May 6, 1947. F. O. HENNIG 2,420,135

SUPPORT FOR EXPANSIBLE MEMBERS

Filed June 7, 1944 2 Sheets-Sheet 1

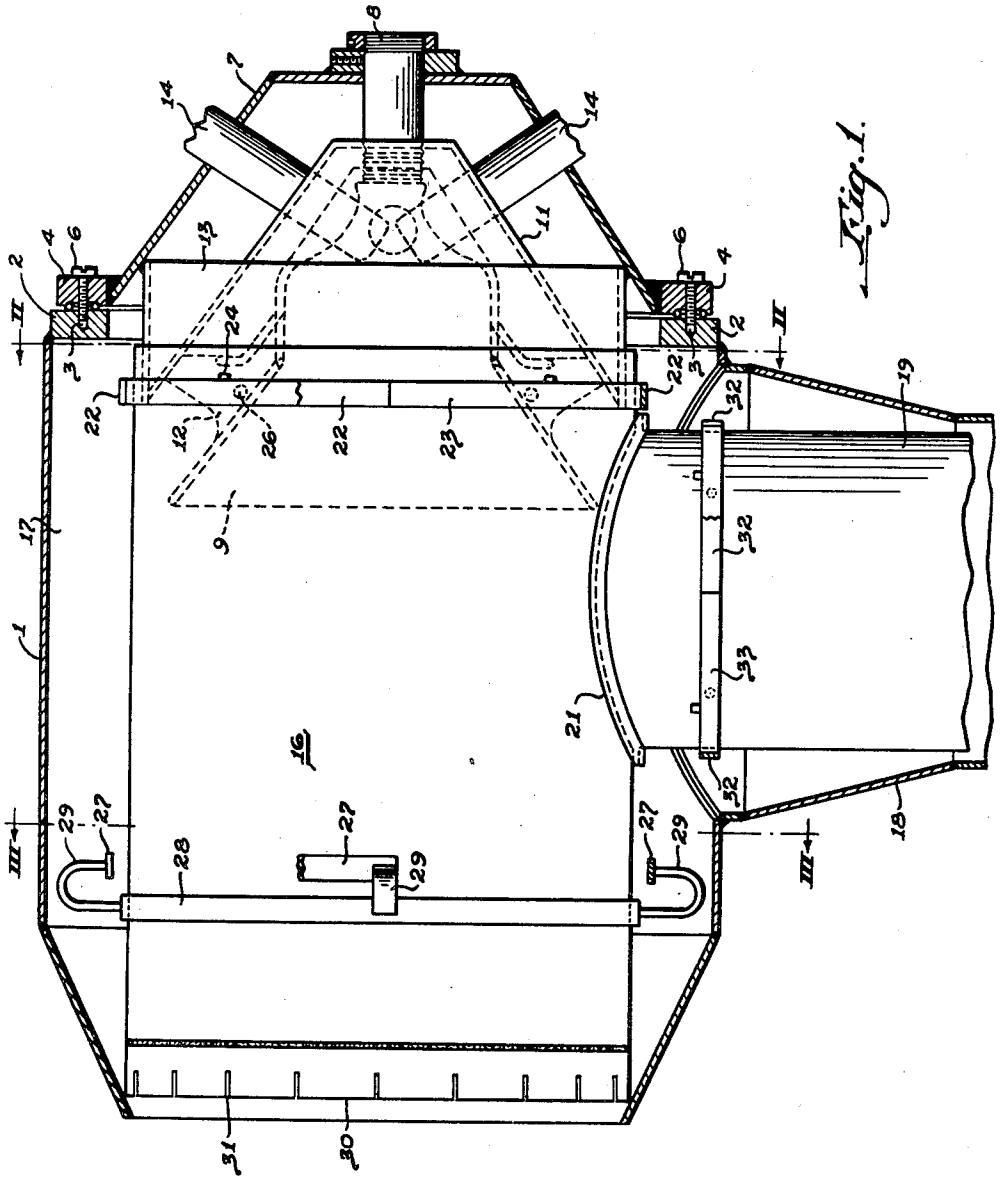


Fig. 1.

