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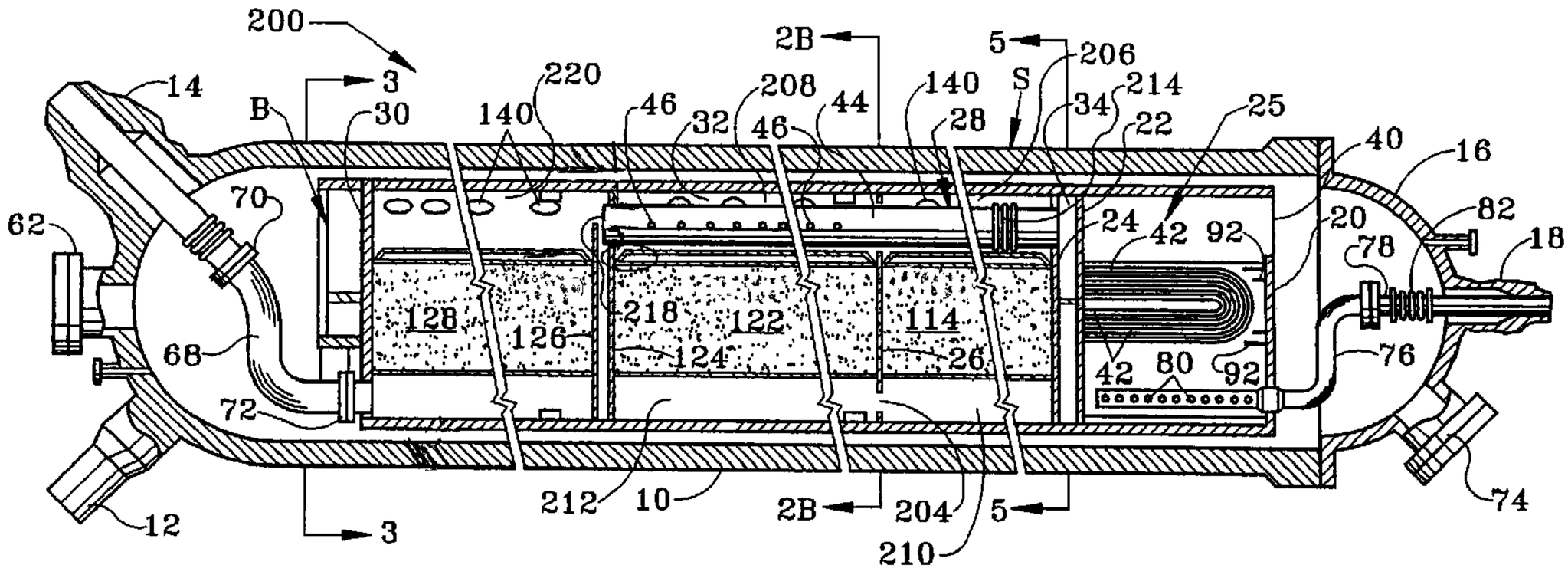
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(54) Titre : CONVERTISSEUR D'AMMONIAC HORIZONTAL ADAPTE POUR CATALYSEUR A ACTIVITE ELEVEE
(54) Title: HORIZONTAL AMMONIA CONVERTER ADAPTED FOR HIGH ACTIVITY CATALYST



(57) Abrégé/Abstract:
A method for modifying a standard two-bed horizontal ammonia converter to provide increased conversion and/or production capacity by placing the first secondary catalyst bed of the existing converter in parallel flow with the existing primary catalyst bed and replacing magnetite catalyst in the second secondary catalyst bed with high activity ruthenium-on-carbon catalyst.

ABSTRACT OF THE DISCLOSURE

A method for modifying a standard two-bed horizontal ammonia converter to provide increased conversion and/or production capacity by placing the first secondary catalyst bed of the existing converter in parallel flow with the existing primary catalyst bed and replacing magnetite catalyst in the second secondary catalyst bed with high activity ruthenium-on-carbon catalyst.

HORIZONTAL AMMONIA CONVERTER ADAPTED FOR HIGH ACTIVITY CATALYST

FIELD OF THE INVENTION

This invention relates to horizontal ammonia converters, and especially to a horizontal ammonia converter adapted to use high activity catalyst.

BACKGROUND OF THE INVENTION

The present invention is directed to multi-bed horizontal ammonia converters such as the converter described in U.S. Patent 4,452,760 to Peterson et al. Many of these reactors are in use operating on a magnetite catalyst. It is frequently desired to modify the Peterson et al. reactor for increased ammonia conversion.

With reference to the Peterson et al. ammonia converter shown in Figs. 1 and 1A, the outer shell **S** is a cylindrical pressure vessel which includes a main body **10** having an inlet **12** and an outlet **14** at one end. A head **16** is removably attached to main body **10** and has an exchanger bypass **18**. An inner shell or basket **B** is removably positioned within outer shell **S**. The inner shell **B** is a cylindrical vessel which is divided into sections. The end wall **20** and a first wall **22** define a heat exchange section **25** of shell B. A second wall **24** and a third wall **26** define a first catalyst section **28**. A second catalyst bed section is defined between third wall **26** and the outer end wall **30** of shell **B**. A gas transfer section **34** is disposed between first wall **22** and second wall **24**.

The synthesis gas enters the outer shell **S** of the Peterson et al. reactor through inlet **12**. The gas is at a temperature below the desired reaction temperature, but maintains the outer shell **S** at low temperatures as it passes through the annular space **36** (shown enlarged in Fig. 1A) between the outer shell **S** and the inner shell **B**. Preferably, the gas is introduced through inlet **12** at one end and flows to the other end where it passes through opening **40** in end wall

20. Opening 40 is at the top of end wall 20 where the gas enters the heat exchange section 25 of inner shell B. The gas passes downwardly over a plurality of tubes 42 heating the gas to reaction temperatures. As best seen in Fig. 1A, the gas enters the bottom of gas transfer section 34 and passes to the top where it enters the first catalyst bed section 28 above the horizontal bed of catalyst. As the gas passes through the catalyst, the hydrogen and nitrogen react to form ammonia and due to the exothermic reaction, the product gases are hotter than the entering gas. The product gas contains a mixture of ammonia and unreacted hydrogen and nitrogen. The product gas passes through gas transfer section 34 where it enters the inside of tubes 42. As the product gas passes through the tubes 42 it is cooled in heat exchange section 25. The cooled product gas then re-enters gas transfer section 34 where it enters pipe 44 which extends from gas transfer section 34, through first catalyst bed section 28 and passes through openings 46 in pipe 44 above a horizontal bed of catalyst in second catalyst bed section 32. In the Peterson et al. reactor it is preferred that the second catalyst bed section 32 comprises two horizontal beds of catalyst through which the product gas from the first bed of catalyst passes. Preferably, the second catalyst bed section 32 is in two sections formed by partial wall 124 which extends above catalyst bed 122 and partial wall 126 whcich extends below adjacent catalyst bed 128. Further ammonia is produced in the catalyst beds 122 and 128 and again the product gas is heated. The hot reaction product gas then passes through end wall 30 through an outlet pipe 48 where it passes through outlet 14.

