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(54) **PRESSURIZED AIR SEAL FOR COMBUSTION CHAMBER**

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(73) Assignee: **AOS Holding Company**, Wilmington, DE (US)

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**Related U.S. Patent Documents**

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Filed: **Sep. 9, 1991**

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(58) **Field of Search** .................... 431/159, 328; 126/515, 516, 521; 122/19, 17.1

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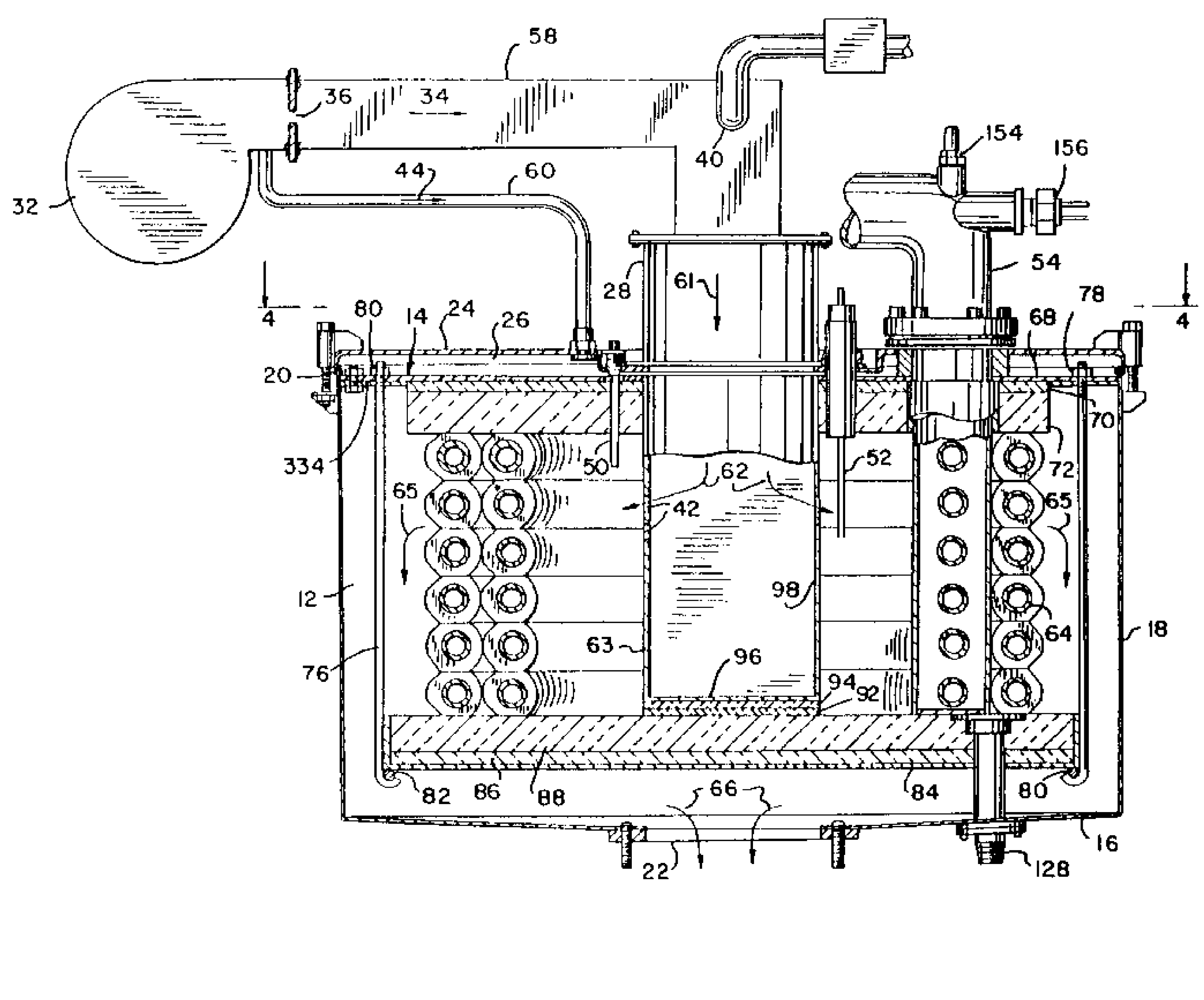
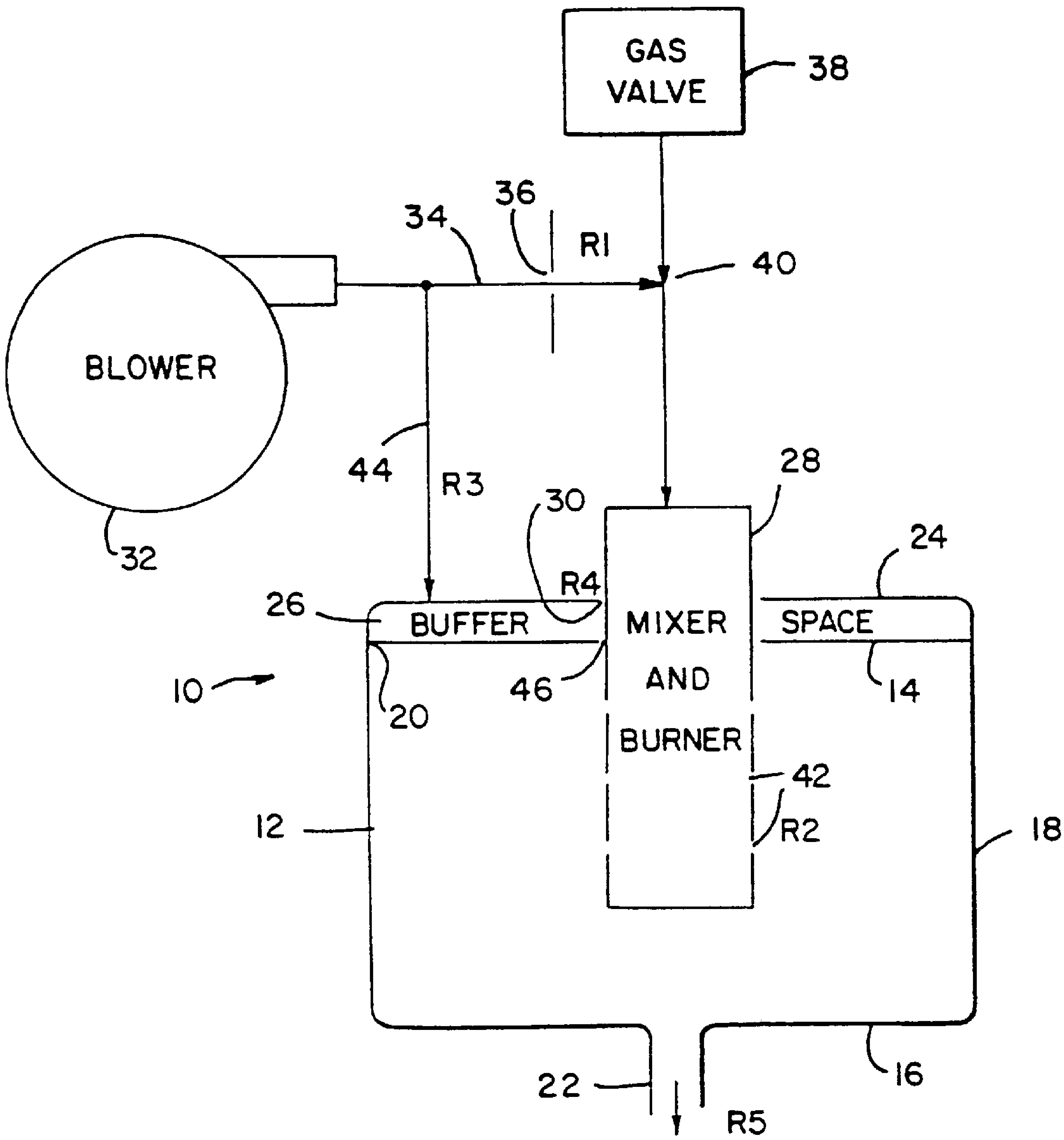
(57) **ABSTRACT**

