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COMBUSTION CHAMBER FOR A GAS TURBINE ENGINE

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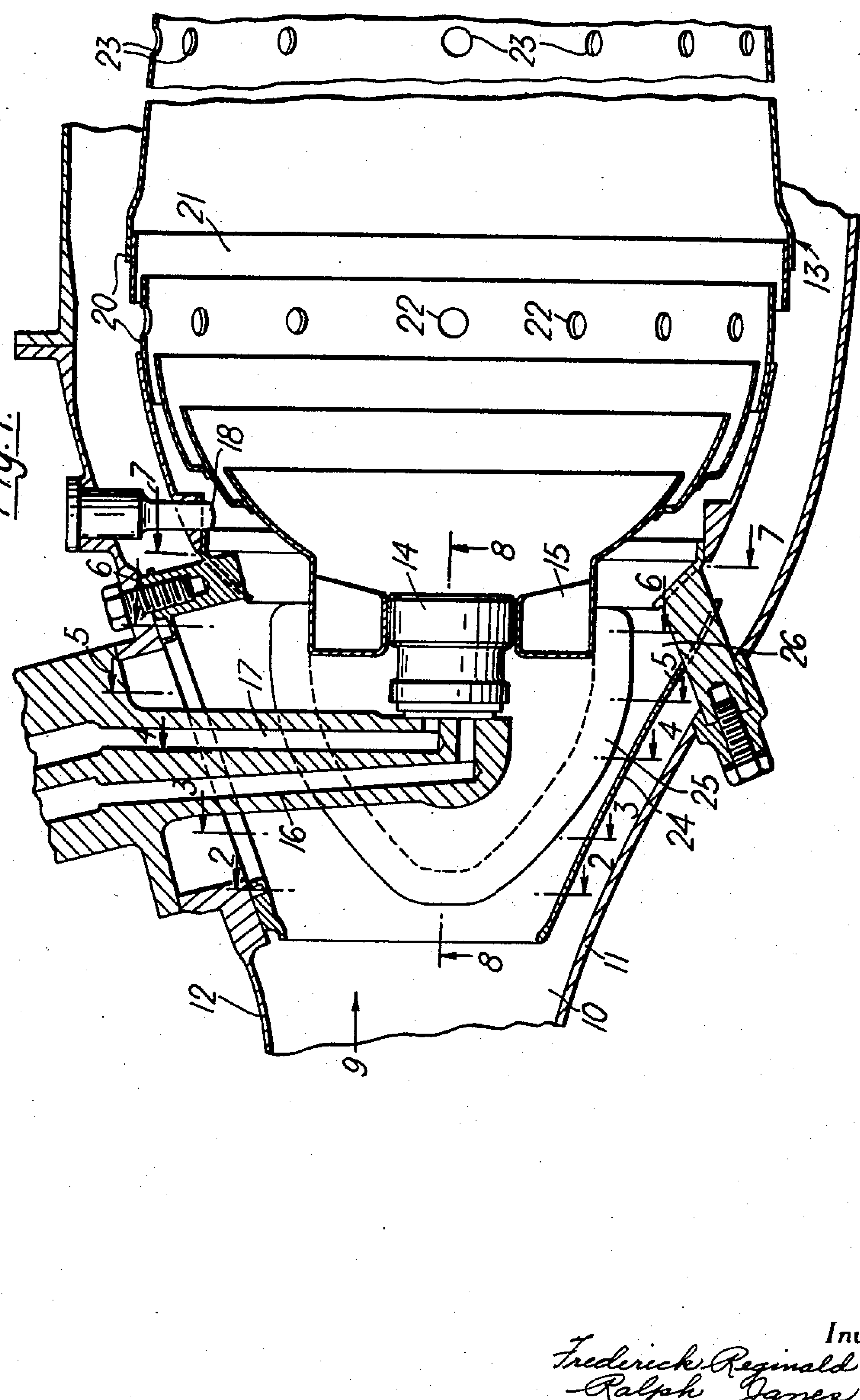

Fig. 1.

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Fig. 2.

