United States Patent

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[72] Inventors **Frederick W. Williams**
Oxon Hill, Md.;
John E. Johnson, Annandale, Va.

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[73] Assignee **The United States of America as represented by the Secretary of the Navy**

[54] **CATALYTIC AIR PURIFIER**
2 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** ..... **23/288 R,** 23/4, 23/288 F, 23/288 J
[51] **Int. Cl.** **B01j 9/04**
[50] **Field of Search** ..... 23/288.3 F, 288.4, 288.8, 288.9, 288.91, 288.92, 289, 284, 288, 4; 60/29, 30

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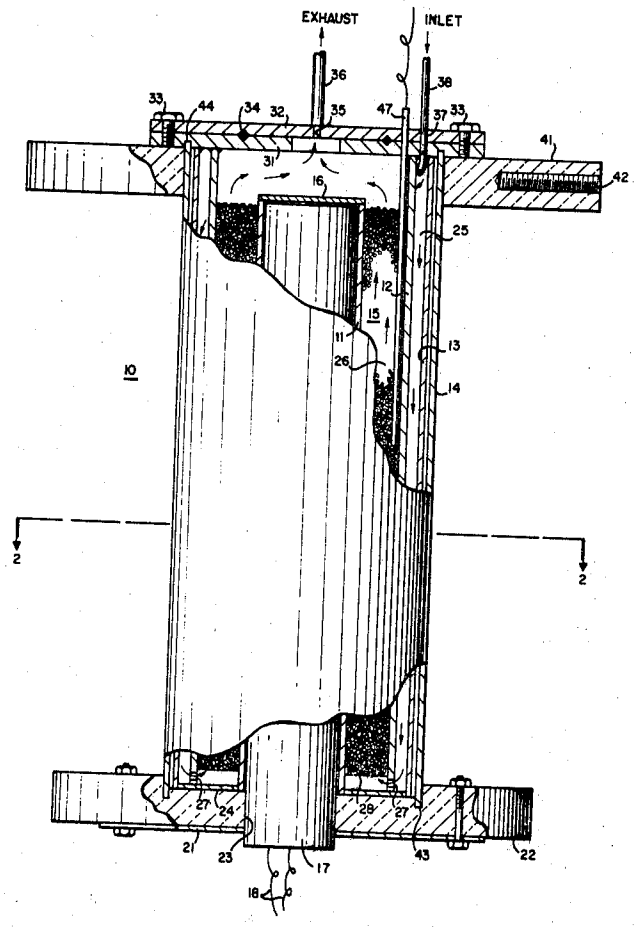
Primary Examiner—Morris O. Wolk
Assistant Examiner—D. G. Millman
Attorneys—R. S. Sciascia, M. L. Crane and A. L. Branning

ABSTRACT: A catalytic air purifier which makes use of a heater positioned along the axis of the device coaxially arranged within surrounding chambers through which the gaseous medium passes. The surrounding chambers are assembled without any screw-threaded joints which prevents galling due to the heat and contact with the gaseous medium or the surrounding atmosphere.



