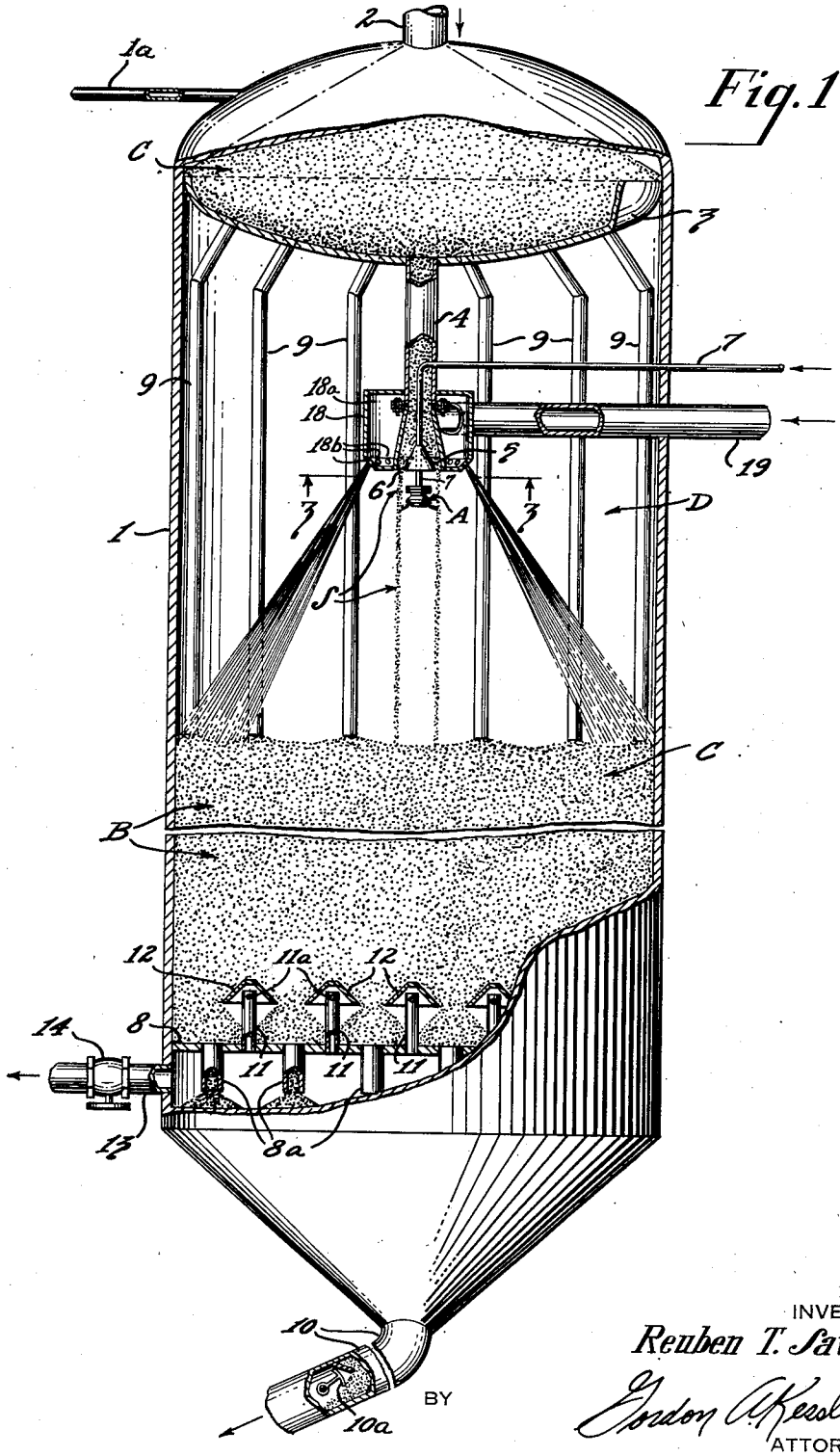
Jan. 3, 1950 R. T. SAVAGE 2,493,035

METHOD OF AND APPARATUS FOR MINIMIZING DEPOSITION OF CARBONACEOUS MATERIAL

Filed Dec. 19, 1947 2 Sheets-Sheet 1

Fig. 1



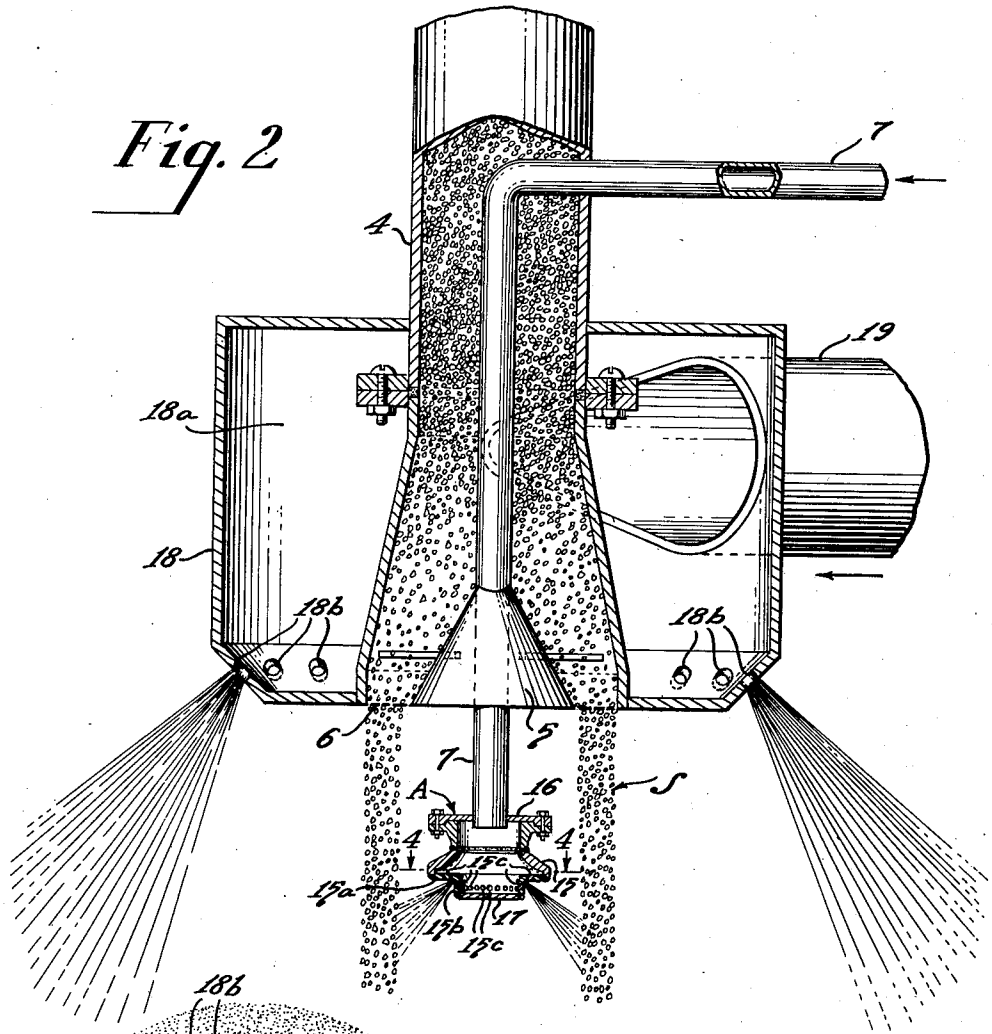

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METHOD OF AND