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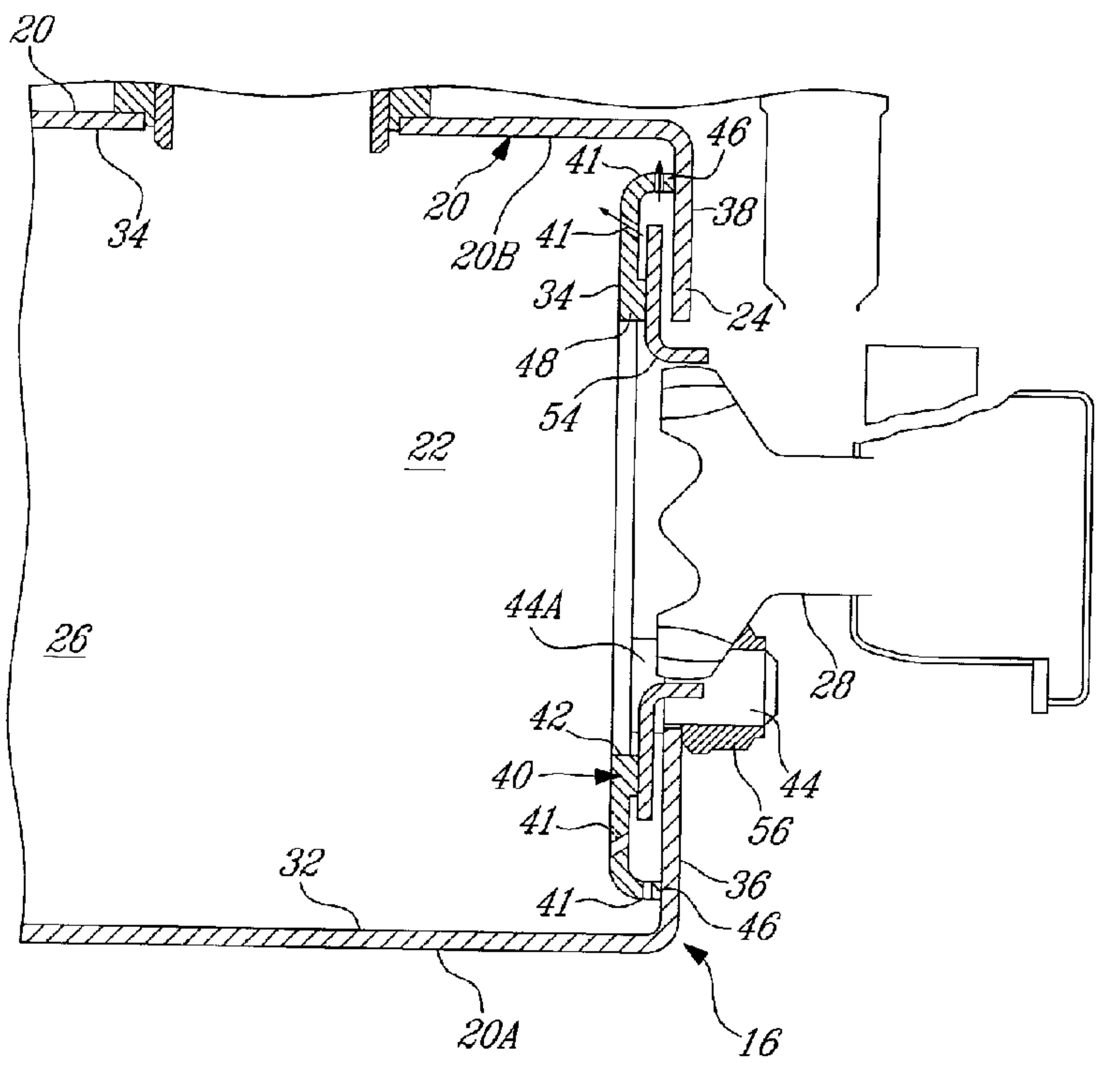
(71) Demandeur/Applicant:
PRATT & WHITNEY CANADA CORP., CA

(72) Inventeurs/Inventors:
MORENKO, OLEG, CA;
PATEL, BHAWAN B., CA

(74) Agent: SWABEY, MITCHELL, HOULE, MARCOUX & SHER

(54) Titre : CHEMISE THERMIQUE DE CHAMBRE DE COMBUSTION
(54) Title: COMBUSTOR HEAT SHIELD



(57) Abrégé/Abstract:
A heat shield for a gas turbine engine having a combustor includes an annular configuration extending substantially 360 degrees about the combustor for protecting a dome portion thereof, which is formed by radially extending flanges of inner and outer liners of the combustor. The heat shield fixedly secures the radially extending flanges of the inner and outer liners together in a sealing relationship such as to structurally form the dome portion of the combustor. The heat shield is disposed internally within the combustor and substantially entirely overlying the dome portion. The heat shield includes at least two separate heat shield segments cooperating to provide the annular heat shield, each heat shield segment being sheet metal and including at least two circumferentially spaced apart openings therein for receiving fuel nozzles therethrough. Each of the heat shield segments has a circumferential span not exceeding 180 degrees.

ABSTRACT

A heat shield for a gas turbine engine having a combustor includes an annular configuration extending substantially 360 degrees about the combustor for protecting a dome portion thereof, which is formed by radially extending flanges of inner and outer liners of the combustor. The heat shield fixedly secures the radially extending flanges of the inner and outer liners together in a sealing relationship such as to structurally form the dome portion of the combustor. The heat shield is disposed internally within the combustor and substantially entirely overlying the dome portion. The heat shield includes at least two separate heat shield segments cooperating to provide the annular heat shield, each heat shield segment being sheet metal and including at least two circumferentially spaced apart openings therein for receiving fuel nozzles therethrough. Each of the heat shield segments has a circumferential span not exceeding 180 degrees.

COMBUSTOR HEAT SHIELD

TECHNICAL FIELD

[0001] The present invention relates generally to gas turbine engine combustors and, more particularly, to a low cost combustor heat shield configuration therefor.

BACKGROUND OF THE ART

[0002] Gas turbine combustors are the subject of continual improvement, to provide better cooling, better mixing, better fuel efficiency, better performance, etc. at a lower cost. For example, heat shields are known to provide better protection to the combustor, but heat shields also require cooling. Although heat shield cooling schemes are known in the art, most are generally difficult to assemble. There remains a continuing need for improvement.