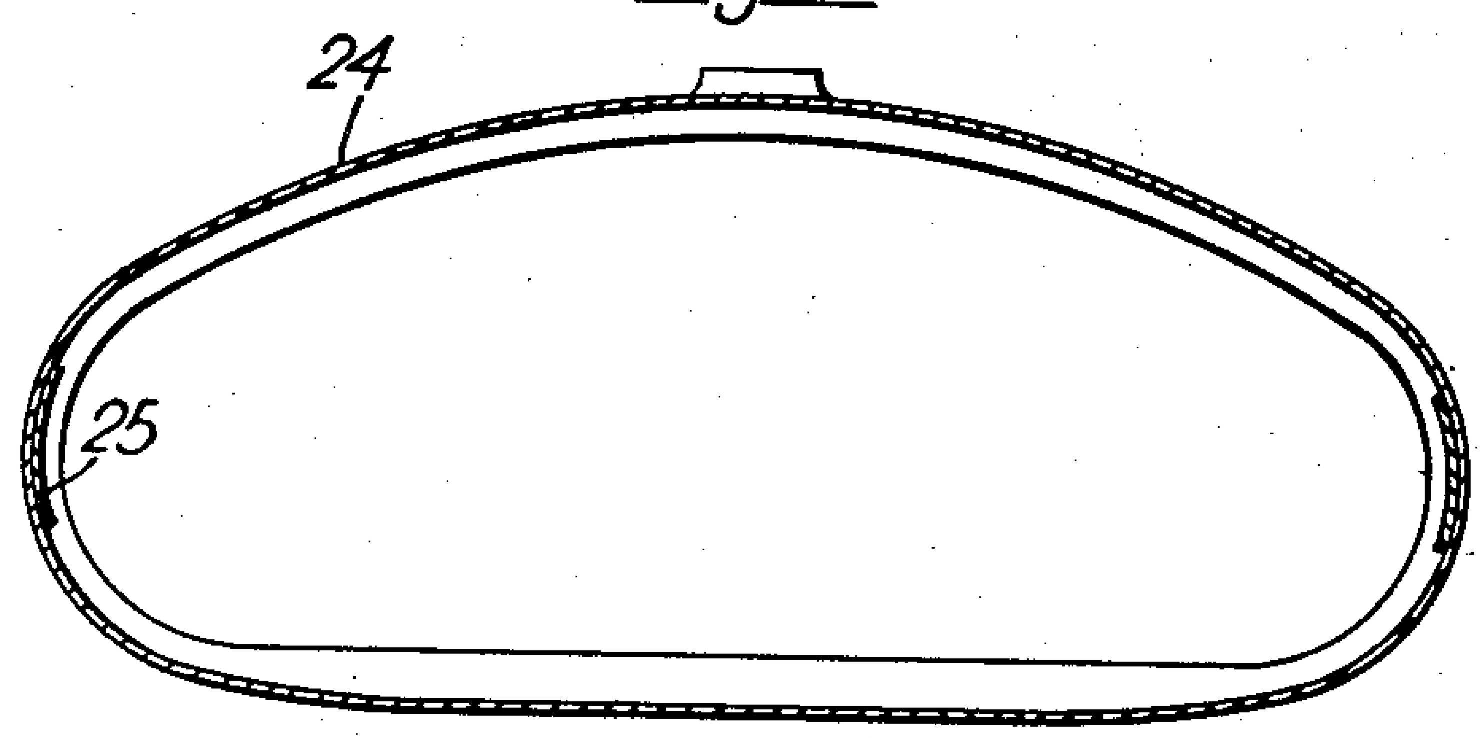

Fig. 3.

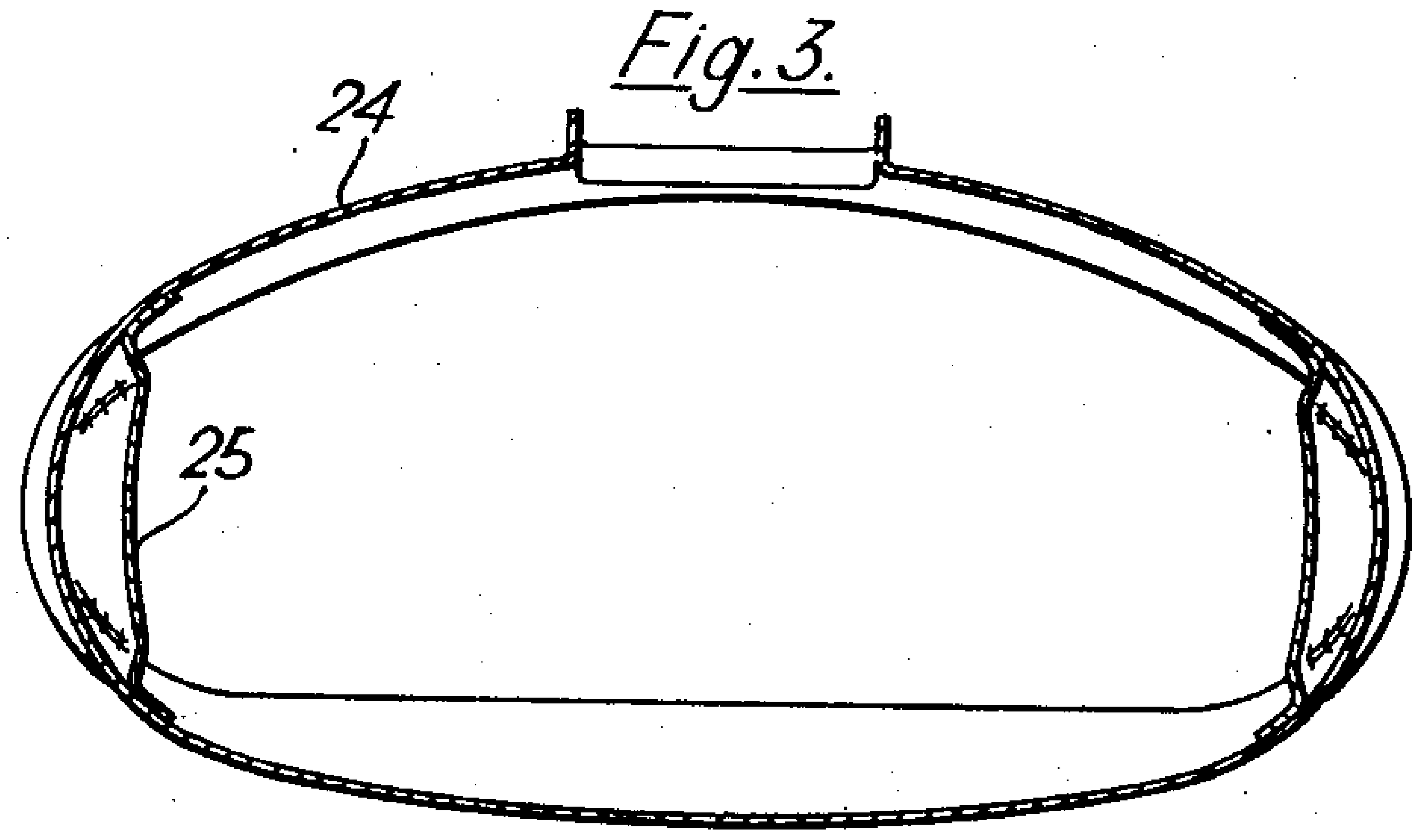

Fig. 4.

