Dec. 14, 1948. R. H. GODDARD 2,456,402

COMBUSTION CHAMBER AND MEANS FOR SUPPLYING PLURAL LIQUID FUELS THERETO

Filed Oct. 20, 1942

Fig. 1.

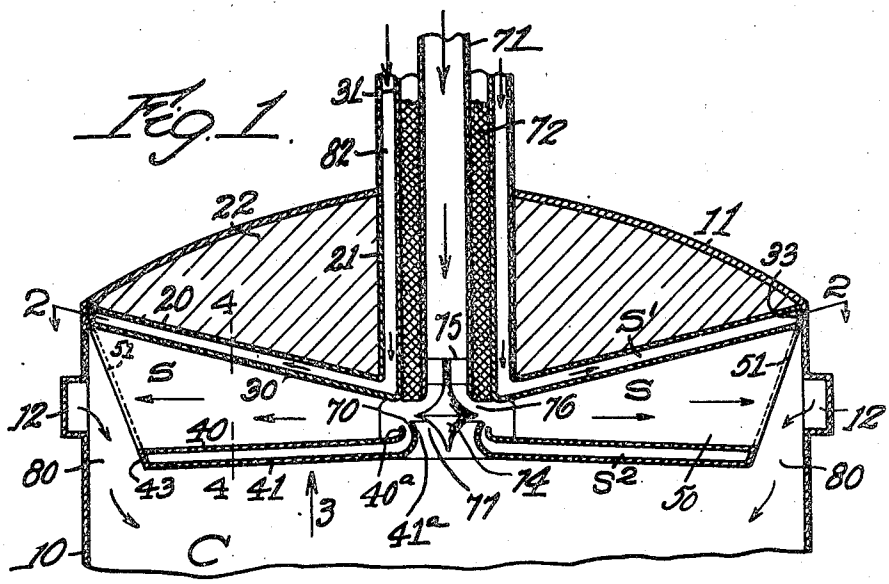


Fig. 5.

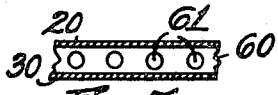


Fig. 2.

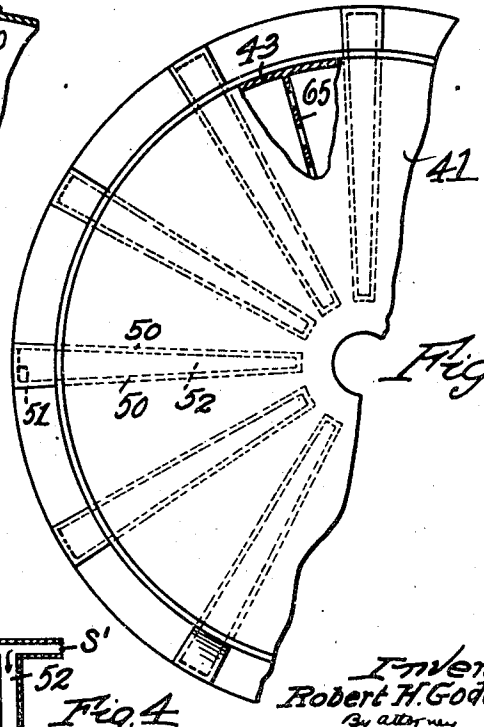


Fig. 3.

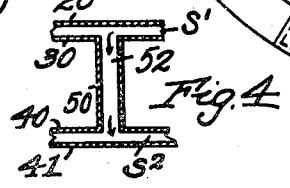


Fig. 4.

Inventor
Robert H. Goddard.
By attorney

Patented Dec. 14, 1948 2,456,402

UNITED STATES PATENT OFFICE

2,456,402

COMBUSTION CHAMBER AND MEANS FOR SUPPLYING PLURAL LIQUID FUELS THERETO

Robert H. Goddard, Roswell, N. Mex., assignor of one-half to The Daniel and Florence Guggenheim Foundation, New York, N. Y., a corporation of New York

Application October 20, 1942, Serial No. 462,709

14 Claims. (Cl. 158—4)

1

This invention relates to chambers in which combustion is maintained by feeding coacting combustion liquids thereto. Such combustion liquids may be gasoline or some other liquid fuel, and liquid oxygen or some other liquid oxidizing agent.

It is the general object of my invention to provide improved means for feeding a combustion liquid to a combustion chamber and for developing substantial pressure in said liquid in addition to the initial feeding pressure.

A further object is to provide improved means for cooling exposed surfaces in a combustion chamber.

I also provide means by which the velocity of the liquid may be substantially increased before combustion of any substantial part thereof and after the liquid has left the pipe through which it is supplied. I preferably accomplish such increase in velocity by initial combustion of a relatively small part of the liquid fuel.