SUMMARY

[0003] In accordance with one aspect there is provided a heat shield for a gas turbine engine having a combustor defining a combustion chamber therein, the combustor being formed by cooperating inner and outer liners, the heat shield comprising an annular configuration extending substantially 360 degrees about the combustor for protecting a dome portion thereof which is formed by radially extending flanges of the inner and outer liners, the heat shield fixedly securing the radially extending flanges of the inner and outer liners together in a sealing relationship such as to structurally form the dome portion of the combustor, the heat shield being disposed internally within the combustor and substantially entirely overlying the dome portion, the heat shield including at least two separate heat shield segments cooperating to provide the annular heat shield, each said heat shield segment being sheet metal and including at least two circumferentially spaced apart openings therein for receiving fuel nozzles therethrough, and wherein each said heat shield segment has a circumferential span not exceeding 180 degrees.

[0004] There is also provided a gas turbine engine combustor comprising a liner enclosing a combustion chamber and being formed of cooperating inner and outer liners, an annular heat shield mounted inside the combustor adjacent a dome portion thereof which is formed by radially extending flanges of the inner and outer liners, the annular heat shield being axially spaced apart from the dome portion to define an air space therebetween, the annular heat shield fixedly securing the radially extending flanges of the inner and outer liners together in a sealing relationship such as to structurally form the dome portion of the combustor, the dome portion of the combustor and heat shield each having a plurality of circumferentially spaced apart fuel nozzle openings defined therein which are respectively circumferentially aligned to receive fuel nozzles therethrough, the heat shield further comprising at least two separately formed and circumferentially extending segments which are mounted end-to-end to form the annular heat shield, each said segment being sheet metal and including at least two of said fuel nozzle openings therein, and wherein each said segment has a circumferentially extending span not exceeding 180 degrees.

[0005] In accordance with another aspect there is also provided a combustor liner and heat shield combination comprising at least separate inner and outer annular shells having radial flanges at one end which define, together with a segmented heat shield, a dome surrounding an array of fuel nozzles, the heat shield further comprising at least two sections with each section having an annular span less than 180° and including at least two fuel nozzle receiving openings therein, the heat shield sections and the liner shells being interlocked in an integrated assembly to form a combustor dome assembly.

[0006] In one particular embodiment of the above-reference combustor liner and heat shield combination, the heat shield sections include studs with each stud including a shank in a collar with a collar being adjacent the heat shield and extending a distance corresponding to the air space required between the heat shield and the flanges, the shanks passing through the flanges to receive a locking fastener to thereby interlock the heat shield and the flanges to form the dome.

[0007] In another particular embodiment of the above-reference combustor liner and heat shield combination, lips are formed along the edges of the heat shield sections and extending perpendicular to the heat shield sections to sealing engage the flanges.

[0008] In another particular embodiment of the above-reference combustor liner and heat shield combination, lips are formed along the edges of the heat shield sections and extending in a direction away from the flanges will allow cooling air to flow freely along the liner walls.

[0009] There is further provided a method of assembling a gas turbine engine combustor defining a combustion chamber therein comprising: providing inner and outer annular liner shells with radially extending flanges at an upstream end thereof which define a portion of the combustor dome; assembling a plurality of heat shield segments in an annular configuration within the combustion chamber adjacent the flanges at the combustor dome; and attaching fasteners to interconnect the heat shield segments and the radially extending flanges of the combustor liner to form an integrated dome of the combustor, including fastening the heat shield segments in place such as to maintain air cooling spaces between the heat shield segments and the radially extending flanges of the combustor dome.

[0010] A method of assembling a gas turbine engine combustor defining a combustion chamber therein comprising: providing inner and outer annular liner shells with radially extending flanges at an upstream end thereof which define a portion of the combustor dome; assembling a plurality of heat shield segments in an annular configuration within the combustion chamber adjacent the flanges at the combustor dome; and attaching fasteners to interconnect the heat shield segments and the radially extending flanges of the combustor liner to form an integrated dome of the combustor, including fastening the heat shield segments in place such as to maintain air cooling spaces between the heat shield segments and the radially extending flanges of the combustor dome.

[0011] Further details of these and other aspects of the present invention will be apparent from the detailed description and Figures included below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] Reference is now made to the accompanying Figures depicting aspects of the present invention, in which:

[0013] Figure 1 shows a schematic cross-section of a turbofan gas turbine engine having an annular combustor;

[0014] Figure 2 shows an enlarged radial cross section view of the combustor of Figure 1;

[0015] Figure 3a shows a perspective view of a portion of a heat shield of Figure 2;

[0016] Figure 3b shows an enlarged perspective view of a detail shown in Fig. 3a;

[0017] Figure 4a is a cross-section of one embodiment of a detail shown in Fig. 3b;

[0018] Figure 4b is a cross-section similar to Fig. 4a, showing a different embodiment; and

[0019] Figure 5 is a radial cross-section similar to Fig. 2, showing indifferent embodiment thereof.

DETAILED DESCRIPTION

[0020] Figure 1 illustrates a gas turbine engine 10 preferably of a type provided for use in subsonic flight, generally comprising in serial flow communication a fan 12 through which ambient air is propelled, a multistage compressor 14 for pressurizing the air, an annular combustor 16 in which compressed air is mixed with fuel and ignited for generating an annular stream of hot combustion gases which is then redirected by combustor 16 to a turbine section 18 for extracting energy from the combustion gases.

[0021] The combustor 16 is housed in a plenum 17 supplied with compressed air from the compressor 14. As shown in Fig. 2, the combustor 16 comprises a reverse flow annular combustor shell 20 composed of a radially inner liner 20a and a radially outer liner 20b, defining a combustion chamber 22. The combustor 16 has a bulkhead or inner dome portion 24 and an exit portion 26 for communicating combustion gases with the turbine section 18. As shown in Fig. 1, a plurality of fuel nozzle 28 are mounted to extends through the dome portion 24 of the combustor 20 to deliver a fuel-air mixture to the chamber 22.

