

Nov. 11, 1969

S. KITRILAKIS

3,477,412

VAPOR ENGINE BOILER

Filed March 18, 1968

2 Sheets-Sheet 1

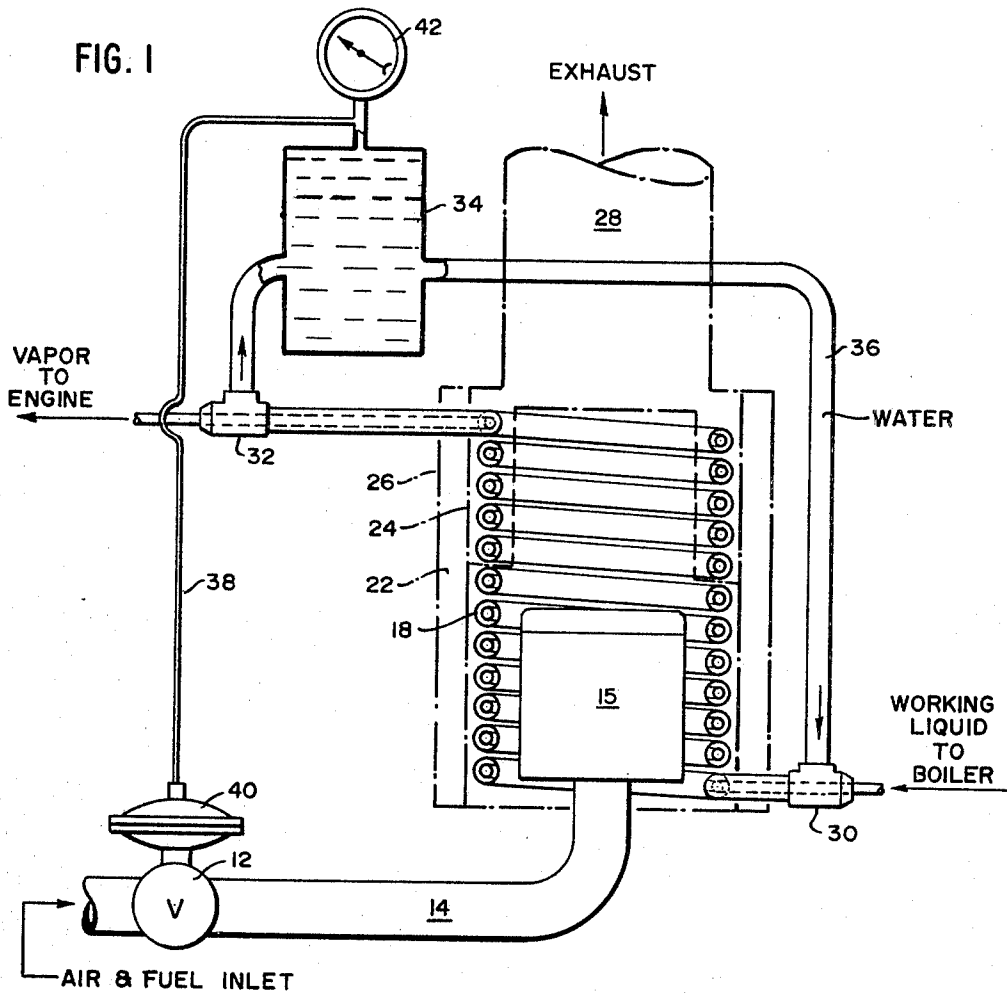
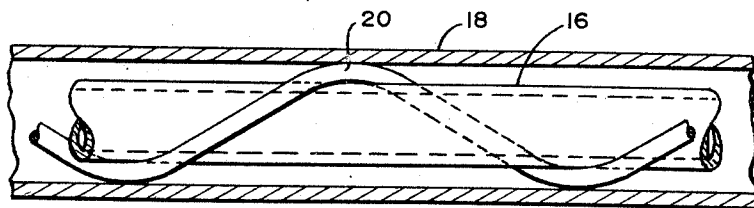


FIG. 2

INVENTOR.