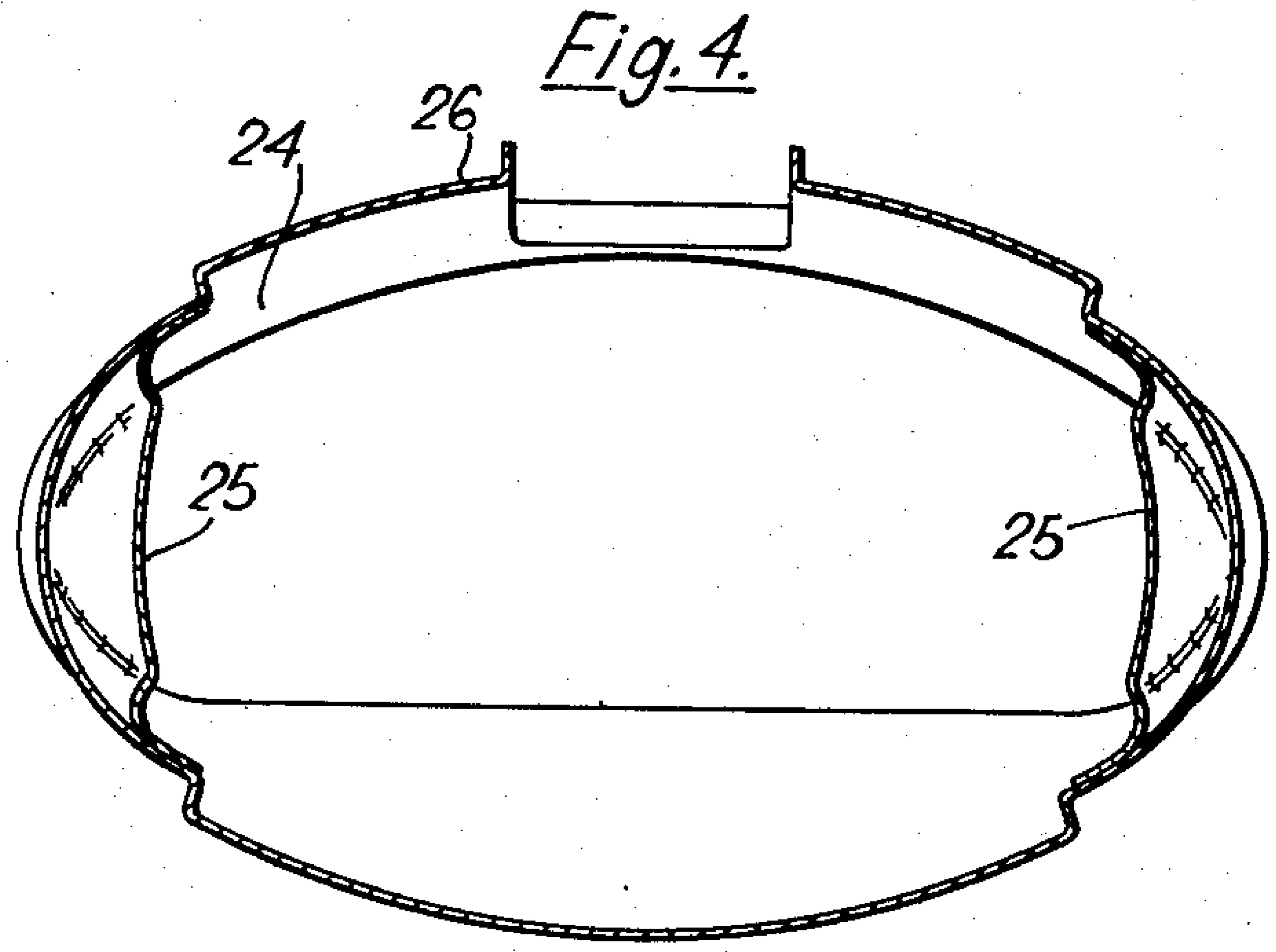

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Fig. 5.