[0022] A plurality of effusion holes (not shown) may be defined in the inner and outer liners 20a and 20b for cooling purposes, and dilution holes (not shown) may also be provided for combustion purposes. Inner and outer liners 20a and 20b may have any suitable configuration, and thus are shown in dotted lines only in Fig. 2. The inner and outer liners 20a and 20b are preferably made out of sheet metal, though any suitable material(s) and manufacturing method(s) may be used. A thermal barrier coating or "TBC" (not shown) may also be applied to the inner combustion facing surfaces 32, 34 of the liners 20a and 20b to protect them against the high temperatures prevailing in the combustion chamber 22.

[0023] As shown in Fig. 2, the inner and outer liners 20a and 20b respectively include radial flanges 38 and 36 which overlap each other so as to form part of the dome 24 of the combustor shell 20. The flanges 36 and 38 are directly fixedly secured together by a plurality of circumferentially distributed dome heat shield segments 40a mounted inside the combustion chamber 22 to form and protect the dome 24 from the high temperatures in the combustion chamber 22. Cooling holes 41 are provided at strategic locations on the heat shield 40, as shown in figure 2 and as will be described further. The heat shield 40 therefore has an annular configuration which extends substantially 360 degrees about the combustor for protecting a dome portion of the liner. The heat shield is thus disposed internally within the combustor, and covers, or substantially entirely overlies, the internally facing surface of the dome portion of the liner. The heat shield having a main body portion lying in a plane which is substantially parallel to the dome portion of the combustor liner,

[0024] The heat shield 40, as shown in Figures 3a and 3b, is made up of at least two segments (only heat shield segment 40a is shown) that are pressed from sheet metal. In one example, the heat shield had a thickness of 0.035 inches and was made from an alloy: INCO 625. The heat shield segments 40a can cover a span of 180° or less. At a minimum, each segment will have at least two openings 42 and will therefore extend over at least two nozzles 28. Whether there are two or more segments in a set, the segments are assembled within the annular combustion chamber 22 during assembly of the latter. Each said heat shield segment 40a is therefore pressed from a sheet metal alloy and includes at least two circumferentially spaced apart openings 42 therein for receiving fuel nozzles therethrough.

[0025] Each heat shield segment 40a will include mounting studs 44. Each stud has a collar 44a. Studs 44 are welded to the sheet metal forming segment 40a by resistance or friction welding. The studs 44 may be treaded to receive suitable nuts or other fasteners. For instance, when assembling the heat shield segments 40a with the flanges 36 and 38, the studs will pass through openings in the flanges 36, 38 to be received by nuts 56. The collar 44a acts as a spacer to provide cooling air space between the flanges 36, 38 and the heat shield 40. The pressing of the heat shield segment 40a allows lips 46 to be formed along the edges of the heat shield segment as well as lips 48 to be formed around the openings 42. Each of the lips 46 and 48 are provided with a sealing surface 50 in a common plane.

[0026] Figures 4a and 4b show a divider rib 52 or a press formed divider 152 extending somewhat centrally of the heat shield segment 40a. The divider 52, as shown in Fig. 4b, is friction or resistance welded to the sheet metal forming the heat shield segment 40a. Likewise with the embodiment shown in figure 4a the divider 152 is actually pressed from the sheet metal. Although linear dividers are shown, the dividers can have whatever geometry is required to properly distribute the cooling air flow on the upstream surface of the heat shield. The downstream side is coated with a TCB coating. The cooling air enters between the flanges 36 and 38, and the heat shield 40. The cooling air as shown in Fig. 2 is trapped within the space but can exit through the strategically located cooling holes 41.

[0027] As shown in Figure 2, the heat shield segments 40a are assembled to form the annular heat shield 40. The heat shield 40 therefore includes at least two separate heat shield segments 40a, each having a partial circumference, which cooperate to provide the fully annular heat shield 40. The heat shield segments 40a are mounted directly to the flanges 36, 38 in a sealing relationship, to form the dome 24. The heat shield 40, formed of the segments 40a, therefore fixedly secures the radially extending flanges 36, 38 of the inner and outer liners of the combustor together in a sealing relationship such as to structurally form the dome portion 24. The floating collar 54 surrounding the nozzle 28 presses against the sealing surfaces 50 of the lips 48. In practice, the cooling air entering the dome area will be directed through the passages between the floating collar 54 and the dome flanges 36,38 and the heat shield 40 to then pass through the cooling openings 41.

[0028] In the case of repair the heat shield, it can be readily replaced because of its sheet metal and segmented construction and the segmented construction of the combustor e.g. the shells 20a and 20b. The sheet metal renders the heat shield 40 more flexible while the segmented construction provides easier manipulation of the heat shield segments within the confines of the combustor.

[0029] Another embodiment of the heat shield is illustrated in figure 5. In this embodiment the heat shield 140 is similar to heat shield 40 in most respects. However the lip 146 along the edges of the heat shield 140 are pressed outwardly from the plane of the heat shield 140 so that when mounted within the combustion chamber 22, the lips 146 are directed, downstream. In this configuration, the cooling airflow is similar to that described in US patent 7,681,398 issued March 23, 2010 to Patel et al, which is incorporated herein by reference.

[0030] The above description is meant to be exemplary only, and one skilled in the art will recognize that changes may be made to the embodiments described without departing from the scope of the invention disclosed. For example, the present approach can be used with any suitable combustor configuration, and is not limited to application in turbofan engines. It will also be understood that the combustor shell construction could be different than the one described. For instance, the dome panel could be integrated to the inner or outer liners. Still other modifications which fall within the scope of the present invention will be apparent to those skilled in the art, in light of a review of this disclosure, and such modifications are intended to fall within the appended claims.

CLAIMS:

1. A heat shield for a gas turbine engine having a combustor defining a combustion chamber therein, the combustor being formed by cooperating inner and outer liners, the heat shield comprising an annular configuration extending substantially 360 degrees about the combustor for protecting a dome portion thereof which is formed by radially extending flanges of the inner and outer liners, the heat shield fixedly securing the radially extending flanges of the inner and outer liners together in a sealing relationship such as to structurally form the dome portion of the combustor, the heat shield being disposed internally within the combustor and substantially entirely overlying the dome portion, the heat shield including at least two separate heat shield segments cooperating to provide the annular heat shield, each said heat shield segment being sheet metal and including at least two circumferentially spaced apart openings therein for receiving fuel nozzles therethrough, and wherein each said heat shield segment has a circumferential span not exceeding 180 degrees.