Combustion apparatus **(10)** includes a combustion chamber **(12, 212)**, a cover **(24, 208)** covering an end wall **(14, 210)** of the combustion chamber and defining a buffer space **(26, 206)** therebetween, and a blower **(32, 202)** external to the cover and supplying air to the buffer space and pressurizing the buffer space to a higher pressure than the combustion chamber such that leakage at penetrations **(46)** and/or interface **(334, 336)** flows from the buffer space into the combustion chamber, rather than the reverse, eliminating the need for leak-tight seals, and instead permitting leakage in a desired direction. In one embodiment, a first conduit **(58)** supplies air along a path **(34)** from the blower to the mixer and burner assembly without passing through the buffer space, and a second conduit **(60)** independently supplies air from the blower to the buffer space. A pressure dropping orifice **(36)** is provided between the blower and the mixer and burner assembly. A gas inlet port **(40)** is external to the cover **(24)** and downstream of the pressure dropping orifice **(36)**. The buffer space **(26)** communicates with the blower **(32)** along an air flow path **(44)** upstream of the pressure dropping orifice **(36)**. In another embodiment, air flows through the buffer space **(20)** to the mixer and burner assembly. The buffer space **(26, 206)** is thin and flat, and the cover **(24, 208)** covers only one end wall **(14, 210)** of the combustion chamber, not the other end wall nor the sidewall, such that the latter are accessible without removing the cover.

**9 Claims, 5 Drawing Sheets**




GAS
VALVE
38
36
34
R1
40
BLOWER
44
R3
28
30
24
32
R4
26
BUFFER
MIXER
SPACE
AND
46
14
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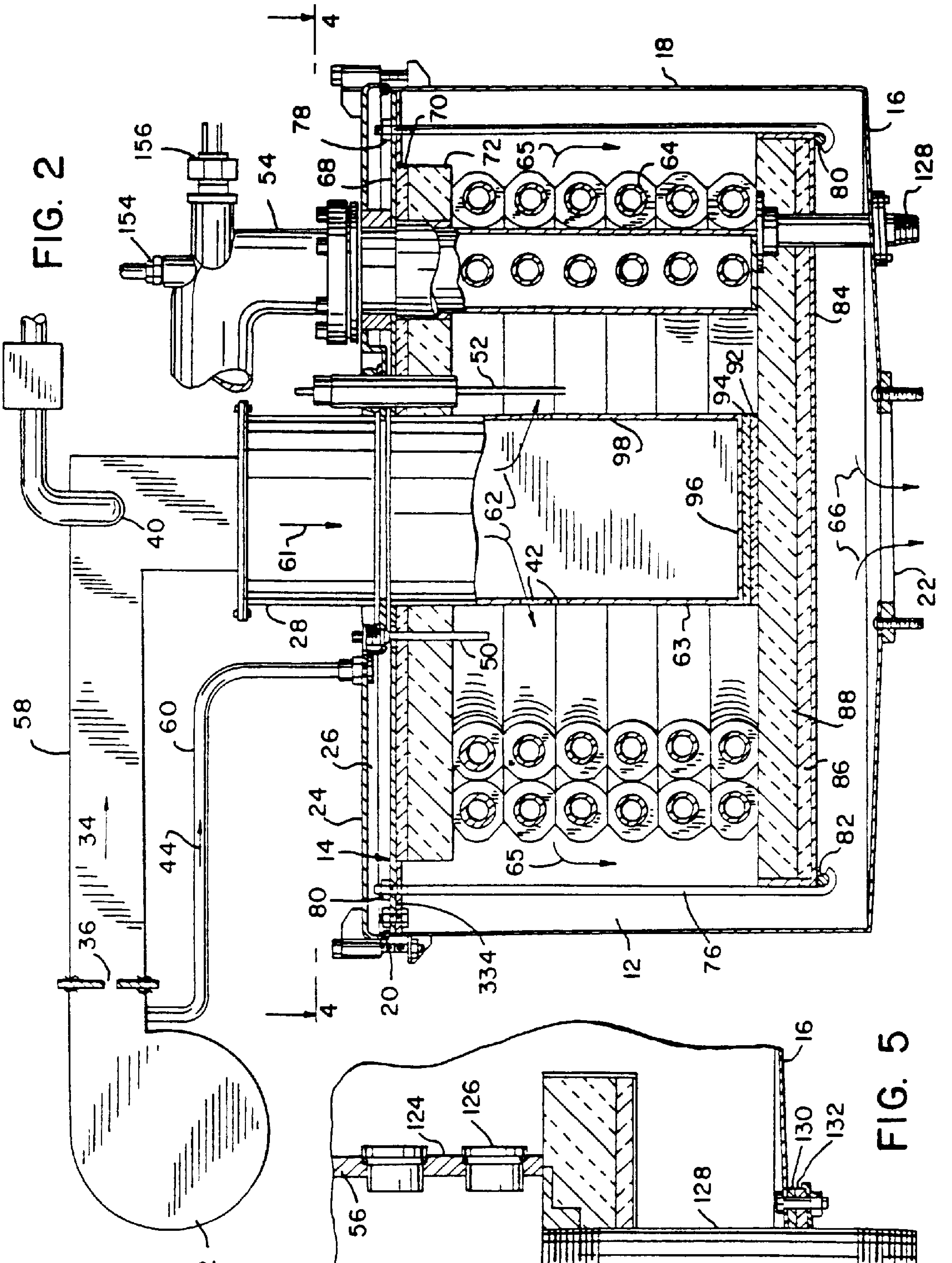
BURNER
42
12
R2
18
22
16
R5