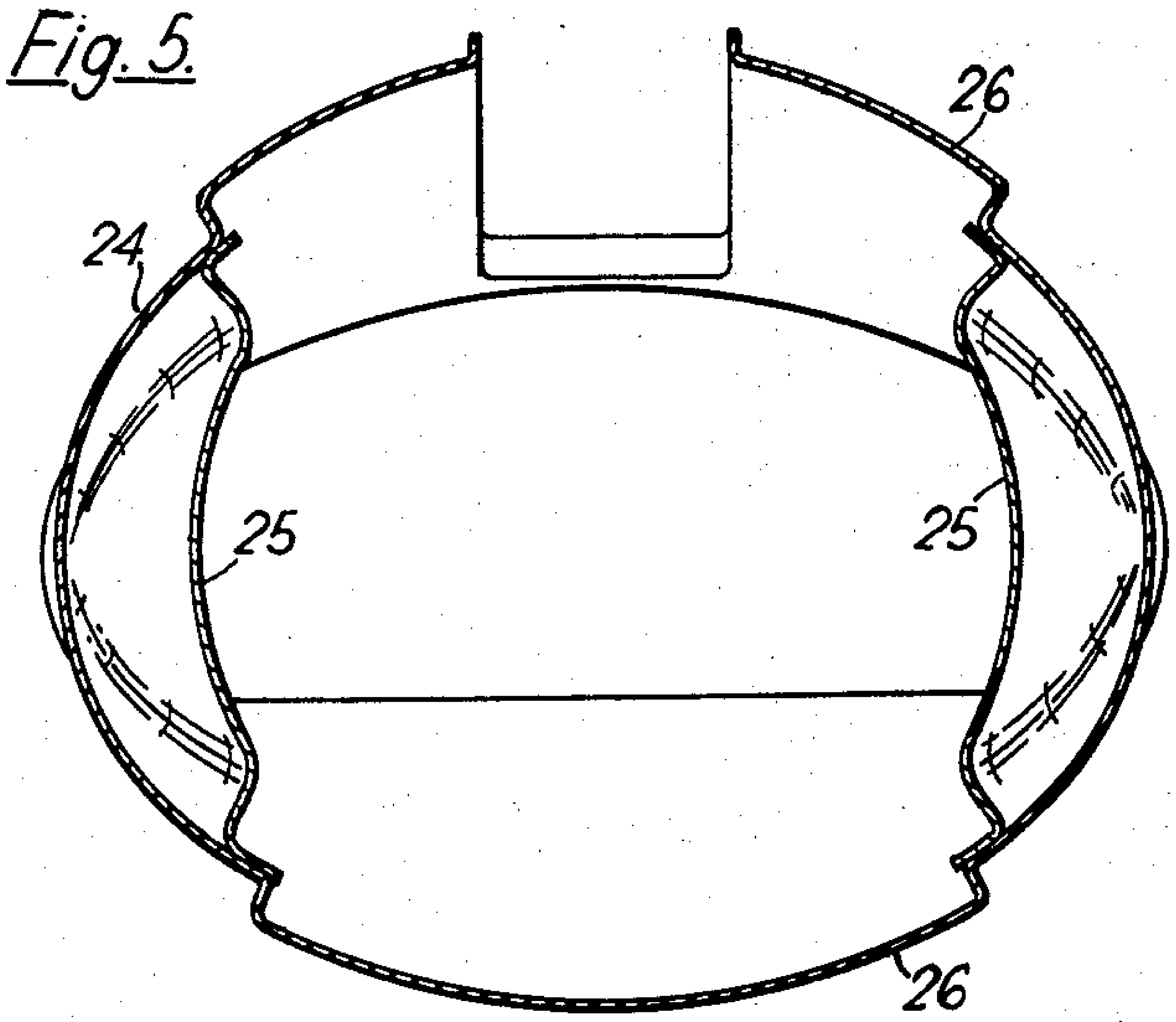

Fig. 6.

