illustrating the arrangement of a plurality of cooling tubes, a plurality of spray nozzles, and a plurality of fuel-oxidizer nozzles utilized in the invention.

2

Figure 7 is an enlarged fragmentary sectional view of the spray nozzle utilized in the invention.

With particular reference in Figure 1 of the drawings, the gas generator of the present invention, generally indicated at 1, includes a gas generator assembly 2, an injector assembly 3, and an outlet duct 4. The injector assembly 3 consists of a blank assembly 6 and a ring assembly 5. Said ring assembly 5 includes a recessed open area at one end thereof, which area is known as the combustion zone, generally indicated at 3a. It is noted that the gas generator assembly 2 is open at both ends, one end of which is affixed to the injector assembly 3 and the other end to the outlet duct 4. The open end of said generator assembly 2 adjacent to said injector assembly 3 forms a continuous chamber or passageway with said combustion zone 3a. Said blank assembly 6 is welded to said ring assembly 5 at 5a and 5b, respectively. To said ring assembly 5 are welded two tube fittings 7e and 7f at 6a, 6b, 6c and 6d, respectively. Said tube fittings are adapted for the reception of two tubes 7 and 8, respectively. Said tubes 7 and 8 are adaptable for connection to suitable sources of fuel supply and oxidizer supply, respectively. Said injector assembly 3 is welded to said gas generator assembly 2 at 7c and 7d, respectively. Said injector assembly 3 is also internally screw threaded at 7a and 7b for attachment to any desired supporting structure. The gas generator assembly 2 may be made either of aluminum or stainless steel. Aluminum may be used even though it has a relatively low melting point due to the cooling means of the present invention which is to be hereinafter described in detail. Where stainless steel is utilized, the need for a regenerative cooling jacket is eliminated by the cooling system of the subject invention.

As seen clearly in Figure 1, the gas generator assembly 2 has a combustion chamber generally indicated at 9 which is in continuous communication with the combustion zone 3a of the injector assembly 3; it is into said chamber 9 that steam or combustible products flow after being formed by combustion in said combustion zone 3a on admission therein and ignition of a mixture of fuel and oxidizer admitted into said injector assembly 3. The steam so formed flows into the outlet duct 4 from whence it flows on to operate the turbine or pressurized tanks of a rocket power plant. The injector assembly 3 includes three main circular passages indicated at 14, 15 and 16, respectively. Fuel is admitted into said injector assembly 3 by way of the tube 7, the circular passage 16, the intercommunicating channel 13, and the circular passage 14 at which point it enters a plurality of fuel-spray nozzles 11, whereas oxidizer is admitted into said injector assembly 3 by way of the tube 8 and the circular passage 15 at which point it enters a plurality of oxidizer-spray nozzles 17. It is noted with particular reference to Figure 6 of the drawings that said plurality of fuel-oxidizer nozzles 11, 17 are integrally formed in pairs in said injector assembly 3 and are circumferentially arranged as shown in Figure 1 around the combustion zone 3a, said circular passage 14 providing fuel for said plurality of fuel nozzles 17 and said circular passage 15 providing oxidizer for said plurality of oxidizer nozzles 17. It is noted that said plurality of pairs of fuel-oxidizer nozzles 11, 17 are arranged so as to inject their respective mixtures of fuel and oxidizer into the combustion zone 3a at which time said mixtures are ignited by any appropriate ignition means which may be incorporated in the interim wall surface of said injector assembly 3 adjacent to said plurality of fuel nozzles 11 as indicated generally at 10 in Figure 1 of the drawings.

Furthermore, the circular passage 16 provides a supply of additional cooling fuel to a plurality of additional

3

nozzles, hereinafter described in detail with respect to the gas generator assembly 2.

