

Sept. 2, 1952

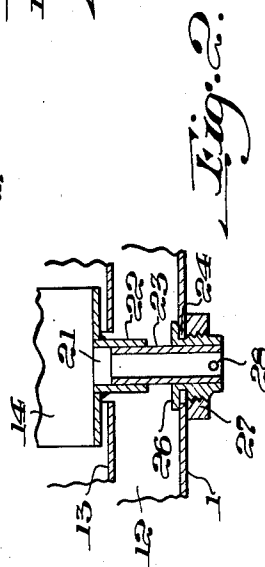
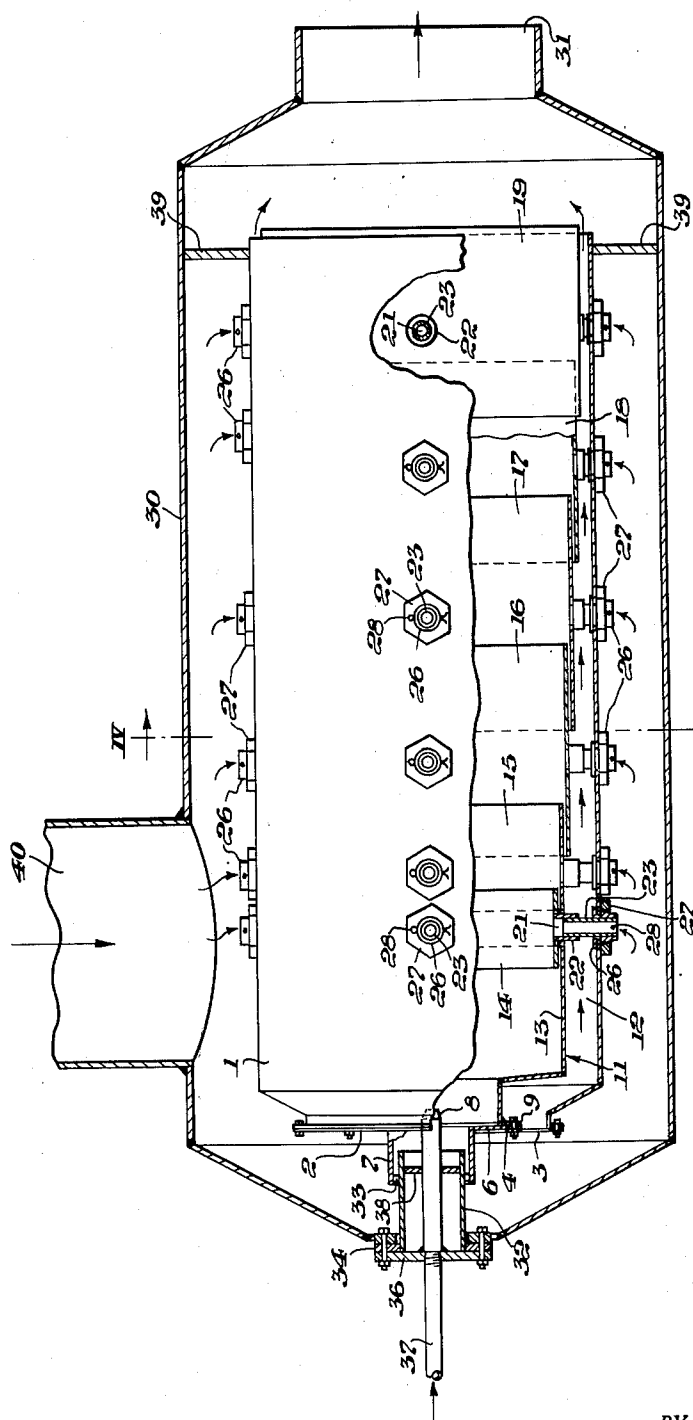
D. ARONSON

2,609,040

COMBUSTION APPARATUS USING COMPRESSED AIR

Filed March 14, 1950

2 SHEETS--SHEET 1



INVENTOR.
DAVID ARONSON.

BY
Brown, Pitcher, Flick & Peckham
his
ATTORNEYS.

