March 6, 1951 R. H. GODDARD 2,544,419

COMBUSTION CHAMBER WITH WIDE-ANGLE DISCHARGE
FOR USE IN PROPULSION APPARATUS

Filed March 22, 1947

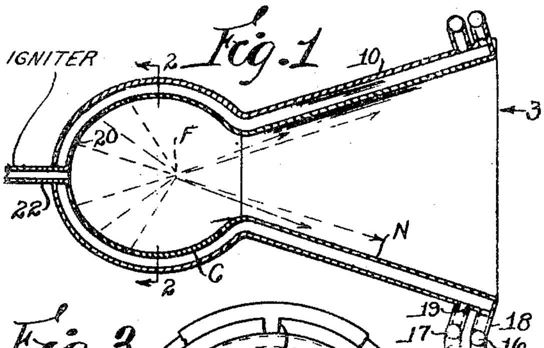

Fig. 1

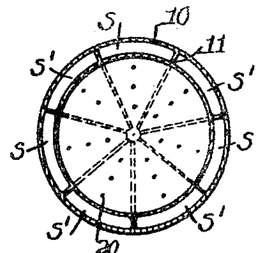

Fig. 2

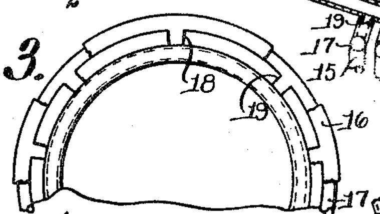

Fig. 3

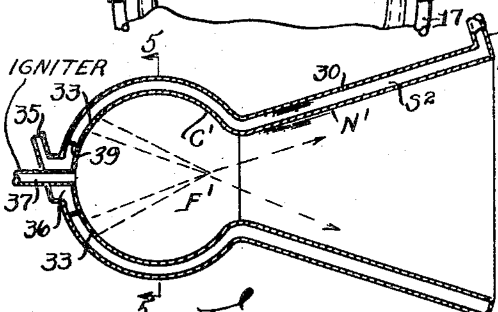

Fig. 4

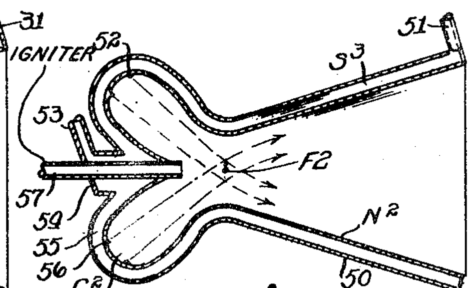

Fig. 6

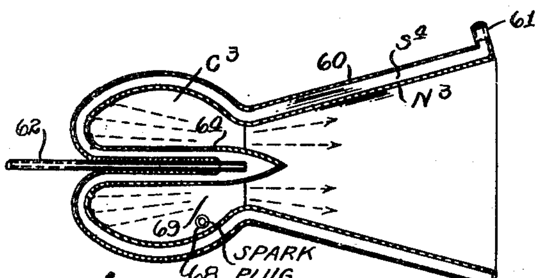

Fig. 7

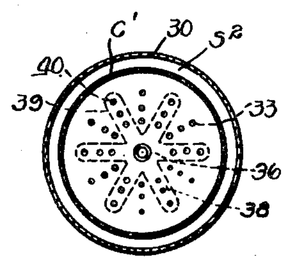

Fig. 5

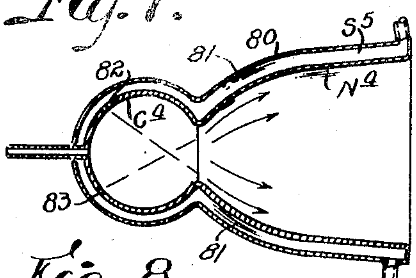

Fig. 8

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COMBUSTION CHAMBER WITH WIDE-ANGLE DISCHARGE FOR USE IN PROPULSION APPARATUS

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1 Claim. (Cl. 60—35.6)

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This invention relates to combustion chambers as used in propulsion apparatus and which are provided with open rearward discharge nozzles.

It is well known that the out-flow of gases from a combustion chamber of this type tends to form a gas stream having only a small angle of divergence, and that this compact steam does not substantially expand until it has passed beyond the nozzle. Where liquid combustion elements are used, such as gasoline and liquid oxygen, the discharged gases frequently contain small drops or particles of fuel which are detonated or burned only as the gas stream expands and as the gas pressure is correspondingly reduced. Such detonation or rapid combustion of fuel drops or particles then produces radial forces beyond the nozzle, where they contribute nothing in the way of useful thrust.

It is the general object of the present invention to provide a combustion chamber having a discharge nozzle of relatively wide angle, so that final combustion of entrained fuel may take place within the diverging walls of the nozzle, where a useful thrust reaction may result.

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

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

Fig. 1 is a sectional side elevation of a combustion chamber embodying this improvement;

Fig. 2 is a transverse sectional view, taken along the line 2—2 in Fig. 1;

Fig. 3 is a partial end view, looking in the direction of the arrow 3 in Fig. 1;

Fig. 4 is a sectional side elevation of a modified combustion chamber;

Fig. 5 is a transverse sectional view, taken along the line 5—5 in Fig. 4; and

Figs. 6, 7 and 8 are longitudinal sectional views of additional modified constructions.