Said gas generator assembly 2, which includes the previously mentioned combustion chamber 9, incorporates a plurality of spray nozzles extending from its end wall adjacent to said injector assembly 3 downstream at spaced intervals in the chamber walls towards the outlet duct 4. Referring again to the Figure 6 of the drawing, said gas generator assembly 2 includes a plurality of circumferentially arranged substantially parallel cooling tubes 18 located in the walls of said combustion chamber 9. Said cooling tubes 18 are in communication with the circular passage 16 from which passage additional fuel is injected. Moreover, said cooling tubes 18 are in communication with said plurality of additional spray nozzles. Said circular passages 16 also provides fuel to a plurality of spray nozzles 18a located or positioned in the end wall of said combustion chamber 9 nearest to said injector assembly 3. Positioned downstream from said end wall are located said plurality of additional spray nozzles consisting of three main sets of spray nozzles circumferentially disposed around said combustion chamber 9. Said plurality of nozzles, indicated at 18b, 18c and 18d, respectively are so arranged to provide maximum cooling of the combustible products of the mixture ignited in the combustion zone 3a. The spray nozzles 18a located in the end wall of said combustion chamber 9 remote from said injector assembly 3 consist of a total of eight nozzles as clearly seen in Figure 4. In said Figure 4 said spray nozzles 18a are illustrated looking from the rear, these being the same nozzles 18a illustrated from the front in Figure 6. The spray nozzles 18b are clearly seen in Figure 2 wherein a total of four such nozzles are indicated, whereas in Figure 3 four additional nozzles 18d are illustrated in staggered relation to those of Figure 2. Positioned between said nozzles 18b and 18d are located eight additional nozzles 18c indicated generally in Figure 1 and clearly seen in Figure 3 of the drawings. This arrangement of spray nozzles 18b, 18c and 18d constitutes a desirable one for the main objective of providing maximum coverage of the combustible products flowing in the combustion chamber 9.

Referring particularly to Figure 7 of the drawings there is illustrated an enlarged view of one of the spray nozzles utilized in the invention. Since each of the above described spray nozzles is identical in every respect and constitutes the crux of the present invention, the following description is made with reference to the nozzle 18a only. Said spray nozzle 18a is formed integral with the walls of the combustion chamber 9 by means of the internal contour of a spray nozzle body being machined in the wall section, indicated at 19. In this way, the former problem of excessive free carbon deposits formed by the excess fuel on said wall section 19 which normally clogs the ordinary separate spray nozzle and piping is substantially eliminated. In addition, with the spray nozzle construction and arrangement of the present invention, aluminum may be used as the material for said combustion chamber wall 19 providing the additional considerable advantages of decreased weight and lower cost. Furthermore, with the wall spraying system of the present invention, the need for a regenerative cooling jacket is eliminated where stainless steel is utilized. Moreover, a baffle of somewhat curved or twisted configuration and indicated generally at 20 in Figure 7 is inserted and rigidly affixed in each of said spray nozzles 18a, 18b, 18c and 18d in any desirable manner for the purpose of imparting a definite spinning to the propellant or fuel passing therethrough, resulting in a well-defined, consistent, and conical-shaped spray pattern. Said baffle 20 is illustrated schematically only since it is obvious that by changing the hole dimensions or altering the shape or size thereof, a particular spray pattern may be obtained.

4

The gas generator assembly 2 also includes a second chamber 2a in communication with the spray nozzles 18b 18c and 18d and, also, in communication with the plurality of cooling tubes 18. Said chamber 2a is formed by the cover 2b and the outside wall surface of the combustion chamber 9 as clearly seen in Figure 1 to provide a reservoir of cooling fuel to supply the nozzles 18b, 18c, and 18d.

To summarize the operation of the wall spraying system of the instant invention, fuel is admitted into the injector assembly 2 by way of tube 7. Initially, said fuel flows into the circular passage 16 which passage has three (3) main outlets, the first outlet being through the channel 13 to the plurality of fuel nozzles 11 integrally formed in the injector assembly 3, the second outlet being through the plurality of fuel nozzles 18a integrally formed in the end wall of the combustion chamber 9, and the third outlet being through the plurality of cooling tubes 18 to supply the plurality of integrally formed nozzles 18b, 18c and 18d by way of the reservoir chamber 2a.