FIG. 1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20
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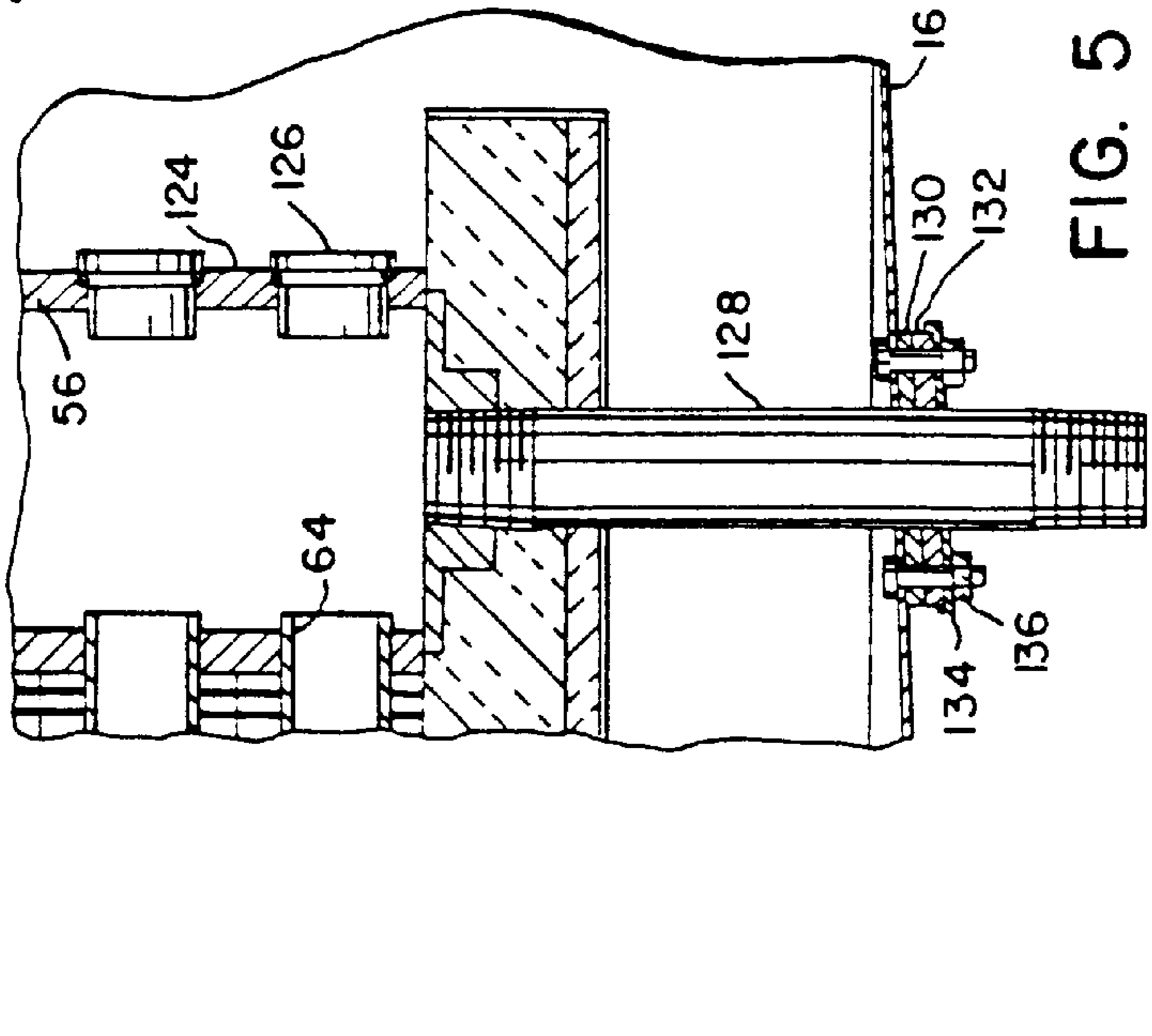
FIG. 2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134
136

