March 18, 1947. B. PINKEL 2,417,445

COMBUSTION CHAMBER

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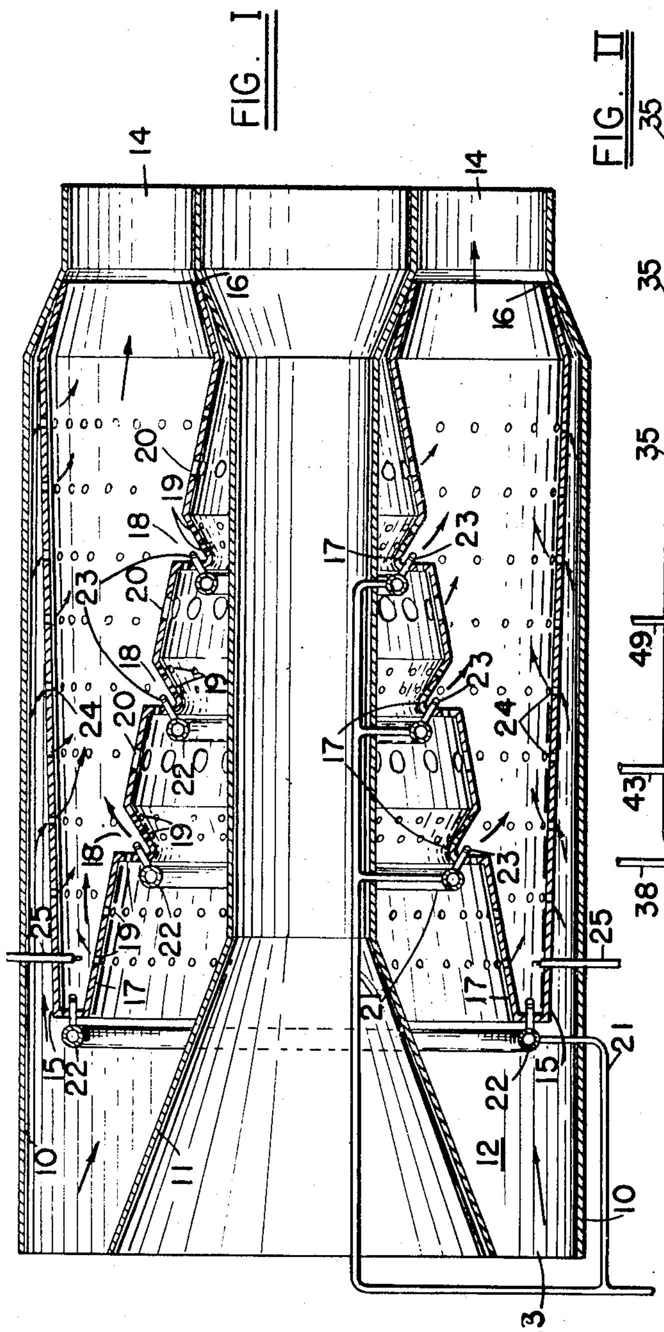