2. The heat shield as defined in claim 1, wherein each said segment of the heat shield includes at least one lip or rib stamped from the sheet metal and extending circumferentially along each said heat shield segment, said at least one lip or rib protruding from the heat shield segment perpendicularly relative to a plane of the heat shield.

3. The heat shield as defined in claim 2, wherein a plurality of studs are provided on one side of the heat shield for fastening the heat shield to the radially extending flanges of the inner and outer liners of the combustor, the studs extending perpendicularly to said plane of the heat shield.

4. The heat shield as defined in claim 3, wherein the studs are resistance or friction welded to the heat shield.

5. The heat shield as defined in claim 1, wherein the heat shield having a main body portion lying in a plane which is parallel to the dome portion formed by the radially extending flanges of the inner and outer liners of the combustor.

6. The heat shield as defined in claim 1, wherein the heat shield consist of only two heat shield segments, each spanning 180 degrees.

7. A gas turbine engine combustor comprising a liner enclosing a combustion chamber and being formed of cooperating inner and outer liners, an annular heat shield mounted inside the combustor adjacent a dome portion thereof which is formed by radially extending flanges of the inner and outer liners, the annular heat shield being axially spaced apart from the dome portion to define an air space therebetween, the annular heat shield fixedly securing the radially extending flanges of the inner and outer liners together in a sealing relationship such as to structurally form the dome portion of the combustor, the dome portion of the combustor and heat shield each having a plurality of circumferentially spaced apart fuel nozzle openings defined therein which are respectively circumferentially aligned to receive fuel nozzles therethrough, the heat shield further comprising at least two separately formed and circumferentially extending segments which are mounted end-to-end to form the annular heat shield, each said segment being sheet metal and including at least two of said fuel nozzle openings therein, and wherein each said segment has a circumferentially extending span not exceeding 180 degrees.

8. The combustor as defined in claim 7, wherein the segments of the annular heat shield includes at least one lip or rib projecting from the sheet metal and extending circumferentially along each said segment, said at least one lip or rib protruding axially from the heat shield segment perpendicularly relative to a plane within which the heat shield segment lies.

9. The combustor as defined in claim 8, wherein the at least one lip or rib protrudes an axial distance from the segment which corresponds to the air space defined between the heat shield and the dome portion of the combustor.

10. The combustor as defined in claim 7, wherein a plurality of studs are provided on one side of the heat shield for fastening the heat shield to the radially extending flanges of the inner and outer liners of the combustor, the studs extending perpendicularly to said plane of the heat shield.

11. The combustor as defined in claim 10, wherein each said stud includes a shank in a collar, with the collar being adjacent the heat shield and extending an axial distance corresponding to the air space defined between the heat shield and the dome portion of the combustor.

12. The combustor as defined in claim 11, wherein the shank of each said stud is threaded to receive a nut when the heat shield is fastened to the radially extending flanges of the inner and outer liners.

13. The combustor as defined in claim 9, wherein each of the ribs or lips provides a sealing surface which sealingly abuts an inner surface of the dome portion of the combustor.

14. The combustor as defined in claim 7, wherein cooling air holes are provided at strategic locations on the heat shield, the cooling air holes provided air flow communication between said air space, defined between the heat shield and the dome portion of the combustor, and an inwardly facing surface of the heat shield facing said combustion chamber.

15. The combustor as defined in claim 13, wherein a floating collar is provided within each of said fuel nozzle openings in the dome portion of the combustor, the floating collar being adapted to sealingly engage the sealing surfaces of the ribs or lips when cooling air is directed against the floating collar.

16. The combustor as defined in claim 8, wherein the at least one lip or rib is stamped from the sheet metal heat shield and extends in a direction downstream from the liner.

17. The combustor as defined in claim 7, wherein a circumferentially extending divider protrudes from the heat shield to form circumferential cooling air channels.

18. The combustor as defined in claim 17, wherein the divider is welded to or stamped from the sheet metal forming said head shield segments.

19. A method of assembling a gas turbine engine combustor defining a combustion chamber therein comprising: providing inner and outer annular liner shells with radially extending flanges at an upstream end thereof which define a portion of the combustor dome; assembling a plurality of heat shield segments in an annular configuration within the combustion chamber adjacent the flanges at the combustor dome; and attaching fasteners to interconnect the heat shield segments and the radially extending flanges of the combustor liner to form an integrated dome of the combustor, including fastening the heat shield segments in place such as to maintain air cooling spaces between the heat shield segments and the radially extending flanges of the combustor dome.

20. The method as defined in claim 19, including the steps of press forming the heat shield segments from sheet metal, including forming lips along edges of the heat

shield segments, and then welding studs to the sheet metal forming said heat shield segments.