FIG. 5

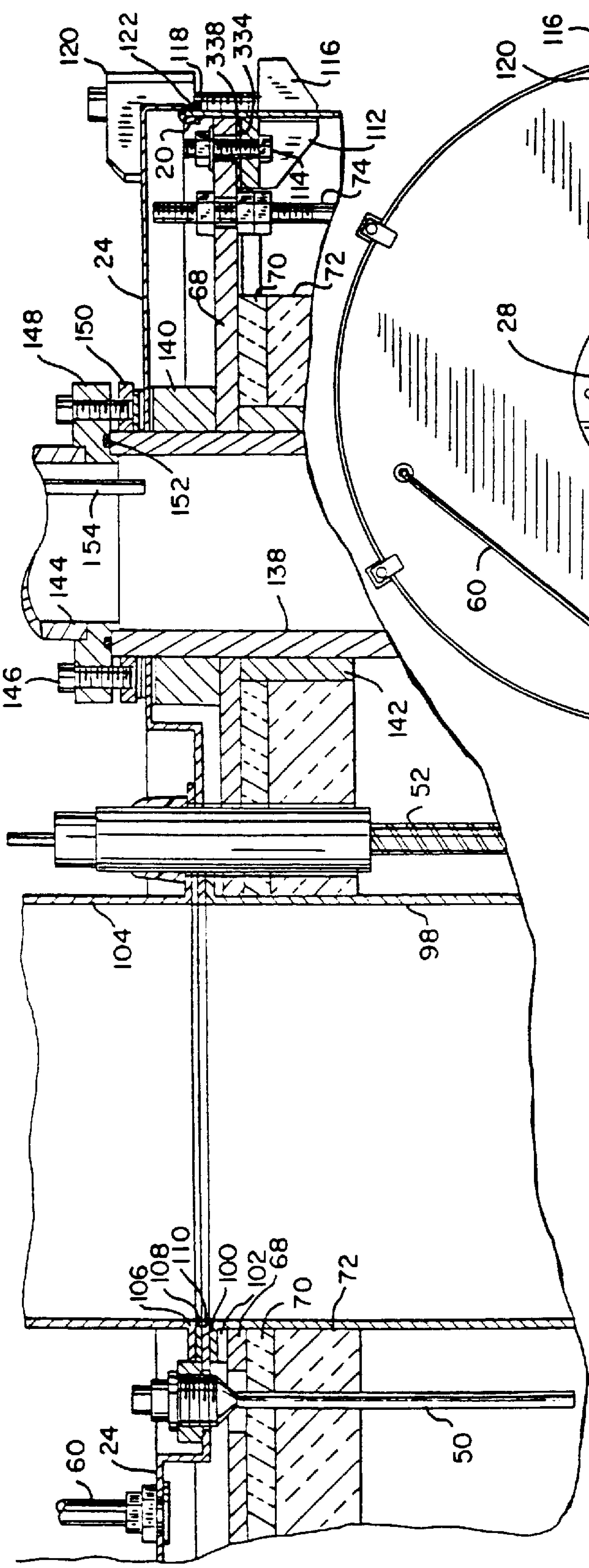


FIG. 3

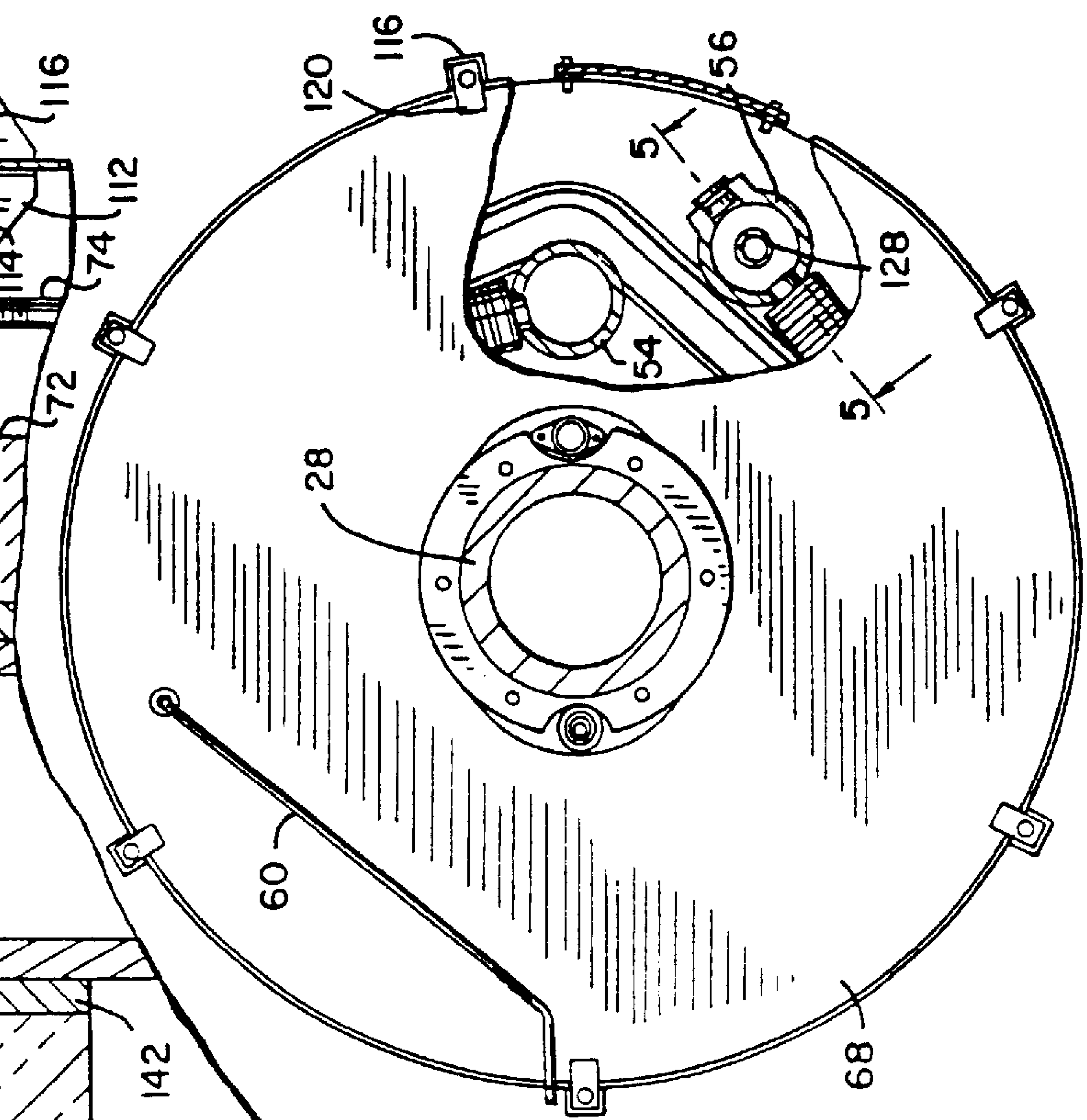
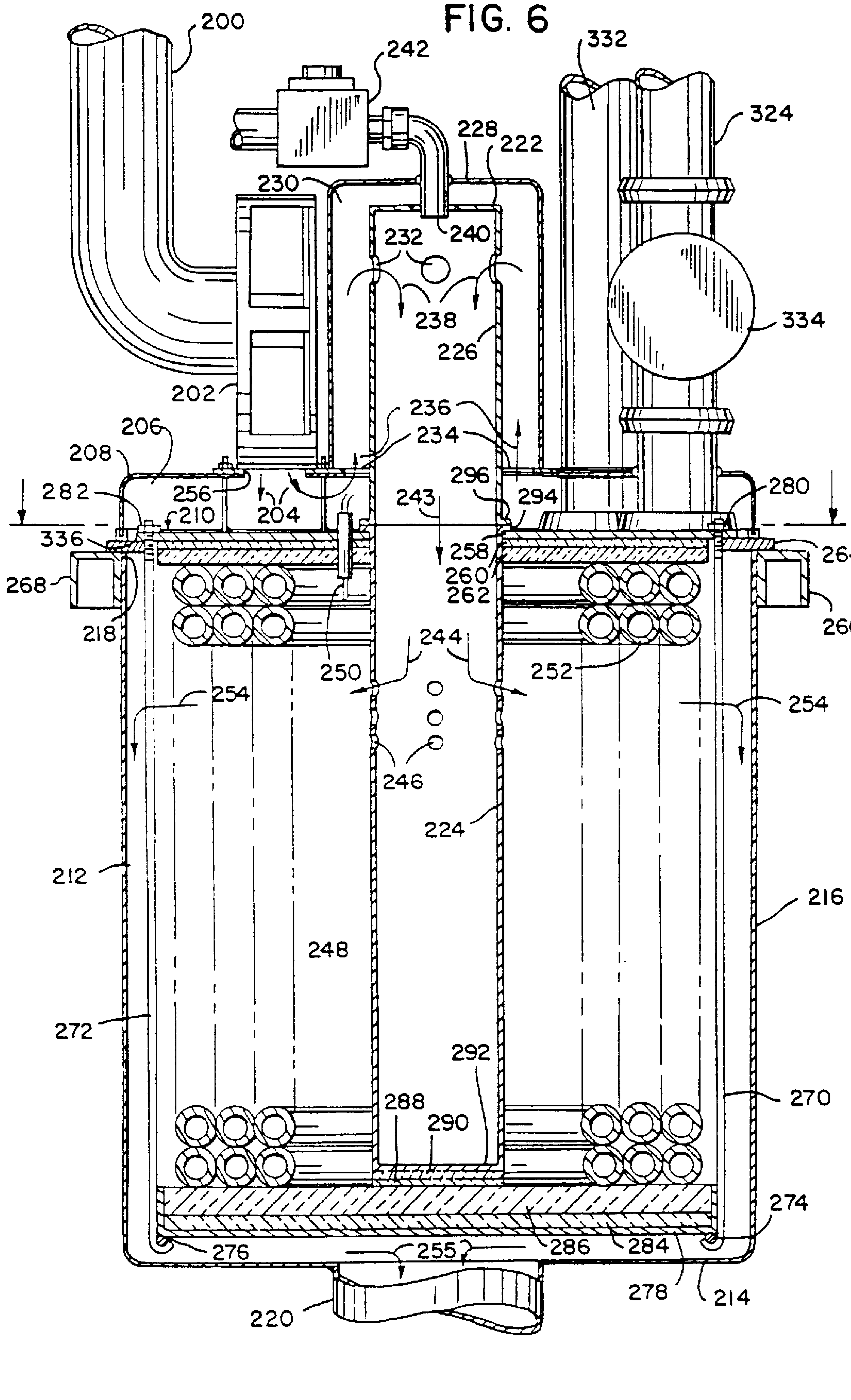


