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R. F. RUTHRUFF

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CONVERSION OF HYDROCARBONS

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FIG.1.

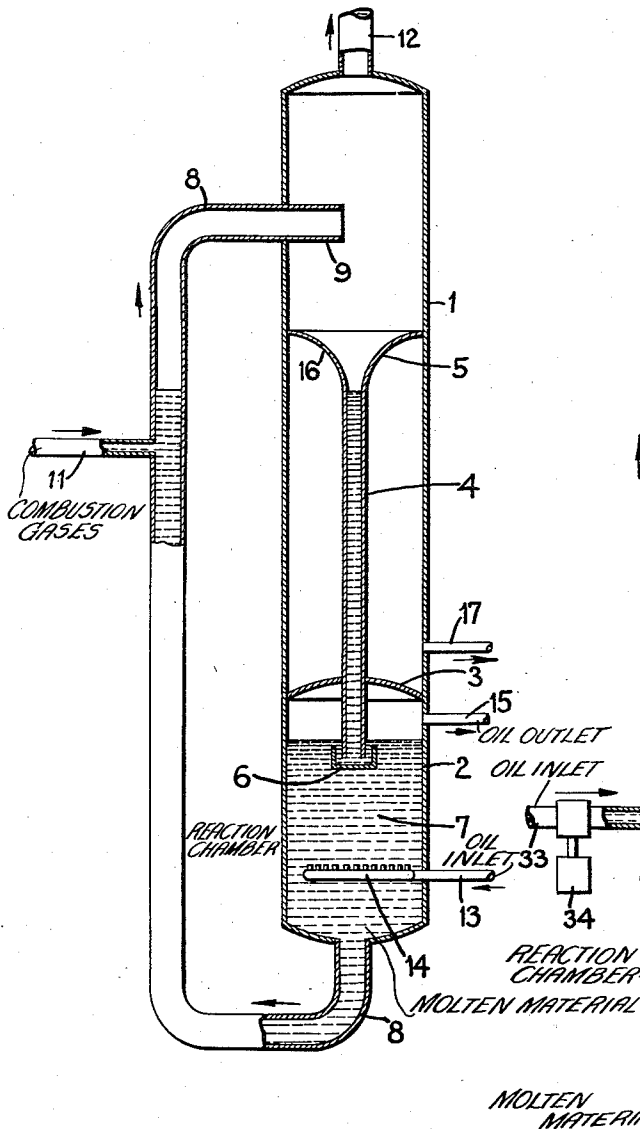
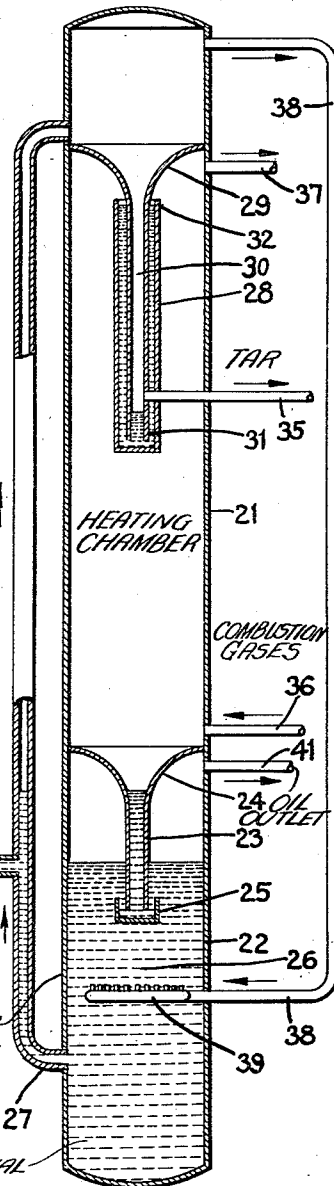


FIG.2.



