Dec. 17, 1935. I. M. LEVINE 2,024,828

VAPOR PHASE CRACKING APPARATUS

Filed April 25, 1933 2 Sheets-Sheet 1

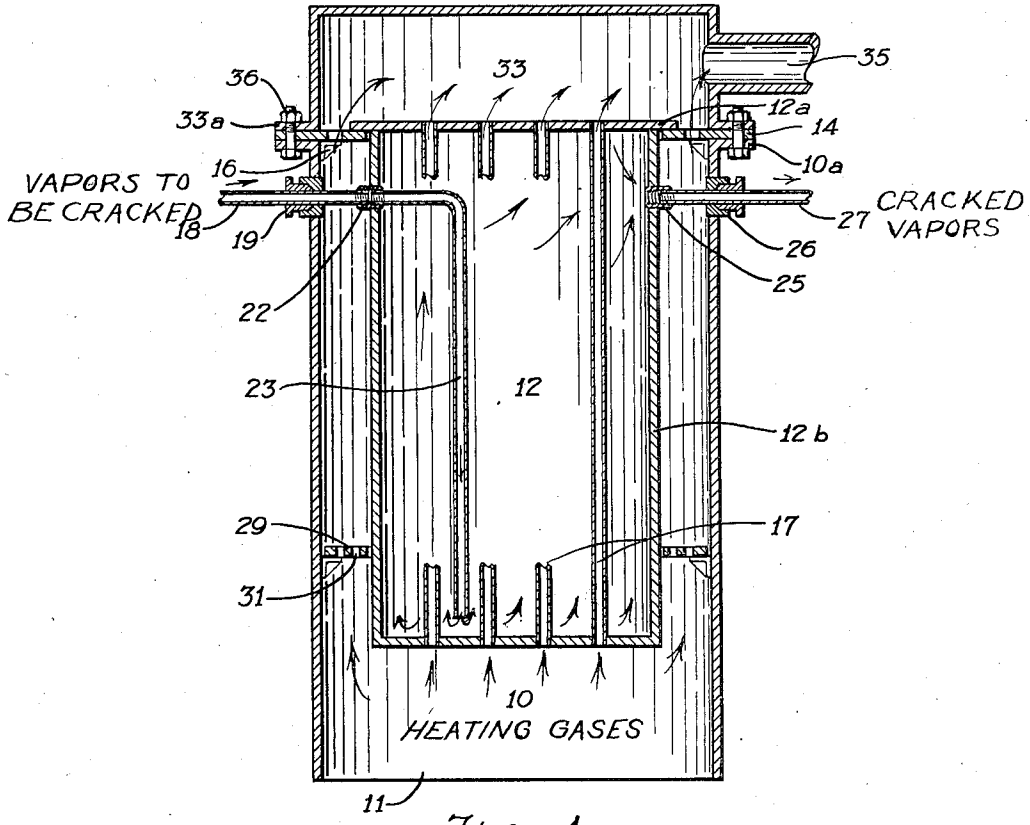


Fig. 1.

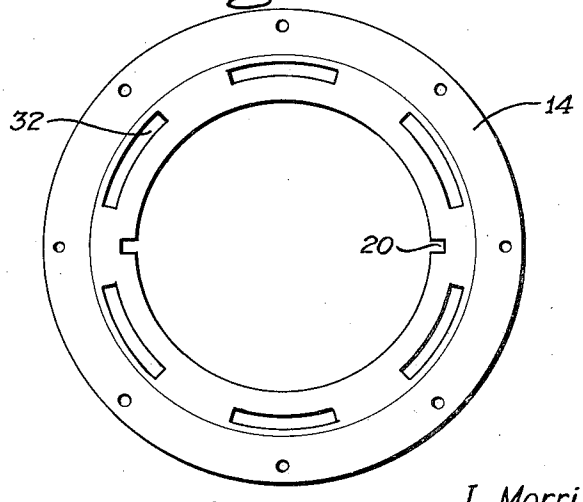


Fig. 3.

INVENTOR.
I. Morris Levine.
BY
Hammond & Littell
ATTORNEY.