Sept. 2, 1952

D. ARONSON

2,609,040

COMBUSTION APPARATUS USING COMPRESSED AIR

Filed March 14, 1950

2 SHEETS—SHEET 2

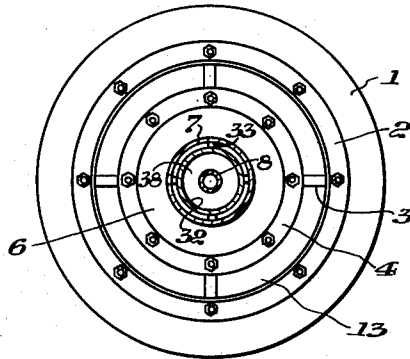


Fig. 3.

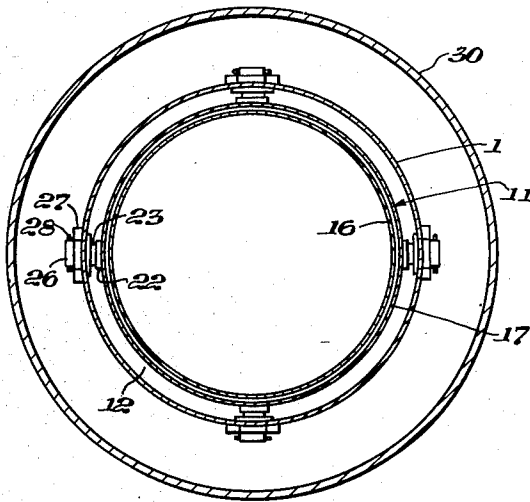


Fig. 4.

INVENTOR.
DAVID ARONSON.

BY
Brown, Britchlow, Flick & Beckham
his
ATTORNEYS.

UNITED STATES PATENT OFFICE

2,609,040

COMBUSTION APPARATUS USING
COMPRESSED AIRDavid Aronson, Greensburg, Pa., assignor to
Elliott Company, Jeannette, Pa., a corporation
of Pennsylvania

Application March 14, 1950, Serial No. 149,588

9 Claims. (Cl. 158-4)

1

This invention relates to combustion apparatus, and more particularly to the delivery of compressed air to a combustion chamber for creating turbulence therein and cooling its walls.

In combustion apparatus utilizing compressed air, the combustion chamber walls are provided with openings through which air is admitted. In most cases this air enters with two velocity components; one radial and one parallel with the axis of the chamber. The axial component is present because the chamber generally has inner and outer walls which form an annular passage through which air can flow from one end of the chamber to the other. The outer wall may or may not be a pressure wall. The flow of air through the annular passage cools the inner wall by forced convective heat transfer between the metal and the air. The higher the air velocity in this passage the more effective is the cooling action. The radial component of the air entering the combustion zone produces a high degree of turbulence which aids the combustion process by mixing the fuel and air. At a given pressure drop across the combustion chamber walls, the magnitude of the radial component decreases as the axial component increases. Therefore, in order to obtain both adequate cooling of the chamber walls and effective mixing of fuel and air it is necessary to have a large pressure drop.

It is among the objects of this invention to provide combustion apparatus of the type discussed above in which efficient combustion is produced at lower air pressure losses than heretofore, in which the full pressure drop of the compressed air is available for producing turbulence in the combustion zone as well as for cooling of the chamber walls, in which the two types of air flow have pressure drops which are equal but not additive, and in which the inner combustion chamber wall may be supported by tubular members through which air is delivered to the combustion zone.

In accordance with this invention, the combustion apparatus includes a combustion chamber formed from spaced inner and outer walls. The inner wall is provided with a plurality of circumferentially spaced openings, to which are connected tubular members that extend out beyond the space between the two walls. A burner is disposed at one end of the inner wall. Air under pressure is directed to the outer ends of the tubular members and to the space between the burner end of the inner wall and the surrounding outer wall. This air may be delivered through separate conduits or to a casing surrounding the combus-

2

tion chamber walls. The full pressure drop of the air is thus available for turbulent mixing within the combustion zone, and at the same time the full pressure drop also is available for cooling the combustion chamber walls. Preferably, the tubular members extend radially out through the outer wall of the combustion chamber and are slidably mounted in one of the walls so as to support the inner wall and permit it to expand freely. Also, it is preferred to formed the inner wall from telescoping rings that are spaced apart radially to permit some of the air to flow axially between them.