SUMMARY OF THE INVENTION

The present invention is a horizontal ammonia conversion reactor which can be made by new fabrication or modification of the Peterson et al. reactor. The horizontal ammonia conversion reactor of this invention uses a combination

of magnetite and high activity catalyst, and has a higher conversion rate than the magnetite-based Peterson et al. reactor.

In one aspect, the present invention provides a horizontal multi-bed ammonia converter. The converter has a horizontal cylindrical outer shell having a removable head at one end thereof. A horizontal basket has a horizontal cylindrical inner shell having fore and aft end walls and defines an annular passage between the inner and outer shells. A gas inlet through the outer shell is in fluid communication with the annular passage. A first transverse partition disposed on the inner shell is longitudinally spaced from the fore wall to define a heat exchange section therebetween. The heat exchange section has a plurality of tubes passing therethrough and a tube sheet which is adjacent to the first transverse partition. The heat exchange section includes a shell-side inlet and outlet for directing gas across the tubes. The shell-side inlet is in fluid communication with the annular passage. A second transverse partition disposed on the inner shell is longitudinally spaced from the first transverse partition to define a first primary catalyst bed therebetween which is adapted for downward flow of gas therethrough. A third transverse partition is longitudinally spaced between the second transverse partition and the aft wall to define a second primary catalyst bed between the second and third transverse partitions and a secondary catalyst bed between the third partition and the aft wall. The second primary catalyst bed and the secondary catalyst bed are adapted for downward flow of gas therethrough. First upper and lower plenums are formed above and below the primary catalyst beds and are defined by the inner shell and respective tops and bottoms of the primary catalyst beds. Second upper and lower plenums are formed above and below the secondary catalyst bed and are defined by the inner shell and a respective top and bottom of the secondary catalyst bed. A first passageway is formed from the shell-side outlet through the first partition to the first upper plenum. A second passageway is

formed from the first lower plenum through the first partition to a tube-side inlet of the heat exchange section. A third passageway is formed from a tube-side outlet of the heat exchange section through the first, second and third partitions to the second upper plenum. A gas outlet is provided in fluid communication with the second lower plenum.

The ammonia converter can include distributors for introducing gas from the first and second upper plenums respectively into the primary and secondary catalyst beds. The ammonia converter can include a bypass line for introducing gas directly into the heat exchange section adjacent to the shell-side outlet. The secondary catalyst bed preferably comprises high activity catalyst.

The third passageway can include a conduit disposed in the first upper plenum and passing through the second and third partitions into the second upper plenum. The first upper and lower plenums can include openings through the second partition. The first partition can include horizontal and vertical cruciform walls, an outer flow path from the shell-side outlet around the cruciform wall to the first upper plenum, a lower flow path inside the cruciform wall from the first lower plenum to the tube-side inlet, and an upper flow path inside the cruciform wall from the tube-side outlet to the conduit.

In another aspect, the present invention provides a method for retrofitting a horizontal multi-bed ammonia converter as disclosed in Peterson et al. Before retrofit, the ammonia converter comprises: (1) a horizontal cylindrical outer shell having a removable head at one end thereof; (2) a horizontal basket comprising a horizontal cylindrical inner shell having fore and aft end walls and defining an annular passage between the inner and outer shells; (3) a gas inlet through the outer shell in fluid communication with the annular passage; (4) a first transverse partition longitudinally spaced from the fore wall to define a heat exchange section therebetween having a plurality of tubes passing therethrough and a tube

sheet adjacent to the first transverse partition, said heat exchange section having a shell-side inlet and outlet for directing gas across the tubes, the shell-side inlet in fluid communication with the annular passage; (5) a second transverse partition longitudinally spaced from the first transverse partition to define a first catalyst bed therebetween adapted for downward flow of gas therethrough; (6) a third transverse partition longitudinally spaced between the second transverse partition and the aft wall to define a second catalyst bed between the second and third transverse partitions and a third catalyst bed between the third partition and the aft wall, the second and third catalyst beds adapted for downward flow of gas therethrough; (7) first, second and third upper plenums above and below the respective catalyst beds defined by the inner shell and respective tops and bottoms of the catalyst beds; (8) a first passageway from the shell-side outlet through the first partition to the first upper plenum; (9) a second passageway from the first lower plenum through the first partition to a tube-side inlet of the heat exchange section; (10) a third passageway from a tube-side outlet of the heat exchange section through the first and second partitions to the second upper plenum; (11) a fourth passageway from the second lower plenum through the third partition to the third upper plenum; and (12) a gas outlet in fluid communication with the third lower plenum. The retrofitting method comprises the steps of: (a) cutting flow windows through the second partition to establish fluid communication between the first and second upper plenums and the first and second lower plenums; (b) sealing off the fourth passageway; (c) extending the third passageway through the third transverse partition to be in fluid communication with the third upper plenum, and sealing off the third passageway with respect to the second upper plenum; and (d) filling the third catalyst bed with high activity catalyst.

The method can also include the step of (e) closing off holes in the distributor at the top of the first catalyst bed, e.g. by applying blanking strips, so that the hole area in the distributor, per linear foot of length of the first catalyst bed, is substantially the same as the hole area in a distributor at the top of the second catalyst bed per linear foot of length of the second catalyst bed. The method preferably includes filling the first and second catalyst beds with 1.5 to 3 mm magnetite catalyst. The bed supports at the bottom of the first, second and/or third catalyst beds can be overlaid with smaller screens as needed.

Step (c) preferably includes adding a short pipe extension to the third passageway, cutting a hole in the third transverse partition to receive the short pipe extension, and seal-welding the short pipe extension to the third transverse partition.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 (prior art) is a sectional view of the horizontal converter of Peterson et al.

Fig. 1A (prior art) is a sectional schematic view showing the gas flow through the converter of Peterson et al.

Fig. 1B (prior art) is a sectional view taken along the lines 1B-1B of Fig. 1.

Fig. 2 is a sectional view of the horizontal converter of the present invention.

Fig. 2A is a schematic sectional view showing the gas flow through the converter of the present invention.

Fig 2B is a sectional view taken along thr lines 2B-2B of Fig. 2.

Fig. 3 is a sectional view taken along the lines 3-3 of Figs. 1 and 2 showing one end of the inner cylindrical shell.

Fig. 4 is an expanded, isometric view of the gas transfer section, separated to show the details of this section within the inner cylindrical shell.

Fig. 5 is a sectional view taken along the lines 5-5 of Figs. 1 and 2

Fig. 6 is a sectional view of a portion of the distribution plates of the catalyst bed shown in section 5 of Figs. 1 and 2.