APPARATUS FOR MINIMIZING DEPOSITION OF CARBONACEOUS MATERIAL

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Fig. 2



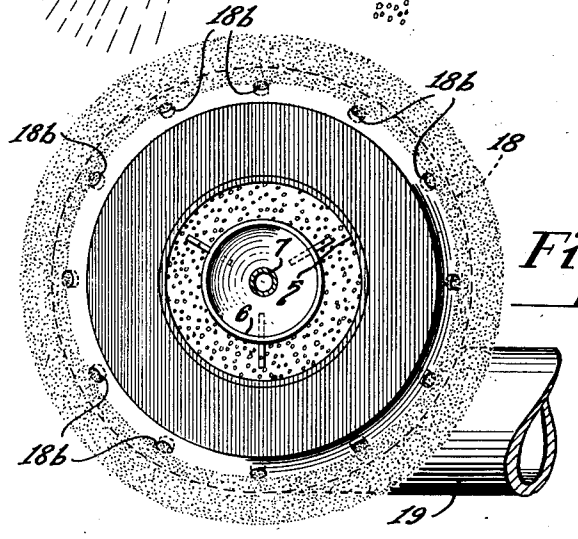




Fig. 3

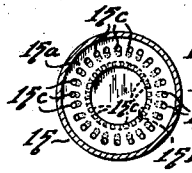



Fig. 4

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Patented Jan. 3, 1950 2,493,035