INVENTOR.
ROBERT F. RUTHRUFF

BY *Donald H. Mace*
ATTORNEY

UNITED STATES PATENT OFFICE

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CONVERSION OF HYDROCARBONS

Robert Freeborn Ruthruff, Whiting, Ind., assignor to Standard Oil Company (Ind.), Chicago, Ill., a corporation of Indiana

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14 Claims. (Cl. 196—70)

This invention relates in general to the conversion of hydrocarbon fluids and more especially to improvements in the art of thermally converting hydrocarbon fluids wherein such a fluid is heated to the desired elevated temperature by passing it in heat exchange relation with a fluid heat transfer medium, such as molten material, the fluid heat transfer medium being circulated from and to a reaction chamber of an apparatus for carrying out the process by another medium capable of exerting a gas lift effect thereon with provision being made for the heating of the molten material during circulation thereof, preferably, by directly contacting it with hot gaseous or vaporous fluid.

As contemplated by my invention, a body of fluid heat transfer medium, such as a molten material, may be maintained at an elevated temperature in a reaction chamber of a suitable apparatus. The molten material may be circulated from and to said body by introducing directly into a stream thereof, withdrawn from the body of molten material, a medium capable of exerting a gas lift effect on the molten material to effect circulation thereof, such as hot combustion gases, these hot gases heating the molten material to an elevated temperature during the circulation thereof before the circulating molten material is collected in said body. My invention also contemplates effecting circulation of molten material from and to said body maintained in the reaction chamber by introducing a hydrocarbon fluid, such as a liquid oil, under superatmospheric pressure into a stream thereof withdrawn from the body, the hydrocarbon fluid being preheated while exerting a gas lift effect on the molten material. During the circulation of the molten material by the hydrocarbon fluid, the molten material is heated by direct contact with hot combustion gases to elevate the temperature thereof prior to its being collected in the aforementioned body.

The hydrocarbon fluid after being preheated in effecting circulation of molten material may thereafter be passed in heat exchange relation with the body of molten material collected in the reaction chamber and heated to the desired elevated temperature.

My invention further contemplates withdrawing the hot combustion gases used to heat the molten material from the apparatus independently of the heated hydrocarbon. Thus circulation of molten material is effected by a medium that exerts a gas lift effect thereon, the molten material being heated to an elevated temperature during circulation thereof by direct contact with

hot combustion gases and thereafter collected in a body. The desired heating of the hydrocarbon fluid to a conversion temperature may be accomplished by passing it in heat exchange relation with the body of molten material, without either the hot combustion gases or the hydrocarbon fluid coming into direct contact with each other. It will, therefore, be evident that my invention provides for the necessary heating and conversion of the hydrocarbon fluid to produce the desired product, such as a motor fuel of the gasoline boiling range, without the necessity of subsequent separation of the effluent resulting from the heat treatment of the hydrocarbon fluid and the hot combustion gases directly contacted with the molten material for the purpose of heating it to the desired elevated temperature.

In order to make my invention more clearly understood, I have shown in the accompanying drawing, means for carrying the same into practical effect without limiting the improvements in their useful applications to the particular constructions which, for the purpose of explanation, have been made the subject of illustration.

Figure 1 is an elevational view of an apparatus capable of carrying out my invention.

Figure 2 is an elevational view of another type of apparatus also capable of carrying out my invention.

Referring to Figure 1 wherein circulation and heating of the molten material may be simultaneously accomplished by introducing hot combustion gases into a stream of molten material, there is shown an enlarged vessel 1 having a reaction chamber 2 at the lower portion thereof. The reaction chamber 2 may be separated from the upper portion of the vessel 1 by means of a dome-plate 3. The vessel 1 may also be provided with a conduit 4 within the vessel for returning molten material heated to an elevated temperature to a body thereof collected in the reaction chamber 2. The conduit 4 may have a trough arrangement 5 at the upper end thereof for directing reheated molten material, as will hereinafter be explained, returned to the upper portion of the vessel, through the conduit 4 into a trap 6 immersed in a body of molten material 7, collected in the reaction chamber 2.