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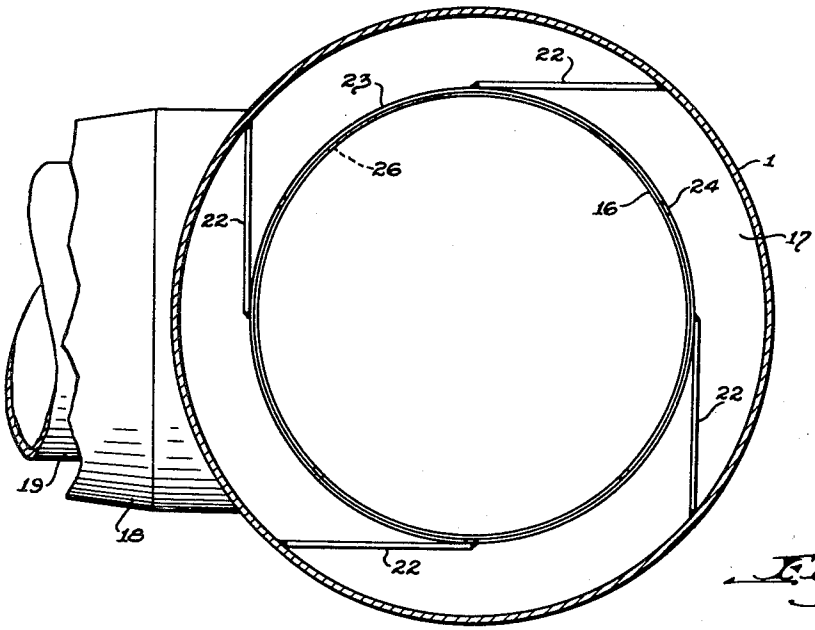


Fig. 2.

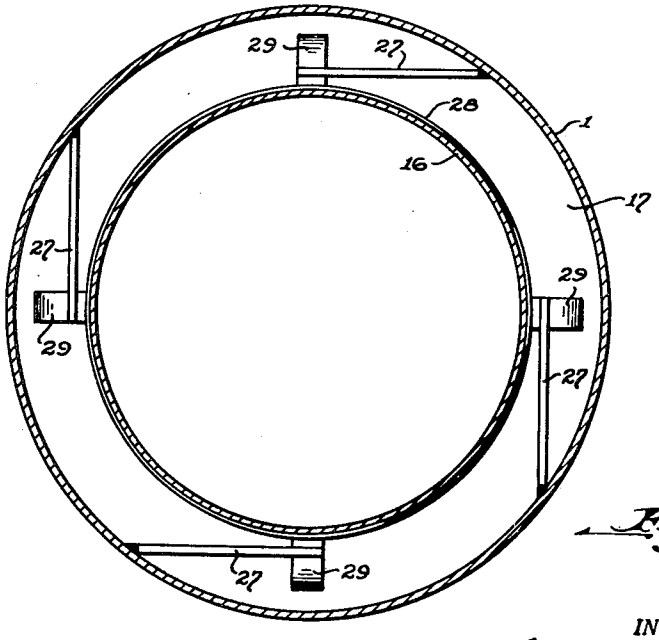


Fig. 3.

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SUPPORT FOR EXPANSIBLE MEMBERS

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8 Claims. (Cl. 263—19)

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This invention relates primarily to combustion chambers, but it is also applicable to other structures subject to high temperatures and in which an inner member is surrounded by an outer member that is spaced from it.