# UNITED STATES PATENT OFFICE

2,493,035

## METHOD OF AND APPARATUS FOR MINIMIZING DEPOSITION OF CARBONACEOUS MATERIAL

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Application December 19, 1947, Serial No. 792,809

9 Claims. (Cl. 196—52)

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My invention relates to a hydrocarbon conversion system and has particular reference to a method of and apparatus for at least substantially preventing deposition of carbonaceous material on the interior surface of a conversion housing or on selected surfaces interiorly thereof.

As known in the art of converting hydrocarbons, it is desirable, under some circumstances, for atomized liquid hydrocarbon material to form at least a part of the total hydrocarbon charge which is engaged with heated contact material adapted to gravitate or flow through a housing while having conversion temperature. In a process of this character, the atomizer for the liquid hydrocarbon material is suitably located in a chamber of said housing which, in part, is traversed by atomized liquid material ejected by the atomizer into engagement with at least a substantial portion of the gravitating contact material. This atomized liquid material is ejected from the atomizer at high velocity, some of which, in an unintended or undesired manner and, unless prevented, migrates or tends to migrate to the interior housing surface and/or the surface or surfaces of one or more other members disposed within said housing. In the event that such atomized liquid material reaches said surface or surfaces, as the conversion operation proceeds, there is a resultant undesired accumulation of carbonaceous material thereon.

In accordance with my invention, a suitable casing defining one or more ports is located in the aforesaid chamber and, to this casing, vapors such, for example as hydrocarbon vapors are passed in quantity and at pressure sufficient to produce a stream of high velocity vapors which are ejected in a directional manner from the casing so that they pass into the path followed by atomized liquid material migrating or tending to migrate to such a surface as aforesaid. This stream of vapors deflects at least a substantial portion of such atomized liquid material and effectively minimizes the aforesaid undesired formation of carbonaceous material.

More particularly, in accordance with my invention, the stream of vapors ejected from the aforesaid port-defining casing is circumferentially complete and, preferably, this vapor stream is directed downwardly around the atomizing zone so as to prevent or substantially minimize migration of atomized liquid material to the interior surface of the reaction or conversion housing.

Various other objects and advantages of my invention will become apparent from the following detailed description.

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My invention resides in the method of and apparatus for minimizing deposition of carbonaceous material on one or more surfaces within a conversion housing, features and arrangements of the character herinafter described and claimed.

For an understanding of my invention and for an illustration of one form of apparatus with which the invention may be practiced, reference is to be had to the accompanying drawings, in which:

Fig. 1 is a vertical sectional view, partly in elevation, showing a conversion housing and an associated arrangement for producing a stream of high velocity vapors;

Fig. 2. is an enlarged, vertical sectional view, partly in elevation, showing a part of the apparatus illustrated in Fig. 1;

Fig. 3 is an enlarged horizontal sectional view, taken on the line 3—3 of Fig. 1 looking in the direction of the arrows; and

Fig. 4 is an horizontal sectional view, partly in plan, taken on the line 4—4 of Fig. 2 looking in the direction of the arrows.

In my pending application Serial No. 766,714, filed August 6, 1947, I have disclosed a process of and apparatus for converting hydrocarbon material. For purposes of explanation, the present invention is described in connection with a process and apparatus of the character described in said pending application.

Thus, referring particularly to Fig. 1, I have shown a vertical housing 1 which, in horizontal cross section, may be circular or of any other suitable configuration. The housing 1 defines a reaction zone wherein hydrocarbon material is cracked or otherwise converted in the presence of contact material C which moves downwardly therethrough under the influence of gravity, the contact material C being introduced into said housing 1 in suitable manner, as by an inlet pipe 2 extending through the top housing wall at the center thereof. As shown, a shallow receptacle-like member 3 may be suitably supported in the upper portion of the housing 1, said member 3 having a central discharge pipe 4 opening therethrough and extending downwardly therefrom. The lower end of the pipe 4 may be frusto-conical for the reception of a suitably supported conical member 5 which has external diameter suitably less than the internal diameter of said lower end of the pipe 4. Accordingly, the pipe 4 and the conical member 5 define an annular passage 6 which should have uniform width throughout the circular length thereof.