A conduit 8 extends from the lower portion of the reaction chamber 2 to the upper part of the vessel 1. The molten material is circulated from the body thereof in the reaction chamber 2 to the upper portion of the vessel 1 through the conduit 8, which may extend into the vessel

as indicated at 9, the molten material there-
after dropping through part of the vessel into
the trough 5 from which it is directed to the
trap 6 immersed in the body of molten mate-
rial 7.

In order to force the molten material from
the body 7 to the upper part of the vessel 1 and
to heat it during its circulation from and to the
body of molten material, there may be provided
an inlet 11 for introducing hot products of com-
bustion, produced in any suitable manner, such
as by high pressure burners, directly into the
molten material in the conduit 8. The hot com-
bustion gases which may be at superatmospheric
pressure exert a gas lift effect on the molten ma-
terial thereby raising it in the conduit 8 and
simultaneously heating it to an elevated tem-
perature during the raising thereof. Thus mol-
ten material is circulated from the body 7
through the conduit 8 wherein it is heated to
an elevated temperature and returned to the
body 7 by means of the trough 5 and the con-
duit 4 which directs the molten material fall-
ing from the outlet 9 back into the body of
molten material. The hot combustion gases
used to simultaneously circulate and heat the
molten material may be withdrawn through an
outlet 12 at the upper portion of the vessel 1.

A hydrocarbon fluid, such as a clean gas oil,
to be heated and converted into low boiling prod-
ucts, such as gasoline, may be introduced into
the body of molten material by means of an
inlet pipe 13 connected to a spray nozzle 14 im-
mersed in the body of molten material. The
hydrocarbon fluid to be converted is preferably
preheated in any suitable manner and thereafter
passed in heat exchange relation with the body
of molten material in a relatively short period
of time to thereby rapidly raise it to the desired
conversion temperature. The thus heated hy-
drocarbon may be withdrawn after passing in
heat exchange relation with the molten material
from the reaction chamber 2 by means of an
outlet pipe 15 and conducted to any suitable
apparatus well known in the art for treating the
highly heated hydrocarbon.

In accordance with my invention the hydro-
carbon fluid is preferably introduced into the
body of molten material at a high superatmos-
pheric pressure, this pressure exerting itself on
the column of molten material maintained in
the reaction chamber as well as the conduit 8
connected thereto due to the sealing effect of
the dome-plate 3 and a suitable valve in the
pipe 15. The molten material is thus forced in
the conduit 8 to a higher level than that main-
tained in the reaction chamber 2. If desired,
the hydrocarbon fluid may be passed in indirect
heat exchange with the body of molten mate-
rial by using a suitable heating coil immersed
therein, the desired elevated pressure being
maintained directly on the body of molten ma-
terial in any suitable manner.

In lieu of withdrawing the combustion gases
utilized as a gas lift medium as well as a heat-
ing medium for the molten material through
the conduit 12, the combustion gases may be
passed through an opening 16 in the trough 5.
With such an arrangement the molten material
receives any additional heat remaining in the
hot gases through the conduit 4. The combus-
tion gases after additionally heating the molten
material in the conduit 4 may be withdrawn
through a suitable outlet 17, the outlet 12 being
closed by any suitable valve means.

As indicated in Figure 1, the height of molten
material in the conduit 4 is substantially the
same as the height of molten material in the
conduit 8, to obtain the desired hydrostatic bal-
ance.

If a longer time of contact is desired between
the combustion gases and the molten material
in order to heat the latter to the desired elevated
temperature during the circulation thereof, the
draft gauge principle may be employed. This
principle involves the lengthening of the conduit
8 from the point of the introduction of the hot
combustion gases by inclining it from the hori-
zontal to obtain a longer time of contact.