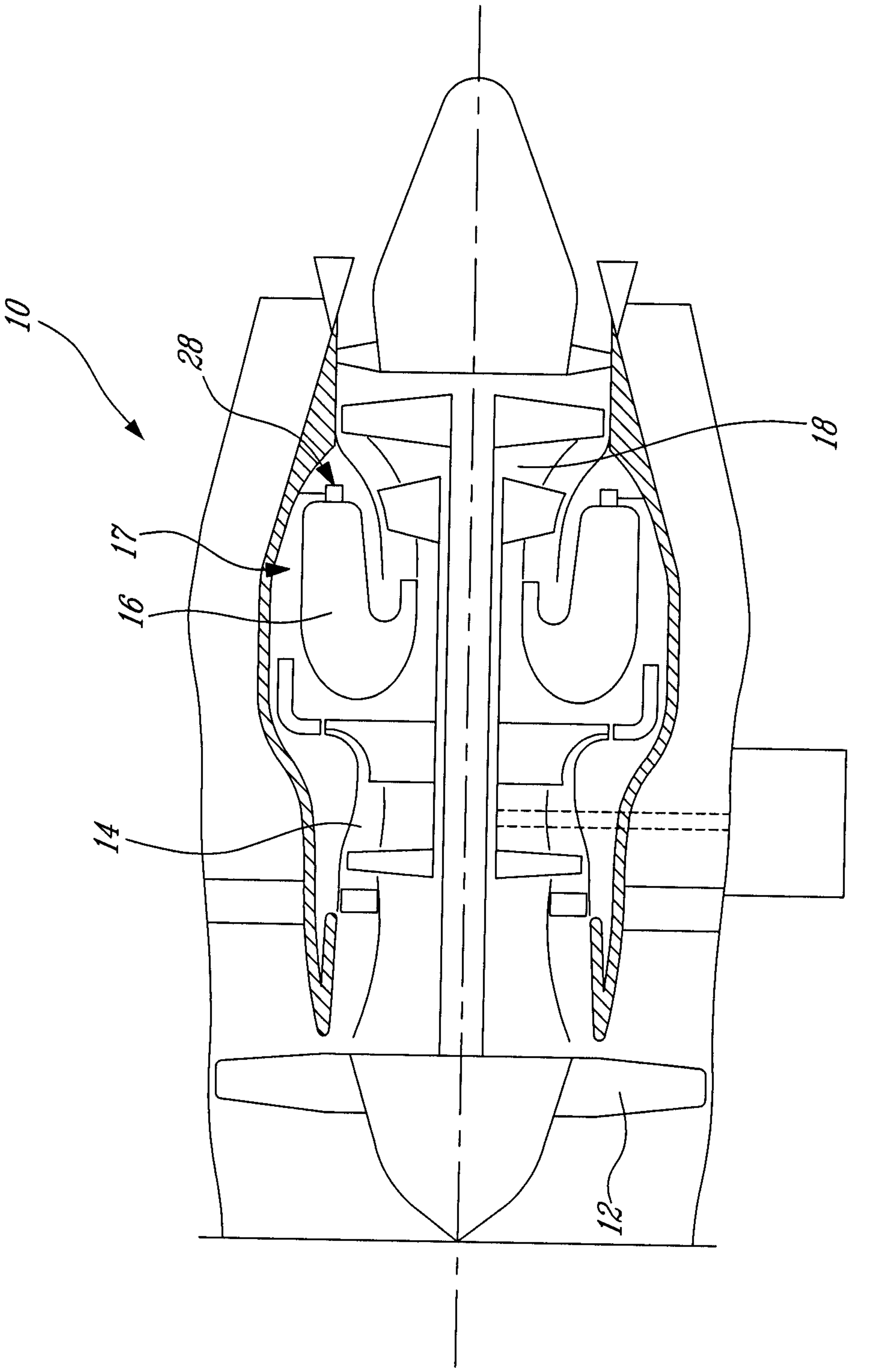


Fig-1

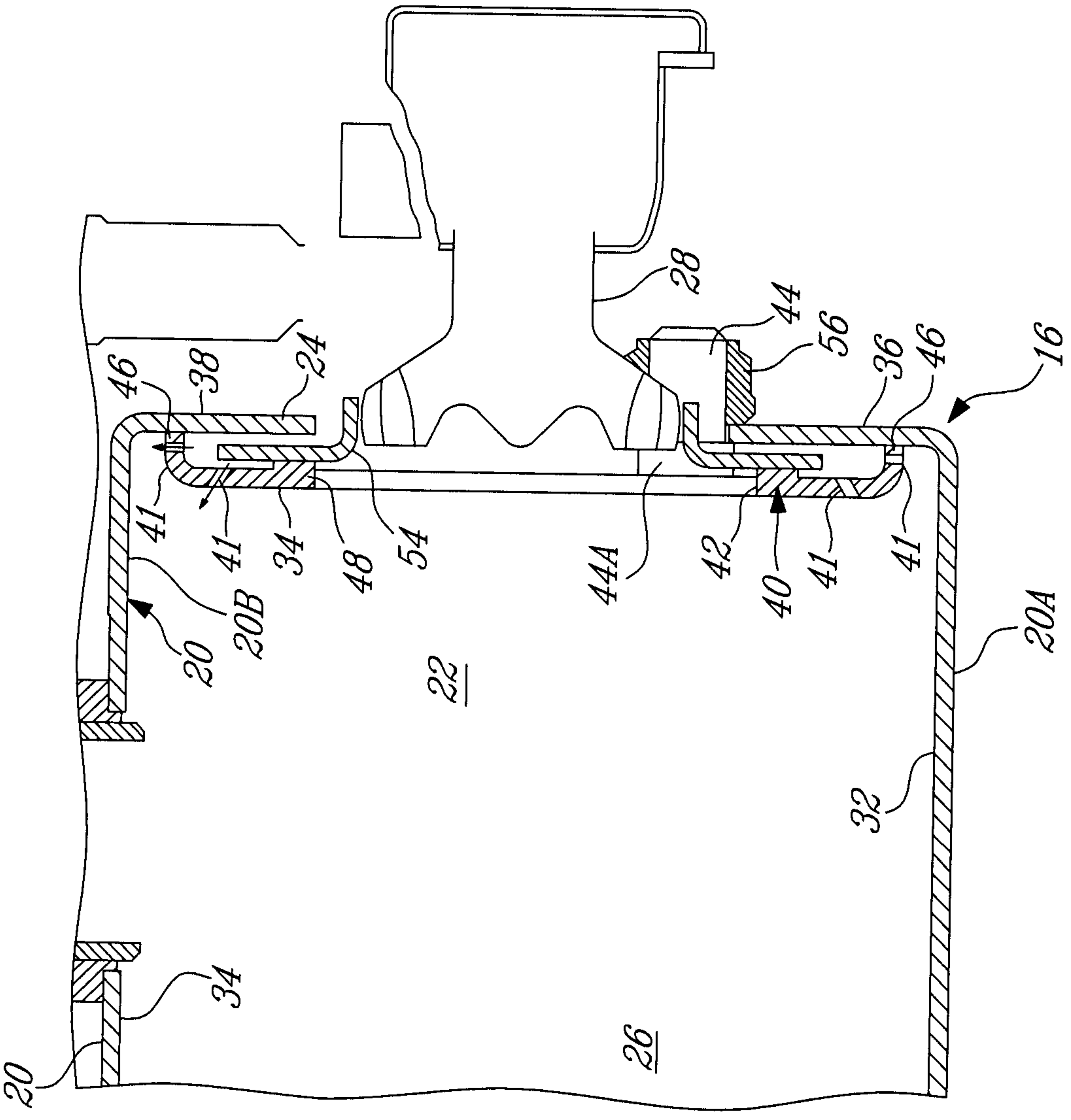

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