A pipe 7, adapted to be traversed by hydrocarbon material which is at least partly in the liquid

phase or which, preferably, is substantially or entirely in the liquid phase, extends from the exterior of the housing 1 to the interior thereof. If desired, this pipe 7 may enter the aforesaid pipe 4 through which and the conical member 5 it extends downwardly so as to communicate with and support an atomizer A of any suitable character such, for example, as is disclosed in pending application Serial No. 756,032, filed June 20, 1947.

As shown, the pipe 4, the conical member 5 and the atomizer A should be so related to each other that their respective longitudinal axes are in coincidence with each other and with the longitudinal axis of the housing 1.

In operation, regenerated contact material C having suitable conversion temperature passes continuously from the pipe 2 and, to suitable extent, fills the receptacle 3 which defines an upper zone of the housing 1. From the receptacle 3, the contact material gravitates through the pipe 4 and then through the annular passage 6 which restricts the downward flow of contact material above the plane thereof. Below this plane, the contact material falls freely under the influence of gravity as a tubular, relatively dense curtain or stream S, which may be circular in horizontal section, until it comes to rest upon and at least partly defines the upper surface of the bed B of gravitating contact material which defines the reaction zone proper, the bottom surface of the bed of contact material engaging a tube sheet 8 horizontally disposed in the housing 1 and suitably secured to the interior surface thereof. While the contact material falls freely as the described curtain below the plane of the annular passage 6, it is engaged by liquid hydrocarbon material after atomization thereof by the aforesaid atomizer A, which, as shown, is supported interiorly of the tubular curtain S.

In view of the foregoing, it clearly appears that the atomizer A is disposed in a chamber D of the housing 1, said chamber D being bounded, at its lower end, by the zone defined by the upper surface of the bed B and, at its upper end, by the aforesaid zone defined by the receptacle 3.

If desired, a plurality of pipes 9 may be spaced uniformly around the interior surface of the housing 1. The upper ends of these pipes 9 communicate with the chamber defined by the member 3, which may support said pipes, and the lower ends thereof terminate at the upper surface of the aforesaid bed of contact material, said pipes 9 being adapted to be traversed by a portion, preferably a minor portion, as 20% more or less of the total amount of contact material gravitating through the housing 1. The pipes 9, when utilized, contribute as regards maintenance of the surface of the bed B at a level approximately that of the lower ends of said pipes.

The aforesaid tube sheet 8 supports a plurality of suitably spaced depending pipes 8*a* which open therethrough. The contact material passes through these pipes 8*a* and thereafter, in known manner, may be discharged from the housing 1 for passage through a conduit 10 which should contain a valve 10*a* utilizable for controlling the flow of contact material therethrough so that the contact material forming the bed B is restricted or impeded as it moves downwardly in solid bed fashion under the influence of gravity.

Adjacent the lower end of the housing 1, any suitable arrangement may be provided for disengaging cracked or converted vapors from the contact material C. To this end, as diagrammatically indicated, the aforesaid tube sheet 8 may support a plurality of tubes 11 which upstand therefrom and open therethrough, the tubes 11 supporting a plurality of suitably arranged channel members 12, or equivalent, which are disposed in inverted relation so that, in known manner, they may be utilized for disengagement of vapors from the contact material, the vapors thereafter entering the tubes 11 by way of passages 11*a* formed, respectively, therein. A pipe 13 opens through the wall of the housing 1 below the tube sheet 8 and communicates with the space above the adjacent conical piles of contact material. This pipe 13 may have associated therewith a control valve 14 and is adapted to receive and conduct the converted vapors to any suitable destination.