In Figure 2 I have shown an apparatus where-
in the molten material may be circulated from
and to the body thereof maintained in a reac-
tion chamber by introducing a hydrocarbon fluid
thereinto, the hydrocarbon fluid exerting a gas
lift effect thereon and at the same time being
preheated to the desired elevated temperature.
In this modification, the molten material during
circulation from and to the body may be heated
by directly contacting it with hot combustion
gases. In this figure, there is shown a vessel
21 having a reaction chamber 22 at the lower
portion thereof. The reaction chamber 22 is
separated from the upper portion of the vessel
21 by means of a trough 24, suitably secured to
the sides of the vessel and having a conduit 23
associated therewith. The trough 24 and con-
duit 23 direct the descending molten material
into a trap 25 immersed in a body of molten
material 26. A conduit 27 may be connected to
the reaction chamber 22 for conveying molten
material from the body thereof maintained in
the reaction chamber to the upper portion of the
vessel. The molten material upon entering the
upper portion of the vessel falls into a trap de-
vice indicated generally by the numeral 28. The
trap device 28 may comprise a trough arrange-
ment 29 secured to the sides of the vessel for
directing the molten material through a passage
30 formed by a suitable conduit to the end 31
from which it is forced due to the accumulation
of molten material through the space surround-
ing the passage 30 to an overflow point 32, from
which it falls, through the trough 24 to the body
of molten material maintained in the reaction
chamber 22.

In order to effect circulation of the molten ma-
terial from the body 26 to the upper portion of
the vessel, a stream of hydrocarbon fluid, such
as a clean gas oil, may be introduced through a
pipe 33 and forced by means of a pump 34 di-
rectly into the molten material maintained in
the conduit 27. The hydrocarbon fluid is va-
porized upon contacting the molten material the
thus vaporized hydrocarbon fluid exerting a gas
lift effect upon molten material in the conduit 80
27 and thereby raising it to the upper part of
the vessel through the conduit 27 from which it
falls into the trap 28 and overflows therefrom at
the point 32. When a gas oil is introduced
through the line 33 or a heavier oil, any unvapor-
ized products collecting in the passage 30 may
be withdrawn through a suitable line 35. The
molten material flowing over the top of the trap
and passing downwardly to the trough 24 may
be heated to the desired elevated temperature
before reaching the body of molten material in
the reaction chamber 22 by directly contacting
it with hot combustion gases. As shown, hot
combustion gases may be introduced through the
conduit 36 and passed countercurrent to the

downwardly flowing molten material, the hot combustion gases after giving up their heat to the molten material leaving the vessel through a conduit 31.

Vaporized constituents of the oil introduced through the line 33 rise to the upper portion of the vessel 21 and may be conducted through a line 38 into the body of molten material for further cracking or conversion by means of a suitable spray nozzle 39 immersed therein.

It will thus be evident from the foregoing that circulation of molten material from and to the body maintained in the reaction chamber 22 is effected by the hydrocarbon fluid introduced into the conduit 27, this hydrocarbon fluid being vaporized and exerting a gas lift effect on the molten material. The molten material after being utilized as a heat transfer medium to pre-heat the hydrocarbon fluid may be heated by direct contact with the combustion gases.

The height of molten material collected in the conduit 23 prior to being directed to the body 26 is as great as the height of molten material in the conduit 27 thus forcing the molten material through the conduit 27 to a point above where the medium for exerting a gas lift effect is introduced. If desired the molten material may be maintained at a greater height in the conduit 23. As shown in the drawing, the distance between the bottom of the trap 28 and the overflow point 32 is approximately equal to the distance between the point of introduction of the hydrocarbon vapors into the body of molten material through the spray 39 and the height of the molten material in the conduit 23. The distance first mentioned should always be as great or greater than the second mentioned distance to insure that vaporized oil does not pass through the trap 28 and out over the overflow point 32.