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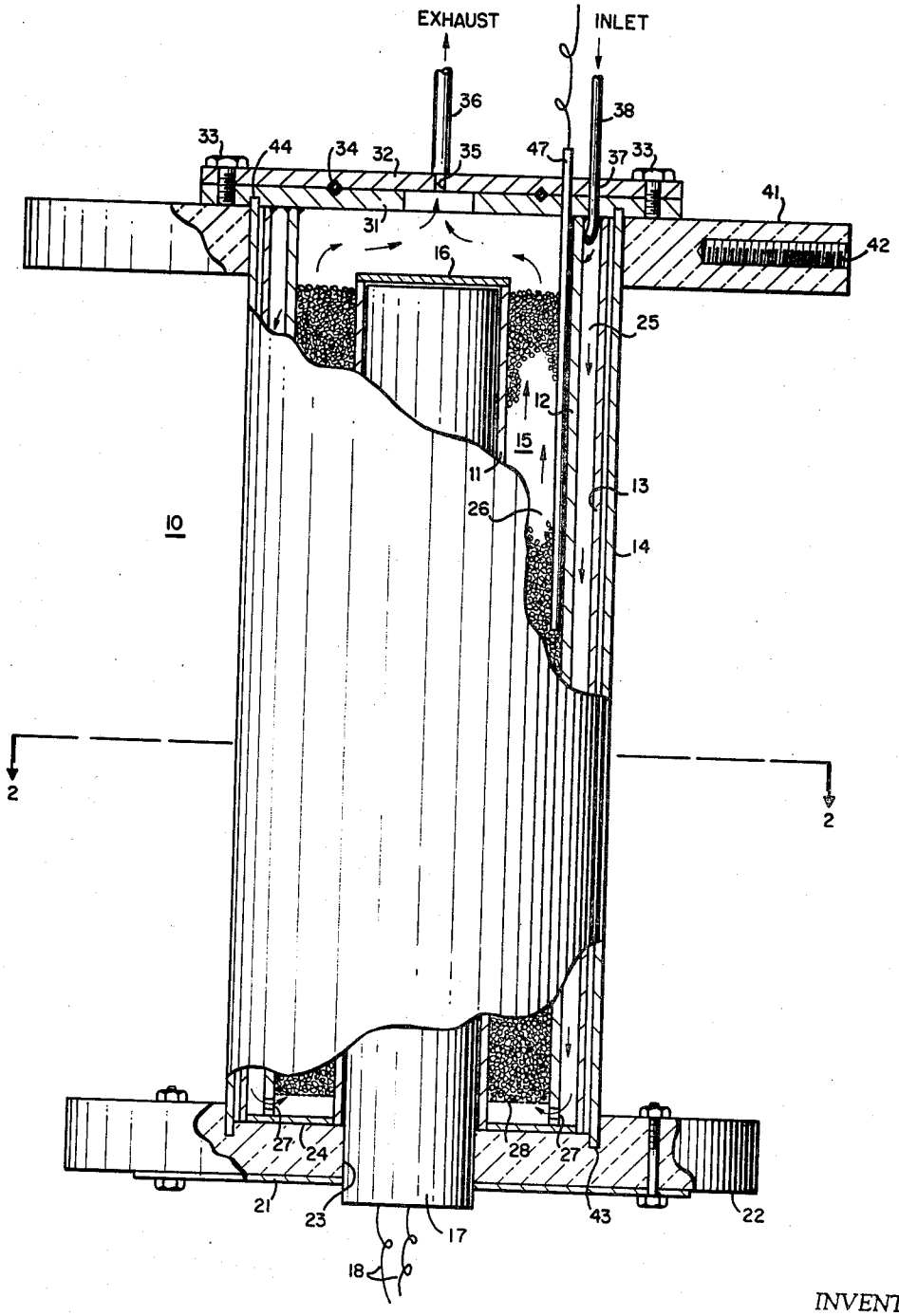
SHEET 1 OF 2