The preferred embodiment of the invention is illustrated in the accompanying drawings, in which Fig. 1 is a side view of the combustion apparatus, shown partly in longitudinal section; Fig. 2 is an enlarged longitudinal section of one of the tubular members; Fig. 3 is a view of the burner end of the combustion chamber; and Fig. 4 is a cross section taken on the line IV-IV of Fig. 1.

Referring to the drawings, the outer wall of the combustion chamber is formed from a long cylindrical shell 1, the inner end of which may be tapered to reduce its diameter. Bolted to the inner end of this shell is a bolting ring 2 which is connected by several radial spokes 3 to an inner bolting ring 4 that is concentric with the outer one. The inner ring is bolted to a flange 6 encircling one end of a sleeve 7, through which a burner 8 may project into the combustion chamber. The flange 6 is clamped between the inner bolting ring 4 and a flange 9 on the reduced end of an inner combustion chamber wall or liner 11 that is concentric with shell 1 and spaced from it to provide an annular passage 12 between them extending from end to end of the chamber. The liner can be a single member like the shell, but preferably is formed from a plurality of telescoping rings 13, 14, 15, 16, 17, 18 and 19. As just shown, the ring 13 at the inlet end of the liner is supported by the inner bolting ring 4. All of the rings are disposed on the same axis and are spaced apart radially, with the largest ring at the outlet end of the chamber. The radial spacing provides annular spaces between the different rings so that forwardly directed air can flow across their inner as well as their outer surfaces. Such air is forced into passage 12 from between the two bolting rings 2 and 4, and leaves the opposite end of the combustion chamber. It cools the combustion chamber walls.

Each of the liner rings, with the exception of the one (13) at the inner end of the chamber,

is shown provided with a plurality of circumferentially spaced openings 21. Four equally spaced openings in each ring have been found to be satisfactory, although more can be used if desired. These openings are so spaced lengthwise of each ring as to fall between the ends of the two adjoining rings. It is a feature of this invention that each of these ring openings is connected by a tubular member to the space outside of the shell 1 so that none of the air flowing through passage 12 between the two walls of the combustion chamber will be diverted radially through openings 21.

Accordingly, each of the tubular members just mentioned includes a sleeve 22 welded to the outside of each liner ring around each of its radial openings. The sleeves are disposed radially of the rings and extend only part way across the space between the rings and the encircling shell. Each sleeve is slidably mounted on the inner end portion of a rigid metal tube 23 that extends out through an opening 24 (Fig. 2) in the shell. The outer end portion of the tube preferably extends through an externally threaded collar 26 that has a head engaging the inner surface of the shell. A nut 27 is threaded on the outer end of this collar and is tightened against the outer surface of the shell to clamp the collar in place. The opening in the shell, through which the collar extends, is larger than the body of the collar so that before the nut is tightened the collar can be adjusted laterally to the proper position in axial alignment with the adjacent sleeve. The tube 23 that extends through the collar can be held in place by a cotter pin 28 extending through aligned radial openings in the outer end of the tube and the portion of the collar projecting beyond nut 27.

It will be seen that by this arrangement each liner ring can be independently supported inside the shell with its axis coinciding with the axis of the shell. Also, when the liner becomes hot, each ring is free to expand independently of the other rings and of the shell, because the sleeves 22 can slide outward on the supporting tubes 23. Consequently, the liner rings, which are at the highest temperature, do not act as structural members. That should prolong their useful life.

Because the tubular members, consisting of the telescoping tubes 23 and sleeves 22, extend out beyond shell 1, none of the compressed air that enters passage 12 between the combustion chamber walls can enter the openings 21 in the sides of the liner rings. As a result, the full pressure drop of the air in passage 12 is available for cooling the chamber walls. The air for turbulent mixing is introduced through the tubular members, by which the liner rings are supported. This air enters the combustion zone with virtually zero axial component, so its full pressure drop is available for mixing. Thus, the two functions of the air in the combustion chamber are separated and it is not necessary to have a pressure drop that is the sum of the pressure drop required for turbulent mixing and the pressure drop required for satisfactory wall cooling. It is only necessary to have a pressure drop that is adequate for the function requiring the greater pressure drop, because that will be sufficient for the other, too.