DESCRIPTION OF THE INVENTION

For illustrative purposes, the converter of the present invention is described herein relative to its use in the catalytic synthesis of ammonia from nitrogen and hydrogen. It is understood that the use of the present converter for ammonia is not necessarily limited to the synthesis of ammonia. In the synthesis of ammonia, a synthesis gas which is predominantly hydrogen and nitrogen, usually in a 3:1 molar ratio, is passed over an ammonia synthesis catalyst, the pressures of which range from 50 to 400 atm. The commercial ammonia synthesis catalysts now employed are either the so-called "magnetite catalysts" made of iron or modified iron which operate at temperatures between 250° and 540°C, or the so-called "high activity catalysts" comprising a platinum group metal such as ruthenium on a graphite-containing carbon support as described in U.S. Patents 4,055,628, 4,122,140 and 4,163,775. The ammonia reaction is exothermic and the converter of the present invention is designed for the removal or handling of the exothermic heat produced in the reaction by an interstage cooler.

The reactor of the present invention can be made by new construction, but is more preferably made by modifying the Peterson et al. device. To modify the Peterson et al. reactor to make the reactor **200** (see Fig. 2) according to the present invention, flow windows **202** and **204** (see Fig. 2B) are cut in the third wall **26** to connect plenums **206**, **208** above the respective first catalyst bed **114** and second catalyst bed **122**, and to connect plenums **210**, **212** below the respective first catalyst bed **114** and second catalyst bed **122**. The flow window **202** preferably circumscribes the pipe **44** to avoid the need for adding another

expansion joint **214** to the pipe **44**. The flow window **216** of the Peterson et al. reactor is sealed off so that partial wall **124** in the Peterson et al. reactor becomes a complete wall corresponding to the third transverse partition in the present reactor **200**. Thus, gas enters from the respective connected plenums **206**, **208** above the first and second catalyst beds **114**, **122**, and flows downwardly therethrough in parallel to the connected plenums **210**, **212** below the respective catalyst beds **114**, **122**. As needed, holes **136** in distributor plate **134** (see Fig. 6) between the plenum **206** and first catalyst bed **114** can be sealed, e.g. with blanking strips **215**, so that the hole area per bed length is the same for both first and second catalyst beds **114**, **122** to achieve an even distribution of feed gas thereto.

Another modification of the Peterson et al. reactor is the sealing off of the holes **46** and extension **218** (see Fig. 2) of the pipe **44** through the wall **124**. The pipe extension **218** can be seal welded along the perimeter of a circular hole cut through the wall **124**. This delivers the gas from the pipe **44** into the plenum **220** above the third catalyst bed **128**.

Finally, the first and second catalyst beds **114**, **122** are filled with conventional magnetite catalyst, preferably 1.5-3 mm. The third catalyst bed is preferably filled with high activity catalyst. If necessary, smaller screens can be overlaid on the supports of the catalyst beds **114**, **122**, **128**.

The first wall **22**, second wall **24** and gas transfer section **34** of the Peterson et al. reactor collectively form the first transverse partition for purposes of the present invention. The third wall **26** of Peterson et al. (appropriately modified to include flow windows **202**, **204**) is taken as the second transverse partition, and the partial wall **124** (appropriately sealed off) and/or partial wall **126** form the third transverse partition. The primary catalyst bed **114** and the first secondary bed **122** of the Peterson et al. reactor become the first and second

primary catalyst beds in the present invention, gas flowing in parallel therethrough without interstage cooling. The second secondary catalyst bed **128** of Peterson et al. becomes the sole secondary bed of the present invention, containing high activity catalyst and receiving process gas from the primary magnetite catalyst beds **114**, **122** after interstage cooling in the tubes **42**.

In the present reactor **200** the outer shell **S** has a removable head **16** so that the inner shell or basket **B** may be removed for loading catalyst and for catalyst changes. Shell **B** is rolled into outer shell **S** by means of wheels **50** and **52** (see Fig. 3) attached to the end of shell **B**. Stops **54** and **56** correctly position the distance shell **B** enters the main body **10** of outer shell **S**. When shell **B** meets stops **54** and **56**, jacks are placed on jack supports **58** and **60** to remove wheels **50** and **52**. Rollers (not shown) on the outer surface of shell or basket **B** assist in maintaining basket **B** centered even when it expands on heating. The wheels are removed through manhole **62** at the end of main body **10**. The shell **B** is then centered in shell **S** and locked into position by locks **64** and **66**. The outlet pipe **48** comprises several sections. Section **68** has flanges **70** and **72** at each end respectively, which are connected by a person working within the main body **10**. After securing shell **B** within shell **S**, the removable head **16** is secured. A person enters through manhole **74** in head **16** to connect a section **76** of the quench gas pipe **78**. The quench gas pipe **78** extends at one end into the bottom of the heat exchange section **25** and has a plurality of openings **80**. By diverting some of the inlet gas past the annular space between shells **B** and **S**, and past the heat transfer tubes **42**, the quench gas pipe **78** can be used as a means for temperature control of the reactor **200**. At the outer end of quench gas pipe **78** is an expansion joint **82** inside the head **16** before passage through inlet **18**.

Referring to Fig. 4, which shows the details of the heat exchange section **25** and the gas transfer section **34**, the fresh synthesis gas introduced through

inlet **12** passes on the outer surface of inner shell **B** and through opening **40** defining a shell-side fluid inlet at the top of end wall **20**. The gas enters heat exchange section **25**. A plurality of tubes **42** extend from lower inlet tubesheet **84** and return to upper outlet tubesheet **86**. Both tubesheet **84** and **86** are part of wall **22**. Wall **22** and wall **24**, together with gas transfer section **34**, collectively constitute a first transverse partition between heat exchange section **25** and first catalyst bed **114**. Surrounding the tubes **42** are retainer walls **88** and **90**. Extending from end wall **20** are a plurality of baffles **92** (see Fig.2). The gas entering heat exchange section **25** thus flows over tubes **42**, because of the retainer walls **88** and **90** and the baffles **92**, to the bottom of section **25**. At the bottom of wall **22**, within retainer walls **88** and **90**, are two openings **94** and **96** where the gas enters transfer section **34**.

The gas transfer section **34** has a reduced internal cross-section **98**. Preferably, cross-section **98** is cruciform, i.e. cross shaped. The internal cross-section **98** is divided by horizontal partition **100** into a lower portion **102** and an upper portion **104**. The shape of lower portion **102** and upper portion **104** conforms to the shape of tube sheets **84** and **86**, which are preferably rectangular. Extending from lower portion **102** is a portion **106** which extends to the inner wall of basket **B**. Likewise, upper portion **108** extends from upper portion **104** to the inner wall of basket **B**. Hence, the gas which passes through openings **94** and **96** passes externally of the reduced internal cross-section **98** from the bottom of gas transfer section **34** to the top where it passes through openings **110** and **112** in wall **24**. The openings **110** and **112** open into plenum **206**, above catalyst bed **114**. Gas then enters plenum **208** through the flow window **202** and then passes in parallel through first and second catalyst beds **114**, **122**. The product gas from first and second catalyst beds **114**, **122** passes from plenums **210**, **212** which are connected by flow window **204** through opening

118 in wall 24 and through the portion 106, and then enters the tubes 42 through inlet tubesheet 84. The gas in tubes 42 is cooled by heat exchange with the fresh gas in heat exchange section 25. The cooled gas passes out of tubes 42 through exit tubesheet 86 and into upper portion 104. The gas then passes into portion 108 and through opening 120 of wall 24 into tube 44. The cooled gas passes through the walls 26 and 124 into plenum 220 above the third catalyst bed 128.