FIG. I

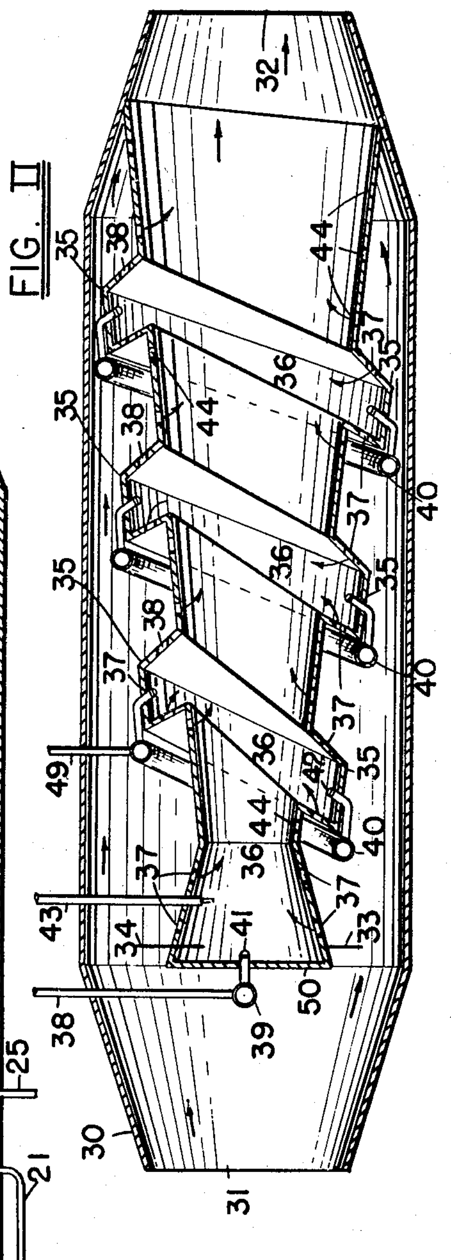

FIG. II

INVENTOR

BENJAMIN PINKEL

BY Ralph L. Chappell

ATTORNEY

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COMBUSTION CHAMBER

Benjamin Pinkel, Cleveland, Ohio

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This invention relates to improvements in combustion chambers for gas turbine and jet propulsion devices.

Combustion chambers of the type mentioned and particularly when used for power plants for aircraft must be compact. Because of the compactness of the combustion chamber it is necessary to first burn the fuel complete to obtain high efficiency and then, to introduce additional air in dilution to obtain as uniform a temperature as possible at the combustion chamber discharge. One of the objections to present known combustion chambers of the above type is that the efficiency over at least part of the operating range is low because of the small sheltered zone for primary combustion and the improper timing of the introduction of the dilution air. A second objection is that the combustion-chamber discharge temperature is non-uniform because of uneven mixing of the dilution air with the products of combustion, which causes burning of the turbine blades at the hot spots.

An object of my invention is to eliminate both of these objections by providing a plurality of sheltered combustion zones longitudinally of the combustion chamber separated by dilution air zones. By locating these sheltered zones longitudinally of the combustion chamber, increased sheltered combustion volume may be provided and a reduction in the gas velocity within the combustion zone may be affected without increase in the diameter of the combustion chamber. A reduction in gas velocity in the combustion zone produces an increase in combustion efficiency. By interspersing the dilution air between the various combustion zones, rapid mixing of the dilution air with the products of combustion is obtained and uniform temperature at the combustion-chamber outlet is achieved.

Other objects and advantages of this invention will become apparent as the discussion proceeds and is considered in connection with the accompanying claims and drawings wherein like characters of reference designate like parts throughout and wherein:

Fig. I is a longitudinal section showing a combustion chamber as embodied by this invention; and

Fig. II is a longitudinal section view of a modification of the combustion chamber as embodied by this invention.

Referring now to the drawings, wherein for the purpose of illustration is shown a preferred embodiment of this invention, the numerals 10 and 11 designate substantially cylindrical shells

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cooperating to form between them an annular combustion chamber 12 having an air entrance or intake port 13 and an exhaust or exit port 14. Located within the said combustion chamber is a tapering annular combustion basket 15, affixed to the inner walls of the cylindrical shell 10 and 11 in any suitable manner at 16, as shown. Other supports may be afforded the said basket, as desired. Annular recessed portions or offsets 17 are provided disposed longitudinally in the basket 15, as shown, to provide a plurality of sheltered combustion zones 18. A plurality of apertures or holes 19 are provided in the recessed portions 17 to introduce primary air for combustion of the fuel within the combustion chamber basket. A plurality of holes 20 are provided in the basket 15, between the combustion zones 18, and also between the combustion zone adjacent the exhaust port 14 and the said exhaust port, as shown, to admit air for dilution into the combustion basket.

A fuel manifold or supply pipe 21 is connected, in any suitable manner, to a conventional supply source (not shown). Connected to the supply pipe 21, in any suitable manner, as by a threaded joint or the like, are fuel headers or rings 22, positioned adjacent the combustion zones 18, outside the basket 15. Carried by the headers 22 is a plurality of injection nozzles 23 jetting fuel into the combustion zones 18, at spaced intervals the circumference of the basket 15, so as to spread the fuel as evenly as possible throughout the entire combustion region of each of the several combustion zones. The holes 20 are arranged at spaced intervals around the circumference of the said basket 15 to provide regions of a substantially solid basket wall to act as bridges between the adjacent combustion zones. A further series of holes 24 are provided in the walls of the basket 15, as shown, opposite the recess portions 17, as in the conventional combustion basket, for the purpose of cooling the outer walls of the said basket. Sources of ignition 25, such as conventional spark plugs, are provided in the up-stream combustion zone, as shown, to initially ignite the charge.

