

Aug. 6, 1940.

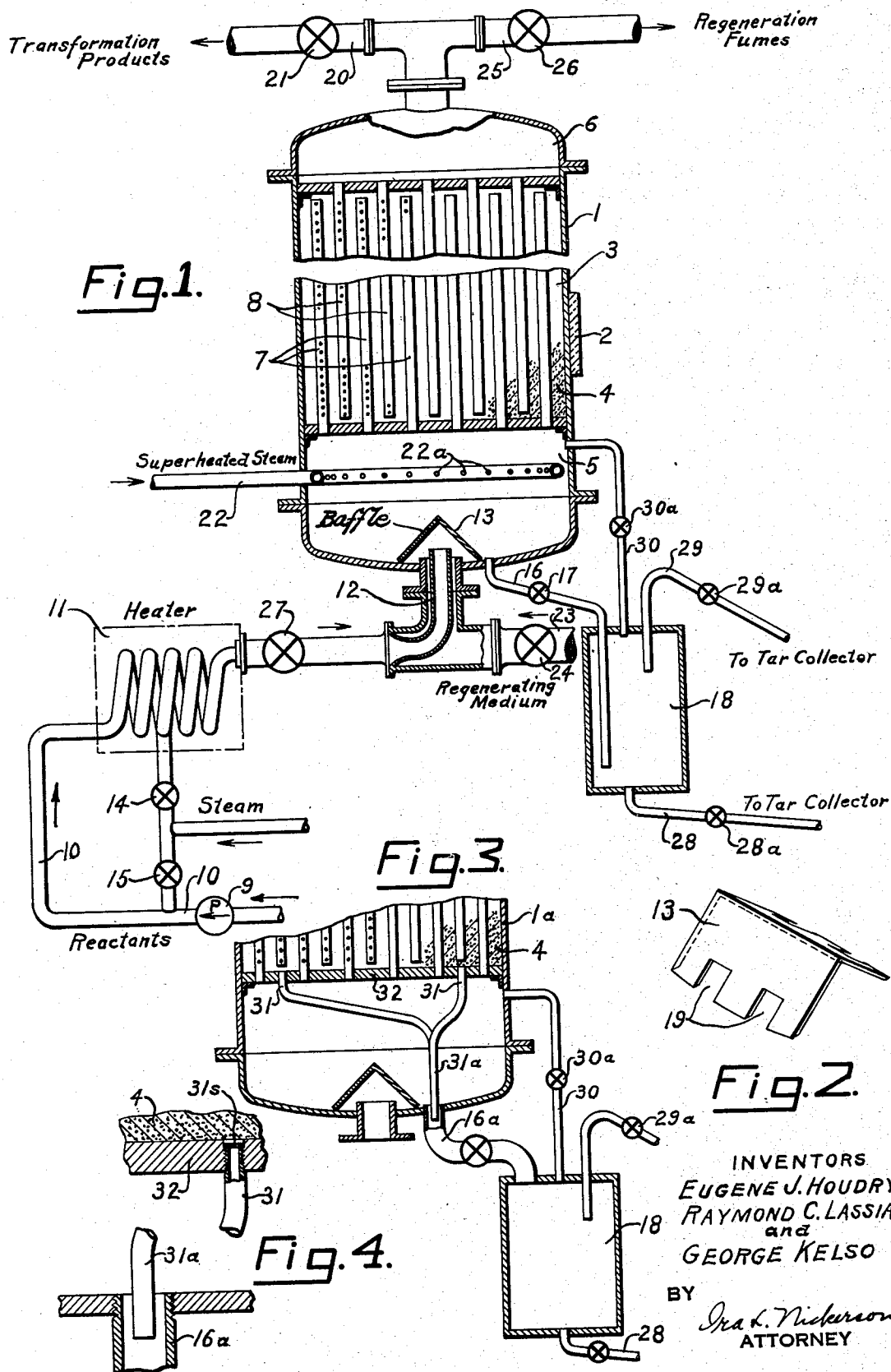
E. J. HOUDRY ET AL

2,209,973

PROCESS AND APPARATUS FOR TREATMENT OF FLUIDS

Filed Jan. 27, 1936

2 Sheets-Sheet 1



INVENTORS
EUGENE J. HOUDRY
RAYMOND C. LASSIAT
and
GEORGE KELSO

BY
Ira K. Nickerson
ATTORNEY

Aug. 6, 1940.

E. J. HOUDRY ET AL

2,209,973

PROCESS AND APPARATUS FOR TREATMENT OF FLUIDS

Filed Jan. 27, 1936

2 Sheets-Sheet 2

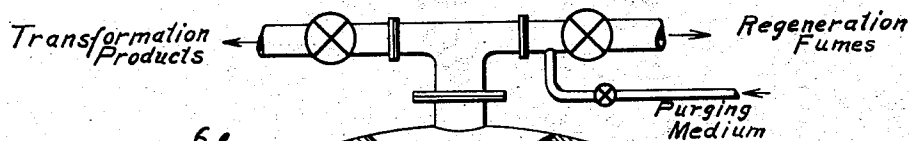


Fig. 5.

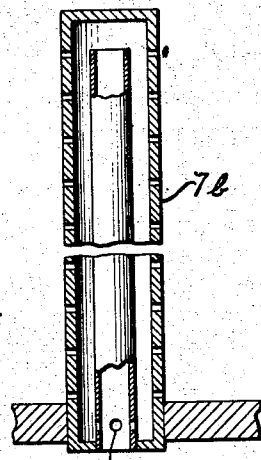
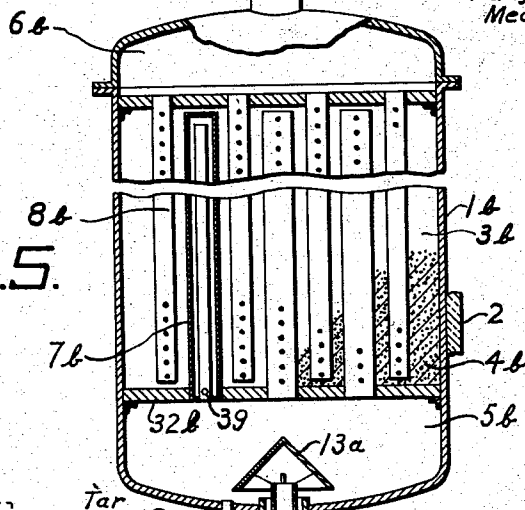


Fig. 6.

Fig. 8.