The gas may be distributed before passing through the catalyst beds 114, 122 and 128 by lower plates 130 (see Fig. 6) which have a larger number of larger openings 132 than in upper plate 134. The upper plate has a fewer number of smaller openings 136 which are positioned so that none are aligned with opening 132 in lower plate 130. A number of manhole plates 138, as shown in Fig. 6, permit access to the catalyst bed. Likewise, a number of manholes 140 in basket B (see Fig.2) permit access to first catalyst bed section 28 and second catalyst bed section 32. When shell B is removed from shell S, easy access may be had to the catalyst beds to load or unload the catalyst.

The reactor 200 is thus easily made by retrofitting the Peterson et al. reactor. The modified reactor can use high activity catalyst in the secondary catalyst bed and has an increased ammonia conversion capacity. The catalyst beds 114, 122 are operated in parallel as one bed, with interstage cooling in the heat exchange section 25 before passing the gas through the secondary bed. The increase in primary bed catalyst volume by placing bed 122 in parallel with bed 114, and the increase in equivalent magnetite catalyst volume by use of high activity catalyst in the secondary bed, allows the modified reactor 200 to obtain a higher ammonia conversion percentage per pass and/or to process feed gas at a higher rate to increase ammonia production capacity.

The above description of the invention is merely illustrative and exemplary of the particular embodiments. Various modifications will become apparent to

those skilled in the art. It is intended that all such modifications within the scope or spirit of the appended claims be embraced thereby.

CLAIMS

1. A horizontal multi-bed ammonia converter comprising:

a horizontal cylindrical outer shell having a removable head at one end;

a horizontal cylindrical inner shell having fore and aft end walls and defining an annular passage between the inner and outer shells;

a gas inlet through said outer shell in fluid communication with said annular passage;

a first transverse partition disposed on the inner shell longitudinally spaced from said fore wall to define a heat exchange section therebetween having a plurality of tubes passing therethrough and a tube sheet adjacent to the first transverse partition, said heat exchange section having a shell-side inlet and outlet for directing gas across said tubes, said shell-side inlet in fluid communication with said annular passage;

a second transverse partition disposed on the inner shell longitudinally spaced from said first transverse partition to define a first primary catalyst bed therebetween adapted for downward flow of gas therethrough;

a third transverse partition longitudinally spaced between the second transverse partition and the aft wall to define a second primary catalyst bed between said second and third transverse partitions and a secondary catalyst bed between said third transverse partition and said aft wall, said second primary catalyst bed and said secondary catalyst bed adapted for downward flow of gas therethrough, wherein said secondary catalyst bed comprises a catalyst having a higher activity than catalyst within the primary catalyst beds;

first upper and lower plenums above and below said primary catalyst beds defined by said inner shell and respective tops and bottoms of said primary catalyst beds;

second upper and lower plenums above and below said secondary catalyst bed defined by said inner shell and a respective top and bottom of said secondary catalyst bed;

a first passageway from said shell-side outlet through said first transverse partition to said first upper plenum;

a second passageway from said first lower plenum through said first partition to a tube-side inlet of said heat exchange section;

a third passageway from a tube-side outlet of said heat exchange section through said first, second and third partitions to said second upper plenum; and

a gas outlet through said outer shell in fluid communication with the second lower plenum.

2. The ammonia converter of claim 1 further comprising distributors for introducing gas from said first and second upper plenums respectively into said primary and secondary catalyst beds.

3. The ammonia converter of claim 1 wherein said third passageway includes a conduit disposed in said first upper plenum and passing through said second and third partitions into said second upper plenum.

4. The ammonia converter of claim 3 wherein said first upper and lower plenums include openings through said second partition.

5. The ammonia converter of claim 4 wherein said first partition includes horizontal and vertical cruciform walls, an outer flow path from said shell-side outlet around the cruciform walls to said first upper plenum.

6. A method for retrofitting a horizontal multi-bed ammonia converter comprising:

(a) a horizontal cylindrical outer shell having a removable head at one end thereof;

(b) a horizontal basket comprising a horizontal cylindrical inner shell having fore and aft end walls and defining an annular passage between the inner and outer shells;

(c) a gas inlet through said outer shell in fluid communication with said annular passage;

(d) a first transverse partition longitudinally spaced from said fore wall to define a heat exchange section therebetween having a plurality of tubes passing therethrough and a tube sheet adjacent to the first transverse partition, said heat exchange section having a shell-side inlet and outlet for directing gas across said tubes, said shell-side inlet in fluid communication with said annular passage;

(e) a second transverse partition longitudinally spaced from said first transverse partition to define a first catalyst bed therebetween adapted for downward flow of gas therethrough;

(f) a third transverse partition longitudinally spaced between the second transverse partition and the aft wall to define a second catalyst bed between said second and third transverse partitions and a third catalyst bed between said third partition and said aft wall, said second and said third catalyst beds adapted for downward flow of gas therethrough;

(g) first, second and third upper and lower plenums above and below said respective catalyst beds defined by said inner shell and respective tops and bottoms of said catalyst beds;

(h) a first passageway from said shell-side outlet through said first transverse partition to said first upper plenum;

(i) a second passageway from said first lower plenum through said first partition to a tube-side inlet of said heat exchange section;

(j) a third passageway from a tube-side outlet of said heat exchange section through said first and second transverse partitions to said second upper plenum;

(k) a fourth passageway from said second lower plenum through said third transverse partition to said third upper plenum; and

(l) a gas outlet in fluid communication with the third lower plenum, comprising the steps of:

(i) forming flow windows through the second partition to establish fluid communication between the first and second upper plenums and between the first and second lower plenums;

(ii) sealing off the fourth passageway;

(iii) extending the third passageway through the third transverse partition to be in fluid communication with the third upper plenum and sealing off the third passageway with respect to the second upper plenum; and

(iv) filling the third catalyst bed with high activity catalyst.

7. The method of claim 6 further comprising the step of:

sealing holes in a distributor at the top of said first catalyst bed so that the hole area in said distributor per linear foot of length of said first catalyst bed is the same as a hole area in a distributor at the top of said second catalyst bed per linear foot of length of said second catalyst bed.

8. The method of claim 6 wherein the first and second catalyst beds are filled with 1.5 to 3 mm magnetite catalyst.

9. The method of claim 8 further comprising overlaying bed supports at the bottom of said first, second or third catalyst beds with smaller screens.