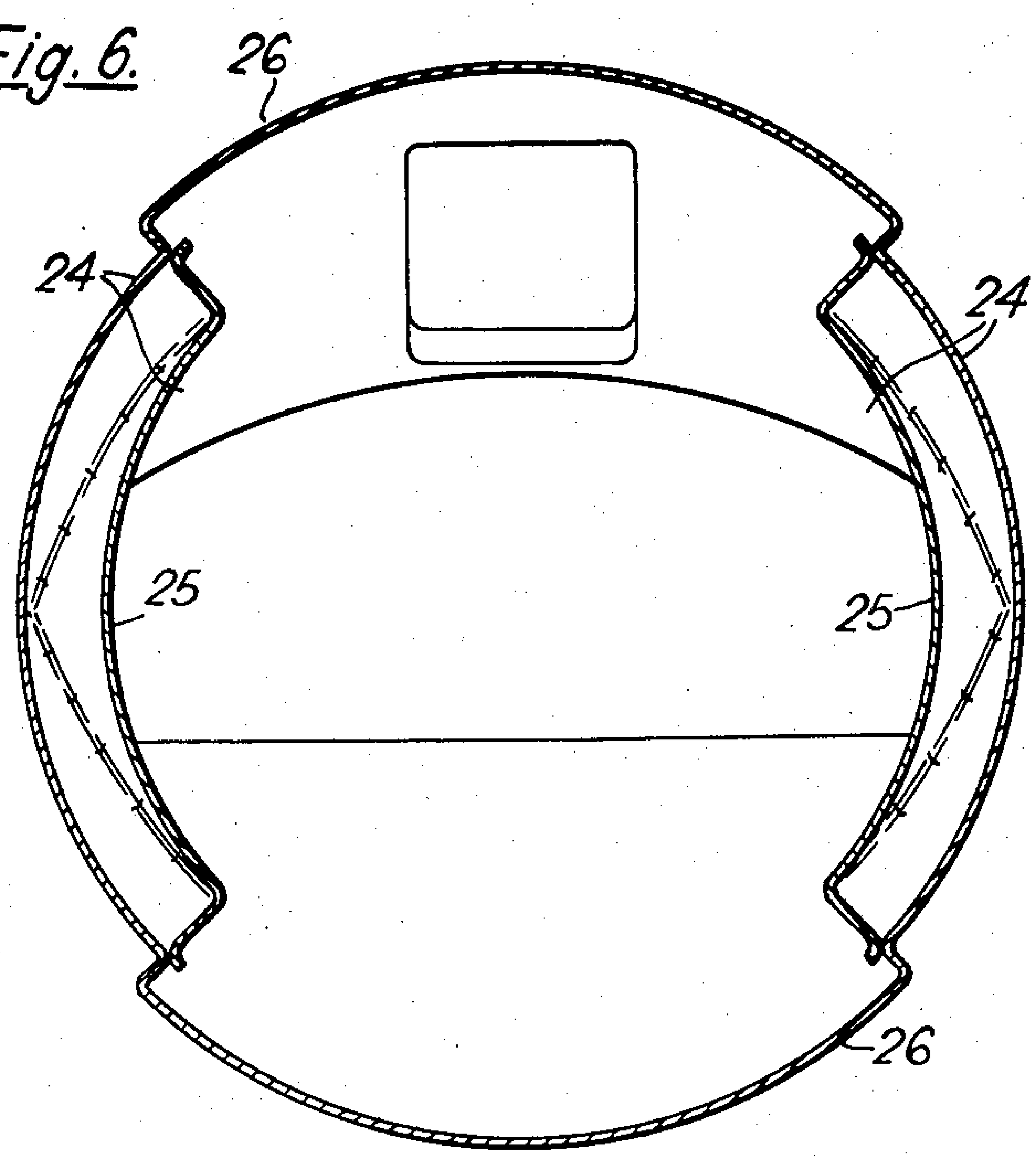

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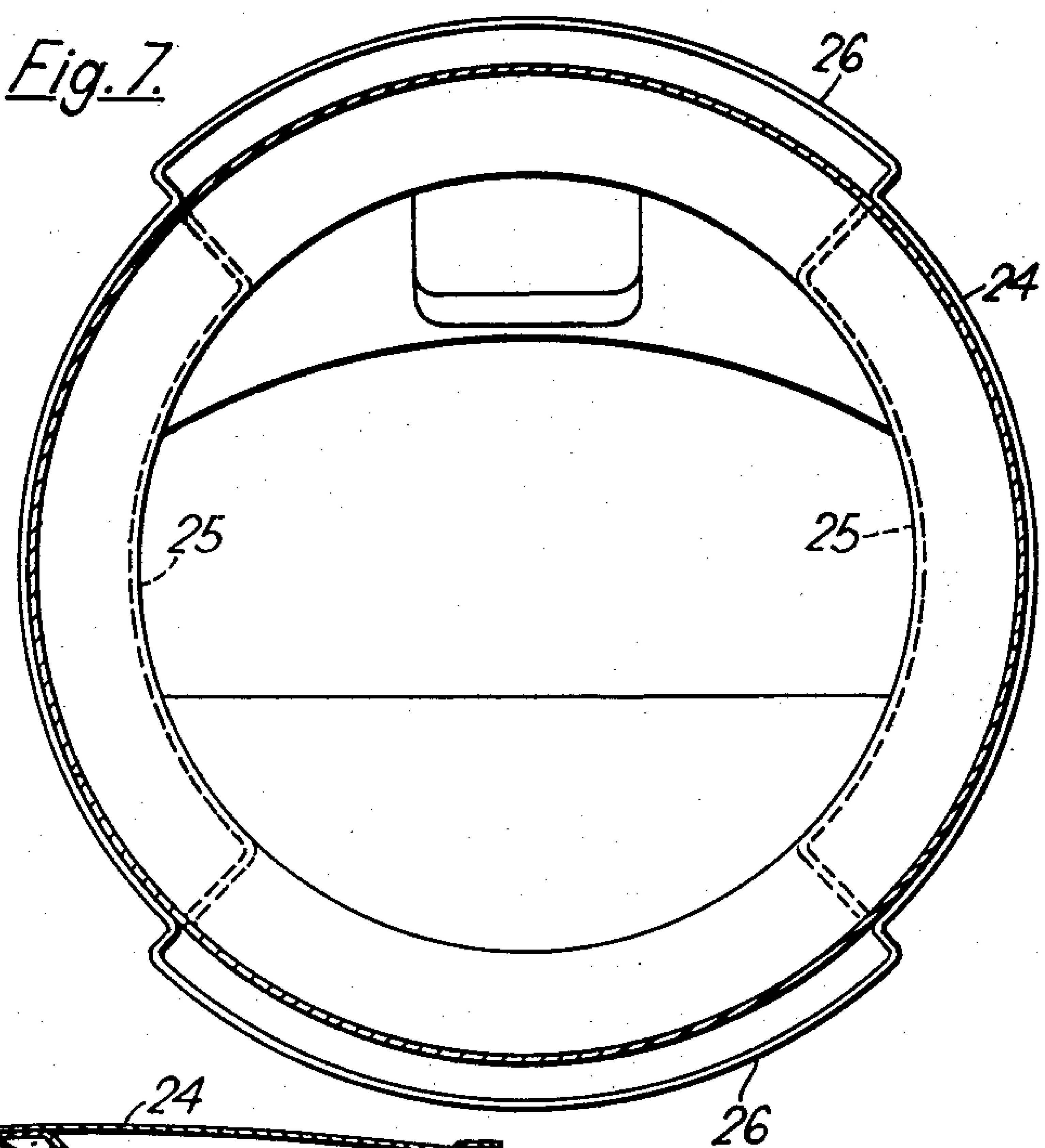
Fig. 7.