FIG. 4

FIG. 6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206
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294
280
210
204
336
258
264
260
268
262
266
218
244
250
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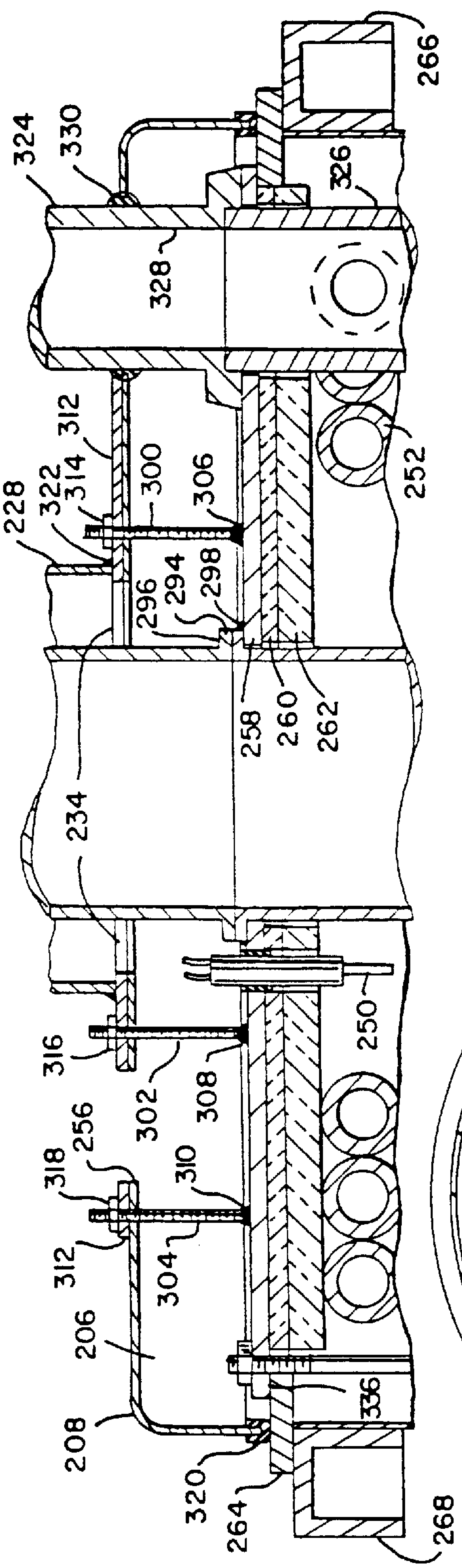
220


266
324
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300
306
296
294
298
258
260
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302
308
256
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304
206
208
336
320
264
268

FIG. 7

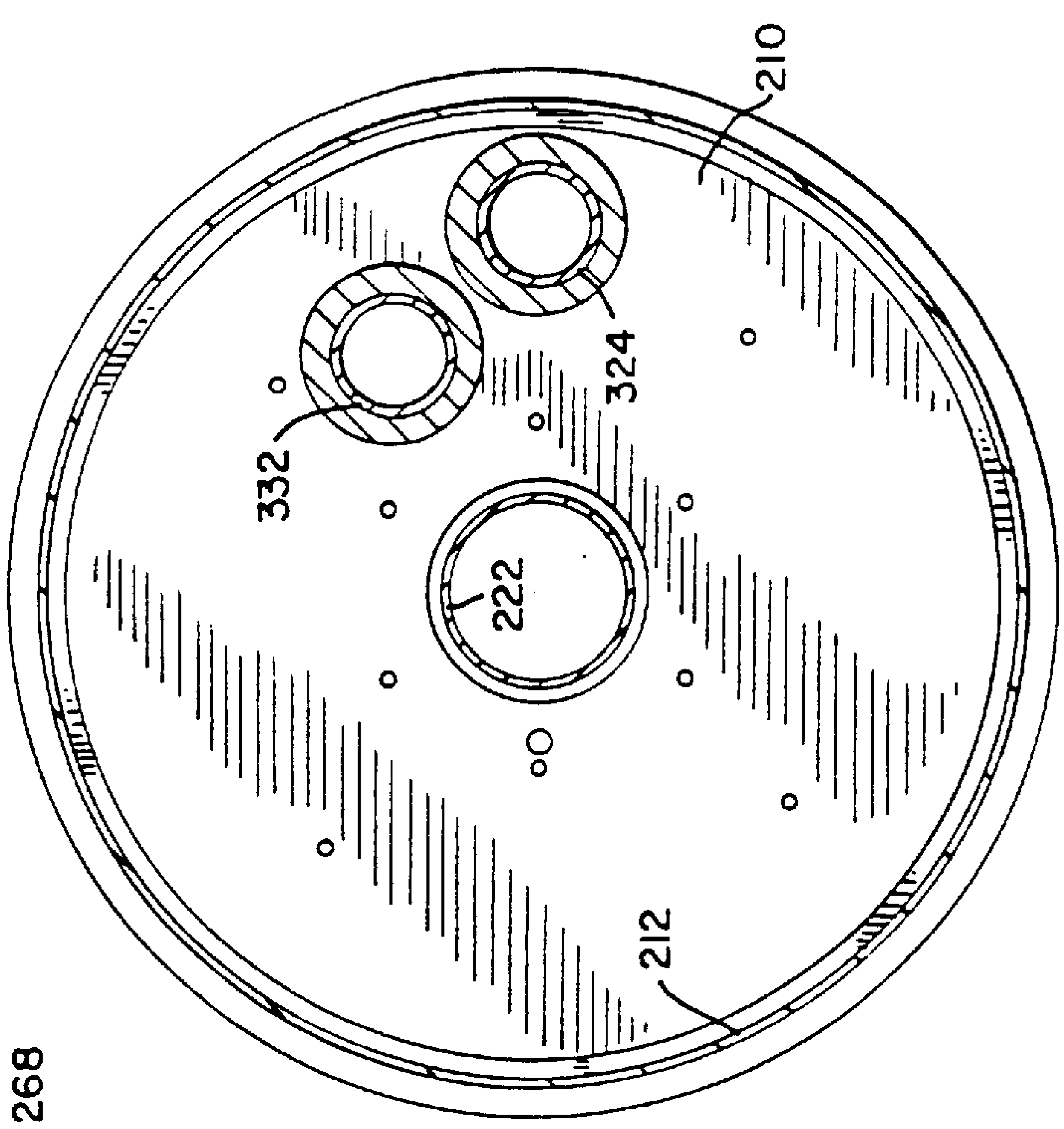
210
324
332
222
212

FIG. 8

# PRESSURIZED AIR SEAL FOR COMBUSTION CHAMBER

**Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.**

## BACKGROUND AND SUMMARY

The invention relates to combustion apparatus, and more particularly to a sealing arrangement preventing leakage of combustion products through penetrations and interfaces, such as piping and mixer and burner penetrations and end wall interfaces, without requiring leak-tight seals.