10. The method of claim 6 wherein said step (iii) includes adding a short pipe extension to said third passageway, forming a hole through said third transverse partition to receive the short pipe extension and seal-welding the short pipe extension to the third transverse partition.

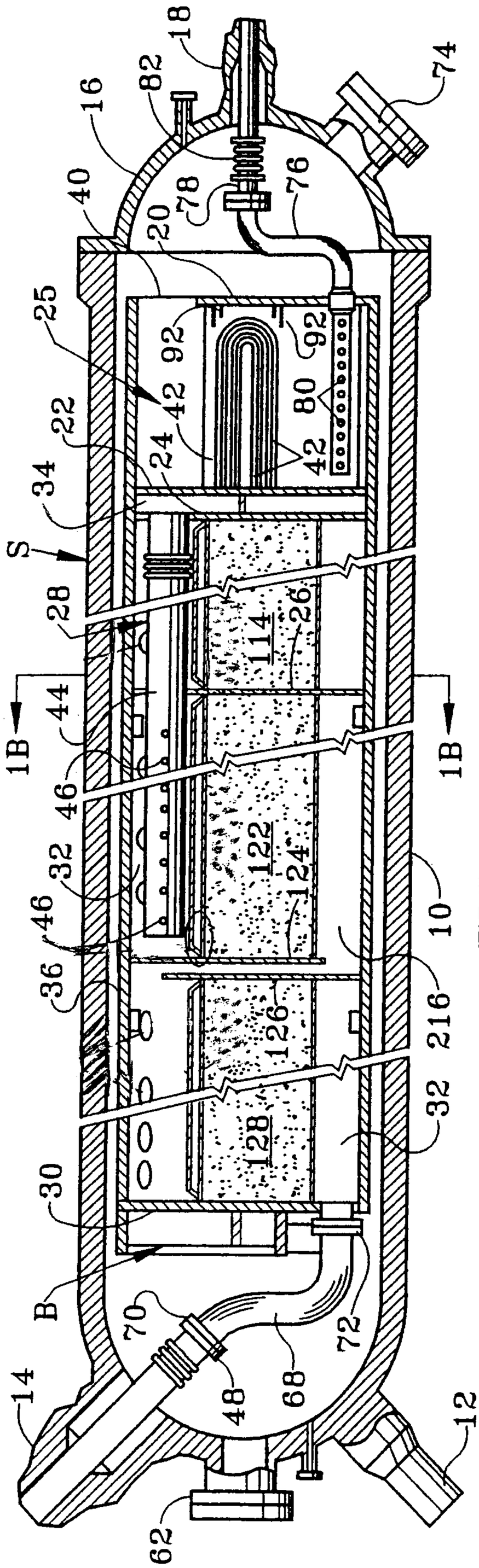


FIG.1
(PRIOR ART)

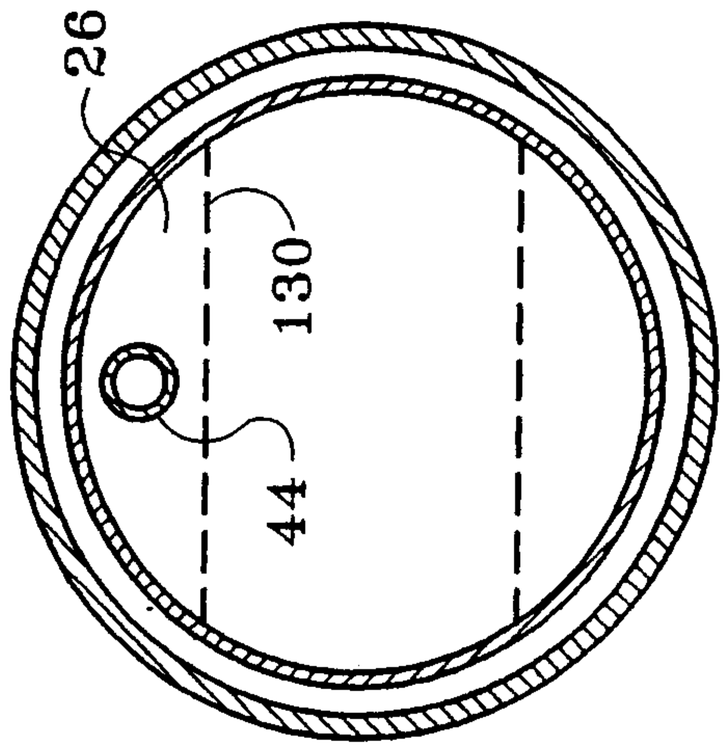


FIG.1B
(PRIOR ART)

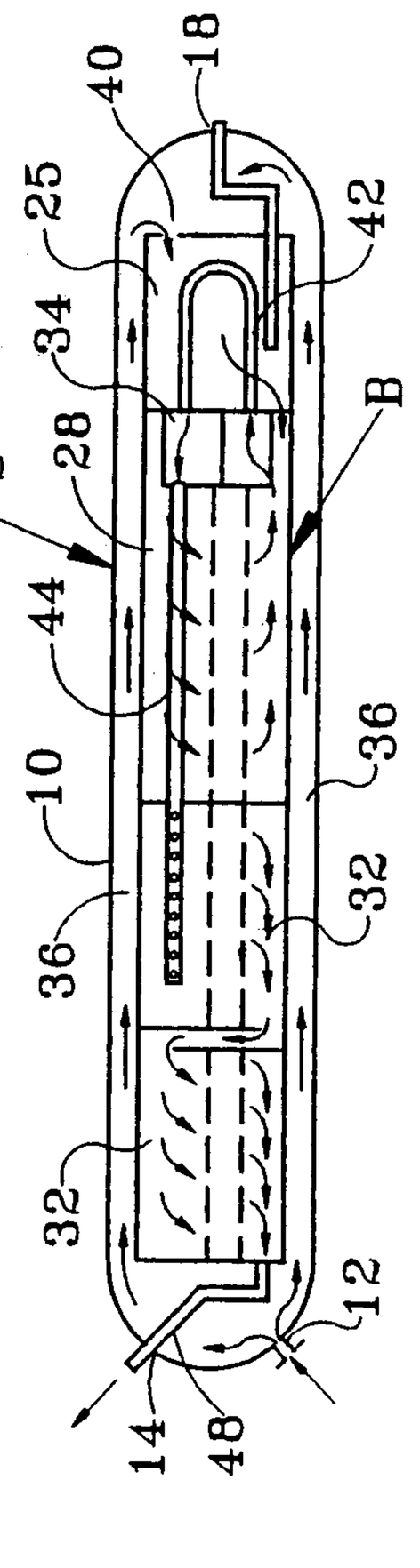


FIG.1A
(PRIOR ART)