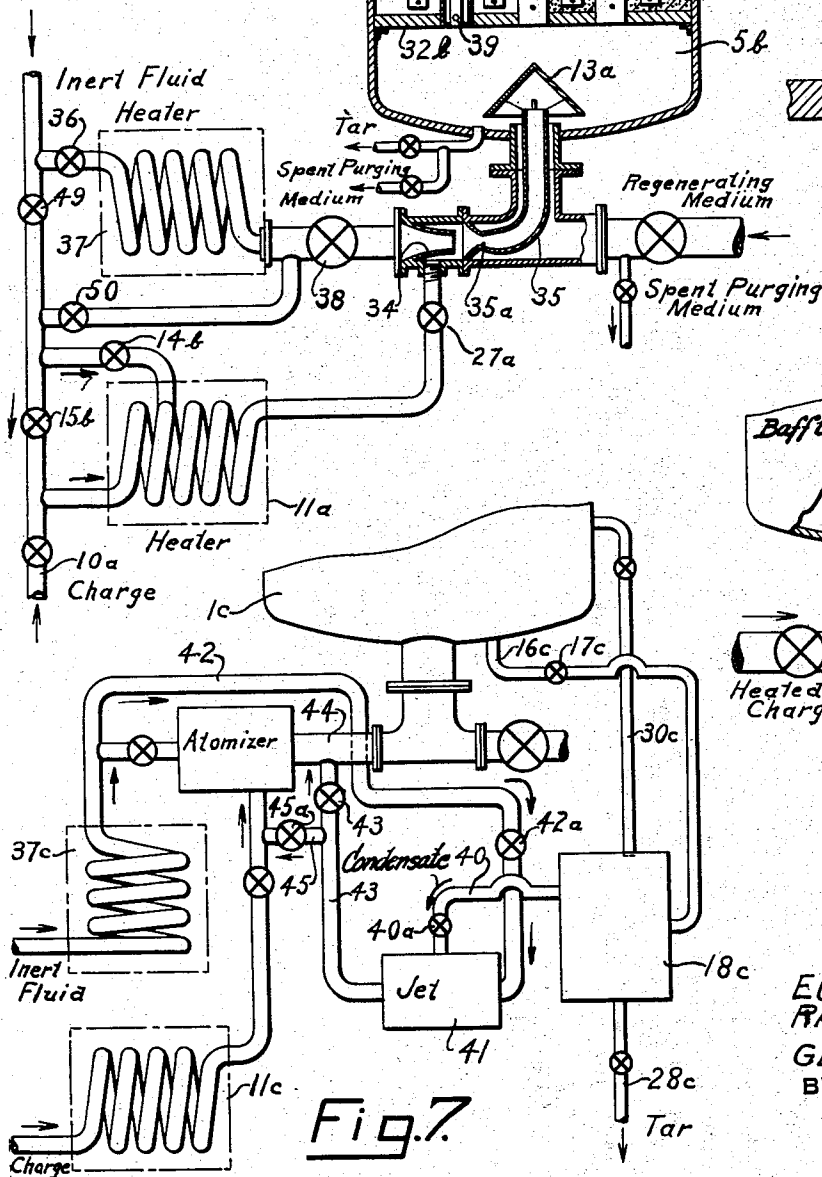
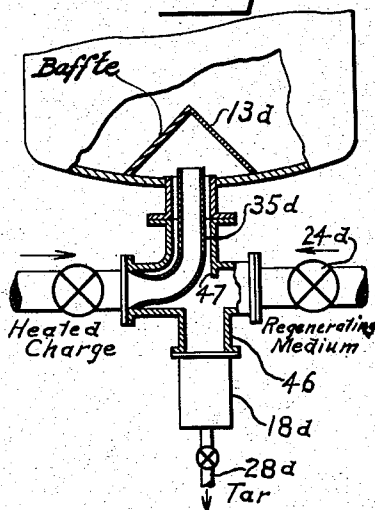


Fig. 7.

INVENTORS
EUGENE J. HOUDRY
RAYMOND C. LASSIAT
and
GEORGE KELSO
BY
Ira L. Nickerson
ATTORNEY

UNITED STATES PATENT OFFICE

2,209,973

PROCESS AND APPARATUS FOR TREATMENT OF FLUIDS

Eugene J. Houdry, Rosemont, Pa., Raymond C. Lassiat, Woodbury, N. J., and George Kelso, Chester, Pa., assignors to Houdry Process Corporation, Dover, Del., a corporation of Delaware

Application January 27, 1936, Serial No. 61,024

20 Claims. (Cl. 196—52)

The present invention relates to the art of treating or converting fluids, particularly where a contact mass or catalyst is employed, and has special application to the simplification and improvement of process as well as to providing a more advantageous and economical apparatus. The treatment of various fluids is contemplated, and especially composite fluids, such, for example, as hydrocarbons whether of coal, petroleum or other origin, natural or artificial. By way of illustration, the invention is particularly useful in the treatment of heavy hydrocarbons, such as tars and other distillation residues and gas oils, and particularly heavy or high-boiling gas oils, which are difficultly vaporizable and, when vaporized, may contain entrained therewith unvaporized material such as tars, asphalts or the like, in the form of finely divided liquid droplets or mist. However, the invention in its broader aspect contemplates the treatment or conversion of hydrocarbon fluids generally and various other fluids, especially those of a composite nature, whether of similar or higher or lower boiling points or ranges.

Heretofore various methods have been pursued in the handling and treatment of such heavy, high-boiling materials as the residua, etc., referred to above. One method has been to pass such material at suitable superatmospheric temperature, e. g. 750° to 975° F., through a vaporizing mass which often resulted in the making of a product which is desirable as a charging stock for a cracking operation for the production of gasoline. Among the vaporizing masses employed were contact materials which are porous and absorbent and which may be practically catalytically inert or may possess mild or very slight catalytic activity, including silicates of alumina or relatively inert clayey materials of the type and in the molded form disclosed in Patent No. 1,818,403 issued to Alfred Joseph on August 11, 1931. The charging material, such as high boiling hydrocarbon fluid, with or without a preliminary fractionation, has sometimes been subjected to thermal or catalytic treatment to produce gasoline. Another method has been to subject such heavy material to a mild thermal cracking operation and then subject the resultant product to a further thermal or catalytic conversion. Some such processes have met with more or less success, but, in many instances, large formations or deposits of carbonaceous material have commonly been encountered which tended to render inoperable the contact mass or plug up the equipment; also two or more major pieces

of equipment have been commonly required in such operations. We have found in our present invention that such materials can be handled favorably with a minimum amount of equipment and without causing large or excessive deposits of carbonaceous materials or other solids.