In both of the modifications herein shown for carrying out my invention, the hot combustion gases utilized to heat the molten material to an elevated temperature are withdrawn from the apparatus independently of the hydrocarbon fluid heated to the desired conversion temperature. Thus when practicing my invention there is no necessity for providing equipment to separate out the waste combustion gases from the more desirable products resulting from the conversion operation, the desirable products being treated in any suitable manner for the recovery of motor fuel, such as gasoline.

In operating my invention in accordance with the showing of Figure 1, the body of molten material 7 may be maintained at a temperature of about 1000°-1200° F. and a hydrocarbon fluid, such as a clean gas oil preheated to a temperature of about 800° F. and while under a pressure of about 200 to 300 pounds per square inch or as high as a thousand pounds, may be passed through the body of molten material in a relatively short period of time, preferably in the order of one second and up to a few seconds and raised to a high temperature of about 1000° F. The molten material being circulated from and to the body thereof may be contacted by hot combustion gases introduced through the conduit 11 at a temperature of about 2000°-3000° F. while under a pressure of from 10 to 50 pounds per square inch or as much higher as desired. These hot gases exert a gas lift effect on the molten material and simultaneously heat it to the aforementioned temperature prior to its return to the body in the reaction chamber 2.

When carrying out my invention in an apparatus of the type shown in Figure 2, the body of molten material 26 may be maintained at a temperature of from 1000°-1200° F. and a hydrocarbon fluid, such as a clean gas oil, introduced into the molten material in the conduit 27 under a pressure up to a thousand pounds to thus be preheated and, if desired, subjected to thermal conversion by the molten material or cracking and also exert a gas lift effect thereon to cause circulation from the body 26 through the conduit 27 back to the body 26. The molten material before entering the body 26 may be heated to an elevated temperature by introducing combustion gases at a temperature of from 2000°-3000° F. into direct contact therewith through the conduit 36, these combustion gases after passing in direct contact with the descending molten material leaving the vessel through the conduit 31.

The hydrocarbon fluid in raising the molten material through the conduit 27 into the upper part of the vessel 21 is preheated to a temperature upwards of 800° F. which results in vaporization of this oil. The vaporized constituents are conducted through the line 38 into the body of molten material through the nozzle 39 wherein they are directly contacted with the molten material and therein rapidly raised to a temperature of about 1000°-1200° F. in a relatively short period of time of about from one second to a few seconds. The thus highly heated hydrocarbon fluid may be conducted after passing in heat exchange relation with the body of molten material from the vessel through an outlet line 41 and passed to suitable well known after equipment 35 for further treatment.

Any suitable fluid heat transfer medium may be used in accordance with my invention. For instance molten lead, or other suitable metal, or any suitable alloy of various metals, or fused salts, such as sodium hydroxide or a mixture of fused salts such as sodium and aluminum chloride may be employed. The expression "molten material" used throughout the specification and claims is intended to include any suitable metal alloy of various metals, salts or mixture of various salts.

While my invention has been specifically described in connection with the cracking of a relatively clean gas oil, it is to be clearly understood that other hydrocarbon fluids may also be thermally converted in accordance therewith. For instance, my invention is also applicable to the thermal conversion of normally gaseous saturated hydrocarbons, for the production of gaseous olefins or normally liquid products, and when practicing it in such a manner, temperatures above 1300° and as high as 1600° F. and higher and lower pressures may be employed.

While I have shown and described the preferred embodiment of my invention, and specific examples for each, I wish it to be understood that I do not confine myself to the precise details of construction herein set forth, by way of illustration, as it is apparent that many changes and variations may be made therein, by those skilled in the art, without departing from the spirit of the invention, or exceeding the scope of the appended claims.