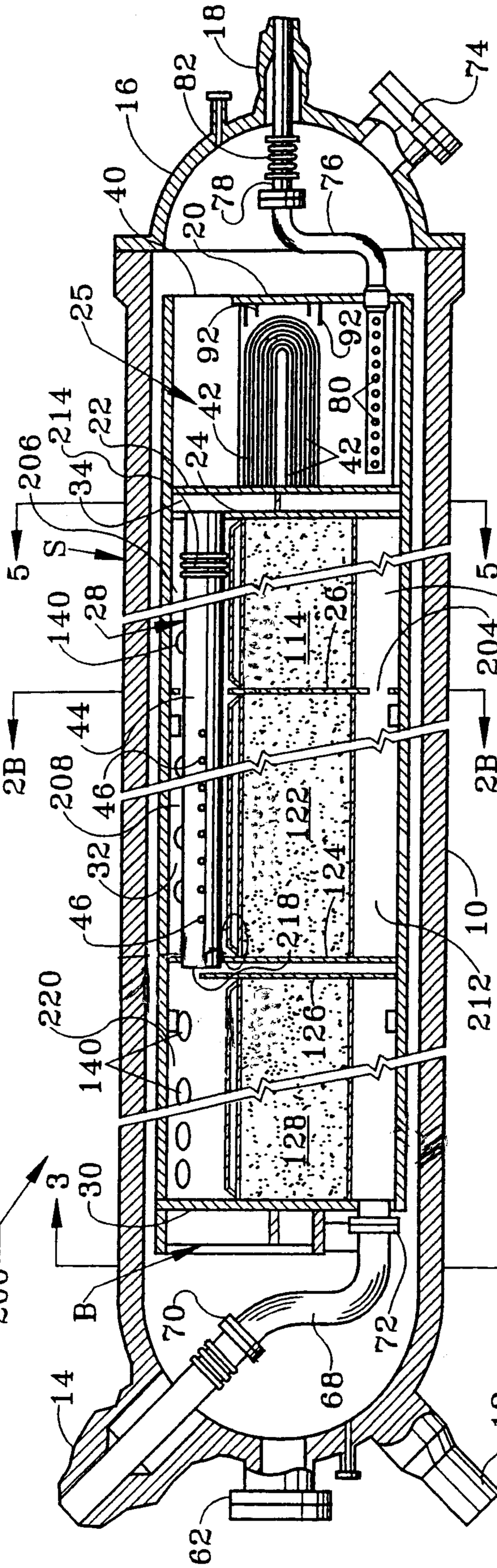


FIG.2

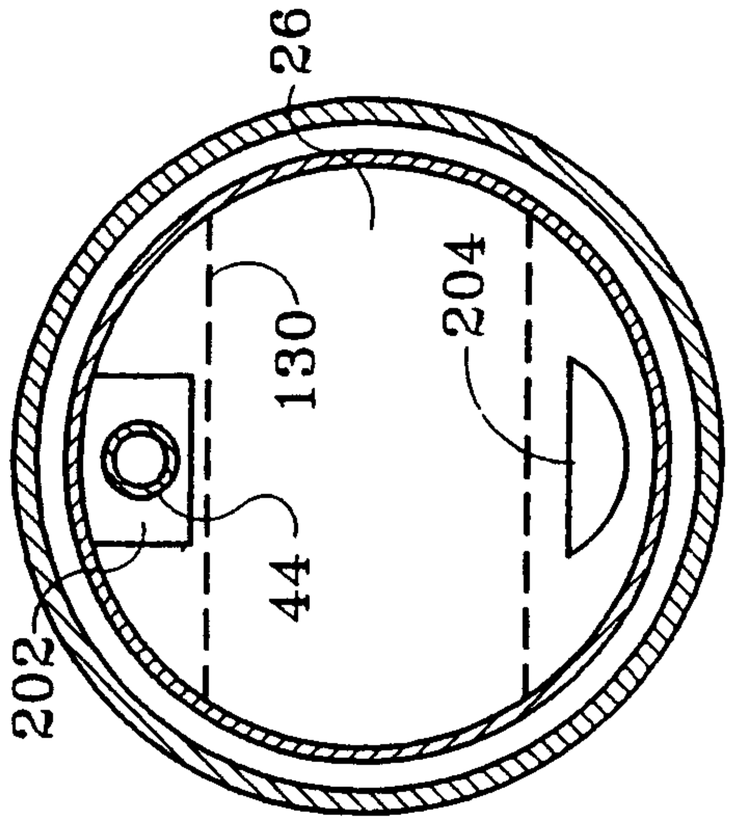


FIG.2B

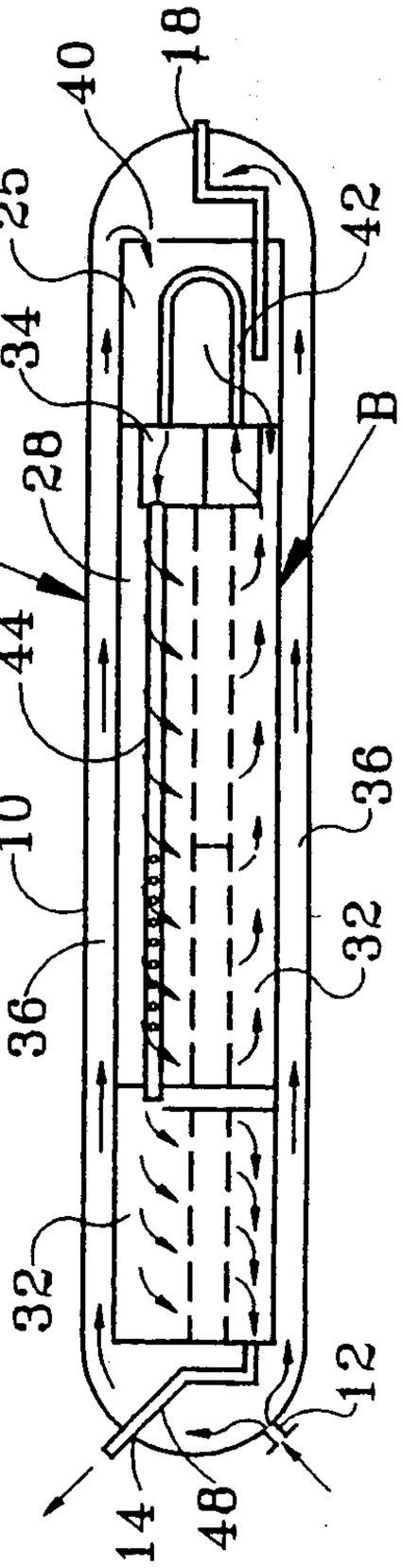


FIG.2A

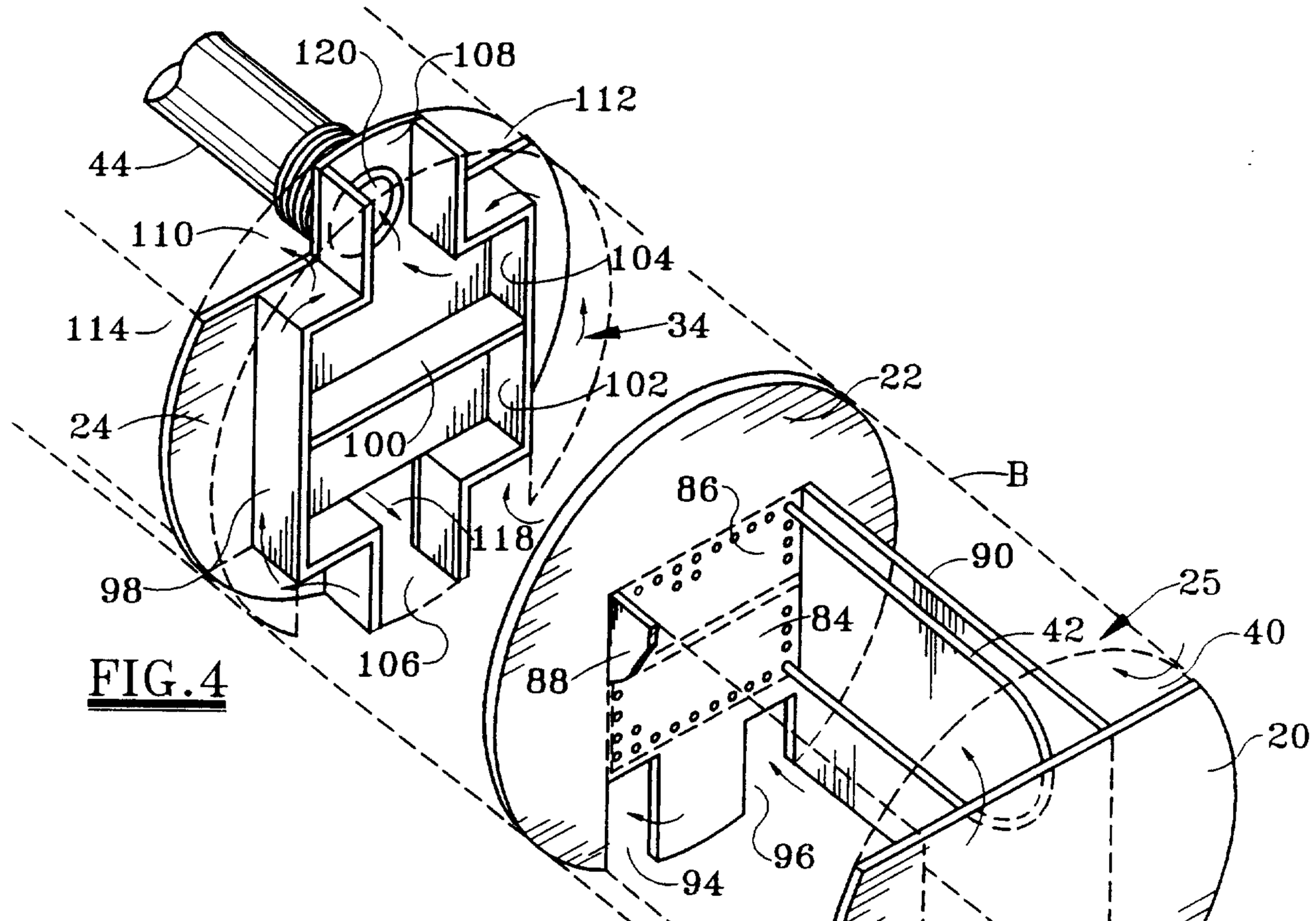


