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VAPOR PHASE CRACKING APPARATUS

Filed April 4, 1933

2 Sheets-Sheet 1

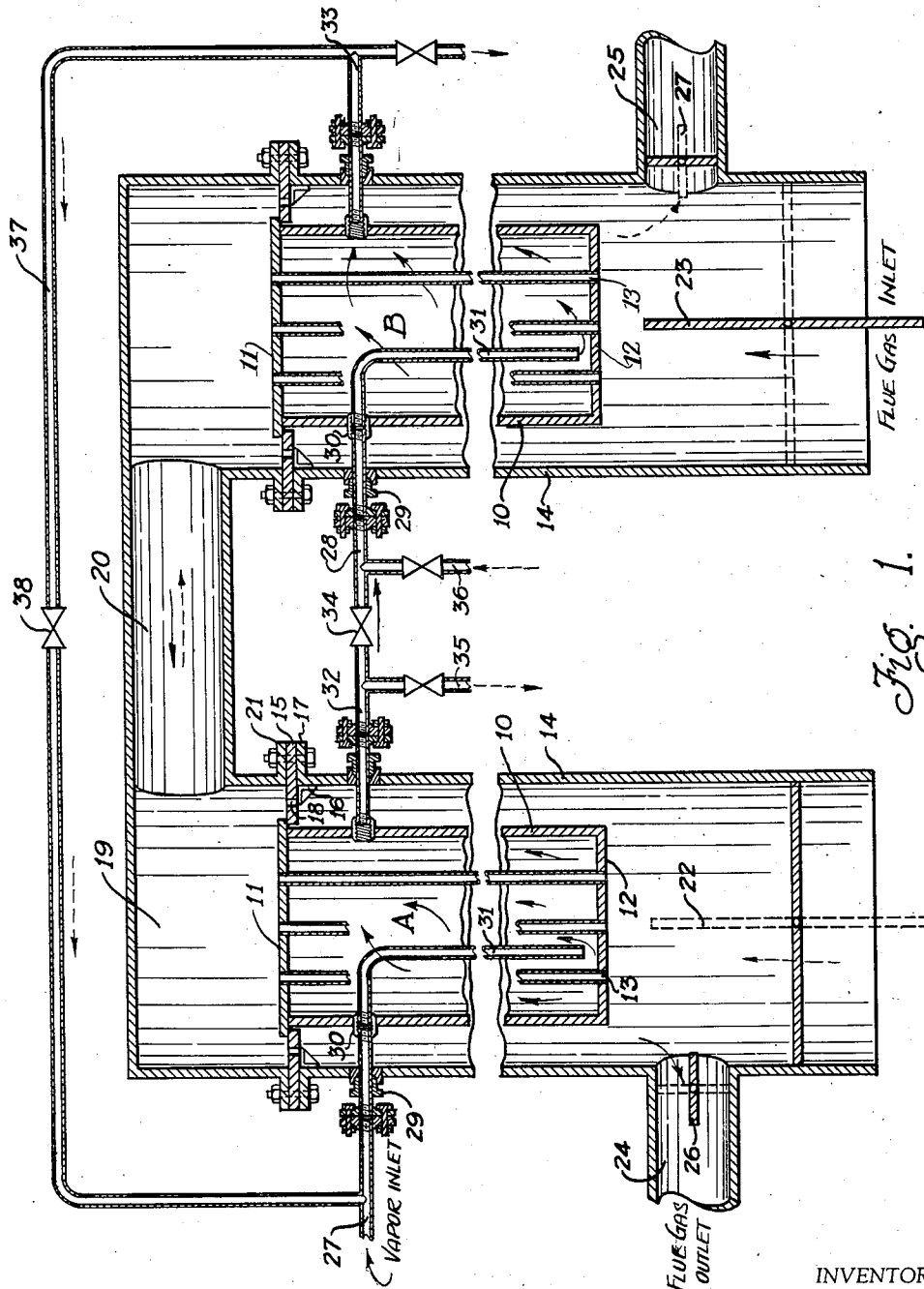


Fig. 1.