The atomizer A hereinbefore referred to should be one which produces fog, mist, spray or other liquid particles having suitable dimensions from the liquid hydrocarbon material admitted thereto. As shown in Fig. 2, the atomizer A comprises a casing 15 having a top wall 16 through which the lower end of the aforesaid pipe 7 opens and to which said pipe is secured. The casing 15 has a lower wall 17 above which said casing 15 comprises circular portions 15*a* and 15*b* related to each other in right-angle relation. In the form of atomizer herein shown, although not necessarily, a row of ports or passages 15*c* open through the respective casing portions 15*a* and 15*b*, these ports 15*c* being alined in sets. Hydrocarbon material admitted by the pipe 7 to the casing 15 passes to and through each of said ports 15*c*. The atomizer A is located interiorly of the tubular curtain S a suitable distance below the annular passage 6 and, preferably, said atomizer A is so positioned that its rows of ports 15*c*, or equivalent, are concentrically related to the curtain S.

In accordance with my invention and for the reasons hereinafter stated, a stream of hydrocarbon vapors is directed downwardly around the aforesaid tubular curtain S preferably in spaced relation with respect thereto, these vapors passing through the housing 1 concurrently as regards the contact material C and are converted in the presence thereof. When hydrocarbon material is subjected to a catalytic cracking operation, the temperature of these vapors is usually substantially higher than the hereinafter specified temperature of the liquid hydrocarbon material admitted to the atomizer A in order that the heat content of said vapors may assist as regards vaporization of the liquid hydrocarbon material last named and provide a desired control on the relative quantities of contact material and hydrocarbon material traversing the housing 1. For the purpose stated immediately above, a casing 18 may be suitably secured to the lower end portion of the above described pipe 4, the arrangement being such that there is formed a chamber 18*a* which may be concentrically related with respect to the exterior surface of said pipe 4. The lower wall of the casing 18, which preferably is disposed in alinement with or closely adjacent the plane of the annular passage 6, may comprise a circumferentially complete inclined portion having formed therein a plurality of ports or passages 18*b* which, preferably, are spaced equidistantly with respect to each other or substantially so. In lieu of the ports 18*b*, it will be understood that a continuous slot or port may be utilized for the purpose stated. Extending from the exterior of the hous-

ing 1 to the interior thereof is a pipe 19 which communicates with the aforesaid chamber 18a of the casing 18. In accordance with a preferred form of the invention, the pipe 19 is traversed by hydrocarbon vapors under pressure sufficient to cause said vapors to enter the chamber 18 and then pass therefrom by way of the respective ports 18b, initially, as individual vapor streams having velocity sufficient for the purpose hereinafter described.

When hydrocarbon material is to be cracked in the housing 1, the contact material C hereinbefore referred to should be catalytic in character and the temperature thereof, upon admission to the housing 1, should range between 800° F. and 1000° F. or higher for example, about 900° F. Any suitable kind of catalytic contact material may thus be utilized such, for example, as activated clay pellets, or synthetic silica-alumina pellets or beads, etc. having suitable major dimensions such as between 1/8 and 3/4 of an inch. Other suitable catalyst for cracking include synthetic plural oxide composites, silicious or non-silicious in character, and containing, for example, zirconia, alumina or beryllia. In lieu of a cracking operation, other types of conversion operations such, for example, as one wherein hydrocarbon material of the character referred to below is desulphurized under known conditions with catalytic contact material of the general character referred to above, or equivalent. Or, reforming or dehydrogenation of naphthas or other normally liquid hydrocarbons may be effected in the presence of the above or other desired types of catalyst, certain of which are well known in the art.

During operation with suitable cracking contact material, liquid hydrocarbon material such, for example, as a suitable residual stock, topped or reduced crude having temperature elevated into a suitable range as, for example, from 400° F. to 800° F. is charged continuously through the pipe 7 under superatmospheric pressure ranging, for example, from 10 lbs. to 200 lbs. per square inch gauge or as otherwise may be required for causing the atomized liquid material from the atomizer A to engage and properly penetrate the spaces between the contact material forming the hereinbefore described falling curtain S of contact material. When the temperature of the liquid hydrocarbon material is within the range just specified, little or no carbonaceous material is formed in the pipe 7 and preceding equipment.

The liquid hydrocarbon material traversing the pipe 7 passes through the atomizer casing 15 and then through the sets of alined ports 15c. As regards each set of alined ports 15c, streams of hydrocarbon material pass, respectively, in opposite directions along substantially a straight-line path which is suitably related to a horizontal plane. These streams engage each other in head-on relation between the two alined ports and, due to such engagement and also due to the presence of the barrier defined by the aforesaid casing portions 15a and 15b, there is a resultant stream of atomized material which passes downwardly in an inclined direction, Fig. 1. Preferably, this atomized material exists as a mist or fog and, as it moves from the atomizer A, there is substantial divergence thereof.