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VAPOR PHASE CRACKING APPARATUS

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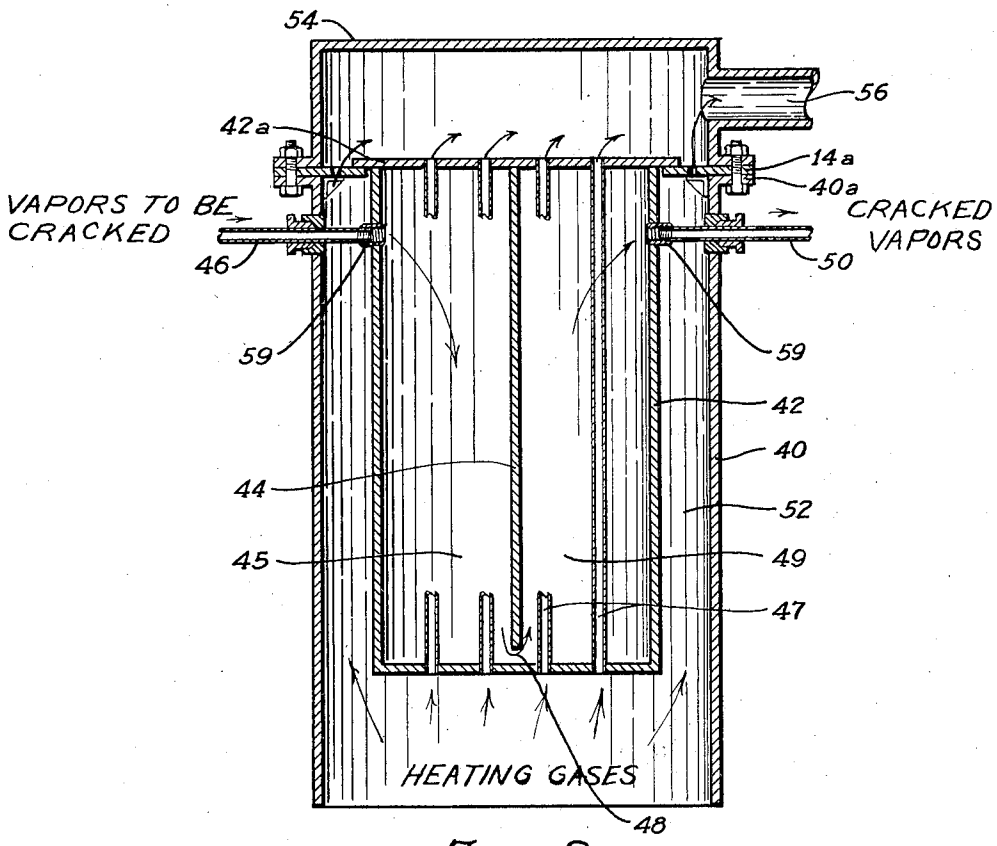


Fig. 2.

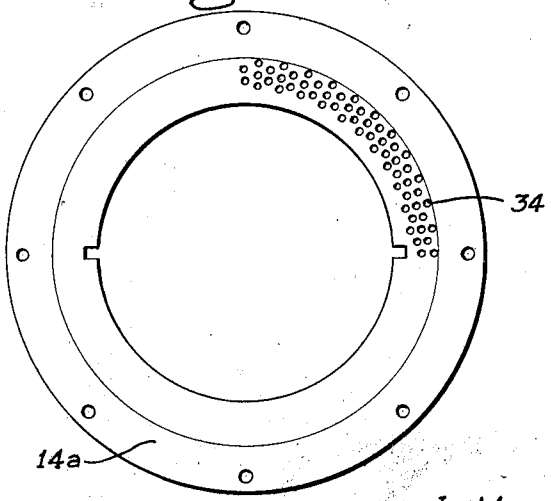


Fig. 4.

INVENTOR.
I. Morris Levine.
BY Hammond & Littell
ATTORNEY.

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UNITED STATES PATENT OFFICE

2,024,828

VAPOR PHASE CRACKING APPARATUS

I. Morris Levine, Fort Worth, Tex., assignor to Texas Pacific Coal & Oil Co., Fort Worth, Tex., a corporation of Texas

Application April 25, 1933, Serial No. 667,766

4 Claims. (Cl. 196—117)

This invention relates to apparatus for the cracking or conversion of hydrocarbons of higher boiling range to produce hydrocarbons of lower boiling range such as gasoline, and more specifically relates to an improved expander for use in vapor phase cracking although it may be useful in other cracking processes.