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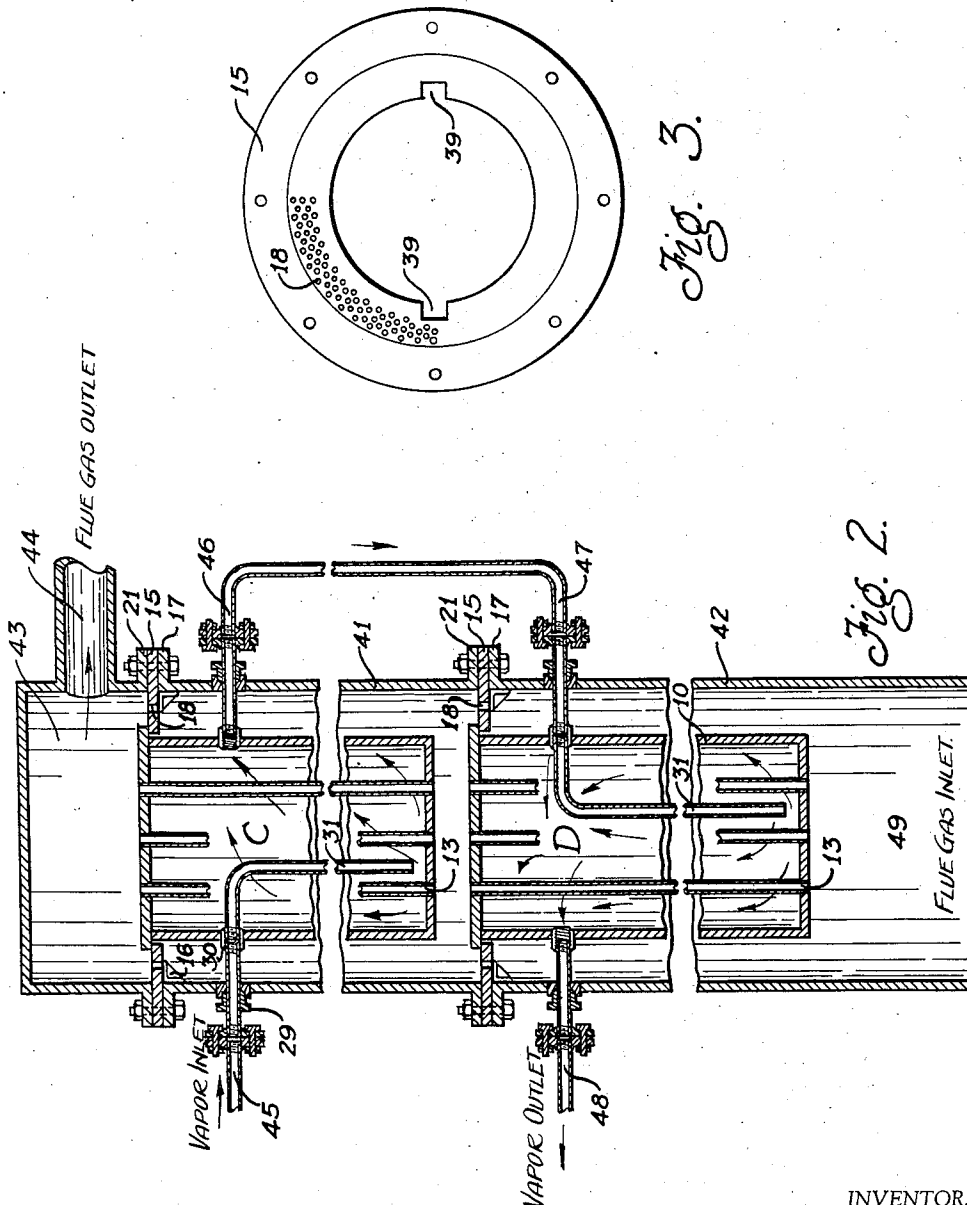
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VAPOR PHASE CRACKING APPARATUS

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13 Claims. (Cl. 196—117)

This invention relates to an apparatus for converting higher boiling hydrocarbons into lower boiling hydrocarbons, and more specifically to a series of two or more connected ex-
5 pander tanks adapted for heating and converting hydrocarbons to produce gasoline especially for use as motor fuel, the hydrocarbons being substantially in the form of vapor during treatment in the expander tanks.