It will be understood that a corresponding stream of atomized material passes from each of the other sets of alined ports 15c. Accordingly, it follows that the respective streams of atomized liquid material pass along paths radiating from a common center which coincides with the longitudinal axis of the atomizer A. These streams of atomized liquid material merge with each other soon after leaving the atomizer A and, in merged condition, engage and penetrate said curtain S of contact material while moving downwardly in inclined directions as indicated in Fig. 1.



As hereinbefore stated, the annular passage 6 restricts the downward flow of contact material through the pipe 4 and causes said contact material to form the tubular curtain S. As described in my aforesaid pending application Serial No. 766,714, the density and thickness characteristics of this tubular curtain may be such that the atomized liquid material ejected from the atomizer A is at least substantially prevented from passing therethrough while obtaining desired or satisfactory penetration thereof. Should the conditions of operation be such that some of the atomized liquid material does pass through the tubular curtain S, there is a definite tendency for at least some of the atomized liquid material last named to migrate, not into engagement with the top surface of the bed B, but into engagement with the interior surface of the housing 1 and the exterior surfaces of the respective pipes 9, when utilized. Should this happen during continuance of the conversion operation, there is resultant production or deposition, on these surfaces, of carbonaceous material which, in the course of time, breaks off into chunks of such material that move into and through the bed B of contact material with resultant partial or complete plugging of the outlets interiorly of the housing 1 at the bottom thereof. Should this happen to any substantial extent, it is necessary for operation of the system to be discontinued for cleaning purposes. The foregoing, of course, is undesired and is at least substantially prevented as hereinafter described.

As the foregoing operation proceeds, and, in accordance with the invention, hydrocarbon vapors such, for example, as vaporized gas oil, naphtha or lighter hydrocarbons having suitable elevated temperature, as in a range from 850° F. to 950° F., are admitted continuously to the casing chamber 18a by way of the pipe 19, the vapors passing as vapor streams at high velocity from said chamber 18a by way of the casing ports 18b. As hereinbefore stated, these vapor streams, upon emergence from said casing ports, are individual but they soon merge to form a single, circumferentially complete vapor stream having generally conical exterior configuration which, while forming a vapor envelope around the tubular curtain S of contact material, moves downwardly toward and into engagement with an outer generally annular upper surface of the bed B.

In accordance with the invention, the quantity of vapors admitted to the casing chamber 18a is sufficient and the pressure interiorly thereof is maintained at proper magnitude to cause the vapors, upon ejection thereof from the casing ports 18b, to have velocity sufficient, first, to reach the upper surface of the bed B as stated above and, second, to deflect any migrating atomized liquid material which traverses the tubular curtain S and effectively sweep the same into engagement with the contact material forming the upper surface of said bed B. In so doing, the aforesaid migrating atomized liquid material is at least substantially prevented from reaching the interior surface of the housing 1, this being desirable for the reasons hereinbefore stated.

In the event that a small portion of the migrating atomized liquid material does pass through the aforesaid conical vapor stream, the latter decreases the partial pressure of said last named atomized liquid material which, accordingly, is more readily vaporized by the ambient heat of the conversion system than would be the case if the partial pressure had not been decreased.

Accordingly, in view of the foregoing, it will be understood that hydrocarbon material admitted to the housing 1 by way of the pipes 7 and 18 is converted in the presence of the contact material C to produce cracked products. As the operation proceeds, hydrocarbon vapors, principally, fill the aforesaid chamber D under pressure determined by the pressure existing in the hereinbefore described outlet pipe 13. In known manner, a suitable sealing medium, such as a stream of flue gases, is admitted to the top of the housing 1 by way of a pipe 1a, Fig. 1, at such a rate as to produce a pressure above the contact material in the receptacle 3 which is slightly greater than that existing in the chamber D, this being done in order to prevent passage of hydrocarbon vapors upwardly through the pipe 2. Due to this pressure relation which exists in the chamber D, hydrocarbon material admitted to said chamber by way of the pipes 7 and 18, as described above, is caused to pass downwardly concurrently as regards the gravitating contact material, this hydrocarbon material being cracked in the presence of said contact material and the resulting cracked vapors being suitably disengaged therefrom whereupon they are passed to any suitable destination by way of the hereinbefore described outlet pipe 13. In known manner and by suitable means, not shown, a suitable gaseous medium such as steam is admitted to the lower portion of the housing 1, below the pipe 13 and under pressure above that existing at the level thereof, to prevent passage of the hydrocarbon vapors through the pipe 18.