The combustion chambers used in continuous combustion gas turbine cycles, for example, generally include a pair of concentric shells that are spaced from each other. A burner is located at one end of the inner shell, the opposite end of which forms the outlet of the combustion chamber. The space between the shells is for insulation or a stream of air. It is important that the two shells be kept concentric, but this is difficult because the expansion of the inner shell that is due to the extremely high temperatures therein throws them out of alignment. The high temperatures also prevent the satisfactory use of links and pins for supporting the inner shell concentrically in the outer shell.

It is among the objects of this invention to provide simple and inexpensive means, unaffected by high temperatures, for maintaining two spaced members in predetermined relation, such as concentric, in spite of thermal expansion of one of them relative to the other.

In accordance with this invention an inner member is surrounded by an outer member spaced therefrom. One of these members, which may be of any desired shape, is exposed to temperatures high enough to cause it to expand considerably relative to the other one. To keep the centers of the two members in substantially fixed position relative to each other during such expansion, there are at least three flexible bars between the inner and outer members for supporting one of them from the other. Each of these bars lies substantially in a plane perpendicular to the axis of the inner member, and is disposed non-radially of that member to which their inner ends are connected, directly or indirectly, at spaced intervals around it. "Non-radially," as used herein, means that the inner ends of the bars intersect radii of the inner member at angles of less than 180°, approximately 90° being preferable. All of the bars extend away from the inner member in the same clockwise or counterclockwise direction, an arrangement that will be referred to herein as symmetrical. The outer ends of the bars are connected to the outer member. In the case of a combustion chamber the two spaced members generally are cylindrical shells concentrically disposed relative to each other. When the inner shell is heated and expands radially, the bars bend and permit the

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expansion to occur without moving the axis of the inner shell laterally in the outer shell. The flexible bars rigidly support one end of the inner shell, preferably the burner end, while the opposite end is connected to the outer shell by means which permit longitudinal expansion of the inner shell while maintaining concentricity. Thus, similar flexible bars may be used at the free end portion of the inner shell, but their inner ends are connected to the shell through members that can expand lengthwise of the combustion chamber.

An embodiment of the invention is illustrated in the accompanying drawings in which Fig. 1 is a plan view of a gas turbine combustion chamber with the outer casing shown in horizontal section; Fig. 2 is a vertical section through the chamber taken on the line II—II of Fig. 1 but with the elements inside the inner shell omitted; and Fig. 3 is a vertical section taken on the line III—III of Fig. 1.

Referring to Fig. 1 of the drawings, the outer shell or casing 1 of the combustion chamber is cylindrical for most of its length, although its front end is tapered to form a conical portion. Rigidly connected to the rear end of the casing is a ring 2 provided in its rear surface with a plurality of circumferentially spaced threaded openings 3. Another ring 4 is clamped against ring 2 by means of bolts 6, and it supports the front end of a rearwardly tapered cap 7 at the back of the casing. The rear wall of this cap is provided with an opening in which the rear end of a short plugged pipe 8 is rigidly mounted. The front end of this pipe supports an ignition cone 9 that extends forward into the casing. The pipe also supports the rear end of another conical member 11 which surrounds most of the ignition cone and engages lugs 12 integral with the cone. The front end of the conical member is supported by the front end of a short cylinder 13 the rear end of which is secured in the front portion of cap 7. The cap, conical member and ignition cone are all provided with two sets of oppositely disposed aligned openings through which a pair of burner nozzles 14 project into the ignition cone. It will be seen that if ring 4 is disconnected from ring 2 and moved back, all of the members referred to thus far, except ring 2, will be removed as a unit from the casing.

Encircling the front portion of cylinder 13 and extending forward through the casing to a point close to its front end, is a cylindrical inner shell or liner 16. The liner is concentric with the casing from which it is spaced to form a cylindrical

chamber 17 for receiving insulation that, for the sake of clearness, is not shown in the drawings. The liner keeps the flame from striking the insulation. The lining and casing are provided at one side near the burner with aligned openings for admission of air under pressure. Extending away from the casing opening is a tubular housing 18 through which a cylindrical conduit 19 extends from an air compressor. The inner end of this conduit is provided with a flange 21 that overlaps the side opening in the liner but does not touch the liner when it is cold, whereby to allow for radial expansion of the liner. The inner end portion of the conduit is supported in housing 18 in a manner to be described later.