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

A preferred form of the invention is shown in the drawings, in which

Fig. 1 is a partial sectional front elevation of my improved combustion chamber, taken along the line 1—1 in Fig. 2;

Fig. 2 is a partial plan view, partly in section, and taken along the line 2—2 in Fig. 1;

Fig. 3 is a partial bottom view, partly in section and looking in the direction of the arrow 3 in Fig. 1; and

Figs. 4 and 5 are detail sectional elevations, taken along the lines 4—4 and 5—5 in Figs. 1 and 2 respectively.

Referring to the drawings, I have shown a portion of a combustion chamber C having a cylindrical side wall 10 and a convex upper end wall 11. One of the combustion liquids, as gasoline, may be introduced tangentially through spaced nozzles 12 (Figs. 1 and 2) in the side wall 10, the nozzle construction preferably being as shown in Figs. 6 to 8 of my prior Patent No. 2,016,921 issued October 8, 1935.

An inverted conical disc 20 having an attached supply tube 21 is secured in the upper end of the combustion chamber C, and the space 22 between the end wall 11 and the disc 20 and tube 21 may be filled with any light heat-insulating material. A second conical disc 30 and a second tube 31 are mounted in spaced relation below the disc 20 and within the tube 21, and the outer edges of

2

the discs 20 and 30 are connected by an end wall 33, also welded or otherwise secured to the wall 10.

A second pair of flat or only slightly conical discs 40 and 41 are mounted below the discs 20 and 30 and are held in spaced relation by an end wall 43.

The discs 30 and 40 are somewhat widely spaced apart longitudinally of the chamber C to provide radial spaces S which are outwardly enlarged and with open outer ends and which are separated by partition walls 50, arranged in pairs and with each pair connected by an end wall 51 to provide a vertical enclosed passage 52 (Fig. 3) through the space S and between the upper and outwardly expanding space S1 and the corresponding lower space S2. The space S1 is enclosed between the discs 20 and 30 and the end wall 33, and the space S2 is enclosed between the discs 40 and 41 and the end wall 43.

It will be understood that the discs 30 and 40 are cut away between the walls 50 of each pair, as indicated in Fig. 4. It will also be noted that the walls 50 of each pair are relatively further apart toward the circumference of the discs 30 and 40.

Spacing partitions 60 may be provided between the upper discs 20 and 30 for additional support, and these partitions 60 may have perforations 61 (Fig. 5) to provide circumferential communication. Similar perforated partitions 65 may be provided between the lower discs 40 and 41. The lower discs 40 and 41 have upturned inner edges 40*a* and 41*a*, which edges are spaced apart to provide an annular orifice 70 (Fig. 1) forming an inlet to the space S.

A tube 71 is mounted within the tubes 21 and 31, previously described, and may be spaced from the tube 31 by heat-insulating material 72.

A streamlined spreader 74 is mounted on a spider 75 at the lower end of the tube 71 and coacts with the tube 71 to provide an annular orifice 76 for additional gasoline or other liquid fuel fed through the pipe 71, said orifice forming an inlet to the space S. The spreader 74 also coacts with the upturned edge 41*a* of the disc 41 to provide an inner annular orifice 77, adjacent the orifice 70 previously described.

It will be noted that the lower discs 40 and 41 are of less outside diameter than the chamber C, thus providing an open annular and longitudinally extending passage 80 from the spaces S to the combustion chamber C.

The improved feeding apparatus above described functions as follows:

Assuming that liquid oxygen is supplied under

light feeding pressure to the annular passage 82 between the tubes 21 and 31, the oxygen will spread outward in the space S1, under induced pressure to be described, and will then flow downward through the vertical passages 52 of the pairs of partitions or walls 50 to the lower space S2, in which space it will flow inward toward the annular orifice 70.

At this point the stream of liquid oxygen is joined by a relatively small supply of gasoline or other liquid fuel, delivered under light pressure through the pipe 71 and through the annular orifice 76. This gasoline is ignited and combines with a small portion of the oxygen to produce a considerable volume of combustion gases which flow rapidly outward through the spaces S and carry with them the major part of the liquid oxygen.

At the open outer ends of the spaces S this mass of liquid oxygen, more or less vaporized by the combustion gases, encounters the main supply of gasoline or other liquid fuel delivered through the tangential nozzles 12. After intermingling therewith, the resulting fluid mixture flows downward through the outer annular passage 80 to the combustion chamber C adjacent the chamber wall 10, thus providing a cooling film for said wall.