Thus, a simple and yet unique wall spraying system has been developed wherein multiple spray patterns are utilized for cooling, washing, even propellant distribution, and good combustion. Moreover, the spray nozzle of the instant invention provides means for effecting the cooling of combustible products with a consistent and dependable spray pattern, without the disadvantage of the formation of carbon deposits as usually where the threaded or welded series of separate nozzles are employed, and has the advantage of a wall coverage superior to that of the usual straight or tangential jet spray pattern.

I claim:

1. A gas generator wall spraying system, comprising, a main casing having open inlet and outlet ends and enclosing a main combustion chamber, an injector assembly affixed to said open inlet end, and an outlet duct affixed to said open outlet end, said injector assembly comprising a ring assembly and a blank assembly affixed thereto, said ring assembly having an inner recessed portion forming a separate combustion zone in continuous communication with said main combustion chamber and terminating in a central opening having an inner, relatively restricted portion and an outer, relatively enlarged portion, an outer circumferential flange portion integral with said ring assembly and located in concentric relation to said relatively restricted portion of said central opening, said blank assembly interfittingly engaged in said restricted opening forming a first circumferential fluid passage between said blank assembly and said ring assembly in said outer, relatively enlarged portion, a first tube fitting affixed to said ring assembly forwardly of said integral flange portion forming a second circumferential fluid passage between said tube fitting and said ring assembly, a second tube fitting affixed to said ring assembly between said integral flange portion and said main casing inwardly of said first tube fitting and forming a third circumferential fluid passage between said ring assembly and said main casing, an oxidizer supply tube attached to said first tube fitting delivering oxidizer to said second fluid passage, a fuel supply tube attached to said second tube fitting delivering fuel to said third fluid passage, an intercommunicating channel incorporated in said ring assembly communicating between said third fluid-passages and said first fluid-passages, a plurality of fuel spray nozzles circumferentially mounted and integrally formed in said ring assembly between said first fluid-passages and said separate combustion zone parallel to the longitudinal axis of said main casing, a plurality of oxidizer spray nozzles integrally mounted in the wall of said ring assembly between said second fluid passage and said separate combustion zone and positioned in respective pairs and at an angle to said first plurality of fuel spray nozzles, a plurality of circumferentially disposed cooling tubes positioned in the walls of said main

casing surrounding said combustion chamber in communication with said third fluid-passage to receive additional fuel therefrom, and a second plurality of fuel spray nozzles circumferentially mounted and integrally formed in the walls of said main casing at spaced intervals downstream of said combustion zone towards said outlet duct in communication with said plurality of cooling tubes.

2. A gas generator wall spraying system including a gas generator assembly comprising a main housing enclosing a combustion chamber open at both ends, an outlet duct engaged with said main housing at one of said open ends, and an injector assembly affixed to the other of said open ends, said injector assembly having an inner outwardly flared circumferential portion forming a recessed combustion zone separate from and having an open end in continuous communication with said combustion chamber and a relatively restricted central opening in communication with said combustion zone, tube means for admitting and mixing oxidizer and fuel under pressure in said combustion zone, and means cooling said combustion chamber, said first-named means comprising a plurality of axially aligned fuel spray nozzles integrally mounted in the wall of said recessed combustion zone adjacent said central opening and a plurality of radially aligned oxidized spray nozzles integrally mounted in the wall of said combustion zone in said outwardly flared circumferential portion with each of said radially aligned oxidized spray nozzles paired with a corresponding axially aligned fuel spray nozzle, said cooling means comprising a plurality of staggered sets of spray nozzles integrally mounted in spaced relation in the wall of said combustion chamber downstream of said combustion zone toward said outlet duct at predetermined intervals to provide maximum cooling of the combustible products downstream of the combustion zone, a plurality of circumferentially disposed cooling tubes arranged in the wall of said combustion chamber in communication with said plurality of staggered sets of spray nozzles downstream of said combustion zone, and means diverting some of the fuel delivered to said combustion zone to said plurality of cooling tubes.