1. In the art of thermally converting hydrocarbons, the method that comprises maintaining a body of molten material at elevated temperature in a conversion zone, circulating molten material from and to said conversion zone by introducing therein a fluid capable of exerting

- a gas lift effect on the molten material, heating said molten material during the circulation and before collection thereof in said body by direct contact with hot gases introduced into intimate contact therewith to raise it to an elevated temperature, passing a hydrocarbon fluid in heat exchange relation with the body of molten material in the conversion zone to thereby raise it to the desired conversion temperature, withdrawing the thus heated hydrocarbon fluid from said conversion zone and withdrawing the hot gases after passing in direct contact with said molten material independently of said heated hydrocarbon fluid.
2. In the art of thermally converting hydrocarbons the method that comprises maintaining a body of molten material at elevated temperature in a conversion zone, circulating molten material from and to said conversion zone by introducing therein a fluid capable of exerting a gas lift effect on the molten material, heating said molten material during the circulation and before collection thereof in said body by direct contact therewith to raise it to an elevated temperature, passing a hydrocarbon fluid in direct contact with the body of molten material in the conversion zone to thereby raise it to the desired conversion temperature, withdrawing the thus heated hydrocarbon fluid from said conversion zone and withdrawing the hot gases after passing in direct contact with said molten material independently of said heated hydrocarbon fluid.
3. In the art of thermally converting hydrocarbons, the method that comprises maintaining a body of molten material at elevated temperature in a conversion zone, circulating molten material from and to said conversion zone by introducing therein a fluid capable of exerting a gas lift effect on the molten material, heating said molten material during the circulation and before collection thereof in said body by direct contact therewith to raise it to an elevated temperature, passing a hydrocarbon fluid in heat exchange relation with the body of molten material in the conversion zone to thereby raise it to the desired conversion temperature, independently withdrawing the thus heated hydrocarbon fluid from said conversion zone and the hot gases after giving up heat without either the heated hydrocarbon fluid or the hot gases coming into direct contact with each other.
4. In the art of thermally converting hydrocarbons, the method that comprises maintaining a body of molten material at elevated temperature in a conversion zone, introducing hot combustion gases at a superatmospheric pressure directly into intimate contact with molten material separate from said conversion zone to thereby heat molten material to an elevated temperature prior to collection thereof in said body and simultaneously effect circulation thereof from and to said conversion zone by the gas lift effect of the combustion gases, passing a hydrocarbon fluid in heat exchange relation with the body of molten material in the conversion zone to thereby raise it to the desired conversion temperature, withdrawing the thus heated hydrocarbon fluid from said conversion zone and withdrawing the hot combustion gases after heating said molten material independently of said heated hydrocarbon fluid and without coming into direct contact therewith.
5. In the art of thermally converting hydrocarbons, the method that comprises maintaining a body of molten material at elevated temperature in a conversion zone, passing a stream of molten material from said conversion zone to another zone separate from said conversion zone, introducing hot combustion gases at a superatmospheric pressure directly into intimate contact with molten material in said last mentioned zone to thereby heat said molten material to an elevated temperature prior to collection thereof in said body and simultaneously effect circulation thereof back to said conversion zone by the gas lift effect of the combustion gases, passing a hydrocarbon fluid in heat exchange relation with the molten material in the conversion zone to thereby raise it to the desired conversion temperature, withdrawing the thus heated hydrocarbon fluid from said conversion zone and withdrawing the hot combustion gases after heating said molten material independently of said heated hydrocarbon fluid and without coming into direct contact therewith.
6. In the art of thermally converting hydrocarbons, the method that comprises maintaining a body of molten material at elevated temperature in a conversion zone, introducing hot combustion gases at a superatmospheric pressure directly into intimate contact with molten material separate from said conversion zone to thereby heat molten material to an elevated temperature prior to collection thereof in said body and simultaneously effect circulation thereof from and to said conversion zone by the gas lift effect of the combustion gases, passing a hydrocarbon fluid in direct contact with the molten material in the conversion zone to thereby raise it to the desired conversion temperature, withdrawing the thus heated hydrocarbon fluid from said conversion zone and withdrawing the hot combustion gases after heating said molten material independently of said heated hydrocarbon fluid and without coming into direct contact therewith.
7. In the art of thermally converting hydrocarbons, the method that comprises maintaining a body of molten material at elevated temperature in a conversion zone, introducing a hydrocarbon fluid at superatmospheric pressure into molten material separate from said conversion zone to thereby heat said hydrocarbon fluid to an elevated temperature and effect circulation of molten material from and to said conversion zone through said separate zone by the gas lift effect of the hydrocarbon fluid, passing hot combustion gases directly into intimate contact with said circulating molten material to heat it to an elevated temperature prior to its being returned to the body thereof maintained in the conversion zone, conducting said hydrocarbon fluid after being heated to an elevated temperature in heat exchange relation with the molten material in the conversion zone to thereby raise it to the desired conversion temperature, withdrawing the thus heated hydrocarbon fluid from said conversion zone and withdrawing the hot gases after passing in contact with said molten material independently of said heated hydrocarbon fluid and without coming into direct contact therewith.
8. In the art of thermally converting hydrocarbons, the method that comprises maintaining a body of molten material at elevated temperature in a conversion zone, passing a stream of molten material from said conversion zone to another zone separate from said conversion zone, introducing a hydrocarbon fluid at superatmospheric