It is an object of this invention to provide a simple and improved process and apparatus for the treatment and conversion of fluids. Other objects and advantages of a more specific or different nature include: (1) the separation of heavy or entrained material from fluid charging stock in the same unit of apparatus which contains the treating or conversion zone, or stated differently, in a zone through which a regenerating medium will pass on its way to or from the treating or reaction zone; (2) the reduction of the magnitude of the pressure drop caused in the passage of fluid into and through the reaction chamber and/or the contact mass contained therein; (3) the maintenance of substantially uniform and predetermined temperatures throughout the depth or volume of the mass; (4) the convenient removal of condensate and/or unvaporized liquid from the reaction zone or chamber where treatment or conversion is conducted in the vapor phase; and (5) the efficient and convenient recovery of desirable lighter fluids from heavy fluids where heavy or entrained fluids are separated from the stream of charging stock preceding its entrance into the reaction zone. These and other objects and advantages will be further understood from the detailed discussion which follows.

An aspect of our invention involves introducing a partly vaporized heavy or composite fluid such as hydrocarbons, or a vaporized fluid having liquid entrained therein, into a reaction zone which may contain a contact mass or catalyst capable of effecting the desired treatment or transformation thereof into different or lower boiling materials. Immediately preceding the advent of such fluid into the reaction zone, it may be subjected to a step of deentrainment to remove liquid mist therefrom, for example, in a zone subjacent to the reaction zone. In certain cases, an inert fluid heated to a suitable temperature, e. g. superheated steam, may be introduced into the vapors after the deentraining step and before they enter the reaction zone. Liquid may be withdrawn from the subjacent zone or equivalent and also liquid condensate may be withdrawn continuously from the reaction zone, and both may be conducted to a common separator, receptacle or the like. These

operations are carried out in a manner so as not to upset or deleteriously affect temperature conditions within and throughout the bed of contact mass, as will appear from the description subsequently given.

To illustrate the invention, concrete embodiments thereof are shown in the accompanying drawings, in which:

Fig. 1 is an elevational view, partly in section, of a converter or casing having a reaction chamber, together with conduits, a heater or other auxiliary equipment;

Fig. 2 is an enlarged isometric or perspective view of an element shown inside of but adjacent the lower end of the converter shown in Fig. 1;

Fig. 3 is a sectional elevation of a modification of the converter or reaction apparatus shown in Fig. 1, with the top of the converter broken off and showing provision for removal of liquids which may accumulate, during operation, above the lower tube sheet of the converter;

Fig. 4 is a detail view of a portion of the lower part of the converter shown in Fig. 3;

Fig. 5 is a sectional elevation of a further modification of the converter or reaction apparatus shown in Fig. 1, differing from the apparatus shown in Figs. 1 and 3 in the auxiliary apparatus for injection and in the provision made for removal of liquids from the reaction chamber above the lower tube sheet of the converter, for example;

Fig. 6 is an enlarged detail view of one of the conduits which extend within the reaction chamber of the converter shown in Fig. 5;

Fig. 7 shows, in broken away elevation, a converter such as shown in Figs. 1, 3 or 5, with the auxiliary apparatus modified to provide for recovery of desired products which may separate out with liquids or tars which are drained from the bottom of the converter; and

Fig. 8 shows a further modification of apparatus for the removal of tar or liquid from the converter.

Referring more in detail to the drawings, in the several figures of which like reference characters denote similar parts, a heavy composite hydrocarbon material, particularly a heavy or high boiling oil such as heavy petroleum gas oil and/or bottoms, may be considered as being treated or converted to produce a substantial amount of light hydrocarbons in the gasoline boiling range, for the sake of a definite illustration. 1 is a converter surrounded by insulation 2, the converter providing a reaction chamber 3 containing a contact mass 4 and having end manifolding chambers 5 and 6, respectively. Perforated inlet conduits 7 and outlet conduits 8 extend within the reaction chamber 3 of the converter and provide for a uniform introduction and withdrawal of fluid which may be subjected to treatment by contact mass 4.

During the on-stream or reaction portion of a complete cycle of operation, the reactants, such as the heavy oil above mentioned, may be forced by pump 9 through conduit 10, heater 11 and elbow duct 12 into chamber 5 and against the baffle or roof-shaped member 13, which is located above and adjacent the bottom head of the converter. An inert gaseous medium such as steam may be introduced with the charge either through valve 14 or through valve 15, or both. Ordinarily, it would be preferred to introduce the steam into the charge through valve 14, unless some introduction of steam through valve 15 is necessary to prevent or minimize thermal crack-

ing in the coils of heater 11. Steam passed through valve 14 may advantageously be introduced into the coil of heater 11 at a point where the oil passing through such coil and the steam are at approximately similar temperatures.

The fluids in the stream directed against baffle 13 ordinarily are primarily in the vapor phase, but where a heavy or high-boiling material is being treated, usually there is present in the vapors an entrainment of mist or droplets of tarry materials. It is often better or even necessary to suffer some entrainment rather than to cause undesirable thermal cracking by going to higher temperatures in an endeavor to get substantially 100% vaporization. These droplets accumulate on the inner surfaces of the baffle 13, drain down to the bottom head of the case, and pass from the converter through line 16, controlled by valve 17, to the tar separator 18. The uncondensed vapors emerge from the baffle through its open ends and through side openings 19 therein and pass upwardly into perforated conduits 7, which may be plain pipes but which are usually of the double or nested variety having perforations or openings in the outer tube of each throughout its length. Vapors or fluids pass through and in contact with the mass or catalyst 4 and leave the reaction chamber through conduits 8, entering the same through the perforations distributed along the lengths thereof. From conduits 8 the fluid reaction products or transformation products enter manifold-chamber 6 and thence leave the converter by passing through duct 20, controlled by valve 21, to any preferred additional treating equipment or to storage, as desired.

To insure that the reactants are and remain in the desired state of vaporization or superheat while passing through the contact mass, superheated steam may be admitted into admixture with the vaporous reactants through conduit 22, being distributed from the conduit through suitable perforations or openings 22a within the manifold-chamber 5. The temperature of the superheated steam may, for example, be approximately that at which it is desired to feed the reactants to the reaction or treating chamber, or higher or lower.

After treatment of such a heavy material has proceeded for a period of time, the contact mass becomes poisoned or reduced in activity by coking, tarry or other contaminants or deposits and it becomes necessary to regenerate the mass in order to restore the efficiency of the apparatus for treatment or conversion of the charging stock. To accomplish this, the flow of reactants is stopped and steam or other inert gas passed through the equipment to remove combustible or explosive hydrocarbons and then the flow of steam may be cut off or decreased and a regenerating medium, such as air, or other oxygen-containing gas, including a mixture of air and flue gas, passed into the converter through conduit 23, controlled by valve 24. The products or fumes of regeneration may be withdrawn from the converter through duct 25, controlled by valve 26, and may be passed to any suitable heat exchangers, economizers, or other equipment, as desired. The path of flow of the regeneration medium through the reaction chamber of the converter may be the same as the path followed by reactants during an on-stream period. When regeneration is completed, as can be told from experience or can be observed from an analysis showing a falling off in the carbon dioxide con-

tent of the regeneration gases, for example, the introduction of regenerating medium is interrupted, the apparatus purged of regenerating medium by the use of steam or other inert medium, and then reactants are again passed into and through the converter to undergo transformation in the course of their passage. Instead of using an inert medium, purging may be effected by vacuum.