It is a feature of this invention that liner 16 is supported in casing 1 in such a manner that the liner can expand, when heated by the burner, without moving its axis laterally relative to the axis of the casing. Accordingly, the rear or burner end of the liner is supported in the casing by a plurality of flexible bars 22 that are symmetrically disposed non-radially of the liner, preferably substantially tangentially, as shown in Fig. 2. Although the inner ends of these bars may be secured directly to the liner, it is preferred to connect them to it through the medium of a ring 23 to which they are welded. The outer ends of these bars are secured to the inner surface of the casing. The liner is held in this ring after it has been inserted therein and moved forward until a plurality of lugs 24 welded to the outer surface of the liner strike against the rear edge of the ring. The liner is fastened to the ring by welding through holes 26 in the liner inside the ring. In order to rigidly support the lines in the casing there must be at least three of these flexible bars which most suitably are equally spaced around ring 23, but as many more may be used as is desired. The drawing shows the use of four bars. When the liner becomes hot and expands, the inner ends of the bars swing outwardly and permit it to expand uniformly in all directions from the common axis of the liner and casing. Expansion of the bars merely rotates the liner on its axis. Consequently, the center of the liner does not move laterally, and the liner stays concentric with the casing.

The front end of the liner is supported by flexible bars 27 and a ring 28 in the same general manner as the rear end of the liner, but to allow for its longitudinal as well as radial expansion, the inner ends of these bars are not connected directly to the ring. Instead, each bar is secured to the rear end of a flexible U-shape metal bar 29 disposed substantially radially of the liner with its front end welded to ring 28. Bars 27 permit radial expansion of the liner to take place without shifting the position of its center, while longitudinal expansion and contraction of the liner is unrestrained because the U-shape bars 29 will open and close to allow for it.

Forming an extension of the front end of the liner is a thin sealing ring 30, as shown in Fig. 1, the front portion of which is provided with a plurality of circumferentially spaced slots 31 extending rearwardly to form short spaced segments. The front edges of these segments engage the conical front end of the casing. When the liner expands, the ring segments are moved forward in the casing and are bent inwardly by it without interfering with expansion of the liner.

The front end portion of compressed air conduit 19 is supported in housing 18 in the same manner as the rear end of liner 16 is supported;

that is, by at least three flexible bars 32 symmetrically disposed more or less tangentially of a ring 33 to which their inner ends are welded. The outer ends of these bars are welded to the surrounding housing. The ring encircles and supports the conduit to which it is fastened.

According to the provisions of the patent statutes, I have explained the principle and construction 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. A combustion chamber comprising two spaced concentric shells, a burner at one end of the inner shell, the opposite end of the outer shell being conical and substantially engaging the adjacent end of the inner shell, said adjacent end of the inner shell being provided with a plurality of inwardly extending and circumferentially spaced slots, and at least three flexible bars between the shells at the burner end, said bars being symmetrically disposed non-radially of the inner shell with their inner ends connected thereto at spaced intervals around it, all of said bars extending away from the inner shell in the same circumferential direction with their outer ends connected to the outer shell.

2. A combustion chamber comprising two spaced concentric shells, a burner at one end of the inner shell, a ring encircling the burner end of the inner shell, at least three flexible bars between the ring and outer shell for supporting the ring, said bars being symmetrically disposed non-radially of the ring with their inner ends secured thereto at spaced intervals around it, all of said bars extending away from the inner shell the same circumferential direction with their outer ends connected to the inside of the outer shell, a second ring encircling the opposite end of the inner shell, at least three flexible bars beside said second ring and being symmetrically disposed non-radially of the inner shell with their outer ends connected to the outer shell at spaced intervals around it, and supporting members expansible lengthwise of said inner shell connecting the inner ends of said least-mentioned bars to said second ring, all of said last-mentioned bars extending away from the inner shell in the same circumferential direction as said first-mentioned bars.