It is preferred, although not essential, to supply the high pressure air to the combustion chamber from a casing 30 of any suitable construction surrounding the chamber. The casing may completely surround the combustion cham-

ber, except for an outlet 31 which is concentric with the outlet of the chamber. The inner end of the combustion chamber is supported in the casing by a short, heavy tube 32 that is telescoped into sleeve 7, but spaced radially from it by circumferentially spaced bosses 33 so that air can enter the sleeve. The outer end of the tube extends through the end wall of the casing and is rigidly mounted in a ring 34 that is bolted to the end wall. Bolted to the outer surface of the ring is a plate 35 provided with a central opening, to which a fuel pipe 37 is connected. This plate also supports the outer end of the burner 8, the inner end being supported by a transverse wall 38 in the tube 32. The outer end of the shell 1 may be supported by a transverse wall 39, through which the shell projects. This wall prevents air from flowing from the casing inlet 40 directly to its outlet without entering the combustion chamber.

The air is delivered to the casing inlet under pressure from a blower or compressor (not shown). Some of the air will flow past the bolting rings 2 and 4 and into passage 12 between the two walls of the combustion chamber. This air will flow lengthwise of the chamber and out of its opposite end. Another portion of the air in the casing will enter the outer ends of tubes 23 and flow radially into the combustion zone to create turbulence. The full pressure drop of the air thus is available for both functions of the air. This invention removes the radial velocity component from the axially flowing air, and also removes the axial velocity component from the radially flowing air. The two functions of the air in the combustion chamber therefore are separated and pressure losses are greatly reduced.

It will be seen that by using a larger diameter casing 30, several combustion chambers can be mounted side by side in the same chamber when that is desirable.

The combustion apparatus disclosed herein is intended primarily for use as part of a gas turbine plant. However, it can be used for such apparatus as drying ovens, high temperature processing and wherever an atmosphere at elevated temperatures (such as in the range from 300° F. to 2000° F.) is required. This apparatus is not intended for general furnace application where it is desirable to operate with the least possible amount of excess air. The tubes 23 not only supply most of the air required for combustion, but they also form supports for the several liner rings. Where the particular operating conditions under which this apparatus is used do not require the full air flow, some of the tubes can be plugged, but they will still serve as supports.

According to the provisions of the patent statutes, I have explained the principle of my invention and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. Combustion apparatus comprising inner and outer combustion chamber walls of approximately the same length having a space between them, said space extending substantially the length of the combustion chamber, the inner wall being provided with a plurality of circumferentially spaced openings, tubular members connected to

said inner wall at said openings and extending out across the space between the two walls to the outside of said outer wall, a burner disposed at one end of the inner wall, and means for directing air under pressure to the outer ends of said tubular members and to the space between the burner end of the inner wall and the surrounding outer wall.

2. Combustion apparatus comprising spaced inner and outer combustion chamber walls, the inner wall being tapered longitudinally and formed from radially-spaced telescoping rings provided with a plurality of circumferentially spaced openings, radially disposed rigid tubular members connected to said inner wall at said openings and extending through said outer wall for supporting the rings from the outer wall, a burner disposed at the smaller end of the tapered inner wall, and means for directing air under pressure to the outer ends of said tubular members and to the space between the smaller end of the inner wall and the surrounding outer wall.

3. Combustion apparatus comprising spaced inner and outer combustion chamber walls, the inner wall being provided with a plurality of circumferentially spaced openings, radially disposed rigid tubular members connected to said inner wall at said openings and extending through said outer wall for supporting the inner wall from the outer one, said tubular members having sliding connection with one of said walls to permit substantially unrestrained thermal expansion of the inner wall, a burner disposed at one end of the inner wall, and means for directing air under pressure to the outer ends of said tubular members and to the space between the burner end of the inner wall and the surrounding outer wall.

4. Combustion apparatus comprising spaced inner and outer combustion chamber walls, the inner wall being provided with a plurality of circumferentially spaced openings, tubular members in the space between the two walls, the inner ends of said members being connected to said inner wall at said openings and the outer ends of said tubular members extending out of said space, a burner disposed at one end of the inner wall, and a casing enclosing said walls and forming an air pressure chamber receiving the outer ends of said tubular members and communicating with the space between the burner end of said inner wall and the surrounding outer wall, the casing being provided with an inlet for air under pressure, whereby some of the air in the casing will enter said last-mentioned space and some will enter the outer ends of said tubular members, the space between said walls being provided with an outlet located between their ends opposite to said burner end.