Of course, valve 21, and usually valve 27, is closed during regeneration; whereas valves 24 and 26 are closed during an on-stream or conversion step.

The tar separator 18 is provided with a lower withdrawal line 28 controlled by valve 28a, and an upper duct or withdrawal line 29, controlled by valve 29a. There is also a duct 30, controlled by valve 30a, providing means for fluid communication between the top of the tar separator and the manifolding chamber 5 of the converter. This duct 30 serves to equalize pressures between the manifolding chamber 5 and the tar separator 18 and may also serve to permit the return of light materials which have been removed from the converter along with the tar, for example, in a state of solution or occlusion therewith.

In Fig. 3 the converter 1a is very similar to converter 1 shown in Fig. 1. The tar separator is similar to that shown in Fig. 1, but a plurality of ducts 31, two only of which appear in the drawings, extend through the lower tube sheet 32 of the converter and serve to drain off condensate, tars, or other liquid which may drain to the bottom of the reaction chamber or accumulate on the upper surface of tube sheet 32. Ducts 31 drain into a common duct 31a which in turn drains into duct 16a, leading to the tar separator 18.

In the absence of ducts 31 or equivalent, small holes may be provided in the lower tube sheet or partition to permit tar or condensate to drain from the reaction chamber during an on-stream or purging operation and may serve to admit a restricted amount of air or other regeneration fluid during regeneration.

In Fig. 5, converter 1b is comparable to the converter shown in Fig. 1, but there are certain important differences, particularly in the auxiliary equipment. Provision is made for atomization of the charge to the converter. Apparatus to accomplish this comprises members 34 and 35, the former providing an orifice and the latter having a Venturi throat at point 35a. Reactants or charge are introduced through duct 10a, heater 11a and valve 27a against the outer circular periphery of member 34. Steam or other inert fluid for atomization may be passed through valve 36, heater 37, and valve 38 through the orifice of member 34, where it picks up the charge of heavy hydrocarbons and carries them through the Venturi throat at point 35a, thereby vaporizing and atomizing them. (In place of passing through the heater 37, the steam or equivalent or a part thereof may by-pass the heater by passing through valves 49 and 50.) The stream of hydrocarbons mixed with steam passes up through the elbow duct 35 and has heavy unvaporized, entrained materials or liquids removed therefrom by baffle 13a. Liquid-free vapors then pass from the manifolding zone 5b upwardly through the inner members of double or nested conduits 7b, from which fluid is distributed throughout the height and diameter of the mass by the perforations or openings in the outer conduits thereof. The reactants pass through and

in contact with the contact mass 4b and leave the reaction chamber through conduits 8b, entering the latter through the perforations or openings spaced from each other along the length of each. Reaction products pass to the manifolding chamber 6b and thence leave the converter through the passages shown, as previously described in connection with Fig. 1.

The inserts or inner conduits of the several nested conduits 7b are open at both ends and, in addition, have one or more holes or perforations 39 in their side walls at the lower end of each, adjacent tube sheet 32b. These holes or openings have two major advantages in the operation of the apparatus. They permit a portion of the charge to enter the near end of the annular spaces or passages between the inner and outer concentric members of conduit 7b, thereby to reduce the resistance or pressure drop which the reactants encounter when sent entirely to the far end of the unit with the necessity of reverse movement before distribution into reaction chamber 3b. The size of the opening or openings 39 may be made so that 10 to 75% of the regenerating medium or reactants which enter the annular passage of each conduit will enter it through the opening or openings 39. In addition, these openings serve to permit tars or condensate to drain from the contact mass or reaction chamber of the converter, and, in this aspect, to some extent take the place of members 31 and 31a, shown in Fig. 3.

During purging as well as during the on-stream reaction period (especially during the purging which follows the on-stream period and precedes regeneration), it is important to have suitable provision for the drainage of tar or condensate from the contact mass or reaction chamber, such as the openings or perforations 39 in the inner members of nested conduits 7b, ducts 31 which are described in connection with Fig. 3, small openings in the lower tube sheet, or equivalent. Otherwise, during purging, heavy material or liquids may collect in the bottom of the reaction chamber of the converter and would tend to plug up or coke up the lower part of the reaction chamber.

Valves 14b and 15b may be controlled to admit steam or equivalent fluid to the stream of hydrocarbon charge at the point or points desired, for the reasons described in connection with Fig. 1. The feed lines and heating system of Fig. 5 may be employed in various other ways from those discussed. For example, steam may be passed successively through valves 36, 50 and 14b before introduction with the charge, when it is desired to employ heater 37 to boost further the temperature of the steam or the like.

In the apparatus shown in Fig. 7, a separation or fractionation of the tar or condensate which is withdrawn from the converter through duct 16c, controlled by valve 17c, is made in separator 18c. The heaviest material is withdrawn from the separator 18c through the valved duct 28c leading from the bottom thereof, while a somewhat lighter fraction of condensate is withdrawn from the separator through duct 40 and valve 40a and passed to the vaporizing chamber 41. Steam or other inert vaporizing fluid may be passed from heater 37c through duct 42, controlled by valve 42a, and thence passed from a jet (not shown) into the vaporizing chamber 41. The liquid material is substantially vaporized or atomized due to the partial pressure supplied by the steam and the mechanical vaporizing

action thereof before the mixture of steam and hydrocarbons passes from the vaporizing chamber through duct 43, controlled by valve 43a into the duct 44 through which charge is being fed to the converter 1c from the atomizer shown; or, where desired, the mixture may be passed, in whole or in part, through branched duct 45, controlled by valve 45a, thereby entering the atomizer together with the charge, which is being fed thereto from heater 11c. Duct 30c serves the same function in this apparatus as duct 30 shown in Fig. 1.

It will be seen that the apparatus just described provides means for carrying out an efficient method of recovering desirable dissolved or occluded components from the separated condensate and does this by making use of some of the steam or other inert fluid which, in addition to this use, provides other valuable functions by being present in the reactants while they are undergoing treatment or conversion.