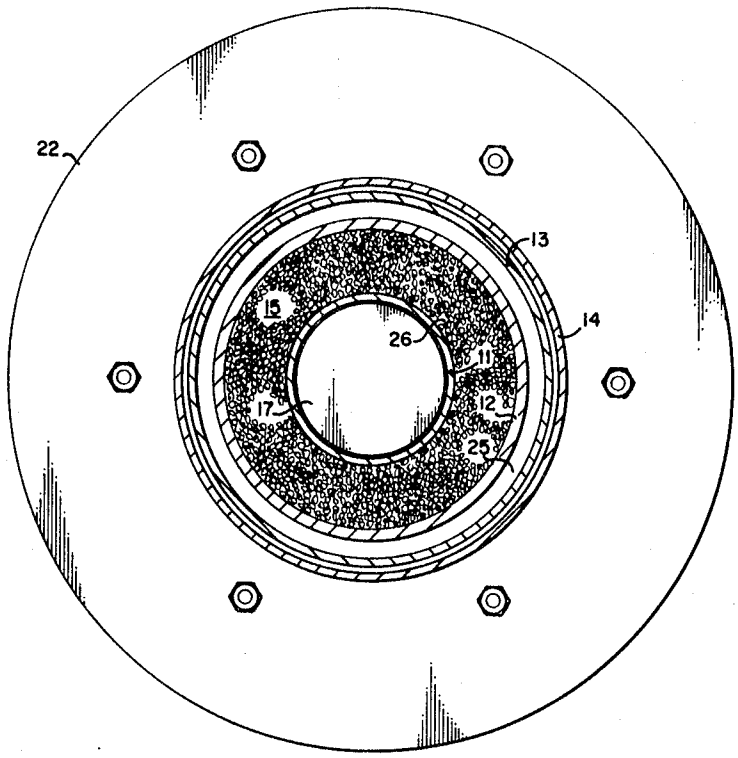
FIG. 1



INVENTORS
FREDERICK W. WILLIAMS
JOHN E. JOHNSON

BY Melvin L. Crane AGENT
ATTORNEY

FIG. 2



INVENTORS
FREDERICK W. WILLIAMS
JOHN E. JOHNSON
BY Melvin L Crane AGENT
ATTORNEY

CATALYTIC AIR PURIFIER

BACKGROUND OF THE INVENTION

Heretofore catalytic air purifiers have made use of semicylindrical heaters which partially surrounded the catalyst bed. These heaters require high voltages due to their low heating efficiency. Such heaters also result in insulation problems. Further, the prior art air purifiers make use of threaded joints which corrode resulting in damage and leaks These prior art devices also make use of solid transite retainers extending to the walls of the container which make good heat conductors thereby conducting a great deal of the heat away from the catalyst. This is another reason that large heat-producing elements are used. Also by placing the heater on the outer surface of the air purifier, the preheater coils are closer to the heater than the reactor zone of the air purifier. Thus, the preheater is exposed to a greater temperature than the reactor tube. Since the heater is on the outside of prior art devices, this results in insulation problems which results in the outside case of the purifier becoming to hot.

SUMMARY OF THE INVENTION

This invention is directed to a catalytic air purification device in which the heater is arranged coaxially with the body of the purifier. The gaseous medium is injected into an outer chamber within which the gaseous medium is preheated. The gaseous medium then traverses the housing in a reverse axial direction with a separate chamber which is adjacent to the axially aligned heater and which contains the catalyst pellets. The heat passing outwardly through the main chamber heats the gaseous medium in the preheater column prior to the gaseous medium traversing the filter column. The purified gaseous medium is conveyed from the catalyst through an exhaust opening which is welded to the housing. The housing is provided with a gastight cover which may be removed in order to replace the catalyst pellets.

It is therefore an object of this invention to provide a catalytic air purifier in which the heater provides the most heat to the catalyst bed.

Another object is to provide a device which is made free of any threaded joints.

Yet another object is to provide a catalytic air purifier which may be insulated against heat losses without affecting heating of the catalyst bed.

Other objects and advantages of the invention will hereafter become more fully apparent from the following description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is partial cross-sectional view of the device.

FIG. 2 is a cross-sectional view normal to the axis looking toward the bottom.

DESCRIPTION OF THE INVENTION

Now referring to the drawings, there is shown by illustration in FIG. 1 a partial cross-sectional view of the device. The device **10** comprises a plurality of cylindrical elements **11**, **12**, **13** and **14** of different diameters and coaxially arranged to form separate coaxial chambers through which a gaseous medium flows and which form a catalyst bed **15**. The cylinder **11** is provided with a plate **16** which is welded or otherwise secured to the upper end thereof to close off the upper end of the cylinder. The cylinder **11** forms a cavity within which an electrical cartridge heater **17** is placed through the bottom of the device. The heater is provided with electrical conductors **18** which supply current from a suitable voltage source, not shown, for simplification of the drawing. The heater is held in place by use of a plate **21** which is secured to the heater and to

the bottom transite plate **22** of the device upon which the purifier elements rest. The bottom plate is provided with a central aperture **23** through which the heater is inserted into the chamber.

Cylindrical elements **11** and **13** have a cylindrical plate **24** welded therebetween at the bottom thereof to close off the space between the two cylinders, and cylinder **12** is welded within the area bounded by cylinders **11** and **13**. Cylindrical element **12** is of less diameter than that of cylinder **13** but is of a greater diameter than the cylinder **11**, therefore, two separate coaxial chambers **25** and **26** are formed by the cylinders. Cylindrical element **12** is provided with a plurality of apertures **27** therethrough near the bottom thereof to permit a gaseous flow therethrough between chambers **25** and **26**. A screen **28** is welded in place within the chamber **26** formed by cylinders **11** and **12** to form a space near the bottom of the chamber **26**. A cylindrical plate **31** is welded to the top of cylinders **12** and **13** to close off the chamber **25** at the top between cylinders **12** and **13**, the bottom being closed off by cylindrical plate **24**. The cylindrical plate **31** also serves to secure a top plate **32** thereto by threaded bolts **33**. An O-ring seal **34** of any suitable type is placed between the cylindrical plate **31** and the top plate **32** to prevent leakage of any gaseous medium. The top plate **32** has a central aperture **35** therein to which an exhaust pipe or tube **36** is secured to permit the gaseous medium to flow from the device. An inlet tube **38** is inserted through an aperture **37** in plates **31** and **32** and welded to plate **31** for admitting a gaseous medium into chamber **25**.