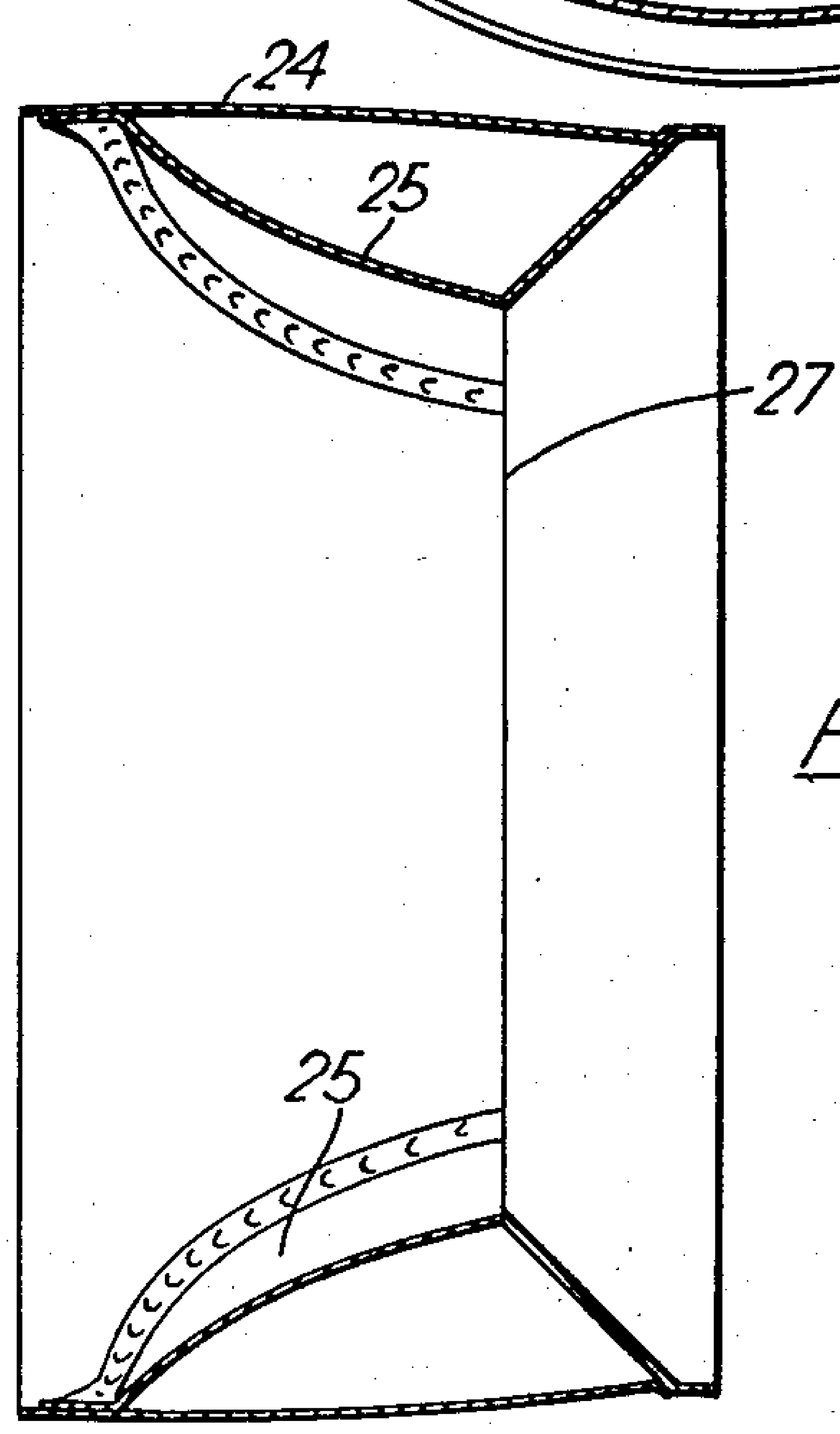


Fig. 8.

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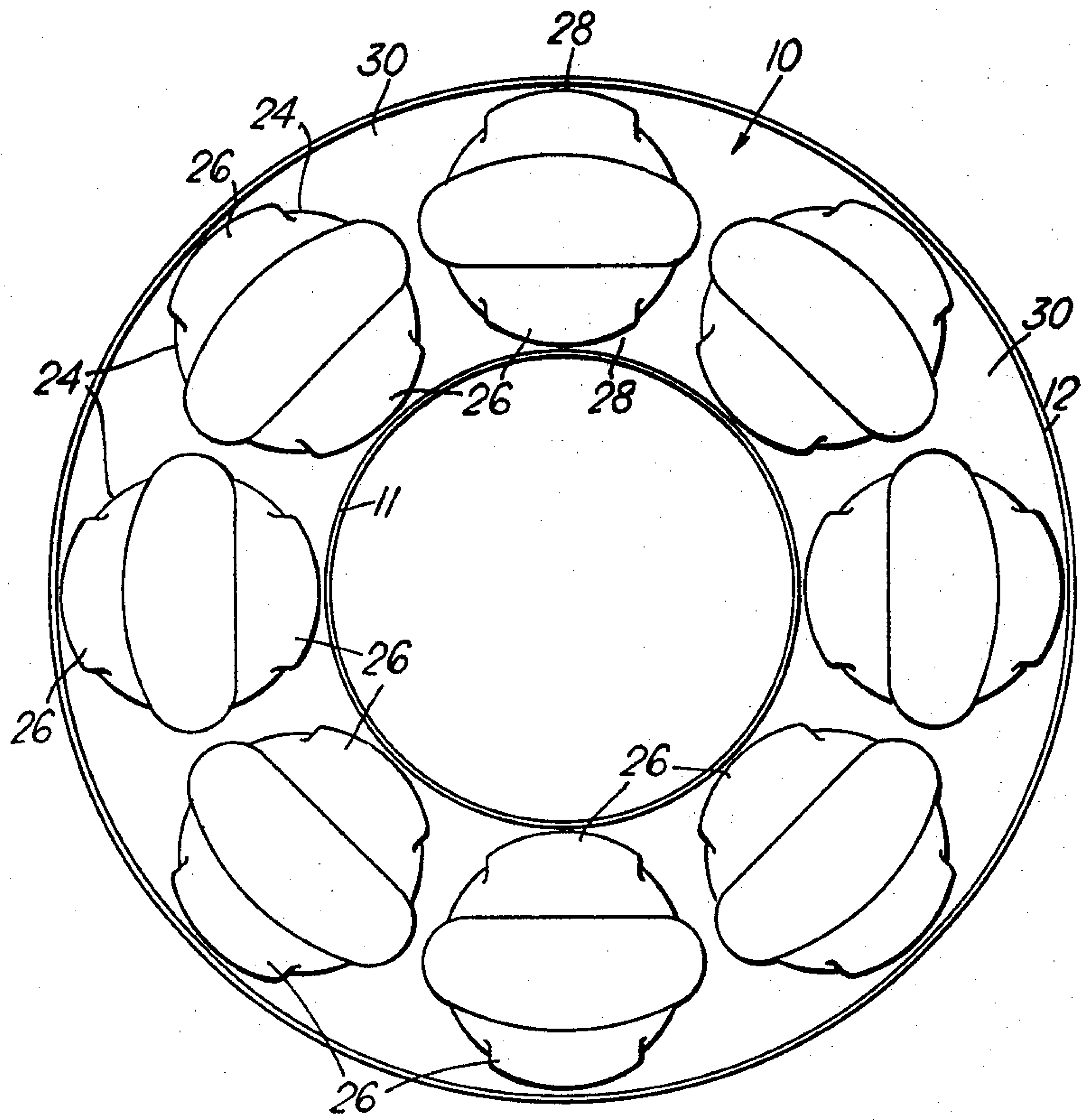
Fig. 9.



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COMBUSTION CHAMBER FOR A GAS TURBINE ENGINE

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4 Claims. (Cl. 60—39.37)

This invention concerns a combustion chamber for a gas turbine engine.

Such a combustion chamber may comprise an annular chamber whose upstream end receives air compressed by the engine compressor, a plurality of angularly spaced apart flame tubes being mounted within the annular chamber. Each flame tube may be open at its upstream end to receive from the annular chamber a supply of "primary" air, i.e. the whole, or the major portion, of the air employed in supporting combustion within the flame tube. Each of the flame tubes may also, if desired, be formed downstream of its combustion zone with a ring of apertures which are open to the air flowing through the annular chamber and through which may flow "secondary" air (i.e. air employed to assist reversal of the direction of flow of the products of combustion within the flame tube and to complete the combustion). Additionally each of the flame tubes may be formed substantially downstream of its combustion zone with a ring of apertures which are open to the air flowing through the annular chamber and through which may flow "tertiary," or "dilution," air (i.e. air employed to dilute the products of combustion so as to cool them to temperatures acceptable to the engine turbine).