10 An object of the present invention is to provide an apparatus capable of converting hydrocarbons at a high thermal efficiency, in which apparatus the hydrocarbons to be converted are evenly heated to and maintained at conversion
15 temperatures without subjecting the apparatus to excessive temperatures, whereby a maximum yield of hydrocarbons of the desired boiling range are obtained in long operating cycles.

20 Another object of the invention is to provide an apparatus of the above character which is simple in construction and easily dismantled for cleaning or for the replacement or repair of parts.

25 A further object of the invention is the provision of an apparatus wherein hydrocarbon vapors may be heated to and maintained at that conversion temperature and for that period of time best suited for the particular stock being treated, whereby maximum yield of de-
30 sired hydrocarbons are assured.

35 A still further object is to provide a pair of expander tanks communicatively connected in series for the passage of hydrocarbon vapors and having flues so connected as to cause the ex-
40 pander tanks to be heated in series, said expander tanks and flues being so arranged that the hydrocarbon vapors and the heating gases may be initially passed through and by either expander tank.

45 Other objects and advantages will be apparent from the following description and the accompanying drawings wherein;

Figure 1 is a vertical longitudinal section through the cracking apparatus wherein the
50 two expander units are connected in series for the passage of heating vapors through a cross-over flue connection, constituting one embodiment of the present invention;

Figure 2 is a similar section of a second embodiment wherein one expander is superimposed upon the other, and,

Figure 3 is a plan view of a portion of the annular baffle or ring employed in connection with the present invention.

55 Referring to Figure 1 in detail there is illus-

trated a pair of expander tanks A and B, each composed of a casing 10, preferably of cylindrical shape, a top end plate 11, and a bottom end plate 12. These plates are joined by a plurality of heating tubes 13 either welded or rolled there-
5 in, said tubes being of uniform size and equidistantly spaced throughout the horizontal area of the expander. Each expander tank is surrounded by a flue casing 14 spaced therefrom.

The top end plate 11 extends over the edge of 10 the expander tank wall serving as a supporting means for the expander tank and rests upon an annular ring 15 in turn supported by brackets 16 and by the flange 17 of the said flue wall or casing. The ring 15 is provided with a plural-
15 ity of holes 18 for the passage of combustion or other heating gases.

Each expander tank is covered by a dome 19, which domes are connected by a cross flue 20, said domes being supported by flanges 21 joined
20 to the flanges 17 through the ring 15 by bolts as indicated, said connection including gaskets (not shown) whereby an air-tight joint is effected. The flue casings 14 are connected at
25 their bottoms with a furnace (not shown) and include dampers or valves 22 and 23 which are alternately opened and closed depending upon which expander is to be heated with gases at the higher temperature. For the discharge of
30 the combustion gases the flue casings 14 are provided with outlets 24 and 25 connected to the stack, said outlets having dampers 26 and 27 also adapted to be alternately operated.

The expander tanks A and B are provided with inlet conduits 27 and 28 near the tops
35 thereof, which pass through relatively large holes in the flue casings 14, said holes being closed by stuffing boxes 29, the bases of which are welded, bolted or otherwise attached to the flue casings. These inlet conduits are threaded
40 into couplings 30 which are in turn welded to the expander tank walls. Within the expander tank walls, there are extensions 31 of the inlet conduits preferably welded to the couplings
45 which are bent downwardly and extended substantially to the bottom of the expander tanks.

