

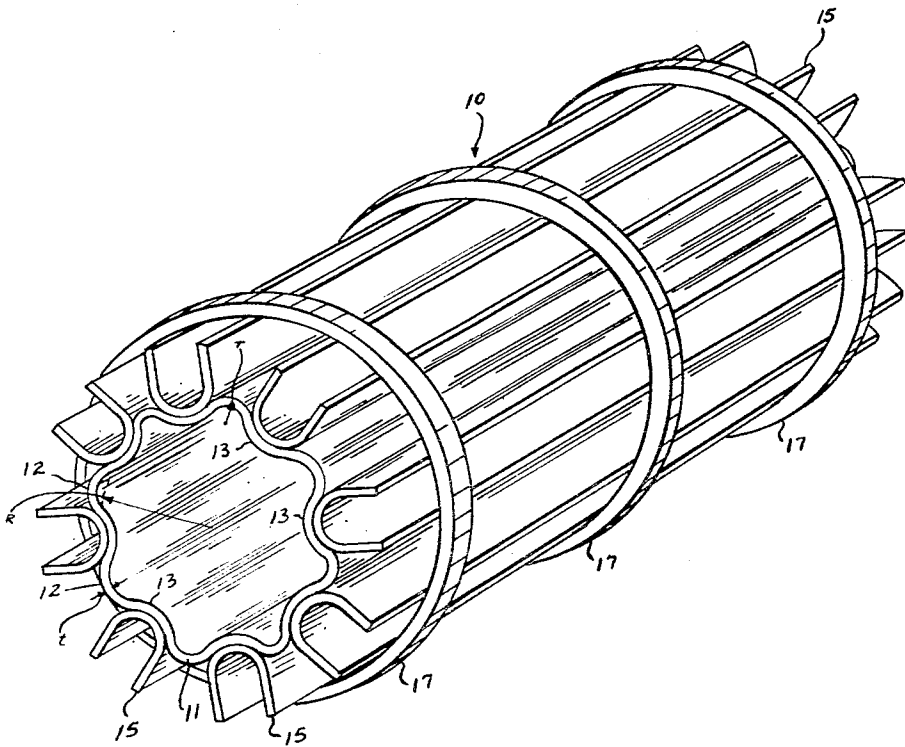
Aug. 27, 1968

R. J. TAYLOR ET AL

3,398,527

CORRUGATED WALL RADIATION COOLED COMBUSTION CHAMBER

Filed May 31, 1966



INVENTORS
RONALD J. TAYLOR
RICHARD M. DUMKE
BY *Harry A. Herbert Jr.*
ATTORNEY
Richard J. Killen
AGENT

1

3,398,527

CORRUGATED WALL RADIATION COOLED COMBUSTION CHAMBER

Ronald J. Taylor, Granada Hills, and Richard M. Dumke, Inglewood, Calif., assignors to the United States of America as represented by the Secretary of the Air Force

Filed May 31, 1966, Ser. No. 554,945

1 Claim. (Cl. 60—39.66)

This invention relates to a radiation cooled combustion chamber such as may be used for a ramjet or a rocket engine.

One object of the invention is to provide a radiation cooled combustion chamber capable of operating at higher temperature and pressure than prior art devices.

This and other objects will be more fully understood from the following detailed description taken with the drawing, wherein:

The single figure shows a corrugated wall combustion chamber according to the invention.

The simplest form of a radiation cooled chamber is a single wall type fabricated from a homogeneous refractory material. At high combustion gas temperatures, there are particularly severe conditions imposed on this type of structure because the chamber pressures and thus heat transfer coefficients, increase the heating rates to the wall, which in turn increases the wall temperature. The effect of increased pressure requires that the wall be thickened to reduce the hoop tension stresses. The higher wall temperature also dictates an increase in the wall thickness, since the wall material becomes weaker at higher temperatures. Consideration must also be given to the thermal stresses in the wall which are additive to the pressure stresses. Thermal stresses are proportional to the temperature variation through the wall and, consequently, are greater through a thicker wall. The pressure and thermal stress combination with available materials limit the allowable chamber pressures.

According to this invention, the chamber hoop tension stresses are reduced by corrugating the high temperature inner wall. The pressure the wall receives due to pressure is then based on the corrugation radius r instead of the chamber radius R . The primary hoop tension reacting structure is placed away from the intense heat which results in higher ring member strength properties and increased material efficiency. Stiffeners are provided between the corrugated wall and the primary hoop tension reacting members. The primary hoop tension reacting ring members are located at spaced intervals so that the corrugated chamber wall and stiffeners are able to radiate to space to provide maximum temperature differential between the radiating surface and space.

Reference is now made to the signal figure of the drawing wherein reference number 10 shows a combustion chamber having an elongated corrugated wall member 11, with outwardly convex portions 12 and concave portions 13. An elongated U-shaped stiffener 15 is located in each of the concave portions 13. The stiffeners 15 are retained in engagement with the wall member by means of a plurality of ring members 17. The rings are located at spaced intervals so that the wall member 11 and stiffeners 15 are able to radiate to space.

The stress state in the wall can be approximated by

2

the formula $\sigma_t = Pr/t$, where P is the internal pressure, t the chamber wall thickness, r the corrugation radius plus one-half t and σ_t the hoop tension stress. The maximum σ_t is determined by the tensile properties and the t by thermal stress considerations, therefore, Pr has a maximum upper limit independent of chamber diameter. So for a desired P , a corresponding r may be chosen with some consideration to optimum weight design. The point is that the designer has quite a degree of latitude in choosing the best chamber geometry to suit the required thrust fluid parameters. In the conventional wall configuration, the final design is dictated by the pressure and dependent on the chamber diameter. To illustrate, the same approximate equation holds as above, but instead of r , the chamber radius R plus one-half t is used. So PR is equal to the same upper limit as before but $R \gg r$, therefore, the maximum allowable pressure is much lower for the conventional design than for the corrugated design.

The function of the stiffeners 15 is two-fold. They retain the inner wall by preventing the corrugations from expanding and at the same time collect the pressure loads and beam them to the rings. This utilized building block concept reduces the thermal loads to one dimension and lends itself to an attractive design feature wherein the stiffeners are free to expand and alleviate any induced thermal stresses, thereby enabling them to contribute their entire cross section to carrying pressure loads and not be penalized by the thermal stresses.

The function of the ring member 17 is to react to the primary hoop tension loads and yet allow the hot corrugated wall to radiate to space. Since the rings are removed from intimate contact with the hot chamber wall, they are at a lower temperature where the material has a higher strength/weight ratio and are thus more efficient. With the rings spaced at intervals, the chamber wall is able to radiate to space with minimal interference, thereby obtaining the optimum radiation possible by having the maximum temperature differential between the radiating surface and space.

The chamber of the invention is not limited to the cylindrical shape shown, but could be used for other developed shapes as well.

There is thus provided a radiation cooled combustion chamber capable of higher operating temperature and pressure than prior art devices.

While a certain embodiment has been described, it is obvious that numerous changes may be made without departing from the general principle and scope of the invention.

We claim:

1. A radiation cooled combustion chamber, comprising: a hollow elongated enclosure member having a plurality of longitudinally extending corrugations formed therein; a plurality of spaced angular tension reacting members surrounding said enclosure member; a plurality of U-shaped stiffener members extending between said corrugated enclosure member and said annular tension reacting members with the closed end of said U-shaped stiffener members being located in contact with the external concave portion of the corrugations of said enclosure member.

No references cited.

JULIUS E. WEST, *Primary Examiner*.