3. A combustion chamber comprising two spaced concentric shells, a burner at one end of the inner shell, at least three flexible bars between the shells at the burner end, said bars being symmetrically disposed substantially tangentially of the inner shell with their inner ends connected thereto at spaced intervals around it, all of said bars extending away from the inner shell in the same circumferential direction with their outer ends connected to the outer shell, at least three flexible bars between the shells at the opposite end of the inner shell and being symmetrically disposed substantially tangentially thereof with their outer ends connected to the outer shell at spaced intervals around it, and supporting members expansible lengthwise of said inner shell connecting the inner ends of said last-mentioned bars to said inner shell, all of said last-mentioned bars extending away from the inner shell in the same circumferential direction as said first-mentioned bars.

4. A combustion chamber comprising two spaced concentric shells, a burner at one end of the inner shell, at least three flexible bars between the shells at the burner end, said bars being symmetrically disposed non-radially of the inner shell with their inner ends connected thereto at spaced intervals around it, all of said bars extending away from the inner shell in the same circumferential direction with their outer ends connected to the outer shell, and means connecting the opposite end of the inner shell to the outer shell for movement axially thereof when the inner shell expands lengthwise.

5. The combination with two spaced cylinders one of which is inside the other and is subject to thermal expansion and contraction radially and longitudinally relative to the outer one, of at least three flexible bars between said cylinders at one end, said bars being symmetrically disposed non-radially of the inner cylinder with their inner ends connected thereto at spaced intervals around it, all of said bars extending away from the inner cylinder in the same circumferential direction with their outer ends connected to the outer cylinder, and at least three flexible bars between said cylinders at the opposite end of the inner cylinder and being symmetrically disposed non-radially thereof with their outer ends connected to the outer cylinder at spaced intervals around it, and flexible U-shape members connected at one end to the inner ends of said last-mentioned bars, the opposite end of each of said members being connected to the inner cylinder at a point spaced longitudinally thereof from the adjoining bar, all of said last-mentioned bars extending away from the inner cylinder in the same circumferential direction as said first-mentioned bars.

6. The combination with two spaced elongated members one of which is inside the other and one of which is subject to thermal expansion and contraction radially and longitudinally relative to the other, of at least three flexible bars between said members at one end, said bars being symmetrically disposed non-radially of the inner member with their inner ends connected thereto at spaced intervals around it, all of said bars extending away from said inner member in the same circumferential direction with their outer ends connected to the outer member, at least three flexible bars between said members at the opposite end of the inner member and being

symmetrically disposed non-radially thereof with their outer ends connected to the outer member at spaced intervals around it, and supporting members expansible lengthwise of said inner member connecting the inner ends of said last-mentioned bars to said inner member, all of said last-mentioned bars extending away from said inner member in the same circumferential direction as said first-mentioned bars.

7. In combination, a ring, a shell surrounding it and spaced therefrom, at least three flexible bars between said shell and ring for supporting the ring from the shell, said bars being symmetrically disposed non-radially of the ring at the side thereof with their outer ends connected to the inside of the shell at spaced intervals around it, U-shape flexible members connected at one end to the inner ends of the bars, the opposite end of said members being connected to said ring, all of said bars extending away from said ring in the same circumferential direction, and an inner member mounted in said ring and supported thereby.

8. A combustion chamber comprising an outer shell, a ring in the shell concentric therewith and spaced therefrom, at least three flexible bars between the ring and shell for supporting the ring, said bars being symmetrically disposed non-radially of the ring with their inner ends secured thereto at spaced intervals around it, all of said bars extending away from the ring in the same circumferential direction with their outer ends connected to the inside of the outer shell, an inner shell inserted in said ring and supported thereby, and projections on said inner shell for limiting the distance it can be inserted in the ring.

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