For purposes of explanation, the invention has been described in connection with a conversion system wherein the contact material gravitates through a housing in a particular manner. Obviously, however, the invention is not to be thus limited since it is applicable to conversion systems wherein the contact material to which the atomized liquid material is applied is controlled for movement, gravitating or otherwise, in any desired manner whether freely falling or not. If freely falling, the present invention is not to be restricted to a curtain having the density and thickness characteristics of the character disclosed in my aforesaid pending application Serial No. 766,714.

As will be understood in view of the preceding description, a distinctly important feature of the invention relates to the provision of a port-defining casing utilizable for producing a stream of vapors as and for the purpose described above. As regards the foregoing, the invention has been described in connection with a present preferred form thereof for deflecting migrating atomized liquid material to prevent or largely minimize deposition of carbonaceous material on the interior surface of a reaction or conversion housing. However, the invention is not to be thus limited since, when the stream of high velocity vapors are produced as described above, it may be desirable to prevent or minimize deposition of carbonaceous material on other surfaces interiorly of a reaction housing such, for example, as the



casing surface of the atomizer A, the surface of the pipe leading thereto, the surface of the pipes 9, etc., any or all of these surfaces or equivalent surfaces being hereinafter generically referred to in claim language as "a surface which should be maintained free from a carbonaceous deposit."

It shall also be understood that the invention is not to be limited to the utilization of hydrocarbon vapors for the purpose described herein. Obviously, other vapors such as superheated steam may be admitted to the casing chamber 18a, or equivalent and utilized for deflecting purposes in the manner described.

The preceding description relates to catalytic conversion processes but the invention is not to be so limited. Thus, the contact material C may be substantially inert catalytically such, for example, as fused alumina (Alundum), fused silica and alumina, heat-resistant quartz or quartz pebbles, fused silica, etc., this material having approximately spherical or chunk-like configuration and the major dimensions ranging between ¼ and ¾ of an inch, for example. With contact material of this character, hydrocarbon vapors may be admitted to the housing 1 by way of the pipe 18 under the conditions hereinbefore described and the atomizer A may be supplied with at least partially liquid phase heavy hydrocarbon material such, for example, as entire crudes, reduced or topped crudes, crude bottoms, residual or heavy bottoms, distillation residua, etc., all of which contain heavy, difficultly vaporizable fractions or components such as tar, asphalt or the like in various proportions. Inert contact material of the character described should gravitate through the housing while having temperature within a range between 800° F. and 1250° F. and heavy hydrocarbon material should be supplied to the atomizer A while having having temperature ranging up to 750° F. or higher. When the operation is of this character, the liquid portion of the heavy hydrocarbon material is vaporized and viscosity-broken in response to engagement thereof with the freely falling inert contact material and that forming the top surface of the bed B, the resulting vaporized products being withdrawn from the housing 1 by way of the conduit 13.

Obviously, many modifications and variations of the invention as hereinbefore set forth may be made without departing from the spirit and scope thereof and, therefore, only such limitations should be imposed as are indicated in the appended claims.

I claim as my invention:

1. In the art of converting hydrocarbons in the presence of contact material which moves through a housing while having conversion temperature, the method which comprises causing atomized liquid hydrocarbon material to pass through a part of an upper chamber of said housing for subsequent engagements with at least a substantial portion of said contact material, passing vapors along a path extending into said chamber and communicating with a port-defining zone from which a stream of said vapors is directed into the path followed by some of the atomized liquid material migrating or tending to migrate toward a surface which should be maintained free from a carbonaceous deposit, and maintaining the velocity of the stream of vapors ejected from said zone at magnitude sufficient to deflect at least a substantial portion of the migrating liquid material from said last named path.