The three cylinders **11**, **12** and **13** form walls for the chambers **25** and **26** wherein chamber **25** serves as the preheater column and chamber **26** serves as the catalyst bed column or reactor section. Since the cylindrical plate **31** is welded to the cylinders **12** and **13** at their upper ends and since the cylindrical plate **24** is welded to cylinders **11** and **13** at the bottom thereof, the three cylinders along with plate **16** and cylindrical plates **24** and **31** form an integral unit with two separate chambers. The outer wall of cylinder **11** and the inner wall of cylinder **12** forms chamber **26** within which the catalyst bed is placed and the outer wall of cylinder **12** and the inner wall of cylinder **13** forms the preheated chamber **25**.

The cylinder **14** is fitted near the top on the outside thereof to a square transite plate **41** such that the cylinder **14** extends slightly above the plate. The plate is provided with threaded apertures **42** normal to the axis of the device which receive therein standoff bolts to secure the plate in place. The standoff bolts secure the plate in an insulated housing (not shown) such that the plate does not touch anything other than the standoff bolts, therefore, the only heat transfer from the transite plate **41** is through the four standoff bolts. The bottom of the cylinder **14** is fitted to the bottom transite plate **22** such that the lower end of the cylinder extends downwardly into circular slot **43** within the bottom plate for support purposes. The lower plate **22** is also cut away in the area bounded by the circular slot to receive therein the bottom portion of the integral unit formed by the preheater chamber and the catalyst bed chamber. The plate **31** which closes off the preheater chamber **25** at the top thereof is provided with a circular slot or groove **44** therein to receive therein the protruding end of the cylinder **14** when the integral unit section is placed into the cylinder **14**. Thus, the cylinder **14** and the end plates **22** and **41** forms a housing for the preheater-reactor unit.

The unit is constructed such that the preheater and catalyst bed compartment unit may be removed from the device for facilitating changing of the catalyst bed. Since the preheater section and the catalyst bed (reactor section) are formed by cylinders welded to end plates, there are no threaded joints which may be attacked by the gaseous medium.

The gaseous medium enters into the preheater section through an inlet tube **38** which passes through the top plate **31** and extends into the preheater chamber. The end of the inlet tube that extends into the preheater chamber conforms to the curvature of the cylinders and is at a 60° angle relative to the

top plate for the purpose of causing turbulent flow in the preheater chamber. This turbulent flow increases the preheating efficiency.

As set forth above, the cylinder **11** surrounds the cartridge heater **17** which is retained in place by the bottom plate **22**. The catalyst bed (reactor) is adjacent to the heater so that all heat is directed to the catalyst bed. The preheater chamber surrounds the reactor chamber and since the heat passes radially through the catalyst bed prior to reaching the preheater section the catalyst bed will be maintained at a higher temperature than that of the preheater. The preheater-reactor section is inserted into the outer cylinder **14**. Since the cylinder **14** encircles the cylinder **13** and the cylinder **13** is welded to plates at each end, there is a dead airspace between cylinders **13** and **14** which insulates the preheater section against heat loss. Therefore, very little heat passes through cylinder **13** to cylinder **14**. The entire apparatus is housed within an insulated housing to which the transite plate **41** is secured by standoff bolts. The housing is not shown for simplification of the drawing.

A thermocouple element **47** extends through an aperture in plates **31** and **32** into the catalytic bed and is welded to plate **31** in order to determine the temperature of the catalytic bed.