FIG.4

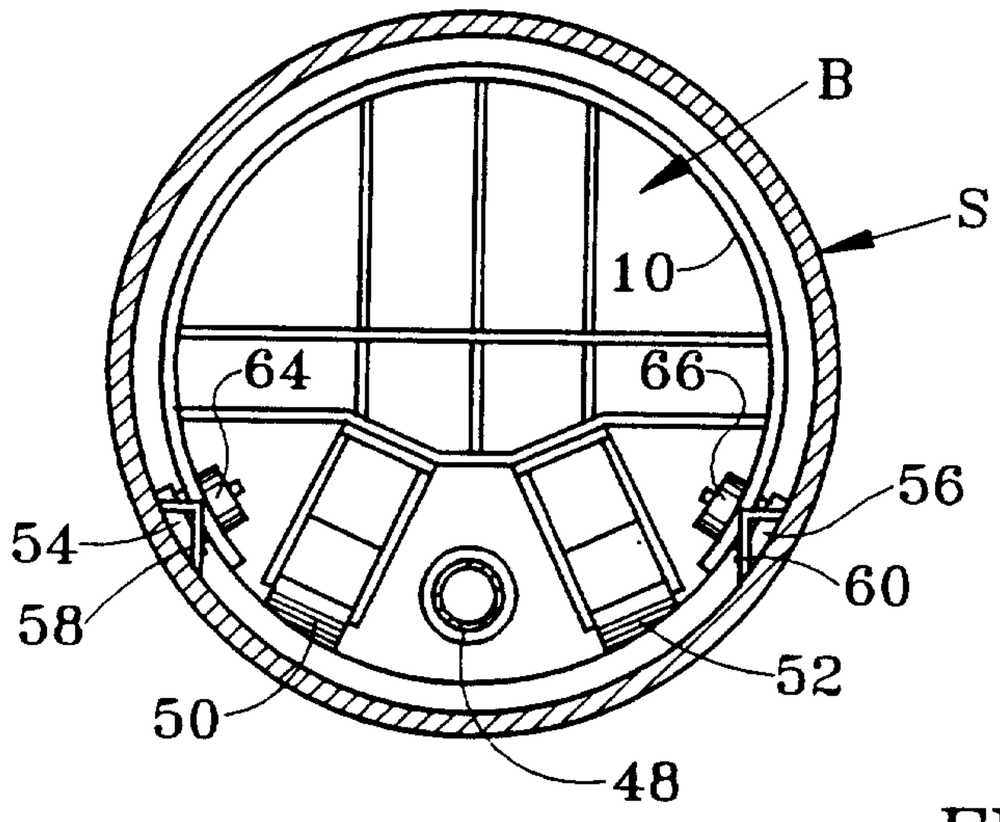


FIG.3

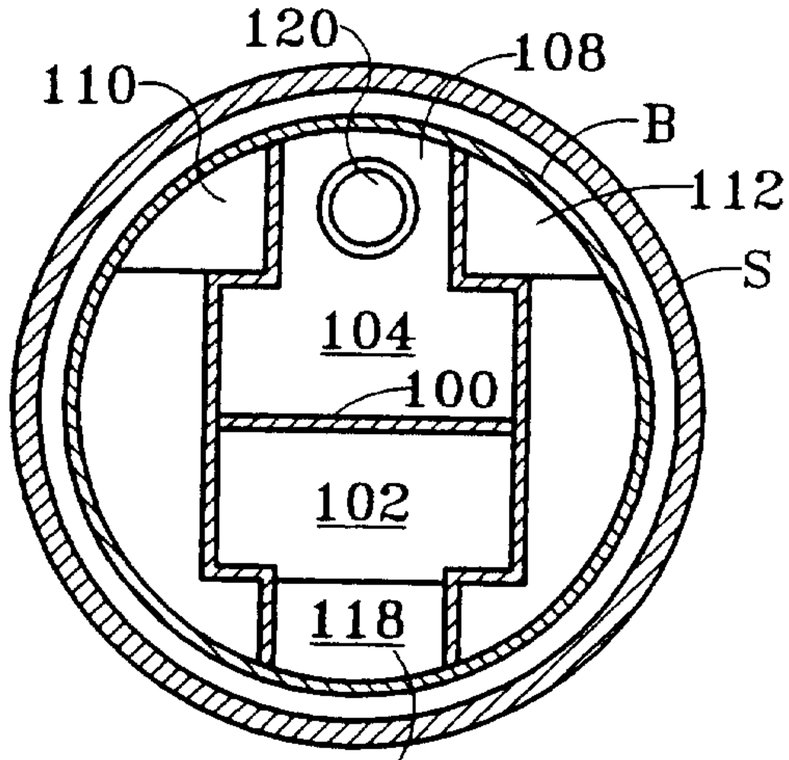


FIG.5

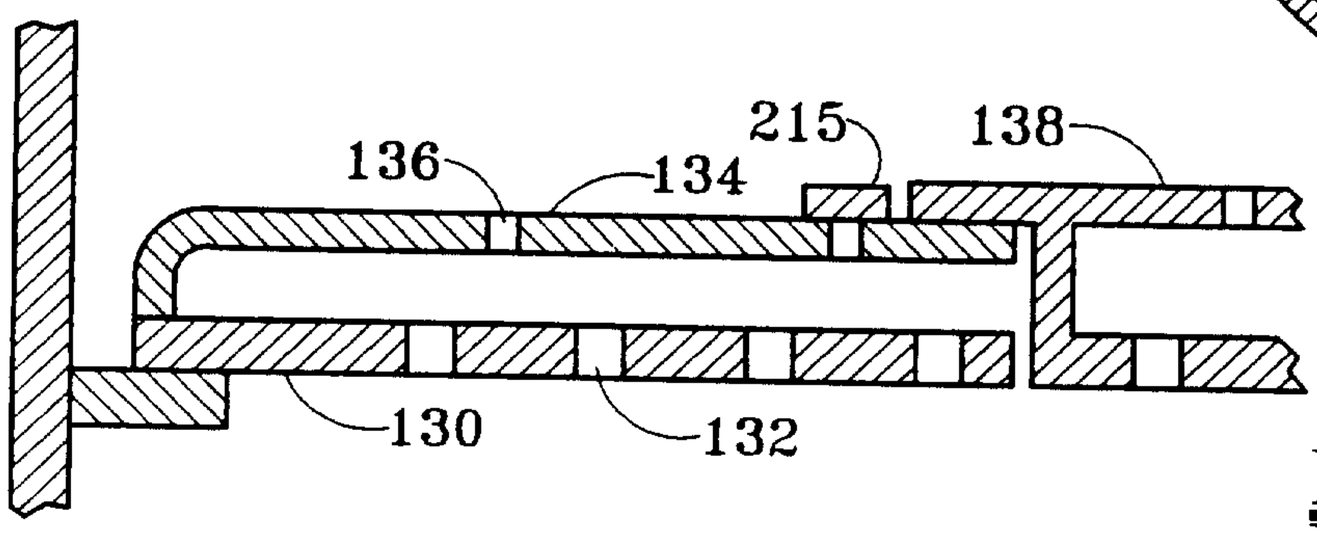
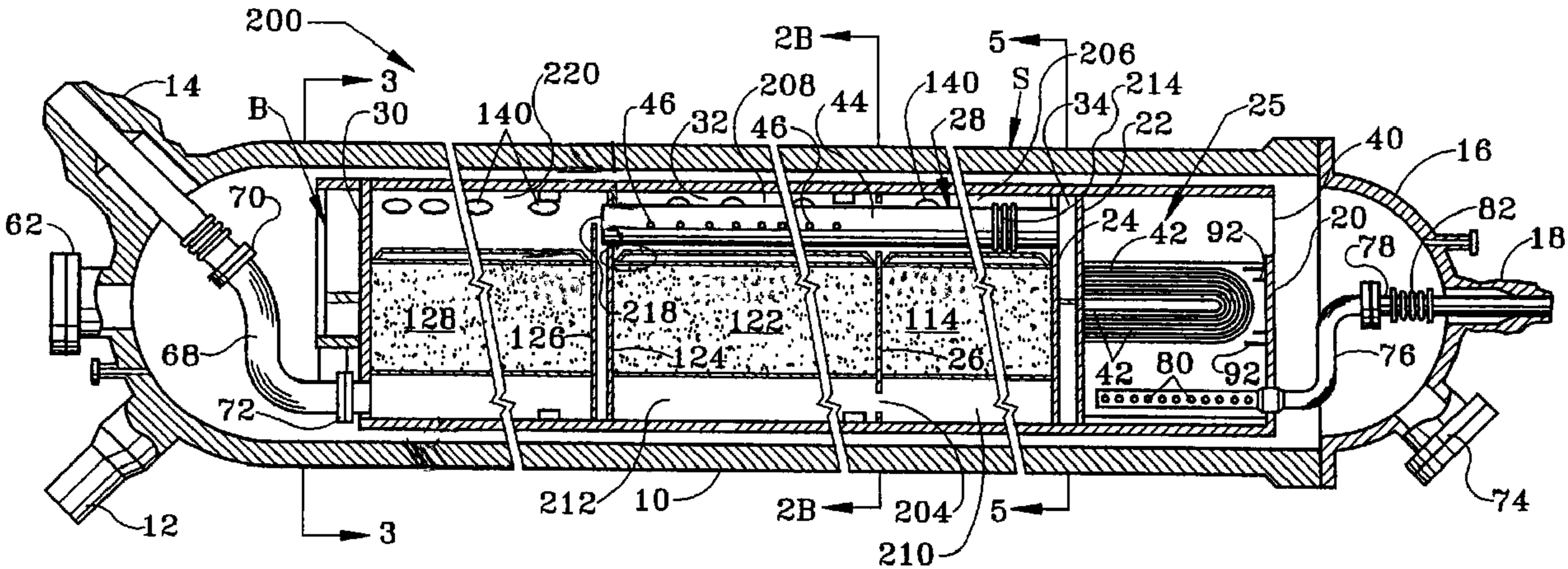


FIG.6


200
3
14
B
30
140
220
46
32
208
46
44
2B
140
28
S
5
206
34
214
22
25
40
16
82
18
62
70
24
42
92
20
78
128
126
218
122
114
68
124
26
42
80
92
76
72
212
10
2B
204
5
74
12
3
210