Fig-2

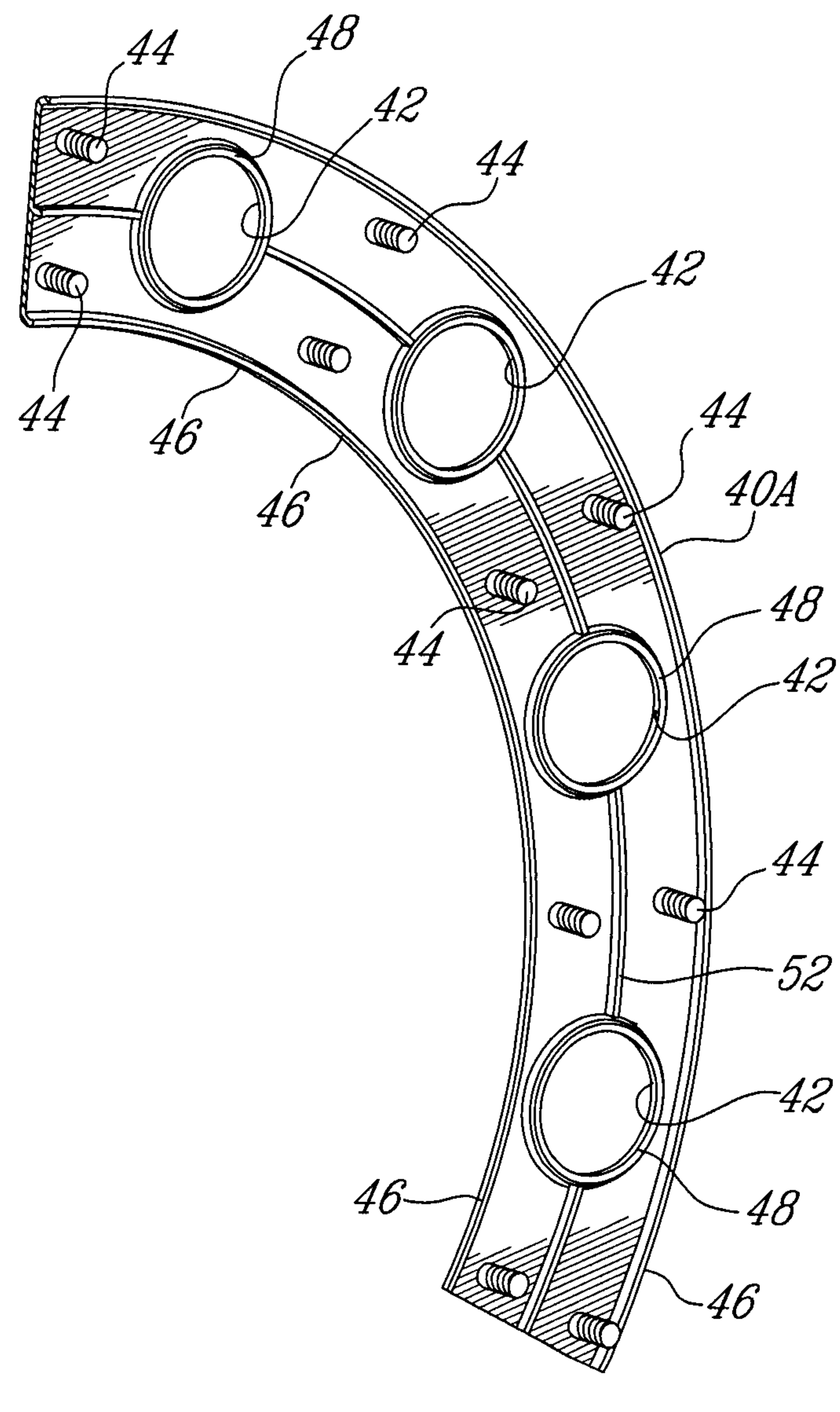


Fig-3A

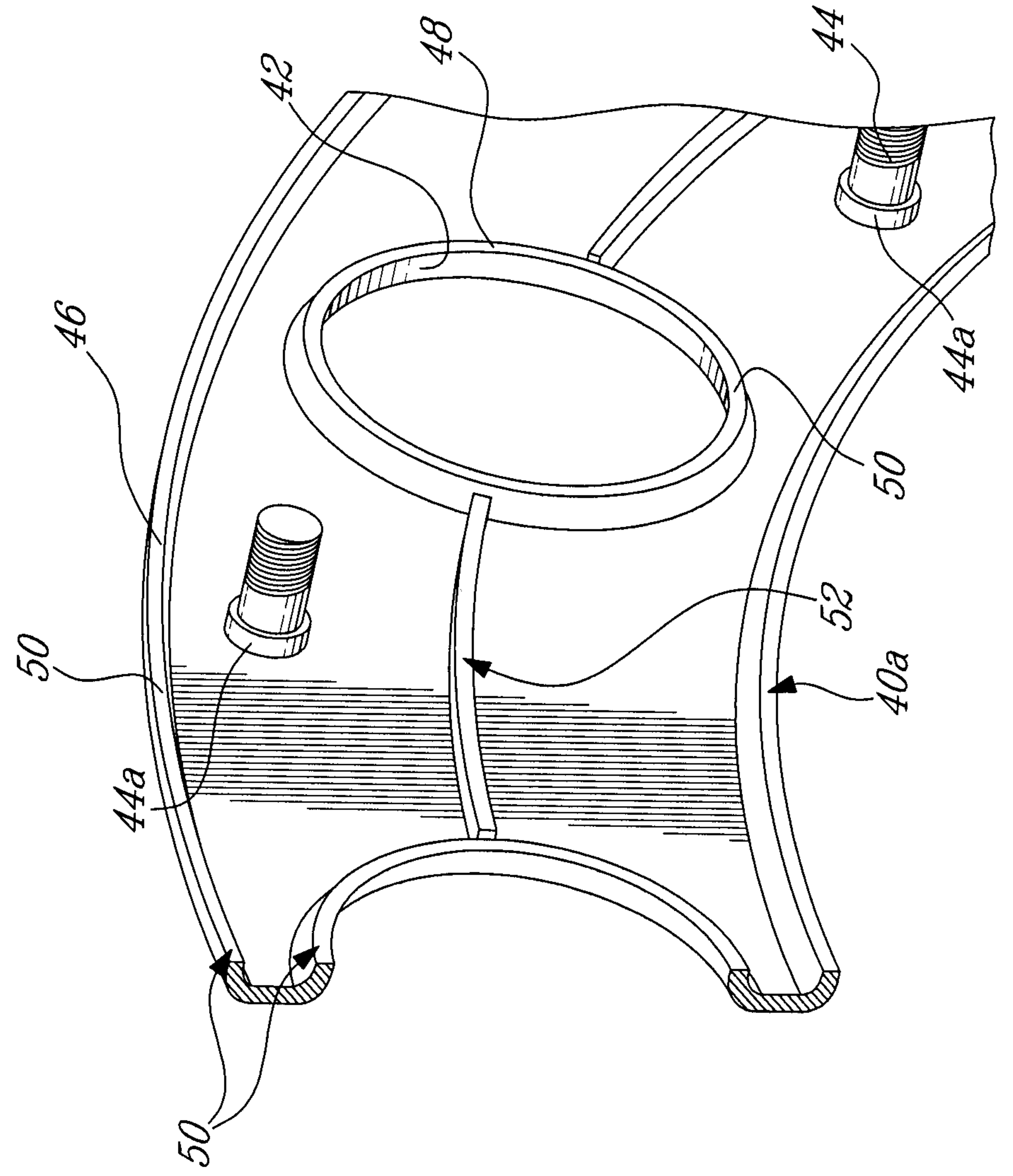