The expanders A and B are provided with outlets 32 and 33 connected in the same manner as the inlets through the flue walls to the
50 expander tank walls. The outlet conduit 32 is connected with the inlet conduit 28 of expander tank B through a valve 34. On one side of the valve 34 there is a valve outlet 35 and on the other a valved inlet 36. The outlet 33 from
55 expander tank B is connected to the inlet con-

duit 27 of expander tank A through a conduit 37 provided with a valve 38.

By supporting the expander tanks A and B solely at one end and providing stuffing boxes 5 for the inlets and outlets, the stresses and strains in all portions of the expander may be relieved. These provisions permit a mechanical equilibrium of the forces which arise due to the difference of the thermal expansion of the 10 different portions of the expander tank and flue casing.

In commencing operations in the above embodiment of the invention, either expander tank may receive the flue gases first to be heated to 15 the higher temperature, the gases after heating one expander tank then passing to heat the other. The hydrocarbon vapors to be converted are preferably introduced initially into the expander tank maintained at the lower temperature. For example, when the hot gases of combustion are introduced through open damper 20 23, the hydrocarbon vapors to be converted are introduced through inlet conduit 27. In the inlet conduit 27, said vapors pass through the flue and expander tank walls and down the extension 31 to be liberated within the expander tank A near the bottom thereof. The vapors rise in expander tank A and pass in a counter-current direction to the heating gases flowing 25 from the cross over flue 20, downwardly within the tubes 13 and within the flue casing 14 around the outside of the expander tank wall 10, the vapors passing out through the conduit 32 through valve 34, conduit 28 into expander tank B. After heating expander tank A, the heating gases pass out through conduit 24, the damper 26 being open. The temperature of the vapors entering this expander tank in the preferred practice are at or near the conversion 30 temperature range. In expander tank B the vapors pass upwardly in indirect heat exchange with the heating gases flowing upwardly through the tubes 13 and the space surrounding the expander tank wall. The converted vapors then pass out through the conduit 33 to be 35 quenched and fractionated.

If expander tank A is to be heated to the higher temperature, the heating gases are conducted into the apparatus through damper 22, dampers 23 and 26 being closed, and after heating both expanders pass out of the apparatus through conduit 25 to the stack, the damper 27 being open, the vapors to be converted initially introduced into expander tank B through 40 the conduits 36 and 28. The vapors then pass through expander tank B in the manner above described leaving through conduit 33, passing in conduit 37 through inlet 27 and flowing into expander tank A. From expander tank A the converted vapors pass through conduits 32 and 45 35 to be quenched and fractionated.

The number and size of the holes 18 in the annular ring 15 are such that the quantity of heating gases which pass around the outside 65 of the expanders 10 is substantially exactly sufficient to heat the vapors adjacent the inside walls of the expanders to a temperature equal to the vapors adjacent the tubes 13 extending through the expanders.

One of the features of the present invention is the facility with which the apparatus can be dismantled for the cleaning or repairing of parts. The dome 19 can be easily removed as a unit by withdrawal of the bolts with which 70 it is attached to the flue casings 14. The vapor

inlet and outlet conduits may be unscrewed from the couplings 30 in the expander tank walls and the expander tanks or tube banks removed by lifting them out of the top by any suitable means. The annular rings 15 are provided with a pair of notches 39 on opposite 5 sides to permit the couplings 30 to pass there-through during removal.

In Figure 2, a second embodiment of the present invention is illustrated in which an expander tank C is mounted directly above an expander tank D. These expander tanks are of the same construction as expander tanks A and B hereinbefore described, the sole difference being in their relative positions. 15

In this embodiment the expander tank C is surrounded by a casing 41 mounted upon a casing 42 surrounding the expander tank D. These casings are joined by the same means employed in the attachment of dome 19 to the casings 20 14 illustrated in Figure 1. Above expander tank C there is a dome 43 having an outlet 44, said dome being attached to said casing 41 also in the described manner.