It will be appreciated that the space separating each flame tube from its adjacent flame tubes and from the inner and outer walls of the annular chamber does not remain constant all the way round the flame tube with the result that there is an uneven distribution of air around the flame tube.

Uneven distribution of air around a flame tube also occurs because the compressed air leaving the compressor has to go through a greater degree of deflection to reach the parts of the annular chamber furthest away from and nearest to the centre line of the engine than the air flowing past the flame tube directly downstream of the compressor outlet. As a result of this uneven distribution of air around the flame tube, the amount of air which will pass through the various apertures of each said ring of apertures in the flame tube will depend upon whether the said aperture is disposed adjacent a part of said space which is well supplied or poorly supplied with air. If, however, unequal quantities of air pass through the various apertures of each ring of apertures, an undesirable temperature distribution will occur within each flame tube with the result that hot spots may develop in the turbine. Poor distribution also adversely affects the cooling of the flame tube walls.

According, therefore, to the present invention, there is provided a combustion chamber for a gas turbine engine comprising an annular chamber whose upstream end is adapted to receive air compressed by the engine compressor, a plurality of angularly spaced apart flame tubes mounted within said annular chamber, each flame tube having at least one series of angularly spaced apart apertures arranged downstream of the combustion zone therein for the admission therethrough of secondary and/or dilution air from the annular chamber, and means for directing air into portions of the space within the annular chamber which otherwise receive a restricted supply of air, whereby to increase the air supply to said portions.

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Thus each flame tube may be provided with an intake means having an upstream end which is adapted to receive air from the upstream end of the annular chamber and a downstream end which is arranged to supply primary air to the respective flame tube, the intake means being provided with chutes or ducts for directing a proportion of the air flowing through the intake means towards the said portions of the annular chamber.

The intake means may have an elongated shape at its upstream end, and the downstream end of the intake means may be substantially circular and provided with the said chutes or ducts.

The intake means may be provided with baffle members which are mounted on the internal wall of the intake means, the baffle members being shaped so as to cause a proportion of the air to flow towards the centre of the intake means.

Preferably there are a pair of diametrically oppositely disposed chutes or ducts and a pair of diametrically oppositely disposed baffle members each of which is disposed between said chutes or ducts.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:

FIGURE 1 is an axial section through part of a combustion chamber according to the present invention.

FIGURES 2–8 are diagrammatic sections taken respectively on the lines 2—2, 3—3, 4—4, 5—5, 6—6, 7—7 and 8—8 of FIGURE 1 and to a larger scale, and

FIGURE 9 is a diagrammatic view looking in the direction of the arrow 9 of FIGURE 1.

Referring to the drawings, a combustion chamber for a gas turbine engine comprises an annular chamber 10 (FIGURES 1 and 9) having an inner wall 11, the outer wall of the chamber 10 being constituted by the engine casing 12. The upstream end of the chamber 10 (i.e. the left hand end as seen in FIGURE 1) is adapted to receive a supply of air which has been compressed by the engine compressor (not shown).

Within the annular chamber 10 there are mounted a plurality (e.g. eight) of angularly spaced apart flame tubes 13 whose upstream ends receive primary air from the chamber 10.

Each of the flame tubes 43 is provided at its upstream end with a fuel injector 14 which is mounted concentrically within an annular arrangement of swirl vanes 15, the latter being adapted to impart a swirl to primary air passing therethrough. The fuel injectors comprise main and pilot burners (not shown) which are supplied with fuel through conduits 16, 17.

The flame tubes 13 are positioned by locating pins 18 and are made up of a plurality of axially consecutive, telescopically arranged, sections 20 between which are disposed corrugated annular members 21. Cooling air may flow from the chamber 10 and between the corrugations of the members 21 so as to cool the internal surfaces of the sections 20.

A ring of angularly spaced apart apertures 22 are formed in one of the sections 20 so as to be adapted to admit secondary air from the chamber 10 into the flame tube 13 immediately downstream of the combustion zone therein. The secondary air completes the combustion and assists a reversal of direction in the flow of the products of combustion within the flame tube.

Downstream of the apertures 22 there is a further ring of angularly spaced apart apertures 23 which are adapted to admit dilution air from the chamber 10 and into the flame tube 13 so as to reduce the temperature of the said products of combustion to values acceptable to the engine turbine.

Mounted at the upstream end of each of the flame tubes 13 is an intake member or "snout" 24 on whose internal wall are mounted a pair of diametrically oppositely disposed baffle members **25**. The upstream end of each intake member **24** is adapted to receive air from the upstream end of the annular chamber **10** while the downstream end of each intake member **24** is arranged to supply primary air to the respective flame tube **13**.

Each intake member **24** has, at its upstream end, a shape which is elongated circumferentially of the annular chamber **10**. At its downstream end, the intake member **24** is substantially circular and is provided with a pair of diametrically oppositely disposed chutes **26**, each of the baffle members **25** being disposed between the chutes **26**.

As will be seen from FIGURES 2–9, the shape of the intake member **24** changes smoothly from its circumferentially elongated upstream end to its substantially circular downstream end.

Each baffle member **25** has a convergent-divergent form, its "throat" **27** being disposed adjacent the fuel injector **14**. The arrangement is such that while the air flowing through the intake member **24** in the region of the baffle members **25** is directed towards the centre of the intake member **24** so as to pass into the flame tube through the swirl vanes **15**, it is also deflected towards the corners of the chutes **26** to ensure a smooth flow into the chutes **26** thereby avoiding vertices in the corners of the chutes.

It will be noted from FIGURE 9 that the intake members **24** (and hence the flame tubes **13** which are not shown in FIGURE 9) are well spaced from each other circumferentially of the annular chamber **10** but are disposed closely adjacent the casing **12** and inner wall **11** radially of the chamber **10**. In the regions **28** there is therefore restricted space for the flow of air whereas in the regions **30** there is ample space for the flow of air. Accordingly the air flowing through the regions **28** will be of lower velocity than that flowing through the regions **30** and, but for the chutes **26**, any apertures **22**, **23** in the regions **28** would therefore have smaller quantities of air passing therethrough than passes through the apertures **22**, **23** in the region **30**. The chutes **26**, however, are directed towards the regions **28** and therefore ensure that there is an even velocity traverse of the secondary and dilution air around each of the flame tubes **13**.