In a forced draft combustion system, the pressure of gases within the combustion chamber is usually greater than that of the surroundings. It is often difficult to assure that penetrations for components that pass through the wall of the combustion chamber will not leak, especially since such components must often be readily removable for service or replacement. Also, it is usually necessary for a wall or panel of the combustion chamber to be removable for inspection or maintenance of the combustion chamber or heat exchanger within it. While it is possible to provide individual leak-tight seals for such components, it is expensive to do so, and furthermore it cannot be assured that they will be maintained in proper condition.

The present invention provides penetration and interface seals that are permitted to leak slightly. The invention conditions the environment of the seals so that the leakage is not detrimental. The invention provides an air seal arrangement and combination including a buffer space at penetrations and interfaces, and pressurizes the buffer space to a higher pressure than the combustion chamber, such that any leakage flows into the combustion chamber rather out of the combustion chamber. The direction of leakage into the combustion chamber prevents unwanted escape of combustion gases. Any leakage from the buffer space to the atmosphere will simply be air leakage. The arrangement prevents leakage of gases from the combustion chamber without relying upon leak-tight fittings or seals.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic illustration of combustion apparatus in accordance with the invention.

FIG. **2** is a side view partially in section of combustion apparatus in accordance with the invention.

FIG. **3** is an enlarged view of a portion of the structure of FIG. **2**.

FIG. **4** is a sectional view taken along line **4**—**4** of FIG. **2**.

FIG. **5** is a sectional view taken along line **5**—**5** of FIG. **4**.

FIG. **6** is a view like FIG. **2** and shows an alternate embodiment.

FIG. **7** is an enlarged view of a portion of the structure of FIG. **6**.

FIG. **8** is a sectional view taken along line **8**—**8** of FIG. **6**.

## DETAILED DESCRIPTION

FIG. **1** shows combustion apparatus **10** including a combustion chamber **12** having distally opposite top and bottom end walls **14** and **16**, and having a sidewall **18** extending



between the end walls. The combustion chamber has an upper opening **20** covered and closed by end wall **14**, and has a lower exhaust outlet **22** through end wall **16**. A cover **24** external to the combustion chamber covers end wall **14** and defines a buffer space **26** therebetween. One or more penetrations, including a mixer and burner assembly **28**, extends through cover **24** and end wall **14** into the combustion chamber. Buffer space **26** has a buffer outlet at penetration **30**. Blower **32** supplies air along path **34** through pressure dropping orifice **36** to mixer and burner assembly **28**. A gas valve **38** supplies combustion gas to the air stream at gas inlet port **40** downstream of pressure dropping orifice **36**. The combustible air-gas mixture flows downwardly in mixer and burner assembly **28** and then radially outwardly through orifices **42** and is ignited to provide heat to a heat exchanger, FIGS. **2** and **6**, in combustion chamber **12** to in turn heat liquid in the heat exchanger. Blower **32** supplies air along path **44** to buffer space **26**. Pressure dropping orifices **36** and **42** provide a restricted flow path of smaller diameter than flow path **44**, such that buffer space **26** is pressurized to a higher pressure than the combustion chamber, such that leakage at penetration **46** flows from buffer space **26** into combustion chamber **12**, rather than the reverse. The sum of the pressure drops across orifices **36** and **42** relative to the pressure drop across exhaust outlet **22** is greater than the pressure drop from blower **32** along path **44** to buffer space **26** relative to buffer outlet **30**, i.e.,

$$\frac{R3}{R4} < \frac{R1 + R2}{R5}$$

where **R1** is the pressure drop from the blower to the mixer and burner assembly across pressure dropping orifice **36**, **R2** is the pressure drop from the mixer and burner assembly across orifices **42** to the combustion chamber, **R3** is the pressure drop from the blower to the buffer space, **R4** is the pressure drop across buffer outlet **30**, and **R5** is the pressure drop across exhaust outlet **22**.

Referring to FIG. **2**, combustion chamber **12** has distally opposite top and bottom end walls **14** and **16**, and a sidewall **18** extending between the end walls. Cover **24** is external to combustion chamber **12** and covers end wall **14** and defines buffer space **26** therebetween. End wall **14** has penetrations therethrough, including forced draft mixer and burner assembly **28**, flame sensor **50**, ignitor **52**, and header pipes **54** and **56**, FIG. **4**. Blower **32** is external to cover **24** and supplies air to buffer space **26** and pressurizes the buffer space to a higher pressure than combustion chamber **12** such that leakage at the penetrations flows from the buffer space into the combustion chamber.

Conduit **58** supplies air along path **34** from blower **32** through pressure dropping orifice **36** to mixer and burner assembly **28**. Conduit **60** independently supplies air along path **44** from blower **32** to buffer space **26** and pressurizes the buffer space to a higher pressure than the interior of combustion chamber **12**.

Air from conduit **58** and gas from gas valve **38** at gas inlet port **40** flow downwardly as shown at arrow **61** in mixer and burner assembly **28** and then radially outwardly as shown at arrows **62** through orifices **42** in burner sidewall **63** and into the interior of combustion chamber **12**, and the air/gas mixture is ignited by ignitor **52**, to in turn heat liquid in heat exchanger coil **64**. The combustion products flow radially outwardly and then downwardly as shown at arrows **65**, and are exhausted as shown at arrows **66** at outlet **22**. The combined pressure drops provided across pressure dropping orifice **36** and orifices **42** relative to exhaust outlet **22** is greater than the pressure drop through conduit **60** to buffer space **26** relative to the buffer outlets at the penetration such that the pressure in the combustion chamber is less than the pressure in buffer space **26**, and hence leakage at penetrations through end wall **14** flows from buffer space **26** into combustion chamber **12**, rather than the reverse.