pressure into molten material in said last mentioned zone to thereby heat said hydrocarbon fluid to an elevated temperature and effect circulation of molten material from and to said conversion zone through said separate zone by the gas lift effect of the hydrocarbon fluid, passing hot combustion gases directly into intimate contact with said circulating molten material to heat it to an elevated temperature prior to its being returned to the body thereof maintained in the conversion zone, conducting said hydrocarbon fluid after being heated to an elevated temperature in heat exchange relation with the molten material in the conversion zone to thereby raise it to the desired conversion temperature, withdrawing the thus heated hydrocarbon fluid from said conversion zone and withdrawing the hot gases after passing in contact with said molten material independently of said heated hydrocarbon fluid and without coming into direct contact therewith.

9. In an apparatus for the heat treatment of hydrocarbon fluids, an enlarged vessel, a reaction chamber at one end thereof, a body of molten material within said reaction chamber, a conduit exterior of said vessel and connected at one end to the reaction chamber and at the other end to said vessel beyond the reaction chamber, means directly connected to said conduit for introducing hot gases directly into said conduit to raise molten material from said reaction chamber in said conduit back to said vessel by the gas lift effect produced thereby and heat the molten material to an elevated temperature prior to its return to said body thereof, means for introducing a hydrocarbon fluid to be heated into heat exchange relation with said body of molten material in the reaction chamber and means for withdrawing the thus heated hydrocarbon fluid from said reaction chamber.

10. In an apparatus for the heat treatment of hydrocarbon fluids, an enlarged vessel, a reaction chamber at one end thereof, a body of molten material within said reaction chamber, a conduit exterior of said vessel and connected at one end to the reaction chamber and at the other end to said vessel beyond the reaction chamber, means directly connected to said conduit for introducing hot gases directly into said conduit to raise molten material from said reaction chamber in said conduit back to said vessel by the gas lift effect produced thereby and heat the molten material to an elevated temperature prior to its return to said body thereof, means for preventing the hot gases from coming in contact with said body of molten material in said reaction chamber, means for introducing a hydrocarbon fluid to be heated into heat exchange relation with said body of molten material in the reaction chamber, means for withdrawing the thus heated hydrocarbon fluid from said reaction chamber, and means for withdrawing the combustion gases independently of said heated hydrocarbon fluid.