Many vapor phase cracking processes include as one step the introduction of vapors at or near a cracking temperature into an expander, from which the cracked vapors are withdrawn to be further processed in any of a number of ways as in a fractionating tower. Such vapors must be heated to a high temperature and due to the fact that they have a relatively low rate of heat transfer, it is essential that they be heated uniformly in such manner as to avoid heating any portions thereof to an excessive degree. In prior constructions, improper functioning of the cracking units have occurred because of the difference between the temperature of the vapors being heated adjacent the wall of the expander and that of the vapor in the center of the expander. Furthermore, mechanical difficulties have been experienced in attempting to make the expander sufficiently flexible to permit expansion and contraction in length and diameter during changes in temperature and at the same time sufficiently air tight that there would be no escape of vapor from the expander. A prior form of expander having a single wall, has in addition to the above objection, a low degree of safety in the event of the occurrence of a leak and consequent combustion of escaping vapors.

It is the principal object of the present invention to provide an expander apparatus in which the vapors to be cracked are uniformly heated and to accomplish the same by constructing an apparatus in which the heating of the vapors in the expander is effected at a plurality of points from within and also at the entire external surface of the expander. This object is attained by constructing a plurality of spaced heating flues within the expander or vapor chamber and mounting the chamber within a somewhat larger chamber adapted for the passage of heating gases, the heating gases during use of the expander passing in part through the heating flues and in part through the space between the chamber and expander.

Another object of the invention is to provide an improved support for mounting the inner vapor chamber expander in the flue or outer wall for heating hydrocarbon vapors so that the chamber is free to expand and contract during the great changes in temperature, the vapor connections being located near the support to prevent strains due to the expansion, such vapor connections being readily disconnected for the removal of the vapor chamber from the outer chamber for cleaning or repairing if such becomes necessary.

Another object of the invention is to provide an improved double walled apparatus for uniformly heating hydrocarbon vapors and liquids which includes an inner vapor chamber having a plurality of equi-distantly spaced tubes for the passage of heating gases and a baffle means for the gases passing in contact with the outer walls of the chamber, arranged to proportion properly the heating gases as between the outer surface of the expander and the inner surface of the tubes within, to obtain uniform heating.

Other objects of the invention will appear from the following description thereof taken in connection with the attached drawings which illustrate preferred embodiments of the device and in which:

Figure 1 is a vertical section showing the relative location of an expander and a flue gas chamber,

Figure 2 is a similar vertical section showing a slightly modified form of internal construction,

Figure 3 is a plan view of the ring 14, of Figure 1, and,

Figure 4 is a plan view of a modified form of ring.

The expander preferably includes two chambers, the larger of which may be termed the heating gas or flue gas chamber 10, which is adapted to receive hot gases from any desired source not shown, which gases in preferred practice are introduced through the opening 11, to pass upwardly through the chamber 10. Within this chamber the vapor chamber or expander proper 12 is mounted and is heated by the hot gases introduced at the inlet 11. The vapor chamber 12 is supported preferably as shown in Figure 1 by means of flange 12*a*, which may be and preferably is the edge of the top plate of the vapor chamber 12 overlapping the wall 12*b*, supported by an annular perforated ring 14 in turn supported by the flange 10*a* of the wall of the flue gas chamber 10. Suitable angle brackets 16 attached to the wall of said chamber 10 further support the ring 14.

The vapor chamber 12 is provided with a series of longitudinal heating tubes 17 which are uniformly spaced from each other and from the side walls 12*b* of the vapor chamber. These tubes

are flues for the passage of a portion of the hot gases passed in contact with the vapor chamber. The vapors to be cracked, continually passing through the vapor chamber enter through the inlet conduit 18 which conduit is connected through a suitable stuffing box 19 attached to the outside of the wall of the flue gas chamber 10. The conduit 18 extends into or is threaded into a fixed union 22 welded or otherwise permanently secured in the wall of the vapor chamber. A fixed extension conduit 23 is connected to the union 22 on the inside of the chamber 12 and causes the vapors to pass downwardly to be liberated near the bottom of the vapor chamber. After passing upwardly through said chamber the vapors are discharged through the outlet pipe 27 which pipe is similarly secured to a fixed union 25. The outlet pipe also extends through a stuffing box 26 mounted on the outside of the flue gas chamber 10, the pipe 27 leading the heated vapors to other apparatus for further processing. If desired the vapors may be passed into another expander, although it is usually unnecessary inasmuch as sufficient heat may be acquired for the reaction in one expander.

In view of the arrangement of the heating tubes 17 and the provision of external heating of the chamber 12, the flue gases will enter into relatively close indirect contact with all parts of the vapors passing through the chamber, imparting to them a uniform quantity of heat and resulting in a uniform temperature throughout the vapor space in any cross section of the chamber, a result not possible with any indirect heat exchange cracking chambers heretofore known. Baffles 29 may be provided between the respective chambers to regulate the flow of heated flue gases passing upwardly in contact with the exterior of the vapor chamber 12. The size of the apertures 31 in said baffle are dependent upon the size and number of tubes 17 and are so chosen as to proportion the heating gases between the tubes and the annular space between the chambers to obtain a heating of the vapors near the chamber wall equal to that of the vapors near the tube walls.