End wall **14** is provided by three layers, including metal plate **68**, FIG. **3**, a heat insulating blanket **70**, such as provided by Carborundum Corporation under the tradename Fiberfrax Durablanket, and a lower heat insulating board **72**, such as provided by Carborundum Corporation under the tradename Fiberfrax Duraboard. Four J-bolts, two of which are shown at **74** and **76**, FIG. **2**, are mounted on plate **68** by respective nuts such as **78** and **80** and extend downwardly and at their bottom ends curl around a short length of a respective dowel rod such as **80, 82** which is welded to the underside of a metal tray **34**, such that tray **34** is suspended and supported below metal plate **68** and adjusted by threaded nuts **78** and **80** at the upper end of respective J-bolts **74** and **76**. Resting in tray **84** is a heat insulating blanket **86**, such as provided by the above noted Fiberfrax Durablanket, and a heat insulating board **88**, such as provided by the above noted Fiberfrax Duraboard. Heat exchanger coil **64** is disposed between boards **88** and **72**. Resting on board **88** is a heat insulating blanket **92**, such as provided by the above noted Fiberfrax Durablanket, and a heat insulating board **94**, such as provided by the above noted Fiberfrax Duraboard. Board **94** engages the bottom **96** of lower portion **98** of the mixer and burner assembly **28**. Lower portion **98** of the mixer and burner assembly has an upper flange **100**, FIG. **3**, resting on gasket **102** on metal plate **68**. Upper portion **104** of the mixer and burner assembly has a lower flange **106** resting on gasket **108** on flange **110** of cover **24**. The outer edge of metal plate **68** rests on support blocks **112** welded to the inside of sidewall **18** of combustion chamber **12**. Plate **68** is secured to support blocks **112** at bolts **114**. Clamp blocks **116** are welded to the outside of sidewall **18** of the combustion chamber and have bolts **113** extending upwardly therefrom for receiving clamps **120** which clamp cover **24** downwardly on the combustion chamber at upper opening **20** at gasket **122**.

The liquid to be heated enters through header pipe **56**, FIG. **4**, circulates through heat exchanger coil **64**, and exits through header pipe **54**. Header pipe **56** has a lower manifold section **124**. FIG. **5**, with removable plugs **126** for accessing and cleaning respective sections of heat exchanger coil **64**, and has a lower drain **128** which extends downwardly through bottom end wall **16** and is preferably leak-tight sealed thereto by gaskets **130, 132**, plate **134**, and bolts **136**. Header pipe **154** includes lower portion **138**, FIG. **3**, extending downwardly through cover **24**, spacer **140**, plate **68**, and sleeve **142** through layers **70** and **72**. Header pipe **54** includes an upper portion **144** mounted by bolts **146** and flange **148** to upper flange **150** of lower portion **138** and providing a seal at O-ring **152**. The upper portion of header pipe **56** is comparable. Upper portion **144** of header pipe **54** includes first and second temperature sensors **154** and **156**.

In an alternate embodiment, FIGS. **6–8**, air from air inlet **200** is supplied by blower **202** as shown at arrows **204** to buffer space **206** between cover **208** and end wall **210** of combustion chamber **212**. The combustion chamber has distally opposite top and bottom end walls **210** and **214**, and a sidewall **216** extending between the end walls. The combustion chamber has an upper opening **218** covered and closed by top end wall **210**, and has a lower exhaust outlet **220** through bottom end wall **214**.

Mixer and burner assembly **222** has a lower portion **224** extending downwardly through top end wall **210** and into combustion chamber **21**. Mixer and burner assembly **222** has an upper portion **226** external of the combustion chamber. A second cover **228** is external to first cover **208** and covers external portion **226** of mixer and burner assembly **222** and defines a second buffer space **230** therebetween. Mixer and burner assembly **222** at upper portion **226** has inlet ports **232** communicating with buffer space **230**. Cover **208** has a port **234** communicating with buffer space **230** such that buffer spaces **206** and **230** are in communication with each other through port **234**.

Air from blower **202** supplied to buffer space **206** also flows through port **234** as shown at arrows **236** to buffer space **230** and then to inlet **232** and into the mixer and burner assembly as shown at arrows **238**. Combustion gas is supplied at gas inlet port **240** from gas valve **242**. The combustion air and gas flows downwardly in mixer and burner assembly **222** as shown at arrow **243** and then radially outwardly as shown at arrows **244** through orifices **246** in sidewall **248** of lower portion **224** of the mixer and burner assembly, and into the interior of combustion chamber **212** for ignition by ignitor **250**, to in turn heat the liquid in heat exchanger coil **252**. The combustion products flow radially outwardly and then downwardly as shown at arrows **254**, and are exhausted at outlet **220** as shown at arrows **255**. Pressure dropping orifices **232** and **246** provide a restricted flow path reducing the pressure in the combustion chamber to a pressure lower than that in buffer space **206**, such that the buffer space is pressurized to a higher pressure than the combustion chamber, and leakage at penetrations flows from buffer space **206** into combustion chamber **212**, rather than the reverse. The sum of the pressure drops across orifices **232** and **246** relative to that across exhaust outlet **220** is greater than the pressure drop from blower **202** into space **206** across inlet **256** relative to the buffer outlets at the penetrations.

Top end wall **210** is provided by three layers including an upper metal plate **258**, a central heat insulating blanket **260**, such as provided by the above noted Fiberfrax Durablanket, and a lower heat insulating board **262**, such as provided by the above noted Fiberfrax Duraboard. The outer edge of metal plate **258** rests on an annular disc **264** which is welded to sidewall **216** of the combustion chamber at upper opening **218**. The outer edge of annular disc **264** rests on supporting side rails **266** and **268** which are part of the mounting structure for the combustion chamber. Another side rail (not shown) is provided behind the combustion chamber, and the combustion chamber is slid into the page in FIG. **6** between side rail supports **266** and **268** to be supported thereby and by the rear side rail support. Extending downwardly from metal plate **258** are four elongated J-bolts, two of which are shown at **270** and **272**. The lower end of the J-bolts curl around a short length of dowel rod such as **274, 276** which is welded to the underside of a metal tray **278**, such that tray **278** is suspended and supported below metal plate **258** and adjusted by threaded nuts **280** and **282** at the upper end of respective J-bolts **270** and **272**. Resting in pan **278** is a heat insulating blanket **284**, such as provided by the above noted Fiberfrax Durablanket, and a heat insulating board **286**, such as provided by the above noted Fiberfrax Duraboard. Heat exchanger coil **252** is disposed between boards **286** and **262**. Resting on board **286** is a heat insulating blanket **288**, such as provided by the above noted Fiberfrax Durablanket, and a heat insulating board **290**, such as provided by the above noted Fiberfrax Duraboard. Board **290** engages the bottom **292** of lower portion **224** of mixer and burner assembly **222**. Mixer and burner assembly **222** includes the noted lower and upper portions **224** and **226** bolted to each other at flanges **294** and **296** and welded to metal plate **258** at weldment **298**, FIG. **7**.

Cover **208** is mounted to end wall **210** by bolts such as **300**, **302**, **304**, FIG. **7**, which are welded to plate **258** at respective weldments **306**, **308**, **310** and extend upwardly through cover **208** and metal plate **312** and are secured by respective nuts **314**, **316**, **318**. The outer circumferential edge of cover **208** is received in gasket **320** on annular disc **264**. Cover **228** rests on plate **312** on cover **208** and is welded thereto at weldment **322**. Header pipe **324** includes a lower portion **326** extending through layers **258**, **260**, **262** of wall **210**, and an upper portion **328** extending through cover **208** at grommet **330**. Header pipe **332** is comparable. The liquid to be heated flows through inlet header pipe **324** as pumped by pump **334**, and flows through heat exchanger coil **252**, and exits through header pipe **332**.