During operation of this embodiment the hydrocarbon vapors to be converted are introduced 25 through inlet 45 into expander tank C to pass upwardly therethrough out of conduit 46 directly into inlet 47 into expander tank D to pass upwardly therethrough and out through conduit 30 48. The heating gases are introduced at the bottom of the casing 42 at 49 to pass upwardly through and around expander tank D thence through and around expander tank C and finally out through conduit 44. It will be observed that 35 in the process as described the vapors during conversion pass concurrently with the heating gases. It should be understood, however, that the invention includes the passage of either the vapors or the heating gases in an opposite 40 direction from that described with the result that either countercurrent flow or concurrent flow may be obtained.

If it is desired not to include the reversing feature of the present invention as described in 45 detail in connection with Figure 1, the flue casing around the expander tank maintained at the cooler temperature may be omitted without seriously affecting the efficiency of the process. If this omission is made all of the heating gases 50 will pass only through the tubes 13 of the cooler expander tank.

The chief advantages obtained by the use of the apparatus of the present invention in the cracking of hydrocarbon vapors are as follows: 55

1. Evenness of heating of the vapors is obtained both during the increase in temperature to the conversion range and during the conversion itself. This result is obtained by heating the vapors at a plurality of points within the 60 expander tank and also from the exterior of the expander tank.

2. Good flexibility as to time and temperature treatment of the various cracking stocks is obtained. The heating can be accurately controlled by regulation of the speed of the passage 65 of the heating gases and their temperature and a speed of the vapors to be cracked.

3. Substantially no heat energy is lost from the combustion gases. This result is effected by using the heat remaining in combustion gases after employing them for the conversion step to preheat the vapors to the conversion temperature. 70

4. The life of the expander tank apparatus as 75

a whole is longer than when a single expander tank is used for the reason that the provision of two expander tanks permits a lower temperature to be used in each expander tank. Hence the combustion gases which initially contact with the initial expander tank need not be at as high a temperature as when only one expander tank is used.

5 The simplicity of the expander tank apparatus permits easy removal of the expander tank units for cleaning or repairing, if the same becomes necessary.

6. Considerable time and expense in the cracking of oil are saved because of the above features.

7. An increase in safety over ordinary expander tanks is obtained by the provision of flue walls surrounding the expander tank walls. In the event of an explosion, the outer flue walls will reduce the damage otherwise likely to occur to persons or property in the vicinity.

It should be understood that the instant invention is not limited to the details of construction or operation herein described, but that it includes all variations coming within the terms of the appended claims.

I claim:

1. An expansion tank apparatus for cracking hydrocarbons substantially in the vapor phase comprising, a pair of expander tanks, means for passing hydrocarbon vapors through said tanks in series, a plurality of vertical heating tubes extending through each of said tanks and means for passing heating gases alternatively through the tubes of either tank and thence through the tubes of the other tank.

2. An expansion tank apparatus for cracking hydrocarbons substantially in the vapor phase comprising a pair of expander tanks, conduits for introducing hydrocarbon vapors initially into either of said tanks, means for passing said hydrocarbons upwardly through said tanks, conduits connecting said tanks in series, conduits for finally removing the treated hydrocarbons from either of said tanks, a plurality of heating tubes extending through said tanks, and means for passing heating gases alternatively through the tubes of either tank and thence through the tubes of the other tank.

3. An apparatus for cracking hydrocarbons substantially in the vapor phase comprising, two or more expander tanks, means for passing hydrocarbon vapors through said tanks in series, a plurality of vertical heating tubes extending through each of said tanks, a flue casing extending completely around at least one of said tanks and means for passing heating gases through the tubes of one expander and thence through the tubes of another expander and through the space between the expander tank or tanks and the flue casing or casings.

4. The apparatus as described in claim 1 wherein at least one of the expander tanks is enclosed in a flue casing whereby a portion of the heating gases passes along the exterior of the expander tank or tanks.