3. A gas generator wall spraying system as in claim 2, said injector assembly having an enlarged outer opening in communication with said restricted, central opening, means extending into said enlarged outer opening in closing engagement in said restricted opening forming a first circular passage between said closing means and the walls of said injector assembly, first tube mounting means affixed to said injector assembly rearwardly of said combustion zone forming a second circular fluid passage between said first tube mounting means and the outer circumferential walls of said injector assembly, second tube mounting means affixed to said injector assembly adjacent its end nearest said combustion chamber forming a third circular fluid passage, and interconnecting passage means between said third and first fluid passages transferring fuel admitted therein from said third fluid passage.

4. A gas generator wall spraying system as in claim 2, said injector assembly comprising a substantially cylindrical body adaptable for connection at spaced circumferential locations, respectively, to oxidizer and fuel supplies, a plurality of circular passages incorporated in said injector assembly, and a plurality of fuel and oxidizer spray nozzles mounted in pairs and integrally formed in the wall of said combustion zone in communication with said circular passages to direct oxidizer and fuel into said combustion zone, said plurality of circular passages, comprising, a first circular passage in communication between said oxidizer supply and said oxidizer spray nozzles, a second circular passage in communication with said fuel supply, a third circular pas-

sage in communication with said fuel spray nozzles, and an interconnecting passage in communication between said second and third circular passages delivering fuel to said fuel spray nozzles.

5. In a gas generator, a gas generator assembly having a combustion chamber open at its forward and aft ends, an injector assembly having a recessed inner end portion forming a combustion zone affixed to the forward end of said combustion chamber in open and continuous communication with said combustion chamber, an outlet duct affixed to the aft end of said combustion chamber, means for admitting fuel and oxidizer into said combustion zone, said means comprising a fuel inlet and an oxidizer inlet in said injector assembly, a first plurality of jet nozzles integrally machined in the walls of said combustion zone forward of said combustion zone delivering axially flowing fuel spray into said combustion zone, a second plurality of jet nozzles integrally machined in the walls of said combustion zone and individually paired with and at an angle to a respective fuel nozzle delivering oxidizer spray at an angle to said fuel spray and mixing said oxidizer and fuel sprays in said combustion zone, and channel means in intercommunication, respectively, between each of said plurality of fuel and oxidizer spray nozzles and said fuel and oxidizer inlets, means adaptable for igniting said mixture of oxidizer and fuel spray in said combustion zone to form combustible products flowing under pressure from said combustion zone into said combustion chamber, and means cooling the walls of said combustion chamber and reducing the temperature of said combustible products, said means comprising a plurality of longitudinally extending, circumferentially arranged cooling tubes positioned in the outer walls of said combustion chamber in intercommunication with and diverting part of the fuel delivered to said fuel inlet channel intercommunicating means, a cooling chamber in intercommunication with said cooling tubes, and a plurality of additional spray nozzles internally contoured with and circumferentially arranged in the walls of said combustion chamber at spaced, predetermined intervals downstream from said combustion zone and terminating adjacent said outlet end of said combustion chamber in communication with said cooling chamber for spraying additional cooling fuel into said combustion chamber at predetermined spaced locations, each of said jet nozzles consisting of an internal contour of a spray nozzle body integrally machined in the walls of said combustion zone and chamber with a predetermined baffle affixed therein to regulate the pattern of the jet sprays injected into said combustion zone.

6. In a gas generator as in claim 5, and a plurality of additional jet nozzles each consisting of an internally contoured nozzle body integrally machined in and circumferentially positioned in the walls of said combustion chamber in communication with said intercommunicating channel means and circumferentially arranged around the area of communication between said combustion zone and chamber directing additional axially flowing fuel spray downstream of said combustion zone mixing with the combustion products formed downstream from the oxidizer and fuel spray injected in said combustion zone by said first-named plurality of jet nozzles.

References Cited in the file of this patent

UNITED STATES PATENTS

2,016,921	Goddard	Oct. 8, 1935
2,513,325	Hundstad	July 4, 1950
2,742,762	Kuhring	Apr. 24, 1956

FOREIGN PATENTS

708,548	Great Britain	May 5, 1954
---------	---------------	-------------