In the preferred embodiment, FIG. **2**, a first conduit **58** supplies air from the blower to the mixer and burner assembly, and a second conduit **60** independently supplies air from the blower to the buffer space. Air flows through first conduit **58** along a path **34** from blower **32** to mixer and burner assembly **28** without passing through buffer space **26**. In the alternate embodiment in FIG. **6**, air from blower **202** flows through buffer space **206** to mixer and burner assembly **222**. In each embodiment, the penetrations, such as the mixer and burner assembly, header pipes, ignitors, flame sensors, etc., extend through the combustion chamber end wall **14**, **210** and the cover **24**, **208** in non-leak-tight relation, eliminating the need for leak-tight seals therebetween.

In a further desirable aspect, the interface **334**, FIG. **2**, and **336**, FIG. **6**, along which the combustion chamber opening **20**, **213** is covered by the top end wall **14**, **210**, is also within the buffer space **26**, **206** and covered by the cover **24**, **208**, such that leakage at the interface **334**, **336** flows from the buffer space **26**, **206** into the combustion chamber **12**, **212**, eliminating the need for a leak-tight sea at such interface **334**, **336**. In FIG. **3**, gasket **338** at interface **334** may be eliminated. In FIG. **7**, there is no gasket at interface **336**. Since the interface **334**, **336** along which the combustion chamber opening is covered and closed by the top end wall **14**, **210** is within the buffer space **26**, **206** and covered by the cover **24**, **208**, the noted interface **334**, **336** is buffered, and leakage at such interface will flow into the combustion chamber, rather than the reverse.

In another desirable aspect, the cover **24**, **208** covers only the top end wall **14**, **210** of the combustion chamber **12**, **212**, and not the other end wall **16**, **214** nor the sidewall **18**, **216**, such that the latter are accruable without removing the cover **24**, **208**. The buffer space **26**, **206** is thin and flat and covers only the top end wall of the combustion chamber.

In the preferred embodiment in FIG. **2**, pressure dropping orifice **36** is between blower **32** and mixer and burner assembly **28**. Gas inlet port **40** is external to cover **24** and downstream of pressure dropping orifice **36**. Buffer space **26** communicates with blower **32** through path **42** upstream of pressure dropping orifice **36**.

It is recognized that various equivalents, alternatives and modifications are possible within the scope of the appended claims.

We claim:

**1**. Combustion apparatus comprising:

a combustion chamber having distally opposite first and second end walls, and having a sidewall extending between said end walls;

a cover external to said combustion chamber and covering said first end wall and defining a buffer space therebetween;



[one or more penetrations] *a plurality of penetrations including a mixer and burner assembly, a liquid inlet, a liquid outlet, a flame sensor, and an igniter, each* extending through said first end wall between said buffer space and said combustion chamber;

a blower external to said cover and supplying air to said buffer space and pressurizing said buffer space to a higher pressure than said combustion chamber such that leakage at said [one or more penetrations] *penetrations in the first end wall* flows from said buffer space into said combustion chamber;

[a] *said* mixer and burner assembly extending into said combustion chamber and receiving combustion air from said blower;

a pressure dropping orifice between said blower and said mixer and burner assembly such that the pressure in said combustion chamber is lower than the pressure in said buffer space;

a first conduit supplying air from said blower to said mixer and burner assembly, and a second conduit independently supplying air from said blower to said buffer space,

wherein air flows through said first conduit along a path from said blower to said mixer and burner assembly without passing through said buffer space.

**2**. Combustion apparatus comprising:

a combustion chamber having distally opposite first and second end walls, and having a sidewall extending between said end walls;

a cover external to said combustion chamber and covering said first end wall and defining a buffer space therebetween;

[one or more penetrations] *a plurality of penetrations including a mixer and burner assembly, a liquid inlet, a liquid outlet, a flame sensor, and an igniter, each* extending through said first end wall between said buffer space and said combustion chamber;

a blower external to said cover and supplying air to said buffer space and pressurizing said buffer space to a higher pressure than said combustion chamber such that leakage at said [one or more penetrations] *penetrations in the first end wall* flows from said buffer space into said combustion chamber;

[a] *said* mixer and burner assembly extending into said combustion chamber and receiving combustion air from said blower;

a pressure dropping orifice between said blower and said mixer and burner assembly such that the pressure in said combustion chamber is lower than the pressure in said buffer space,

wherein said mixer and burner assembly includes a portion external of said combustion chamber, and comprising a second cover external to said first mentioned cover and covering said external portion of said mixer and burner assembly and defining a second buffer space therebetween, said mixer and burner assembly having an inlet port communicating with said second buffer space.

**3**. The invention according to claim **2** wherein said first cover has a port communicating with said second buffer space such that said first mentioned buffer space and said second buffer space are in communication with each other through said port in said first cover, and such that air from said blower supplied to said first buffer space also flows through said port in said first cover to said second buffer space and then to said inlet port of said mixer and burner assembly.

4. Combustion apparatus comprising:

a combustion chamber having distally opposite first and second end walls, and having a sidewall extending between said end walls;

[one or more] *a plurality of* penetrations, including a mixer and burner assembly, *a liquid inlet, a liquid outlet, a flame sensor, and an igniter, each* extending through said first end wall;

a cover external to said combustion chamber and covering said first end wall and defining a buffer space therebetween;

a blower supplying air to said mixer and burner assembly along a first path through a first conduit, and supplying air to said buffer space along a second path through a second conduit and pressurizing said buffer space to a higher pressure than said combustion chamber, *such that, in use, leakage at penetrations in the first end wall flow from the buffer space to the combustion chamber,* wherein said first path extends from said blower to said mixer and burner assembly without passing through said buffer space.

5. The invention according to claim **4** comprising a pressure dropping orifice between said blower and said mixer and burner assembly such that the pressure in said combustion chamber is lower than the pressure in said buffer space.

6. The invention according to claim **5** wherein said mixer and burner assembly includes a gas inlet port downstream of said pressure dropping orifice.

7. The invention according to claim **6** wherein said gas inlet port is external to said cover.

8. The invention according to claim **5** wherein said buffer space communicates with said blower along said second path through said second conduit upstream of said pressure dropping orifice.

9. Combustion apparatus comprising:

a combustion chamber having distally opposite first and second end walls, and having a sidewall extending between said end walls, said combustion chamber having an exhaust outlet;

[one or more] *a plurality of* penetrations, including a mixer and burner assembly, *a liquid inlet, a liquid outlet, a flame sensor, and an igniter,* extending through said first end wall;

a cover external to said combustion chamber and covering said first end wall and defining a buffer space therebetween, said buffer space having a buffer outlet;

a blower supplying air to said buffer space and to said mixer and burner assembly,

wherein there is a first pressure drop **R1** from said blower to said mixer and burner assembly, a second pressure drop **R2** from said mixer and burner assembly to said combustion chamber, a third pressure drop **R3** from said blower to said buffer space, a fourth pressure drop **R4** across said buffer outlet, and a fifth pressure drop **R5** across said exhaust outlet, wherein

$$\frac{R3}{R4} < \frac{R1 + R2}{R5}.$$

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