5. An expansion tank apparatus for cracking hydrocarbons substantially in the vapor phase comprising a pair of vertically disposed expander tanks, each unit having a plurality of heating tubes extending therethrough, said tubes in each expander being uniform in size and equidistantly spaced, means for passing heating gases through the tubes of one unit and subsequently through the tubes of the other unit,

means for passing hydrocarbon vapors through said last mentioned expander unit and subsequently through said first mentioned expander unit in series, and means for reversing the flow of heating gases through said tubes, and means for reversing the series flow of hydrocarbon vapors through said expander units.

6. An expansion tank apparatus for cracking hydrocarbons substantially in the vapor phase comprising a pair of vertically disposed expander tanks having a plurality of heating tubes extending therethrough, said tubes in each expander being uniform in size and equidistantly spaced, means for passing heating gases through the tubes of one expander tank and thence through the tubes of the other expander, and means for passing hydrocarbon vapors through said last mentioned expander tank in series and subsequently through said first mentioned expander tank, and means for reversing the series flow of hydrocarbon vapors through said expander tanks.

7. The apparatus as described in claim 2, wherein the heating tubes in said expander tanks are of such size and so spaced as to effect substantially uniform heating between the tubes.

8. An apparatus for cracking hydrocarbons substantially in the vapor phase comprising, a pair of expander tanks, means for passing hydrocarbon vapors through said expander tanks in series, a plurality of vertical heating tubes extending through each of said expander tanks, flue casings surrounding said expander tanks, means for passing heating gases through the tubes of and also around one expander tank within the flue casing and thence through the tubes of and also around the other expander tank within the flue casing surrounding the same.

9. The apparatus as described in claim 8 wherein one of said expander tanks is mounted above the other and said casings are contiguous in removable end to end relationship in such a manner that heating gases passing from the tubes of and from around one expander tank may pass directly through the tubes and around the other expander tank.

10. An apparatus for cracking hydrocarbons substantially in the vapor phase comprising, a pair of expander tanks, means for passing hydrocarbon vapors through said expander tanks in series, a plurality of vertical heating tubes extending through each of said expander tanks, a flue casing surrounding each expander tank, said casings having lower ends for the introduction of heating gases therein, each casing being provided with a removable dome at the upper end thereof forming a closure for the same, a cross flue connecting said domes, and means for selectively introducing heating gases into either casing through its lower end whereby the same may pass first through the tubes of one expander tank and through said cross flue and subsequently through the tubes of said other expander tank.

11. An expansion tank apparatus for cracking hydrocarbons substantially in the vapor phase comprising, a pair of casings each adapted to receive heating gases in the lower end thereof, an expander tank suspended in each casing from one end thereof and supported therein centrally in spaced relation thereto, heating tubes extending through each of said tanks, means for passing hydrocarbon vapors into one of said tanks adjacent the bottom thereof, means for conduct-

ing said hydrocarbon vapors from said last mentioned tank and for introducing the same into said first mentioned tank adjacent the bottom thereof, a removable dome closing the upper end
5 of each casing, a cross flue connecting said domes, a means for selectively excluding heating gases from the lower end of either casing whereby heating gases may be selectively introduced
10 into said casings through the lower end thereof and whereby the same may pass through the tubes of each expander tank in series.

12. An apparatus for cracking hydrocarbons substantially in the vapor phase comprising two or more expander tanks connected in series,
15 means for introducing into and removing hydrocarbon vapors from said expander tanks, a plurality of equi-distantly spaced heating flues of uniform size extending through said expander tanks, flue casings extending completely around
20 said expander tanks and means for passing heat-

ing cases through said tubes and around the exterior of said expander tanks within said flue casings, said flue casings being connected such that heating gases emerging from the heating
5 tubes in and from around one expander tank pass through the heating tubes and along the exterior of another expander tank.

13. An apparatus for cracking hydrocarbons substantially in the vapor phase comprising two or more expander tanks, means for passing hydrocarbon vapors through said tanks in series, a
10 plurality of vertical heating tubes extending through each of said tanks, a flue casing extending completely around at least one of said tanks and means for passing heating gases through
15 said tubes and around the walls of the tank or tanks within the flue casing or casings, each casing being provided with a removable dome and a cross flue connecting said domes.

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