In operation of the catalytic air purifier, the device is assembled as set forth above and the heater is secured in place. The catalyst bed material is placed into the reactor section and the preheater-reactor unit is placed into the housing formed by the lower and upper transite plates **22** and **41**, and the cylinder **14** which is in turn housed in an insulated case. The heater is activated and the catalyst bed is permitted to reach the desired temperature. Once the proper temperature has been maintained, the gaseous medium is directed through the inlet into the preheater chamber. On passing through the preheater chamber **25**, the gaseous medium is preheated prior to passing through the apertures **27** near the bottom of cylinder **12** into the reactor chamber. The gaseous medium passes through the catalyst bed where the contaminates or undesired elements are removed and then the purified gaseous medium is exhausted through the outlet **36**.

As an example of operational use, the catalytic air purifier has been used to make compressed air available for use as a gas chromatographic carrier gas and oxidizer in a flame detector by catalytic air purification. Cylinders forming the preheater-reactor chambers were made of stainless steel and with the following dimensions:

Cylinder **14** (2¾-inches OD × 6 11/16 in length); Cylinder **13** (2⅜-inches ID × 6½ in length); Cylinder **12** (1⅞-inches ID × 6 7/16 in length); Cylinder **11** (⅞ID × 6 in length).

The apertures near the bottom of cylinder **12** are one-sixteenth inch drilled at 90° angles. The catalyst bed was formed of one-sixteenth inch; catalyst pellets (Engleharts 0.5 percent palladium on Alumina). The inlet and outlet tubes are formed of one-eighth inch, No. 316 stainless steel tubing.

In using the above-dimensioned catalyst air purifier, the compressed air having a pressure of from 50–100 p.s.i.g. and a flow of 500 cc./min. is introduced through inlet **38** into the preheat chamber. The compressed air is heated, and is forced through the apertures **27** near the bottom of chamber **25** into the reactor chamber. The compressed air then passes through the catalytic bed where the undesired gases such as methane, Freon-12, and Freon-114 are removed. With a gas flow of 360 cc./min. and a catalytic bed charge of 104 grams maintained at a temperature of 325° C., the air purifier has demonstrated the capability of completely removing 200 p.p.m. of methane, 200 p.p.m. of Freon-12, and 200 p.p.m. Freon-114 over a long period of the time such as for at least 300 hours. Once the catalystic bed has become contaminated, the preheater-reactor unit may be removed from the system and the catalytic charge may be replaced with a new charge and then placed back into the system.

The above example has been set forth for a specific purpose using a specific catalytic bed and a specific dimensioned purifier device. It is obvious that larger or smaller catalytic beds may be used for different gaseous media, for different purposes; however, the arrangement of the various elements should be arranged as shown to provide a catalytic air purifier made in accordance with the teaching of this invention.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that the invention may be practiced otherwise than as specifically described.

What is claimed and desired to be secured by Letters Patent of the United States is:

1. A catalytic air purifier; which comprises,

a housing including a cylinder,

a unitary preheater section and a catalyst bed section secured within said housing for removal therefrom as a unit,

said unitary preheater section and catalyst bed section formed by first, second, and third coaxially aligned cylindrical cylinders, with the first cylinder innermost and the third cylinder outermost, said catalyst bed section formed by the space between the first cylinder and the second cylinder, and said unitary preheater section formed by the space between the second cylinder and the third cylinder,

an end plate secured to the bottom of said cylinders enclosing the area included between said cylinders at the bottom end with the area included between said first and second cylinders open at the top end,

said first cylinder open at its bottom end and closed at its top end,

said third cylinder spaced from said housing with the spacing therebetween closed off at each end to form a dead air space between said housing and said third cylinder,

a removable cover rigidly secured to the upper end of said second and third cylinders to close the passage at the upper end between said second and third cylinders, and means for securing said cover to said housing,

said second cylinder including a plurality of spaced apertures near the bottom thereof which form air passages between said preheater section and said catalyst bed section,

an outlet in said removable cover communicating with the space encompassed by the upper end of said second cylinder and above the catalyst bed section,

an inlet tube extending through said cover into said preheater section, and

a heater,

said heater extending into said first cylinder from the bottom thereof coaxial with said unitary preheater section and said catalyst section,

whereby a catalyst placed into said catalyst section will purify air that passes down through said preheater section and up through the catalyst section.

2. A catalytic air purifier as claimed in claim **1**; in which,

the inner end of said inlet tube extending into said preheater section conforms to the curvature of said preheater section and is at an angle of about 60° relative to the top through which the inlet extends.