In the modification of the converter shown in Fig. 8, the tar or condensate, which is separated out by the baffle member 13d or otherwise accumulates in the bottom of the converter, passes from the latter through the annular passage surrounding elbow duct 35d. To obviate the disadvantages caused by tars or heavy condensate getting into the valve 24d and hardening or coking therein, the lower branch 46 of the fitting shown is set off center to the right, and lip 47 projects below the adjacent horizontal wall of the fitting to cause all of the condensate or tar to pass into branch 46 and to be kept out of valve 24d and the horizontal line leading thereto. A tar pot 18d is joined to the bottom of the branch 46 and tar or condensate is drained therefrom, continuously or intermittently by the valved duct 28d.

The fitting, as illustrated in Figs. 1, 5 and 8, through which reactants and regeneration fluid may be introduced into the converter, is of construction which requires special description. The fitting shown in Fig. 1 is T-shaped, and has elbow duct 12 therewithin; whereas, in Figs. 5 and 8, a similar fitting is shown having elbow ducts 35 and 35d, respectively, the former of the two having a Venturi throat in it. The upright portion of each of the elbow ducts shown is spaced from the walls of the upright portion of the T-shaped fitting to provide a passage upwardly through which regenerative fluid may pass or downwardly through which (as in Fig. 8) tar or condensate may drain. However, in Figs. 1 and 5, the fitting extends above the bottom of the manifolding chamber and separate drains are provided for the tar or other condensate.

While in the figures of the drawings a single baffle member is shown in each case for separating entrained liquids from vapors, it will be understood that such showing is illustrative only and any number or types of baffle member may be used in lieu of those shown.

The temperatures which are employed in our treating or converting operation will depend upon the particular liquid being treated and the products desired. The same conditions will, in a measure be determinative of the contact mass or catalyst which may be chosen for the reaction chamber. However, where our invention is applied to the treatment or conversion of hydrocarbons, temperatures of the order of 750° to 950° F. will usually be employed. The temperature of the charge entering the converter, through

the manifolding zone which contains the baffle, will ordinarily be slightly higher, for example, 25 to 50° F. higher than the temperatures desired in the reaction zone. Where heavy materials such as heavy gas oil or residua are being charged to the converter, a temperature of the order of 810 to 950° F. will often be suitable, as, for example, a temperature of about 840 or 850° F. Any contact mass capable of effecting or promoting the desired reaction may be utilized, preferably in the form of fragmentary or molded pieces to facilitate regeneration in place. A suitable catalyst for these hydrocarbon treatments and conversions is one such as described in Patent No. 1,837,971 issued to Alfred Joseph on December 22, 1931, or in the copending applications of Eugene J. Houdry, Serial No. 600,581, filed March 23, 1932 (Patent No. 2,078,945, issued May 4, 1937), and Serial No. 35,101 filed August 7, 1935 (Patent No. 2,078,951, issued May 4, 1937), consisting of molded particles comprising, for example, blends of silica and alumina of natural or artificial origin including activated hydrosilicate of alumina with or without admixture or other catalytically active materials including metals and metallic compounds. Contemplated contact masses include materials which are substantially inert or have any desired restricted degree of activity.

Where a heavy gas oil or similar heavy or residual material is being charged to the converter, a quantity of steam of the order of 5 to 20% by weight of the charge may be introduced therewith as and/or before it goes through the heater, such as heater 11 or 11a and 5 to 20% of additional steam may be added at the atomizer, in an embodiment where the atomizer is employed. In the case where superheated steam is introduced with the charge in the inlet manifolding zone, the amounts of steam introduced at the heater or atomizer may be somewhat reduced. The use of superheated steam as just described, is advantageous in the case of heavy charging materials in that it keeps the reactants in a good state of vaporization during their passage through and in contact with the catalyst or contact mass within the reaction chamber.

While not definitely shown in all the figures of the drawings, it is to be understood that an atomizer or any equivalent equipment may be used with any of the modifications illustrated, especially where the apparatus is to be used to treat or convert a high-boiling material such as heavy bottoms from a distillation of hydrocarbons, or the like. When an atomizer is employed, the inert fluid such as steam, or at least part of it, is preferably used to assist in the atomization but, even in this case, it is often desirable to introduce further steam, in superheated state, in the manifolding zone. Practically always, it is preferred to have the atomizer positioned as close as possible to the inlet to the converter.

The preferred direction and circuit of the purging medium through the converter is obvious from the drawings, especially Fig. 5 thereof. No provision is shown for purging the apparatus of Fig. 1 but it is intended that it be effected in a similar manner. The openings 39 in the inserts or other conduits of double or nested members 7b, as shown in Fig. 5 or in duct 31, shown in Fig. 3, function as well to drain condensate, tars or liquids from the reaction chamber during the intervening purging operations as to drain condensate therefrom during the reaction or on-stream period. In addition to introducing purging me-

dium from the top of the converter, as shown in Fig. 5, steam or other inert medium may be passed into the converter from the bottom through heater 37 and valve 38, thereby to purge out the bottom connections; or all of the purging medium may be supplied from the bottom connections, if desired. It is also contemplated to employ vacuum purging.

It is to be observed that by effecting separation of condensate or tar in a manifolding chamber of the converter, the advantages received by the conversion or reaction zone during regeneration are also available to the tar separation zone in the manifolding chamber.

While our invention is especially applicable to the treatment of heavy or high boiling composite fluids, such as composite hydrocarbon fluids, it will be apparent that it has application in the treatment or conversion of fluids broadly, particularly where a contact mass or catalyst is to be employed.

Where herein or in the appended claims the term "composite fluid or composite hydrocarbon fluid" or the like is employed it will be understood that a fluid having a boiling range, i. e. made up of a number of materials each having at least a slightly different boiling point than the other, is contemplated. Fluids such as petroleum or fractions thereof, coal tar or fractions thereof, fusel oil or other mixtures of alcohols, etc. are commonly spoken of among engineers, as composite fluids.

What we claim is:

1. In the chemical conversion of a composite liquid having a substantial boiling range into a vaporous product comprising lower boiling components in the presence of a catalytic mass, the steps of process which comprise heating and substantially vaporizing said liquid except for a portion of said liquid which comprises the highest boiling components thereof which remain liquid and are carried with the vapors as finely divided entrained particles, continuously passing a stream of the heated and substantially vaporized fluid into a manifolding zone, situate adjacent to and having direct fluid communication with a reaction zone through a plurality of passages, the latter containing a bed of solid adsorptive catalyst, separating unvaporized entrained liquid from the vapors of said stream of fluid within said manifolding zone, withdrawing the separated liquid from said manifolding zone, passing the substantially liquid-free vapors, without substantial loss of heat, directly from said manifolding zone in a multiplicity of streams into said adjacent reaction zone, wherein the desired treatment takes place, and continuously withdrawing reaction products from said reaction zone.