The modification shown in Fig. II represents this invention as applied to a cylindrical type combustion chamber. The numeral 30 designates a cylindrical combustion chamber shell having an inlet port 31 and an exhaust port 32. A cylindrical combustion basket 33 is mounted in any suitable manner within the said shell 30, as shown, and is provided with a circular recess 34 at the end of the basket adjacent to inlet port

31. A continuous spiral recess 35, progressing along the axis of the basket, is provided in the basket 33 and extends substantially intermediate the recess 34 and the terminus of the basket adjacent the exhaust port 32, as shown. The circular recess 34 and spiral recess 35 provide a sheltered combustion zone 36 comparable in function to the combustion zones 18 shown in Fig. I. A plurality of air inlet holes 37 provided circumferentially the basket, in recesses 34 and 35, permit entrance of combustion air into the respective combustion zones. Fuel inlet pipes 38 and 49 carry fuel to headers 39 and 40, which in turn carry communicating spray or injection nozzles 41 and 42 respectively, terminating within the combustion zones 36 for introduction of fuel thereto. An igniter 43, such as a spark plug or the like, is provided in the upstream combustion zone, as shown, to initiate combustion in the basket. A plurality of holes or apertures 44 are further provided circumferentially the basket 33 spaced between the several combustion zones 36 and between the combustion zone adjacent the exhaust port 32 and the end of the combustion basket terminating adjacent the exhaust port 32, as shown, to permit the introduction of dilution air into the said combustion basket.

The operation of the combustion chamber disclosed in Fig. I and in the modification shown in Fig. II is as follows: air enters the combustion chambers at the intake ports 13 and 31, respectively. Part of the air enters the combustion zones 18 and 36 through holes 19 and 37, respectively, which is the primary or combustion air for the ignition charge, while the remainder of the air passes down stream both the basket and the shell through the holes 20 and 44 and provides the secondary or dilution air. Fuel is introduced into the combustion zones 18 and 36 by means of supply pipes 21, 38, and 49, manifolds 22, 39, and 40, and spray nozzles 23, 41, and 42. Combustion is initiated in the upstream zones by means of spark plugs 25 and 43. The flame front is progressive to the several combustion zones by the aid of the portions of the walls of the basket 15 which are devoid of holes 20, which introduce the dilution air. The nozzles are preferably of a type such as to give flat sprays having their faces nearly parallel with the walls of the recessed portions 17 and 35, respectively, in order that the spray does not impinge on the walls of the basket. By providing a small angle to the sprays relative to the walls of the recess portions the sprays are prevented from impinging upon each other.

By arranging several combustion zones longitudinally of the combustion chamber the sheltered combustion volume can be increased and the gas velocity in the combustion zones decreased as compared with the conventional arrangement of the combustion zone only at the forward end of the combustion chamber. A decreased gas velocity in the combustion zone results in an increase in combustion efficiency. The gas flow area in the combustion zones can be increased, thereby decreasing the gas velocity in the combustion zones, by increasing the proportion of the length of the combustion-chamber basket allotted to the primary combustion zones. Increase in the proportion of the length of the combustion-chamber basket allotted to primary combustion zones requires a reduction in combustion-chamber basket wall area through which the dilution air enters the basket and hence an increase in dilution air velocity. An increase in dilution air velocity improves the mixing of the dilution air with the products of combustion. This increased dilution air velocity in combination with the introduction of the dilution air between the several combustion zones provides an improved uniformity of temperature at the combustion-chamber exit.

It is to be understood that the form of this invention, herewith shown and described, is to be taken as a preferred example of the same, and that various changes in the shape, size and arrangement of parts may be resorted to, without departing from the spirit of the invention, or the scope of the subjoined claims.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What I claim is:

1. A combustion chamber comprising a combustion basket in said chamber, a plurality of recesses in said basket, fuel inlet means in said recesses, air inlet means in said recesses, and air inlet means disposed between the said recesses.