Referring to Figs. 1 to 3, a combustion chamber C is shown, having a discharge nozzle N of a relatively wide angle and of large sectional area as compared with the combustion chamber.

The chamber C and nozzle N are enclosed in a casing 10 provided with longitudinal partitions 11 (Fig. 2) and enclosing two series of jacket spaces S and S'. Gasoline and liquid oxygen are fed to the spaces S and S' through feed pipes 14 and 15, annular distributing pipes 16 and 17 and branch pipes 18 and 19. These liquids cool the thin walls of the chamber C and nozzle N.

Spray openings 20 are formed in the rear end

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wall of the chamber C. Sprays from these openings converge substantially at a focus F, somewhat forward of the center of the combustion chamber. Combustion takes place about the focus F, and the combustion gases expand in the nozzle N. Unevaporated drops of the combustion liquids continue at diverging angles, as indicated by the broken lines in Fig. 1. Combustion may be started by an igniter 22.

As this stream of combustion gases rapidly expands, the gas pressure is reduced, and any unconsumed drops or particles of fuel will then vaporize and will be detonated or rapidly burned within the nozzle N and before the combustion gases reach the rear end of the nozzle. Consequently, the outward thrust due to such further combustion will react against the conical wall of the nozzle N to produce additional useful thrust.

In Figs. 4 and 5, a construction is shown in which a chamber C' and nozzle N' are enclosed within a casing 30, providing a jacket space S2 to which gasoline may be fed through a pipe 31. This gasoline acts to cool the walls of the combustion chamber C' and nozzle N', and is sprayed into the chamber C' through spray openings 33 (Fig. 5).

Liquid oxygen is fed from a pipe 35 to an annular passage 36 which surrounds an igniter 37. The passage 36 communicates with branch passages 38 (Fig. 5) which are separated from the space S2 by a star-shaped partition 39. Liquid oxygen is sprayed from the passages 38 through spray openings 40, arranged in radial lines and alternating with the spray openings 33 previously described.

The sprays of gasoline and oxygen converge at a focus F', as in the construction previously described, and the combustion gases expand on leaving the focal point, while unevaporated drops of the combustion liquids continue along diverging lines, which correspond in general to the angle of the nozzle N'.

In the construction shown in Fig. 6, the combustion chamber C2 and nozzle N2 are surrounded by a casing 50 enclosing a jacket space S3 to which gasoline is supplied through a pipe 51. The gasoline is fed to the combustion chamber C2 through spray openings 52, and liquid oxygen is fed through a pipe 53, annular member 54, and branch passages 55 to spray openings 56.

The sprays converge at a focal point F2, and combustion may be started by an igniter 57. With this construction also, the sprays cross at or near the focal point and the combustion gases follow diverging lines as they enter and expand along the nozzle N2.

The construction shown in Fig. 7 is somewhat similar to that shown in Fig. 6, with a chamber C3 and nozzle N3 surrounded by a casing 60 enclosing a jacket space S4 to which gasoline is fed through a pipe 61. Liquid oxygen may be fed through a pipe 62 to the reentrant portion 64 of the rear wall of the chamber C3. A spark-plug 68 may be provided in the chamber wall adjacent the annular combustion space 69 where the sprays converge in a ring-shaped focal area.

The combustion gases are discharged through the nozzle N3 in a gas stream which is of more or less annular section and which is of low density in its axial portion due to the rearward projection of the axial part 64. Thus both outward and inward expansion of the combustion gases may take place to reduce the pressure and to assist final fuel combustion.

The construction shown in Fig. 8 is similar to that shown in Fig. 1, except that the nozzle N4 is substantially bell-shaped rather than conical. This permits expansion of the combustion gases and final combustion of any particles of fuel as in the previously described constructions, and also effects substantially axial final discharge of the gases after such expansion. In this construction, the chamber C4 and nozzle N4 are surrounded by a casing 80 enclosing a jacket space S5 which is separated by partitions 81 into sections receiving gasoline and liquid oxygen respectively. These liquids are sprayed through openings 82 and 83, all as more fully described in connection with Fig. 1.

The term "wide-angle" as appearing in the specification is used to define a nozzle having an included angle of not less than 30°. In Fig. 8, the angle is to be taken between the inner and outer ends of the nozzle N2.

Having thus described several forms of the invention and the advantages thereof, it will be understood that the invention is not to be limited thereto, otherwise than as set forth in the claim, but what is claimed is:

Combustion apparatus comprising a combustion chamber, a discharge nozzle having an included angle of not less than 30°, and means to feed two combustion liquids to said chamber and to cause substantial portions of said liquids to travel along lines which are substantially parallel to the wall of said nozzle as said liquids enter the nozzle and progress therethrough, said combustion chamber and nozzle having a jacket casing spaced therefrom by a plurality of circumferentially-separated and axially-extended partitions defining a plurality of separate jacket spaces, means to feed one combustion liquid to one set of jacket spaces, means to feed a second combustion liquid to the remaining interposed jacket spaces, and each jacket space having spray openings to said combustion chamber through the front end wall of said chamber and directed rearward toward said nozzle.

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Executrix of the Last Will and Testament of Robert H. Goddard, Deceased.

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