2. In the conversion or cracking of a heavy, high-boiling, normally liquid hydrocarbon fluid to produce lower boiling hydrocarbons therefrom in which vaporized fluid is passed into contact with a catalytic mass, the steps of process which comprise heating and substantially vaporizing said fluid, continuously treating a stream of said fluid so as to atomize liquid contained therein, continuously passing a stream of the resultant vapors and atomized liquid into a manifolding zone, situate adjacent to and having fluid communication with a reaction zone through a multiplicity of openings, said reaction zone containing a mass of solid adsorptive cracking catalyst, separating unvaporized entrained liquid from the vapors of said stream of fluid within said manifolding zone, withdrawing the separated

liquid from said manifolding zone, passing the substantially liquid-free hydrocarbon reactant vapors, without substantial loss of heat, directly from said manifolding zone into said adjacent reaction zone through the aforesaid multiplicity of openings and introducing them directly into said reaction zone in contact with said catalyst at a multiplicity of spaced points, and withdrawing reaction products from said reaction zone.

3. In the conversion or cracking of a composite hydrocarbon fluid having a substantial boiling range to produce a hydrocarbon product of different boiling range comprising lower boiling hydrocarbons, the steps of process which comprise heating and substantially vaporizing the liquid except for a portion of said liquid which comprises the highest boiling components thereof which remain liquid and are carried with the vapors as finely divided entrained particles, continuously passing a stream of the resulting heated fluid into a manifolding zone, situate adjacent to and having fluid communication with a reaction zone through a plurality of passages, said reaction zone containing a bed of adsorptive silicious cracking catalyst, separating unvaporized entrained liquid from the vapors of said stream of fluid within said manifolding zone, withdrawing the separated liquid from said manifolding zone, passing the substantially liquid-free vapors, without substantial loss of heat, directly from said manifolding zone into said adjacent reaction zone in a plurality of streams and distributing them directly into said reaction zone at a multiplicity of points within and throughout the volume thereof and passing them through and in contact with the aforesaid catalyst located within said reaction zone, the desired reaction taking place within said reaction zone, introducing superheated steam into said liquid-free vapors preceding their entry into said reaction zone, withdrawing reaction products from said reaction zone at a plurality of points distributed throughout its volume, and withdrawing condensate from said reaction zone.

4. In the transformation or cracking of a heavy, high boiling composite hydrocarbon liquid above the gasoline boiling range and substantially in the boiling range of heavy gas oils and residua to produce therefrom lower boiling hydrocarbons, in which vaporized fluid is passed into contact with a catalytic material, the steps of the process which comprise heating and substantially vaporizing said fluid without any substantial pyrolytic cracking thereof, a small portion of said fluid which comprises highest boiling components thereof remaining liquid and being carried in the vapors as entrained particles, said vapors being raised to a temperature at which the desired catalytic cracking will take place, continuously passing a stream of the heated and substantially vaporized reactant hydrocarbon fluid into a manifolding zone, situate adjacent to and having fluid communication with a reaction zone, said reaction zone containing a mass of solid, adsorptive cracking catalyst, separating unvaporized entrained liquid from the vapors of said stream of fluid within said manifolding zone, withdrawing the separated liquid from said manifolding zone, passing the substantially liquid-free vapors, without substantial loss of heat, directly from said manifolding zone in a plurality of streams into said adjacent reaction zone and through and in contact with the aforesaid catalyst located therein, introducing superheated steam into said liquid-free vapors preceding their entry into the

said reaction zone, and continuously withdrawing reaction products from said reaction zone.

5. In the conversion or cracking of a heavy, high boiling composite hydrocarbon liquid, having a boiling range substantially above that of gasoline to produce therefrom a substantial proportion of components within the gasoline boiling range, the steps of process which comprise passing a confined stream of said hydrocarbon fluid through a heating zone to vaporize and raise the temperature of said fluid to the range in which catalytic conversion or cracking will occur, a small portion of said fluid which comprises highest boiling components thereof remaining liquid and being carried in the vapors as entrained particles, introducing steam into said stream of hydrocarbon fluid during its passage through said zone at the point at which said fluid is approximately the temperature of said steam, introducing a smaller amount of steam into said confined stream prior to the entry of said stream of hydrocarbons into said heating zone to prevent substantially any pyrolytic cracking of said hydrocarbons, continuously passing a stream of the heated fluid with admixed steam to a manifolding zone, adjacent to and having fluid communication with a reaction zone through a multiplicity of passages, said reaction zone containing an adsorptive cracking catalyst, substantially completely separating unvaporized entrained liquid from the vapors of said stream of fluid within said manifolding zone, withdrawing the separated liquid from said manifolding zone, returning lower-boiling components, which are withdrawn with said separated liquid, back to said manifolding zone, passing the substantially liquid-free vapors, without substantial loss of heat, directly from said manifolding zone to said adjacent reaction zone and through and in contact with the aforesaid catalyst located therein, introducing superheated steam into said substantially liquid-free vapors preceding their entry into the said reaction zone, and continuously withdrawing reaction products from said reaction zone.

6. In the conversion or cracking of a high boiling composite hydrocarbon liquid, having a substantial boiling range and composed predominantly of components higher boiling than gasoline, into a lower boiling hydrocarbon product composed to substantial extent of components within the gasoline boiling range, the steps of process which comprise heating and substantially vaporizing the liquid except for a portion of said liquid, which comprises the highest boiling components thereof, which remains liquid and is carried with the vapors as finely divided entrained particles, continuously passing a stream of the resulting heated fluid into a manifolding zone, situate adjacent to and having fluid communication with a reaction zone containing an adsorptive regenerative cracking catalyst, adapted to be employed alternately on-stream to effect the desired conversion of hydrocarbons and in regeneration to restore said catalyst to active, adsorptive condition, separating unvaporized entrained liquid from the vapors of said stream of fluid within said manifolding zone, withdrawing the separated liquid from said manifolding zone, continuously passing the substantially liquid-free reactant hydrocarbon vapors, without substantial loss of heat, directly from said manifolding zone into said adjacent reaction zone in a multiplicity of streams and through and in contact with the aforesaid catalyst located therein, and withdrawing fluid products of reaction therefrom;

after a period of time on-stream stopping the introduction of said hydrocarbon vapors into said reaction zone and purging said reaction zone preliminary to the introduction into said catalyst of an oxygen-containing regenerating medium, said purging being effected in the reverse direction to the feeding of hydrocarbons so that purged material including hydrocarbon vapors leave said reaction zone through the aforesaid manifolding zone.