Fig-3B

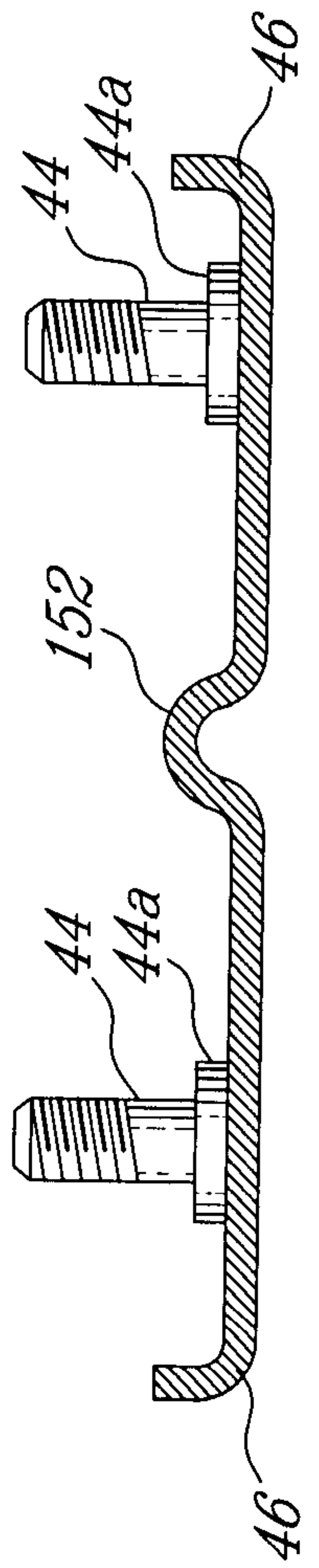


Fig-4A

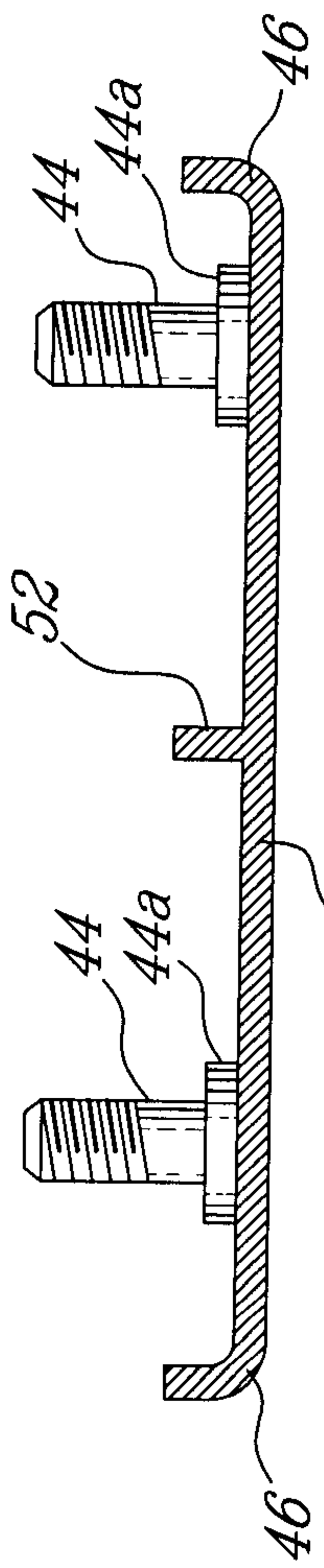


Fig-4B