The upper baffle ring 14 from which the vapor chamber is suspended is provided with apertures 32 as shown in Figure 3. These apertures may be in the form of elongated arcuate slots, as shown in Figure 3 or as illustrated in the modified ring 14*a* in Figure 4 they may be in the form of small holes or perforations 34.

After heating the chamber 12 the gases pass into the collecting chamber or hood 33 from which they pass out through the discharge conduit 35 to the stack (not shown). The chamber 33 is in the form of a cap or hood which is suitably bolted to the top of the wall of the flue gas chamber 10, the bolts 36 projecting through the cap flange 33*a*, ring 14 and flange 10*a*. Suitable gaskets, are provided where necessary. The continued use of the expander causes objectionable accumulation of soot, etc., which must be removed. To dismantle the apparatus the cap 33 and the vapor inlet and outlet connections 18 and 27 are detached. The vapor chamber 12 is then removed by merely lifting the same out of the casing, the extended portion of the nipples 22 and 25 slipping through the slots 20 provided in the ring 14. It is to be noted that the vapor inlet and outlet connections have been placed near the point of support of the vapor chamber so that upon heating, the relative expansion between the same will be small and stresses and strains will be at a minimum.

This form of construction has many advantages over prior constructions, including simplicity, ease of cleaning and increase in safety. Should any failure occur in the wall of chamber 12 even under circumstances in which there is a large excess of oxygen in the flue gases used for heating the vapors, resulting in the combustion of the escaping vapors, the fire will be confined to the flue spaces in chamber 10 and quickly brought to the notice of the operator by the presence of smoke in the flue gas issuing from the stack.

Another important additional factor of safety obtained by this construction is that ruptures of the inner chamber will not cause the projection of vapors into the atmosphere surrounding the expander apparatus. If, for example, there is a mechanical failure of one or more of the heating tubes, top or bottom plates, or inside wall with a consequent escape of processed oil or vapors, the escaped vapors will be diluted with the flue gases and will pass up the stack. The danger of flashing and combustion of the escaped vapor on the outside of the plant is therefore greatly reduced.

Another advantage of the double wall construction becomes apparent in the event of a failure of the outer wall. In the instant construction such failure will involve no danger, for the gases which will escape are inert combustion gases. Provided the break is not too large, the same can be repaired without ceasing the operation of the conversion process. If necessary a larger quantity of heating gases may be introduced to make up for that portion lost through the break.

In the preferred construction, the expander or vapor chamber 12 is fabricated from steel or other heat resistant metal or alloy. The outer wall 10 of the flue gas chamber may be, however, constructed either of metal or of any refractory material such as brick, choice being dependent upon the considerations of cost and ease of fabrication.

The particular form of expander hereinbefore described is designed and constructed for the treatment of vapors in vapor phase cracking, although the same is satisfactory for the heating of liquid oil in liquid phase cracking and for the heating of fluids partially in vapor form and partially in the liquid state.

A slightly modified form of construction of expander is shown in Figure 2 which includes the outer or flue gas chamber wall 40 made of brick, steel or other construction material, having an upper flange 40*a* supporting a ring 14 or 14*a* which in turn supports the expander or vapor chamber 42.

In this embodiment the expander 42 has a partition 44 preferably attached to the top 42*a* of the expander and which extends almost to the bottom thereof. The partition may be positioned in the middle of the expander as designated in the drawings, or to either side of the middle. This partition 44 divides the chamber into two parts, the one on the left indicated at 45 serving as the inlet chamber into which the vapors are introduced through the conduit 46 and the part on the right indicated at 49 serving as the outlet chamber. The vapors introduced into the expander will fill the space between the tubes 47 in the left hand part 45 through which flue gases pass and will become partially heated. Due to the pressure maintained on the vapors, they will travel downwardly in this chamber, pass under the bottom of the partition 44 through the chan-

nel **48** into the second chamber **49** through which they will journey in an upward direction and from which they will be discharged through the outlet conduit **50**.