7. In the conversion or cracking of a composite hydrocarbon liquid composed predominantly of components above the gasoline boiling range to produce a hydrocarbon product comprising lower boiling hydrocarbons in which vaporized fluid is passed into contact with an active catalytic material, the steps of process which comprise passing a confined stream of said hydrocarbon liquid through a heating zone substantially to vaporize said liquid and to raise the temperature thereof substantially to the range desired for catalytic cracking, a small proportion of said fluid which comprises the highest boiling components thereof remaining liquid and being carried in the vapors as entrained particles, introducing steam into said stream of resulting heated and substantially vaporized hydrocarbons and continuously passing a stream of the resulting heated hydrocarbons and steam into a manifolding zone, located adjacent to and having direct fluid communication through a multiplicity of passages with a reaction zone containing a body of adsorptive, regenerative cracking catalyst, separating unvaporized entrained liquid from the vapors of said stream of fluid within said manifolding zone, withdrawing the separated liquid from said manifolding zone, passing the substantially liquid-free reactant vapors, without substantial loss of heat, directly from said manifolding zone through the aforesaid passages into said adjacent reaction zone and introducing said vapors directly into said body of catalyst at a multiplicity of points distributed throughout the same, and continuously withdrawing cracked fluid hydrocarbon products from said reaction zone, whereupon a deposit of combustible contaminants accumulate upon said catalyst and reduces the activity of the latter; after a period of time, stopping the flow of said hydrocarbons to effect a step of regeneration of said cracking catalyst to remove combustible deposits therefrom, and, intermediate the on-stream step for the cracking of hydrocarbons and the subsequent step for the regeneration of said catalyst, purging said reaction zone, said purging being effected so that purged fluids leave said reaction zone through the aforesaid manifolding zone.

8. In the transformation or cracking of a composite hydrocarbon liquid composed predominantly of components boiling above the gasoline boiling range to produce therefrom hydrocarbons of lower boiling points in which vaporized fluid is passed into contact with a catalytic mass, the steps of process which comprise passing a confined stream of said hydrocarbon fluid through a heating zone to vaporize substantially all of said fluid, except for a small amount thereof which remains as entrained liquid particles in the vapors, and to raise the temperature thereof substantially to the range in which the desired catalytic transformation will occur, introducing steam into said stream of hydrocarbon fluid, a portion prior to and another portion during its passage through said heating zone, continuously passing a stream of the heated, substantially vaporized fluid from said heating zone into a manifolding

zone, situate beneath and contiguous to and having fluid communication with a reaction zone containing a deep bed of adsorptive, regenerative cracking catalyst, the latter being adapted periodically to be regenerated in situ to remove combustible contaminants therefrom, separating unvaporized entrained liquid from the vapors of said stream of fluid within said manifolding zone, withdrawing the separated liquid from said manifolding zone, passing the substantially liquid-free vapors, without substantial loss of heat, in a multiplicity of confined streams directly from said manifolding zone upwardly into said reaction zone and distributing such vapors from said confined streams into contact with the aforesaid cracking catalyst at a multiplicity of points spaced throughout the depth and cross-section of said bed thereof, continuously withdrawing fluid products of reaction from said reaction zone, periodically stopping the flow of said hydrocarbons to affect a regeneration of said catalyst, and intermediate the steps of conversion of hydrocarbons and regeneration purging said reaction zone, said purging being effected so that purged fluids leave said reaction zone through the aforesaid manifolding zone located therebeneath.

9. In the conversion or cracking of a composite, higher boiling hydrocarbon liquid with a contact mass to produce a more volatile fluid product therefrom, in which the contact mass gradually becomes contaminated and is consequently alternately on stream and in regeneration, the steps of process which comprise heating and substantially vaporizing said liquid except for a small proportion thereof, comprising the highest boiling components thereof, which is carried with the vapors as finely divided entrained particles, continuously passing a stream of the heated, substantially vaporized fluid into a manifolding zone, situate adjacent to a reaction zone and having fluid communication with the latter through a plurality of passages, said reaction zone containing a bed of adsorptive cracking catalyst, separating unvaporized entrained liquid from the vapors of said stream of fluid within said manifolding zone, passing the substantially liquid-free vapors, without substantial loss of heat, directly from said manifolding zone into said adjacent reaction zone through the aforesaid plurality of passages and through and in contact with the aforesaid catalyst located therein, withdrawing fluid products of reaction from said reaction zone, periodically interrupting the passage of the aforesaid hydrocarbon fluid, subsequently in an alternate regenerative step passing a regenerating fluid through both said manifolding zone and said reaction zone, thereby to free said manifolding zone of deposits simultaneously with the regeneration of said contact mass; and, intermediate the steps of cracking hydrocarbons in the aforesaid reaction zone and regeneration of said contact mass, purging said reaction zone and bed of catalyst in a manner so that purged vapors leave said reaction zone through the aforesaid manifolding zone.

10. Apparatus for the treatment or conversion of fluids which comprises a converter having a reaction chamber and a manifolding chamber, an adsorptive contact material within said reaction chamber, a partition between said manifolding chamber and said reaction chamber, said partition having passages to permit flow of fluid to be treated from the former to the latter, means for conducting condensate out of said reaction chamber from the lower part thereof, means for in-

troducing a vaporized fluid to be treated into said manifolding chamber including a conduit opening thereinto, means located within said manifolding chamber for separating entrained liquid from the entering vapors, means for passing separated entrained liquid or condensate from said manifolding chamber, and means providing passages within said contact material through which treated fluid may be withdrawn from said reaction chamber.

11. Apparatus for the treatment or conversion of fluids which comprises a converter having a reaction chamber, a partition within said converter separating a manifolding chamber from said reaction chamber but having openings permitting communication between said chambers, means for introducing a vaporized fluid to be treated into the manifolding chamber of said converter including a conduit opening into said manifolding chamber, means located within said manifolding chamber for separating entrained liquid from the entering vapors, a plurality of ducts communicating with said reaction chamber through the bottom thereof and being adapted to drain condensate or tar therefrom, means for withdrawing separated entrained liquid from said manifolding chamber, a receptacle for said separated entrained liquid having a vent line to said manifolding chamber to equalize pressure, and passages communicating with said reaction zone through which treated fluid may be withdrawn therefrom.

12. Apparatus for the treatment or conversion of heavy composite fluids which comprises a converter having a reaction chamber with an outlet connection therefrom, a partition within said converter separating a manifolding chamber from said reaction chamber, means providing fluid communication between said chambers, means for introducing a vaporized fluid to be treated into the manifolding chamber of said converter including a conduit opening into said manifolding chamber, means located within said manifolding chamber for separating entrained liquid from the entering vapors, a tar separator exterior to said manifolding chamber and converter, a duct for passing the separated entrained liquid from said manifolding chamber to said tar separator, a duct connected to said tar separator for withdrawing a heavy, high-boiling tarry fraction of liquid therefrom, a vaporizing means, a second duct leading from said tar separator to said vaporizing means, and means including a pipe leading from said vaporizing means to conduct fluid to the aforesaid manifolding chamber.