Combustion then takes place and a small amount of the combustion gases from the chamber C are drawn upward as flame through the annular opening 77 between the spreader 74 and the inner edge 41*a* of the lower disc 41. This hot flame helps to maintain combustion of the small amount of gasoline entering through the port orifice 76 as it mingles with the relatively large amount of oxygen in the spaces S.

The streams of liquids supplied through the annular port orifices 70 and 76 create a relatively low pressure area adjacent the inner and lower port orifice 77, which draws the small igniting flame through the orifice 77 and also prevents back flow of any of the combustion liquids therethrough.

It will be noted that the discs 20, 30, 40 and 41 are all jacketed and cooled by the liquid oxygen passing through the spaces S1 and S2. This is an important advantage, as the disc 41 is exposed to the high temperature in the combustion chamber C, and the discs 30 and 40 are exposed to the high temperature in the spaces S, occasioned by the hot combustion gases passing outward therethrough.

The partial combustion in the spaces S and the resultant expansion of the combustion gases produces high outward velocities in the spaces S and at the annular passage 80 and corresponding induced high velocities in the spaces S1 and S2 between the discs of each pair. The outward enlargement of the vertical passages 52 cause more uniform flow of liquid from the space S1 to the space S2.

The liquid oxygen is carried through the spaces S by the combustion gases at such high speed that evaporation of the oxygen and condensation of the combustion products has no time to take place. Otherwise little pressure would be developed.

Very high impact speeds are thus provided by my invention, without the use of high initial feeding pressure. This high impact speed produces very effective intermingling of the liquids and correspondingly complete combustion.

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 combustion apparatus, means forming a combustion chamber having an end wall, means forming an entrance passage adjacent the chamber axis for a combustion liquid, a hollow double disc communicating near its center with said passage and closed around its outer edge portion, a second hollow double disc also closed about its outer edge portion and having an annular port orifice at its middle portion, hollow partition members fixed between said discs and connecting the hollow interiors of said discs and maintaining said discs in axially aligned but substantially separated fixed relation, and means to supply a coacting combustion liquid to said first liquid adjacent said annular port orifice.

2. The combination in a combustion apparatus as set forth in claim 1, in which the hollow partitions are radially disposed and increase outwardly in circumferential width.

3. The combination in a combustion apparatus as set forth in claim 1, in which means is provided to introduce an igniting flame to the mixed liquids at said annular port orifice.

4. The combination in a combustion apparatus as set forth in claim 1, in which the upper and lower members of each hollow double disc are held in fixed spaced relation by a plurality of radially disposed and transversely perforated partition elements.

5. In a combustion apparatus, means forming a combustion chamber having a substantially cylindrical outer wall, means to supply a combustion liquid entering tangentially at said outer wall, means to supply a coacting combustion liquid adjacent the axis of said chamber, and distributing means including a plurality of radial passages through which said second liquid is projected against said outer wall at high radial outward velocity whereby said two liquids are intimately intermingled and said radial passages expanding substantially outward both in width and height.

6. In a combustion apparatus, means forming a combustion chamber enclosed at least in part by a surface of revolution, separate means to supply liquid fuel and a liquid oxidizing agent adjacent the axis of said chamber, distributing means including a plurality of expanding delivery passages for said liquids, and structure defining two adjacent annular concentric port orifices positioned at the inner ends of said radial passages and from which adjacent orifices said liquids are simultaneously discharged and intermingled, and means to conduct said two liquids to said concentric orifices.

7. The combination in a combustion apparatus as set forth in claim 6, in which a third port orifice is provided adjacent the first two orifices, which third orifice communicates with the body of the combustion chamber and delivers a relatively small portion of hot combustion gases to the intermingling liquids.

8. In a combustion apparatus, means forming a combustion chamber enclosed at least in part by a surface of revolution, means to supply liquid oxygen and a portion of a liquid fuel to said chamber adjacent the axis of said chamber, means to intermingle said liquids and to conduct the intermingled liquids radially outward at high speed and against the combustion chamber wall, and means to supply additional liquid fuel at the zone of impact of said intermingled liquids with said wall.

9. In a combustion apparatus, means forming

a combustion chamber enclosed at least in part by a surface of revolution, structure in said chamber defining an annular orifice adjacent the axis of said chamber, means to supply liquid fuel to said orifice, structure in said chamber defining a second concentric and adjacent annular orifice, means to supply a liquid oxidizing agent to said second orifice, structure defining a third concentric and adjacent annular orifice through which an igniting flame is drawn from said chamber, and a fixed axial spreader having portions integral with said orifice-defining structures, a streamlined lower surface of said spreader forming one side of said third orifice and a streamlined upper surface of said spreader forming one side of said first-mentioned orifice.