2. A combustion chamber having inlet and outlet ports comprising a combustion basket in said chamber, a plurality of recesses in said basket, at various distances from said inlet and outlet ports, fuel inlet means in said recesses, air inlet means adjacent said fuel inlet means in said recesses, air inlet means disposed between the said recesses and between the recess adjacent the above mentioned outlet port and the said outlet and initial firing means located in the recess adjacent the inlet port whereby the flame front progresses from the recess adjacent the inlet port to the recess adjacent the outlet port.

3. A combustion chamber having an air inlet port and outlet port, a combustion basket mounted in said combustion chamber, a plurality of recesses located in the said basket at various distances from said inlet and outlet ports adapted to form sheltered combustion zones, a plurality of apertures in the said basket adapted to permit the entrance of combustion air into the said sheltered combustion zones, means to introduce fuel into the sheltered zones formed by the said recesses, apertures in the said basket disposed between the said recesses adapted to admit dilution air into the said basket and means to ignite the mixed fuel and air.

4. A combustion chamber having an air inlet port and outlet port, a combustion basket mounted therein, a plurality of recesses in the combustion basket disposed at various distances between the said air inlet port and outlet port, adapted to provide sheltered combustion zones in the said basket, means for introducing fuel into the sheltered combustion zones, apertures in the said recesses adapted to admit air into the said combustion zones, and apertures in the said basket disposed between the said recesses adapted to admit dilution air into the said basket.

5. A combustion chamber having an air inlet port and an exhaust port, a combustion basket mounted in the said combustion chamber, a plurality of recesses formed in the said combustion basket at various distances between said air inlet port and exhaust port, adapted to form sheltered combustion zones, a plurality of apertures in the said basket adapted to admit combustion air into the said combustion zones, means to admit fuel into the said combustion zones, a plurality of apertures in the said basket disposed between the said recesses adapted to admit dilution air into

the said basket, said apertures between said recesses being grouped to leave portions of solid combustion basket wall between adjacent combustion zones to provide flame bridges, and means to ignite the fuel-air mixture in the said basket.

6. A combustion chamber of the type described comprising cylindrical shells cooperating to form annular chamber air inlet ports and exhaust ports in the said chamber, an annular combustion basket mounted in the said chamber, a plurality of annular recesses in the said basket adapted to form combustion zones, fuel inlet means communicating with the said combustion zones, apertures provided in the said recesses adapted to admit combustion air into the said combustion zones, means to ignite the fuel air mixture located in the combustion zone adjacent the said air inlet port, apertures provided in the said combustion basket located between the said recesses and located between the recess adjacent the exhaust port and the said exhaust port and the said exhaust port adapted to admit dilution air into the said basket and apertures provided in the walls of the said combustion basket opposite the said combustion zones.

7. A combustion chamber of the type described comprising a substantially cylindrical shell having an air inlet port and an exhaust port, a cylindrical combustion basket mounted in the said shell, a substantially cylindrical recess in the said basket adjacent the said air inlet port forming a combustion zone, a continuous spiral recess in the said basket disposed between the said cylindrical recess and the exhaust port forming a second combustion zone, fuel inlet means in the cylindrical recess and in the spiral recess, ignition

means in the said cylindrical recess, a plurality of apertures in the said cylindrical recess adapted to admit combustion air into the combustion zone of said recess, a plurality of apertures in the spiral recess disposed at spaced intervals thereof adapted to admit combustion air in the combustion zone formed by the spiral recess, and a plurality of apertures in the combustion basket located between the cylindrical recess and the spiral recess and between each spiral of the said spiral recess and between the said spiral recess and the exhaust port adapted to admit dilution air into the combustion basket.

8. A combustion chamber having an air inlet port and an exhaust port, a combustion basket mounted within the said combustion chamber, recesses in the said combustion basket adapted to form sheltered combustion zones, at least one of said recesses being in the form of a spiral around the said combustion basket, means for introducing fuel into the said recesses, a plurality of holes in the said recesses adapted to admit combustion air into the said recesses, a plurality of holes provided in the said basket disposed between the said recesses adapted to admit dilution air into the said basket and means to ignite the fuel-air mixture.

9. A combustion chamber comprising a combustion basket in said chamber, a plurality of recesses in said basket disposed at various distances longitudinally of the combustion chamber, fuel inlet means in said recesses, air inlet means in said recesses, and air inlet means disposed between the said recesses.

BENJAMIN PINKEL.