SOTIRIS KITRILAKIS

BY

Kenway, Janney

+ Hilareth

ATTORNEYS

Nov. 11, 1969

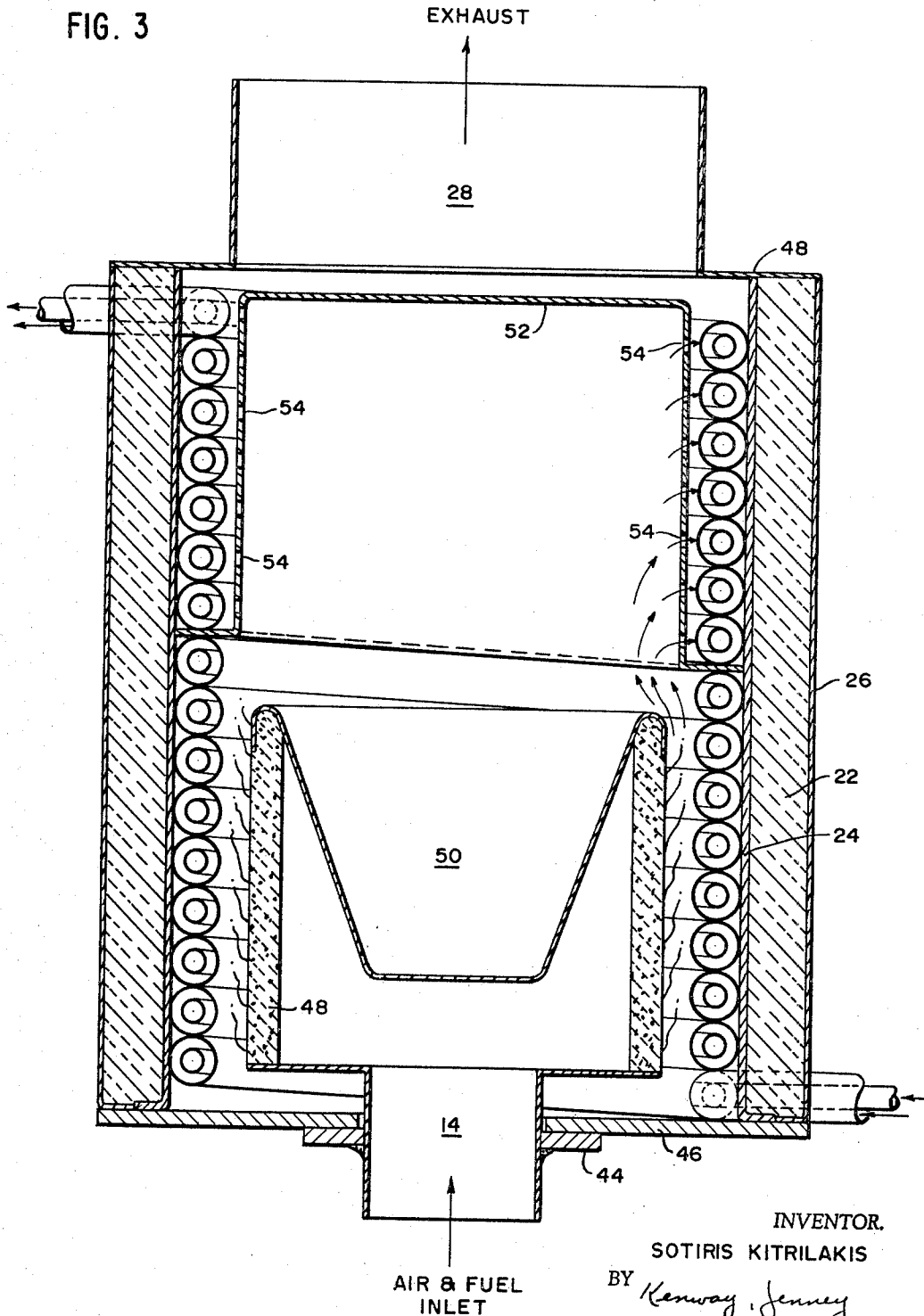
S. KITRILAKIS
VAPOR ENGINE BOILER

3,477,412

Filed March 18, 1968

2 Sheets-Sheet 2

FIG. 3



INVENTOR.
SOTIRIS KITRILAKIS
BY *Kenway, Jenney*
& Silbert
ATTORNEYS

1

3,477,412

VAPOR ENGINE BOILER

Sotiris Kitrilakis, Newtonville, Mass., assignor to Thermo Electron Corporation, Waltham, Mass., a corporation of Delaware

Filed Mar. 18, 1968, Ser. No. 713,647

Int. Cl. F22b 1/02

U.S. Cl. 122—33

5 Claims

ABSTRACT OF THE DISCLOSURE

A boiler for a vapor engine in which the working fluid or vapor is protected from potentially harmful effects of heat by means of a protective jacket of water which is held in a closed system incorporating a pressure sensor for controlling the flow of fuel to the heat source for the boiler. The vapor or working fluid is confined in a tube which is formed into a coil within the boiler. A similar tube of larger diameter encloses the working fluid coil and is concentric with it. The water in the outer tubular member also serves as a buffer stage between the heat from the boiler and the working fluid.