10. In a combustion apparatus, means forming a combustion chamber enclosed at least in part by a surface of revolution, structure in said chamber defining an annular orifice adjacent the axis of said chamber, means to supply liquid fuel to said orifice, structure in said chamber defining a second concentric and adjacent annular orifice, means to supply a liquid oxidizing agent to said second orifice, structure defining a third concentric and adjacent annular orifice through which an igniting flame is drawn from said chamber, and distributing means including walls forming a plurality of expanding delivery passages in which said liquids are intermingled, said igniting flame being drawn into said delivery passages by the jet action of said liquids as they emerge from said first two orifices.

11. In a combustion apparatus, means forming a combustion chamber, means to supply a combustion liquid to said chamber adjacent the axis thereof and at a relatively low initial entrance velocity, means to supply a coacting combustion liquid to said chamber and to intermingle portions of said liquids adjacent the axis of the chamber, means forming directive passages for the combustion liquids and gases and leading outwardly from said last-named means, and means to introduce a relatively small portion of hot combustion gases from within the combustion chamber into the intermingled combustion liquids to sustain preliminary combustion of said intermingled portions, the combustion gases thus produced increasing the velocity of the outward travel of any portion of said first liquid remaining in said outwardly directive passages substantially above its low initial velocity.

12. In a combustion apparatus, means forming a combustion chamber having a substantially cylindrical outer wall, means to supply a combustion liquid entering tangentially at said outer wall, means to supply a second and coacting combustion liquid entering adjacent the axis of said chamber, structure defining a plurality of outwardly expanding radial directive passages, and means to cause preliminary combustion to take place adjacent the inner ends of said radial passages, the outflow of the combustion gases thus produced by preliminary combustion inducing outflow of the unconsumed part of said second liquid through said plurality of radial directive passages and against said outer wall at high radial outward velocity and said two combustion liquids being thereby intimately intermingled at said outer wall.

13. In a combustion apparatus, means forming a combustion chamber having a longitudinal axis, means to supply a combustion liquid to said chamber at a relatively low initial entrance velocity, means to supply a second and coacting combustion liquid adjacent the axis of said chamber, hollow walls within said chamber forming converging passages with constricted inner end orifices and through which constricted orifices said first liquid is fed to and mixed with said second combustion liquid after said first liquid has passed toward the chamber axis through said converging passages, and means to introduce a small portion of hot combustion gases from the combustion chamber to said mixed liquids to cause preliminary combustion of a small vaporized portion of said mixed liquids to take place adjacent the constricted inner ends of said converging passages.

14. In a combustion apparatus, means forming a combustion chamber having a substantially cylindrical outer wall, means to supply a portion of a first combustion liquid axially to said chamber, means to supply the major part of said first combustion liquid tangentially at said outer wall, means to supply a second and coacting combustion liquid to said chamber at a relatively low initial entrance velocity, hollow walls within said chamber forming converging passages with constricted inner end orifices and through which constricted orifices said second liquid is supplied and intimately intermingled with said first liquid after travelling toward the axis of said combustion chamber through said converging passages, means to introduce a small portion of hot combustion gases from the combustion chamber to said mixed liquids to raise the temperature and vaporize said mixed liquids adjacent said axis and to cause preliminary combustion of a vaporized part of the axially delivered portion of said first combustion liquid with a small vaporized portion of said second and coacting combustion liquid to take place adjacent the constricted inner ends of said passages, and means to direct the combustion gases thus produced outward to said outer wall at the locus of tangential introduction of said first liquid, and such outflow of combustion gases substantially increasing the outward velocity of the unvaporized portion of said second liquid above its initial entrance velocity.

ROBERT H. GODDARD.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
980,801	Kraus	Jan. 3, 1911
1,316,021	Doble	Sept. 16, 1919
1,349,876	Doble	Aug. 17, 1920
1,393,207	Du Pont	Oct. 11, 1921
1,633,502	Staley	June 21, 1927
1,633,549	Little	June 21, 1927
1,650,342	Good	Nov. 22, 1927
1,676,501	Moors	July 10, 1928
1,699,732	Balmat	Jan. 22, 1929
1,828,784	Perrin	Oct. 27, 1931
1,923,614	Clarkson	Aug. 22, 1933
2,016,921	Goddard	Oct. 8, 1935
2,031,306	French	Feb. 18, 1936
2,072,731	Crosby	Mar. 2, 1937
2,085,800	Goddard	July 6, 1937
2,164,225	Walker	June 27, 1939
2,195,617	Clarkson	Apr. 2, 1940
2,217,649	Goddard	Oct. 8, 1940
2,286,909	Goddard	June 16, 1942