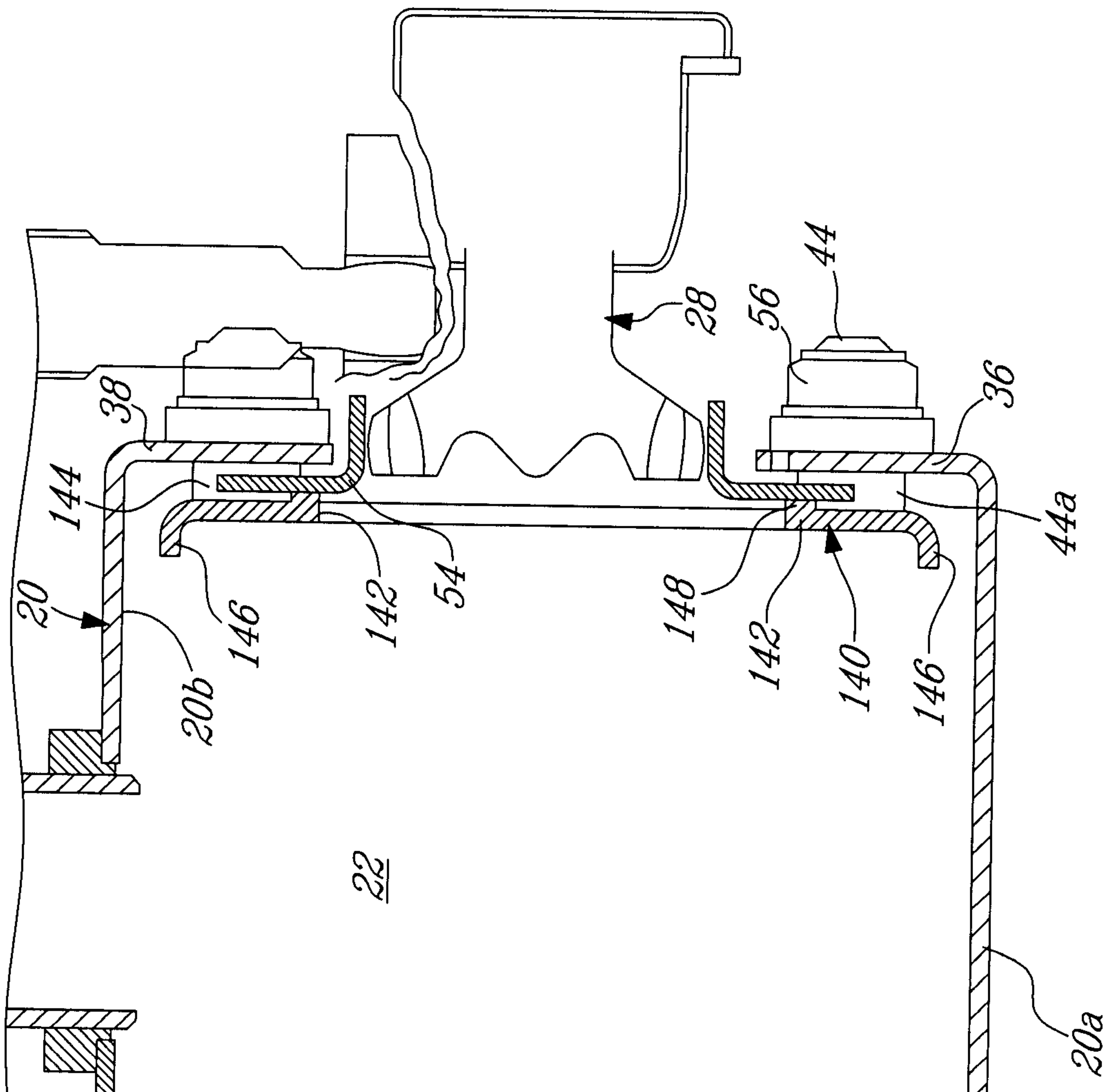
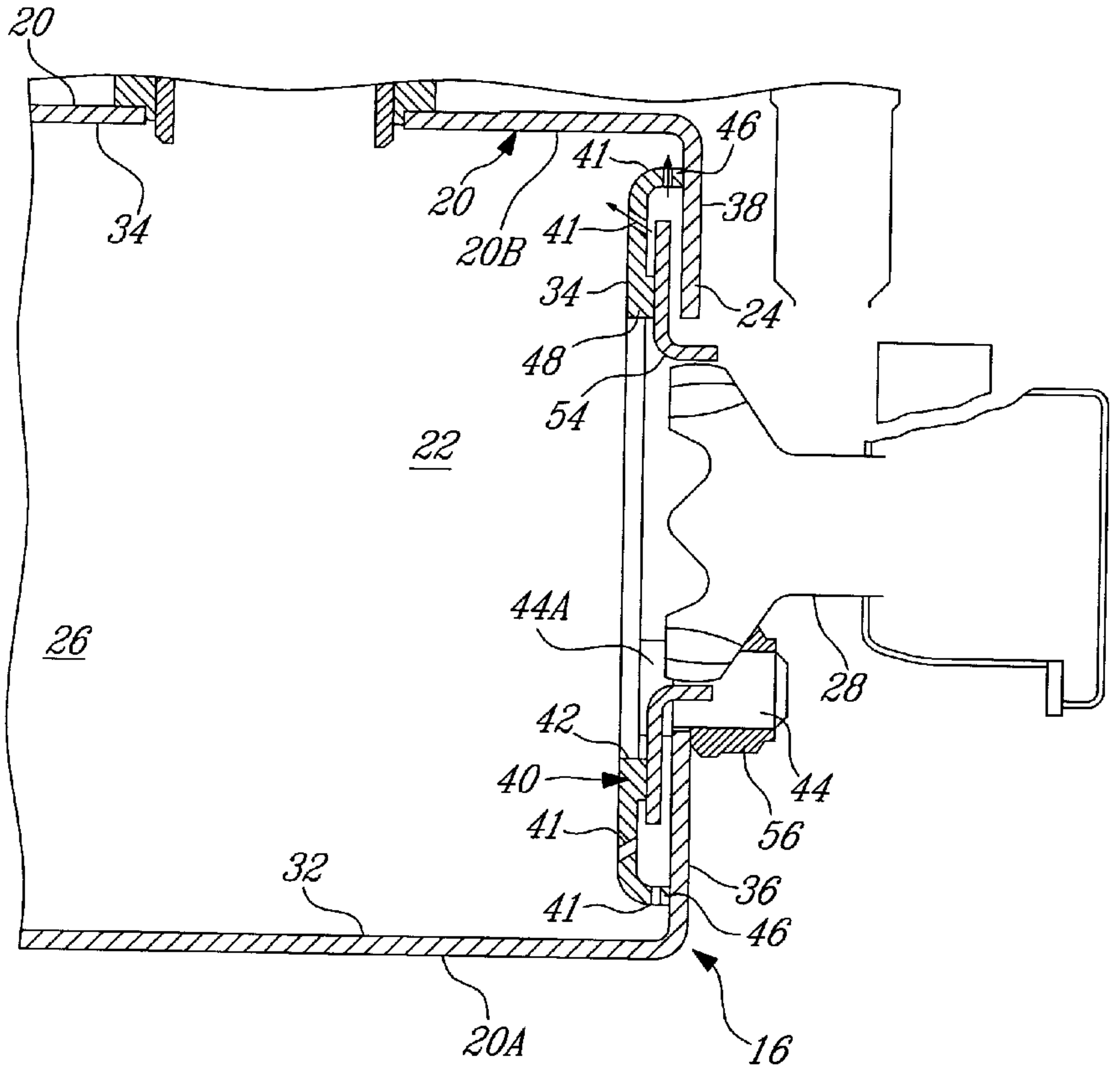


Fig-5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