Reciprocating vapor engines are enjoying a rebirth of interest in a variety of applications because their characteristics are currently assuming new importance. For example, the non-polluting operation of vapor engines as contrasted to the problems with exhaust gases from internal combustion gasoline or diesel engines is a feature now deemed to be of great significance. Moreover, various technological advances have made it possible to bring the efficiency of operation of vapor engines much closer to that of internal combustion engines than was possible a few years ago. These advances include the development of new materials and techniques for fabrication of vapor engines, new heat sources, improved auxiliary engine components, and even such prosaic elements as the boiler for the vapor engine.

The present invention is concerned principally with the last-mentioned item, namely the boiler for a vapor engine. Vapor engines of the type to which the boiler of the present invention applies include that disclosed in U.S. Patent Nos. 3,279,326 and 3,361,036 which are assigned to the assignee of the present application. Also, the boiler of the present invention finds use in vapor engines of the type disclosed in the co-pending U.S. patent application No. 713,984 of Harvey and Doyle entitled Vapor Engine.

However, the present invention has its greatest usefulness where a vapor or working fluid which is decomposable under heat is used. Generally, the problem centers about the use of organic fluids. Although many such fluids have thermodynamic characteristics which make them particularly valuable in vapor engines, excess heat can cause cracking of the fluids resulting in "coking" that ultimately leads to destruction of the boiler. Even when more conventional fluids such as water or mercury are used, hot spots in the boiler may be encountered which may be due to any one of several reasons such as a thin wall of the fluid container of the boiler or a localized concentration of heat on a particular area of the container. Such hot spots also, of course, may lead to an early destruction of the boiler.

The principal object of the present invention is, therefore, the improvement of boilers for vapor engines.

Another object of the present invention is making possible the use of a wide range of working fluids in vapor engines.

A further object of the present invention is to render practical the use of organic and other fluids previously

2

thought impractical because of their susceptibility to decomposition under heat.

Generally, the present invention is based upon the concept of providing a dual-purpose buffer between the heat source and the container of working fluid in a boiler. In a specific boiler, the working fluid is desirably contained in a coiled tube. A second tube concentric with the first tube is wound in a similar coil and it is separated throughout its length from the first tube to provide a continuous jacket about the first tube. The jacket preferably contains water in a closed system. The two tubes may be maintained uniformly separated by the interposition of a spacing member such as a helically wound wire. The necessary heat for the operation of the boiler may be derived from combustion of any one of a variety of fuels. In one section of the boiler, the products of combustion are played directly upon the outer tube or water jacket. In a second stage of the boiler, hot gases are jetted upon the same jacket. The actual working fluid for the boiler is, as noted, contained within the inner coiled tube and is at no time exposed directly to heat from the fuel combustion.

Control of the operation of the boiler may conveniently be obtained by incorporating in the closed water system a pressure sensor. The sensor may, in turn, control the flow of fuel to the heat source for the boiler. For a better understanding of the present invention, together with other and further objects, features and advantages, reference should be made to the following description of a preferred embodiment of the invention, which should be read in connection with the appended drawing in which:

FIG. 1 is an elevation, partly schematic and partly in section, of a boiler and associated components for a vapor engine,

FIG. 2 is a fragmentary view, partly in section, of a portion of the concentric tubing of the boiler, and

FIG. 3 is a sectional elevation of the boiler per se of the invention.

A mixture of fuel and air for combustion is introduced as shown at the lower left of FIG. 1. The mixture is passed through a pressure-controlled valve 12 and a connecting tube 14 to a burner 15. The burner 15 may be conventional in nature or may be similar to those disclosed in a co-pending application of Brosens et al., Ser. No. 694,744, entitled Radiant and Convective Burner, that application being assigned to the same assignee as the present invention. Further detail on preferred forms of the burner 15 will be found hereinbelow.