11. In an apparatus for the heat treatment of hydrocarbon fluids, an enlarged vessel, a reaction chamber at one end thereof, a body of molten material within said reaction chamber, a conduit exterior of said vessel and connected at one end to the reaction chamber and at the other end to said vessel beyond the reaction chamber, means directly connected to said conduit for introducing hydrocarbon fluid directly into said conduit under superatmospheric pressure to contact molten material therein thereby elevating the temperature of said hydrocarbon fluid and raising molten ma-

terial from said reaction chamber in said conduit back to said vessel by the gas lift effect produced thereby, means for introducing hot combustion gases into direct contact with said circulating molten material to heat it to an elevated temperature prior to its return to said body in the reaction chamber, means for conducting said hydrocarbon fluid at elevated temperature to said body of molten material and passing it in heat exchange relation therewith to thereby raise the temperature of the hydrocarbon fluid and means for withdrawing the thus heated hydrocarbon fluid from said reaction chamber.

12. In an apparatus for the heat treatment of hydrocarbon fluids, an enlarged vessel, a reaction chamber at one end thereof, a body of molten material within said reaction chamber, a conduit exterior of said vessel and connected at one end to the reaction chamber and at the other end to said vessel beyond the reaction chamber, means directly connected to said conduit for introducing hydrocarbon fluid directly into said conduit under superatmospheric pressure to contact molten material therein thereby elevating the temperature of said hydrocarbon fluid and raising molten material from said reaction chamber in said conduit back to said vessel by the gas lift effect produced thereby, means for introducing hot combustion gases directly into contact with said circulating molten material to heat it to an elevated temperature prior to its return to said body in the reaction chamber, means for preventing the combustion gases from coming in contact with said body of molten material in said reaction chamber, means for conducting said hydrocarbon fluid at elevated temperature to said body of molten material and passing it in heat exchange relation therewith to thereby raise the temperature of the hydrocarbon fluid, means for withdrawing the thus heated hydrocarbon fluid from said reaction chamber and means for withdrawing the combustion gases independently of said heated hydrocarbon fluid.

13. In apparatus for the heat treatment of hydrocarbon fluids, a vertical chamber, a body of molten material in the lower portion thereof to constitute a reaction zone, a conduit exterior of said chamber and connected at one end to the reaction zone of said chamber and at the other end to the upper end of said chamber beyond said reaction zone, means directly connected to said conduit for introducing directly thereinto a fluid adapted to raise molten material from said reaction zone in said conduit by the gas lift effect produced thereby and thus deliver molten material into the upper portion of said chamber and establish a cyclic movement of molten material between said conduit and said chamber, means for introducing a hydrocarbon fluid for heat treatment into heat exchange relation with the body of molten material in said reaction zone, means for withdrawing the thus heated hydrocarbon fluid from said chamber and means for introducing hot gases into contact with the molten material during a portion of its cyclic movement outside of said reaction zone.

14. In apparatus for the heat treatment of hydrocarbon fluids, a vertical reaction chamber provided with partitioning means to separate said chamber into an upper section and a lower section, a body of molten material in the lower section to constitute a reaction zone, a restricted passageway formed in said partitioning means adapted to constitute means for the delivery of molten material from the upper section into the lower section of said chamber and formed to pro-

vide a seal preventing the passage of fluids from the lower section to the upper section, a conduit exterior of said chamber and connected at one end to the reaction zone in the lower section of said chamber and at the other end to the upper section of said chamber, means directly connected to said conduit for introducing directly thereinto a fluid adapted to raise molten material from the lower section of the reaction chamber in said conduit by the gas lift effect produced thereby and thus deliver molten material into the upper section of the chamber and establish a

cyclic movement of molten material between said conduit and said chamber, means for introducing a hydrocarbon fluid for heat treatment into heat exchange relation with the body of molten material in the reaction zone in the lower section of the chamber, means for withdrawing the thus heated hydrocarbon fluid from the lower section of the chamber, and means for introducing hot gases into contact with the molten material during a portion of its cyclic movement outside of the lower section of the reaction chamber.

ROBERT FREEBORN RUTHRUFF.