It will be appreciated that the area of each intake member **24** will be such as to take in the correct amount of air suitable for the primary combustion zone plus an additional amount of air which is discharged through the chutes **26** towards the restricted regions **28**.

We claim:

1. A combustion chamber for a gas turbine engine comprising an annular chamber having an inner wall and a spaced outer wall, said annular chamber having an upstream end adapted to receive air compressed by the engine compressor; a plurality of angularly spaced apart flame tubes of substantially circular cross section mounted within said annular chamber and defining therewith a space, said space having restricted portions immediately adjacent areas where said flame tubes are situated closest to the inner and outer walls respectively of said annular chamber, said restricted portions of said space normally receiving less air than do the remaining unrestricted portions of said space, each of said flame tubes having means defining at least one series of angularly spaced apart apertures arranged downstream of the combustion zone therein for admission therethrough of air from said space in said annular chamber; intake means mounted adjacent the upstream end of each flame tube and through which flows air to said angularly spaced apart apertures, each of said intake means having an upstream end which receives a portion of the air from the upstream end of the annular chamber and a downstream end which supplies air to the flame tube, said downstream end being provided with chutes adjacent said restricted portions for directing a proportion of the air flowing through the intake

means towards the restricted portions of the space within the annular chamber in order to supply additional air thereto whereby air supply to said restricted portions is increased so that admission of air from said space through said angularly spaced apart apertures is evenly distributed through the same.

2. A combustion chamber for a gas turbine engine comprising an annular chamber having an inner wall and a spaced outer wall, said annular chamber having an upstream end adapted to receive air compressed by the engine compressor; a plurality of angularly spaced apart flame tubes of substantially circular cross section mounted within said annular chamber and defining therewith a space, said space having restricted portions immediately adjacent areas where said flame tubes are situated closest to the inner and outer walls respectively of said annular chamber, said restricted portions of said space normally receiving less air than do the remaining unrestricted portions of said space, each of said flame tubes having means defining at least one series of angularly spaced apart apertures arranged downstream of the combustion zone therein for the admission therethrough of air from said space in said annular chamber; intake means mounted adjacent the upstream end of each of said flame tubes and through which air flows to said angularly spaced apart apertures, each intake means having an upstream end for receiving air from the upstream end of said annular chamber and a substantially circular downstream end for supplying air to the flame tube, said upstream end having a shape which is elongated circumferentially of said annular chamber, said substantially circular downstream end being provided with chutes adjacent said restricted portions of the space within the annular chamber, said chutes providing said downstream end with a shape having a major axis extending radially of said annular chamber, said chutes directing a portion of the air flowing through the intake means toward said restricted portions so as to supply additional air to the restricted portions whereby the air supply to said restricted portions is increased so that the admission of air from said space through said angularly spaced apart apertures is evenly distributed through the same.

3. A combustion chamber for a gas turbine engine comprising an annular chamber having an inner wall and a spaced outer wall, said annular chamber having an upstream end adapted to receive air compressed by the engine compressor; a plurality of angularly spaced apart flame tubes of substantially circular cross section mounted within said annular chamber and defining therewith a space, said space having restricted portions immediately adjacent the areas where said flame tubes are situated closest to the inner and outer walls respectively of said annular chamber, said restricted portions of said space normally receiving less air than do the remaining unrestricted portions of said space, each of said flame tubes having means defining at least one series of angularly spaced apart apertures arranged downstream of the combustion zone therein for admission therethrough of air from said space in said annular chamber; an intake means mounted adjacent the upstream end of each flame tube and through which air flows to said angularly spaced apart apertures, each intake means having an upstream end for receiving air from the upstream end of the annular chamber and a substantially circular downstream end for supplying air to said flame tube, said intake means having an internal wall and including baffle members mounted on said internal wall for causing a proportion of the air to flow towards the center of the intake means, and two chutes disposed diametrically opposite one another at said substantially circular downstream end for directing a proportion of the air flowing therethrough towards the restricted portions of the space within the annular chamber so as to supply additional air into the restricted portions whereby air supply to said re-

stricted portions is increased so that admission of air from said space through said angularly spaced apart apertures is evenly distributed through the same.

4. A combustion chamber for a gas turbine engine comprising an annular chamber having an inner wall and a spaced outer wall, said annular chamber having an upstream end adapted to receive air compressed by the engine compressor; a plurality of angularly spaced apart flame tubes of substantially circular cross section mounted within said annular chamber and defining therewith a space, said space having restricted portions immediately adjacent areas where said flame tubes are situated closest to the inner and outer walls respectively of said annular chamber, said restricted portions of said space normally receiving less air than do the remaining unrestricted areas of said space, each of said flame tubes having means defining at least one series of angularly spaced apart apertures arranged downstream of the combustion zone therein for admission therethrough of air from said space in said annular chamber; intake means mounted at the upstream end of said flame tube and through which air flows to said angularly spaced apart apertures, each intake means having a circumferentially extending elongated upstream end for receiving a portion of the air from the upstream end of the annular chamber and a substantially circular downstream end for supplying air to the flame tube, said intake means having an internal wall and including a pair of diametrically oppositely disposed baffle members mounted on the internal wall of the same for causing a proportion of the air flowing therethrough to flow towards the center thereof, and a pair of diametrically oppositely disposed chutes arranged on a common radius of said annular chamber adjacent said restricted portions, each of said chutes being disposed between said baffle members and forming a part of the downstream end of said intake means, said chutes directing a proportion of the air flowing through said intake means towards the restricted portions of said space within said annular chamber to supply additional air into the restricted portions whereby air supply to the restricted portions is increased so that admission of air from said space through said angularly spaced apart apertures is evenly distributed through the same into said flame tubes.

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