Whatever the type of burner, heat is generated and impinges upon the outer wall of a tube 18 which is coiled about and above the burner 15. Within and concentric with the tube 18 is a smaller tube 16. The two tubes are held in uniform spaced relationship by means of a helical spacer 20, as best seen in FIG. 2. Although spacing elements other than the helically wound wire 20 may be used to provide the desired degree of uniform spacing between the tubular elements, the helical wire 20 is preferred because it offers a convenient and relatively easily fabricated means for establishing and maintaining the spacing.

The coils of concentric tubes 16 and 18 are surrounded by a container which preferably includes a cylindrical layer of insulation 22 held between concentric shells 24 and 26. An opening is provided in the top of the container to accommodate an exhaust outlet 28. Additional openings are provided at the bottom of the container to accommodate the connecting tube 14 and in the side walls to pass the ends of the concentric coiled tubes 16 and 18.

The outer tube 18 forms a part of a closed system which includes a T member 30 at which point water enters the

coil of the outer tube 18. The outlet for the water from the coiled outer tube is at a second T 32 from which it is passed to a reservoir or expansion chamber 34. From the expansion chamber 34, the water is passed through a tube 36 back to the T 30 to complete the closed system. Communicating with the expansion chamber 34 by means of a tube 38 is a pressure-responsive member 40 which controls the operation of the valve 12. Various commercially available devices for valve control in response to pressure are available and the device used in the present invention may be any one of several, such as those made by Robertshaw Controls Co. For convenience, if desired, a pressure gauge 42 may be incorporated in the system to permit pressure to be monitored.

The inner tube 16 may also form a part of a closed system. Such a system is disclosed in the co-pending application Ser. No. 713,643 of Comeau et al., entitled Power Source and assigned to the assignee of the present invention.

Detail on the concentric tubing and spacer is more clearly shown in FIG. 2. The inner or working fluid tube 16 is preferably made of low carbon steel or low alloy steel and its diameter is approximately one-half that of the outer concentric tube 18. The outer tube 18 is also preferably made of low carbon steel or low alloy steel and its diameter may range from $\frac{5}{8}$ " to 1" or more. The spacer wire 20 may also be of low carbon steel and it is preferably of a diameter such that it slips easily between the outside surface of the inner tube 16 and the inside surface of the outer tube 18. The spacer 20 may be wound upon the tube 16 and the two slipped into the tube 18 prior to the winding of the coil. The coil winding may then be done in a conventional manner and assembled with other boiler components.

FIG. 3 is a relatively detailed illustration of the boiler and the burner. The fuel input tube 14 is welded or otherwise tightly sealed through a flange 44 which may be welded to a base plate 46 which forms the bottom of the boiler container. The shell members 24 and 26 which enclose a layer of insulating material 22 are formed into sleeves which are welded or brazed to the base plate 46. The exhaust outlet 28 terminates in an outwardly flaring flange 48 which forms the top of the container. These elements other than the insulating layer 22 may be composed of sheet steel or other suitable material. Any one of several available insulating materials may form the layer 22.

The concentric tubes 16 and 18 enter the container through a suitable opening as indicated at the lower right and are wound in a continuous helix to exit as indicated at the upper left of the drawing. Within the helical coil and disposed adjacent the bottom of the container is the burner 15 which includes a cylindrical combustion member 48. The combustion member 48 may be composed of a metal mesh screen or may, if desired, be made of porous ceramic or other suitable materials. If it is desired to burn a gaseous fuel, combustion will normally take place on the external surface of the element 48 in the manner indicated in the drawing. On the other hand, where liquid fuels are used, combustion preferably takes place within the cylindrical element 48. A baffle 50 having an upper edge turned over the cylindrical element 48 and depending centrally in the form of a cone extending within and toward the bottom of the element 48 serves to direct the fuel mix along the interior surface of the element 48 to avoid unnecessary turbulence and to concentrate combustion at the periphery of the element 48.

Also, a second heat exchange stage is formed by the inclusion of a jet-impingement member 52 within the upper portion of the container. The jet-impingement member 52 is in the form of an inverted sheet-metal cup, the bottom of which is flared outwardly to meet the interior surface of the inner shell member 24. A plurality of openings 54 are formed in the side walls of the jet-impingement member to cause the hot

gases rising from the lower portion of the boiler to impinge as jets directed upon the surface of the outer concentric tube 18. The action of the jets, as is explained in greater detail in the co-pending application Ser. No. 446,476, now U.S. Patent No. 3,416,011 issued Dec. 10, 1968, filed Mar. 29, 1965, entitled Heat Exchanger and assigned to the assignee of the present invention, is to remove stagnant layers of gas which interfere with the efficient exchange of heat. In some situations, it may prove desirable to form the same type of apertures through the element 48 to cause the products of combustion to impinge similarly as jets upon the surfaces of the tube 18 adjacent the lower element 48.