As in the first embodiment, flue gases pass between the walls **42** of the vapor chamber and the wall **40** of the flue gas chamber indicated as the annular passage **52**. A proper correlation of the size and number of apertures **34** in the ring **14***a* at the top of the flue gas chamber controls the amount of gases which pass through this annular passage **52**. This ring **14***a*, may be supplemented by an additional baffle as shown at **29** in Figure 1. The flue gas chamber is surmounted by a cap or hood **54** which is suitably bolted to the frame or flue gas chamber wall **40** in such manner as to maintain the apparatus in a gas tight relation, the flue gases discharging through the outlet **56** to the stack (not shown).

In this construction as in the first embodiment, the inlet and outlet vapor conduits extend through stuffing boxes **60** mounted on the wall **40** and are screwed into fixed unions **59** mounted in the wall **42** of the vapor chamber. In order to allow for expansion, the inlets and outlets are preferably mounted at a point near the point of support of the vapor chamber, between which points there is not much expansion.

The heating of the vapors in this form of the apparatus takes place in steps, due to the partition **44**. Furthermore the multiplicity of equally spaced tubes and the provision for the heating of the outside wall of the vapor chamber heats all portions of the vapors simultaneously making it possible to use a small differential of temperature between the heating gases and the vapors.

Although termed an expander because of the reaction which takes place, the vapor chamber is a special form of heat exchanger particularly adapted for heating vapors to bring about cracking. A special advantage of the present device resides in that the vapor chamber may be readily removed from the flue gas chamber and cleaned and inspected as desired.

The tubes **47** are secured to the respective headers of the vapor chamber by rolling, welding or other methods adapted to make the vapor chamber pressure tight at all times, in spite of the stresses set up due to the differentials in temperatures to which the expander is subjected.

Although the particular embodiments illustrated show cylindrical flue gas chambers and vapor chambers, it is to be understood that other shapes may be equally as satisfactory as far as operating conditions are concerned, although for manufacturing reasons the cylindrical type is preferable.

While I have shown and described only two embodiments of my invention I am aware that modifications may be made without departing from the present invention and I therefore desire a broad interpretation of my invention within the spirit and scope of the description herein and of the claims appended hereinafter.

I claim:

1. In an apparatus for cracking hydrocarbon oils in vapor phase, a vertically disposed flue gas chamber for the passage of heating gases, a vertically disposed vapor chamber spaced therefrom, supported within said first chamber and having top and bottom plates and a plurality of tubes extending vertically therebetween, conduits to introduce oil vapors into and conduct them from said vapor chamber, said tubes serving for the passage of heating gases, baffles between the walls of said chambers adapted to diminish the flow of gases, said flues and baffles being of such relative size that they are adapted to proportion heating gases between the flues and the passage between the walls, thereby to obtain a substantially uniform temperature throughout the cross section of said vapor chamber.

2. An expander tank for cracking hydrocarbon vapors comprising an outer flue gas chamber and an inner vapor chamber, said vapor chamber being adapted for the transmission therethrough and heating therein of hydrocarbon vapors, said vapor chamber having a plurality of hollow conduits extending therethrough for the passage of flue gases therethrough and for the intimate but indirect exchange of heat throughout the vapor chamber, said vapor chamber being spaced from the flue gas chamber wall thereby providing a further passage for flue gases between said vapor chamber and said flue gas chamber, a series of baffle rings in said last mentioned passage to restrict the quantity of flue gas, means to support the inner vapor chamber at one end only, to prevent buckling of said chamber upon expansion thereof, vapor inlet and outlet connections sufficiently near the support for the inner vapor chamber to avoid stresses and consequent strains, said inner vapor chamber being removable from said flue gas chamber having a detachable portion permitting removal of said inner vapor chamber.

3. An expander tank for heating hydrocarbon gases consisting of a flue gas chamber, a vapor chamber mounted therein and spaced therefrom, said vapor chamber having a plurality of flue gas passages extending therethrough, means to support said vapor chamber at one end thereof to permit expansion of the same, means to introduce vapors into and discharge the same from said vapor chamber, means to proportion the flow of gases through the space between the chambers and through said flue gas passages, and means permitting easy removal of the vapor chamber from the flue gas chamber.

4. An expander tank for heating hydrocarbons to a cracking temperature which comprises, a chamber, a plurality of vertically extending heating flues extending through the chamber, said flues providing a plurality of internal heating zones, means to heat said zones and the outer wall of said chamber, inlet and outlet means for the continuous passage of said hydrocarbons through said chamber and means within said chamber to cause incoming hydrocarbons introduced near the top thereof to pass to the bottom of said chamber and discharge from the top thereof, said means including a partition extending from the top of said chamber substantially to the bottom thereof.

I. MORRIS LEVINE.