5. Combustion apparatus comprising spaced inner and outer combustion chamber walls, the inner wall being provided with a plurality of circumferentially spaced openings, radially disposed rigid tubular members connected to said inner wall at said openings and extending through said outer wall for supporting the inner wall from the outer one, said tubular members having sliding connection with one of said walls to permit substantially unrestrained thermal expansion of the inner wall, a burner disposed at one end of the inner wall, and a casing enclosing said walls and forming an air pressure chamber receiving the outer ends of said tubular members and communicating with the space between the burner

end of said inner wall and the surrounding outer wall, the casing being provided with an inlet for air under pressure, whereby some of the air in the casing will enter said space and some will enter the outer ends of said tubular members, said space having an outlet at the opposite end of said inner wall.

6. Combustion apparatus comprising a longitudinally tapered inner combustion chamber wall formed from radially-spaced telescoping rings, a burner disposed at the smaller end of said inner wall, an outer combustion chamber wall surrounding the inner wall and spaced therefrom, means near the opposite ends of the inner wall for supporting the outer wall, said rings being provided with circumferentially spaced openings, tubular members having their inner ends connected to the rings at said openings in the space between the two walls and having their outer ends located outside of the outer wall, said space having an inlet at the smaller end of the inner wall and an outlet at the opposite end, and means for directing air under pressure to the outer ends of said tubular members and to the space between the smaller end of the inner wall and the surrounding outer wall.

7. Combustion apparatus comprising a longitudinally tapered inner combustion chamber wall formed from radially-spaced telescoping rings, a burner disposed at the smaller end of said inner wall, an outer combustion chamber wall surrounding the inner wall and spaced therefrom, said rings being provided with circumferentially spaced openings, radially disposed rigid tubular members connected to the rings at said openings and extending through said outer wall for supporting the rings from the outer wall, said tubular members having sliding connection with one of said walls to permit substantially unrestrained thermal expansion of the rings, and means for directing air under pressure to the outer ends of said tubular members and to the space between the smaller end of the inner wall and the surrounding outer wall.

8. Combustion apparatus comprising radially spaced inner and outer combustion chamber walls provided with circumferentially spaced aligned pairs of openings, radially disposed sleeves rigidly connected to said inner wall at the openings therein, rigid tubes rigidly mounted in the openings in the outer wall and slidably mounted in the adjoining sleeves to support the inner wall and permit it to expand, a burner disposed at one end of the inner wall, and means for directing air under pressure to the outer ends of said tubular members and to the space between the burner end of the inner wall and the surrounding outer wall.

9. Combustion apparatus comprising a longitudinally tapered inner combustion chamber wall formed from radially-spaced telescoping rings, a burner disposed at the smaller end of said inner wall, an outer combustion chamber wall surrounding the inner wall and spaced therefrom, said rings being provided with circumferentially spaced openings, the outer wall being provided with openings aligned with said ring openings, radially disposed sleeves rigidly connected to said rings at the openings therein, rigid tubes rigidly mounted in said outer wall openings and slidably mounted in the adjoining sleeves to support the rings and permit them to expand, and a casing enclosing said walls and forming an air pressure chamber receiving the outer ends of said tubes and communicating with the space

7

between the burner end of said inner wall and the surrounding outer wall, the casing being provided with an inlet for air under pressure, whereby some of the air in the casing will enter said space and some will enter the outer ends of said tubes.

DAVID ARONSON.

REFERENCES CITED

The following references are of record in the 10 file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,857,556	Lasley -----	May 10, 1932
1,918,397	Jezler -----	July 18, 1933

Number
2,268,464
2,396,567
2,398,654
2,446,059
2,483,737
2,500,925
2,510,645

8

Name	Date
Seippel -----	Dec. 30, 1941
Goddard -----	Mar. 12, 1946
Lubbock, et al. -----	Apr. 16, 1946
Peterson et al. -----	July 27, 1948
Parrish -----	Oct. 4, 1949
Bonvillian et al. -----	Mar. 21, 1950
McMahan -----	June 6, 1950

FOREIGN PATENTS

Number	Country	Date
610,641	Great Britain -----	Oct. 19, 1948