Various operational features of the invention may be best understood by reference to FIG. 1. To begin with, the internal tube 16 operates in a conventional manner and serves the usual function of comparable devices in vapor engines in that it brings the working fluid as a liquid to the boiler and carries it from the boiler under pressure to the engine as a vapor. However, the closed system which includes the outer concentric tube 18 is filled with water or other suitable buffer fluid which does not decompose at the boiler operating temperature. Not only does the buffer fluid serve to protect the working fluid from the deleterious effects of excessive heat; it has a further purpose. That is to say, as the temperature becomes excessive, the pressure of the buffer fluid increases throughout the closed system which includes the outer concentric tube 18, the expansion chamber 34, and the pressure sensor 40. With the increase in pressure, the sensor 40 actuates the valve 12 to reduce the flow of fuel mix through that valve to the burner 15. With the decreased flow of fuel mix, less heat is generated and the pressure drops to a point at which the valve is reset to maintain the desired fuel consumption and heat output. Of course, the sensor 40 is capable of adjustment over a range of values to permit the desired amount of heat to be generated.

The second function of the buffer fluid, and perhaps the more important function, is to permit the use of a wide range of, including organic and other heat-decomposable, working fluids in a vapor engine. Because the fluid in the outer concentric tube 18 establishes a limit to the temperature that can be reached by the inner concentric tube, the working fluid is at no time exposed to excessive temperatures. Accordingly, the problems encountered as a result of the cracking of organic fluids with resulting coking of the boiler are eliminated. So also does the buffer stage provided by the concentric tube 18 compensate for possible hot spots which might otherwise be harmful or destructive in boiler operation.

In some instances, it may be desirable to form the jacket for the buffer fluid in configurations other than that shown for the preferred embodiment of the invention. Also, of course, it is not essential to the practice of the invention that the buffer fluid be water. The essential feature of the buffer fluid is that it be non-decomposable at the boiler operating temperature which, of course, may vary, especially with the type of working fluid or vapor which is used.

Although what has been disclosed constitutes a preferred embodiment of the present invention, the invention should not be limited to those details which are shown only to illustrate such an embodiment. Rather, it should be limited only by the spirit and scope of the appended claims.

What is claimed is:

1. In a boiler for a vapor engine having a heat source and a container of organic working fluid, the combination of a jacket formed about said container and disposed in juxtaposition to said heat source, a jet-impingement baffle disposed between said heat source and said jacket whereby hot gases from said heat source are directed as jets to impinge upon said jacket and a buffer

5

fluid which decomposes only the temperatures above those of said hot gases contained within said jacket.

2. In a boiler for a vapor engine as defined in claim 1, the combination wherein said container and said jacket comprises first and second spaced concentric tubes respectively, a helically wound wire being disposed between said first and second concentric tubes to maintain uniform spacing therebetween.

3. In a boiler for a vapor engine having a heat source providing an output of hot gases, the combination of a tubular container of organic working fluid, a jacket formed about said container, a fluid which is non-decomposable at the temperature of said hot gases filling said jacket, said jacket being disposed between said heat source and said tubular container, heat being transferred directly therethrough to said tubular container of organic working fluid.

4. In a boiler for a vapor engine as defined in claim 3, the combination wherein said jacket comprises a tube

6

concentric with and of larger diameter than said tubular container, the spacing between said concentric tubes being relatively small compared to the spacing between said heat source and said outer tube.

5. In a boiler for a vapor engine as defined in claim 3, the combination of a pressure sensor incorporated with said jacket in a closed system, a fuel inlet and a valve for controlling the flow of fuel from said inlet to said heat source, said valve being actuated by said pressure sensor.

References Cited

UNITED STATES PATENTS

2,051,743	8/1936	Pratt	122—33
2,656,821	10/1953	Ray	122—33
3,055,347	9/1963	Bailey et al.	122—33
3,171,387	3/1965	Muller	122—33

KENNETH W. SPRAGUE, Primary Examiner