13. Apparatus for the treatment or conversion of a heavy composite fluid which comprises a converter providing a reaction chamber and a manifolding chamber, a partition separating said reaction chamber from said manifolding chamber, a plurality of passages through said partition to permit fluids to be treated to enter said reaction chamber, a heater, a duct for supplying fluid to said heater, an atomizer, a connection leading from said heater to said atomizer, baffle means within said manifolding chamber, a connection from said atomizer to said manifolding chamber of said converter, said connection being positioned to direct entering vapors against said baffle means thereby to separate out entrained liquid and to prevent it from entering said reaction chamber, means for withdrawing separated entrained liquid from said manifolding chamber, and passages communicating with said reaction chamber

through which treated fluid may be withdrawn therefrom.

1. Apparatus for the treatment or conversion of a heavy composite fluid which comprises a converter providing a reaction chamber and a manifolding chamber, a partition separating said reaction chamber from said manifolding chamber, a plurality of passages through said partition to permit fluids to be treated to enter said reaction chamber, baffle means within said manifolding chamber, means for introducing a vaporized fluid into said manifolding chamber of said converter including a conduit opening into said manifolding chamber and positioned to direct entering vapors against said baffle means, a fluid carrying element extending into said manifolding chamber and positioned in circuit between said baffle means and said partition and being adapted to introduce superheated steam thereinto, and passages communicating with said reaction chamber through which treated fluid may be withdrawn therefrom.
15. Apparatus for the treatment or conversion of a heavy composite fluid which comprises a converter providing a reaction chamber and a manifolding chamber, a partition separating said reaction chamber from said manifolding chamber and providing one wall of said manifolding chamber, the head of said converter forming the other walls of said manifolding chamber, a plurality of passages through said partition to permit fluids to be treated to enter said reaction chamber, baffle means within said manifolding chamber, means for introducing a vaporized fluid into said manifolding chamber of said converter including a conduit opening into said manifolding chamber and positioned to direct entering vapors against said baffle means, a larger duct surrounding the last-mentioned conduit and spaced therefrom to provide a passage for separated tar or condensate to drain from said manifolding chamber, an end of said larger duct being approximately flush with the inner surface of the aforesaid head of the converter, a valved branch through which regeneration fluid is adapted to be introduced into the converter extending from said larger duct, a duct forming a continuation of said larger duct but positioned with its axis shifted away from that of said larger duct in the direction of said lateral valved branch, and passages communicating with said reaction zone through which treated fluid may be withdrawn therefrom.
16. Apparatus for the treatment or conversion of fluid which comprises a converter providing a reaction chamber, a contact mass within said chamber, said mass being adapted to be periodically regenerated in situ by passing a regenerating medium therethrough, said converter accordingly being adapted to be alternately on-stream and in regeneration, a fitting through which reactants and regenerating medium may be introduced to the converter having at least three branches, one of which is connected to said converter at a point where it is desired to introduce fluids thereinto, a second branch thereof being connected to a pipe, having a valve therein, through which regenerating medium may be passed to the converter, and a third branch thereof being joined to a conduit connected to a source of reactants, an elbow duct extending through the first-mentioned branch and said third branch and being joined to the latter adjacent its extremity so that reactants must pass through said elbow duct and not therearound, the exterior

dimensions of said elbow duct being less than the internal dimensions of said first-mentioned branch throughout the respective section of length of the duct which passes therethrough, so as to have a passage for regeneration fluids or other fluids therearound, said elbow duct preventing reactant fluids from lodging around the valve in the said pipe for introducing regeneration fluid.

17. Apparatus for the treatment or conversion of fluids which comprises a converter having a reaction chamber, a partition within said converter separating a manifolding chamber from said reaction chamber, means for introducing a vaporized fluid to be treated into the manifolding chamber of said converter including a conduit opening into said manifolding chamber, ports or openings through the aforesaid partition, a unit comprising inner and outer nested conduits joined to said partition adjacent one of said ports and in registering relation therewith and extending within said reaction chamber, said unit having openings in the outer conduit thereof along its length and having a perforation or opening in the inner conduit adjacent the end thereof adjacent said partition, and passages communicating with said reaction zone through which treated fluid may be withdrawn therefrom.

18. Apparatus for the treatment or conversion of fluid which comprises a converter providing a reaction chamber and a subjacent chamber, a partition separating said reaction chamber from said subjacent chamber, and having an opening therein, and a member for distributing or collecting fluid adapted to extend within said reaction chamber with one end thereof joined to said partition to register with said opening therein, said member comprising inner and outer nested conduits having the inner conduit spaced from the outer one and open at both ends, said outer conduit having perforations or openings through its wall along its length and said inner conduit having at least one opening through its wall adjacent the end of the member which is adapted to be joined to said partition, and means for conducting fluid to be treated to one of said chambers and for withdrawing treated products from the other of said chambers.

19. Apparatus for the treatment or conversion of fluids which comprises a converter having a reaction chamber and a manifolding chamber therebelow, a partition having perforations or openings therein separating said manifolding chamber from said reaction chamber, distributing members, each having inner and outer nested or telescoped conduits spaced from each other to provide a passage therebetween, fitted into said openings in said partition and extending upwardly into said reaction chamber, the said exterior conduits having perforations or openings along their lengths and said interior conduits being open at both ends of each and having at least one perforation or opening adjacent the lower end of each adjacent the aforesaid partition, said last-mentioned opening or openings permitting condensate or tars to drain from said reaction chamber and being of such size as to permit a part only of the fluid being introduced into the said reaction chamber from said manifolding chamber to pass therethrough, means for introducing a vaporized fluid to be treated into said manifolding chamber including a conduit opening into said manifolding chamber, means located within said manifolding chamber for separating entrained liquid from the entering vapors, a receptacle for condensate or tar exterior to said manifolding

chamber and converter, and means for passing separated entrained liquid from said manifolding chamber to said receptacle.

5 20. A distributing unit for fluids which is adapted to be embedded in a contact mass which comprises a unit having inner and outer nested conduits spaced from each other, to provide a passage therebetween as well as within the inner conduit, said outer conduit having perforations
10 or openings spaced from each other along its length and said inner conduit being open at both ends, one open end thereof being the inlet open-

ing for the introduction of fluids and the other open end thereof facing a closed end of the said outer conduit to effect reversal of fluid flow, the said inner conduit having at least one opening or perforation adjacent its said inlet opening which
5 provides direct communication between the said inner conduit and the said passage between the said outer and inner conduits.

EUGENE J. HOUDRY.
RAYMOND C. LASSIAT.
GEORGE KELSO.

10