2. In the art of converting hydrocarbons in

the presence of contact material which moves through a housing while having conversion temperature, the method which comprises causing atomized liquid hydrocarbon material to pass through a part of an upper chamber of said housing for subsequent engagement with at least a substantial portion of said contact material, passing vapors along a path extending into said chamber and communicating with a port-defining zone from which a circumferentially complete stream of said vapors is directed into the path followed by some of the atomized liquid material migrating or tending to migrate toward a surface which should be maintained free from a carbonaceous deposit, and maintaining the velocity of the stream of vapors ejected from said zone at magnitude sufficient to deflect at least a substantial portion of the migrating liquid material from said last named path.

3. In the art of converting hydrocarbons in the presence of contact material having conversion temperature and adapted to gravitate through a part of an upper housing chamber in freely falling manner, the method which comprises causing atomized liquid hydrocarbon material to pass through a part of said chamber and to be engaged with the freely falling contact material, and passing vapors along a path extending into said chamber and communicating with a port-defining zone from which a stream of said vapors is directed into the path followed by some of the atomized liquid material migrating or tending to migrate toward a surface which should be maintained free from a carbonaceous deposit, and maintaining the velocity of the stream of vapors ejected from said zone at magnitude sufficient to deflect at least a substantial portion of the migrating liquid material from said last named path.

4. In the art of converting hydrocarbons in the presence of contact material which moves through a housing while having conversion temperature, the method which comprises causes atomized liquid hydrocarbon material to pass from an atomizing zone disposed in an upper chamber of said housing for subsequent engagement with at least a substantial portion of said contact material, and passing vapors along a path extending into said chamber and communicating with a port-defining zone from which a circumferentially complete stream of vapors is directed downwardly around the atomizing zone and into the path followed by some of the atomized liquid material migrating or tending to migrate toward the interior housing surface, and maintaining the velocity of the stream of vapors ejected from said port-defining zone at magnitude sufficient to deflect at least a substantial portion of the migrating liquid material from said last named path.

5. In the art of converting hydrocarbons in the presence of a bed of contact material which gravitates through a housing, the method which comprises causing contact material having conversion temperature to gravitate from an upper zone to the zone defined by the upper surface of said bed while maintaining a chamber between said zones, causing atomized liquid hydrocarbon material to pass from an atomizing zone disposed in said chamber for engagement with at least a substantial portion of said contact material during movement thereof through said chamber, and passing vapors along a path extending into said chamber and communicating with a port-defining zone from which a circumferentially complete stream of said vapors is directed downwardly around the atomizing zone and into the path followed by some of the atomized material migrating or tending to migrate toward the interior housing surface, and maintaining the velocity and direction of the stream of vapors ejected from said port-defining zone at magnitude such that at least a substantial portion of the migrating liquid material is deflected from said last named path and swept into engagement with the upper surface of said bed.

6. In the art of converting hydrocarbons in the presence of a bed of contact material which gravitates through a housing, the method which comprises causing contact material having conversion temperature to gravitate from an upper zone to the zone defined by the upper surface of said bed while maintaining a chamber between said zones, causing atomized liquid hydrocarbon material to pass from an atomizing zone disposed in said chamber for engagement with at least a substantial portion of said contact material during movement thereof through said chamber, passing hydrocarbon vapors along a path extending into said chamber and communicating with a port-defining zone from which a circumferentially complete stream of said vapors is directed downwardly around the atomizing zone and into the path followed by some of the atomized material migrating or tending to migrate toward the interior housing surface, maintaining the velocity and direction of the stream of vapors ejected from said port-defining zone at magnitude such that at least a substantial portion of the migrating liquid material is deflected from last named path and swept into engagement with the upper surface of said bed, maintaining vapor pressure in said chamber sufficient to produce concurrent flow of the hydrocarbon material with respect to the contact material with resultant production of converted vapors, and disengaging said converted vapors from said contact material in a lower area of said bed.

7. In apparatus of the character described, a vertical housing, means for admitting contact material having conversion temperature to said housing for subsequent downward passage therethrough under the influence of gravity, atomizing means disposed in an upper chamber of said housing, a pipe for conducting hydrocarbon material while at least partly in the liquid phase to said atomizing means which serves to engage atomized liquid material with at least a substantial portion of said contact material, a port-defining casing disposed in said chamber, and means for conducting vapors into said casing from which they are ejected into the path followed by some of the atomized liquid material migrating or tending to migrate toward a surface which should be maintained free from a carbonaceous deposit, the velocity of the vapors ejected from said casing being sufficient to deflect at least a substantial portion of the migrating liquid material from said path.

8. In apparatus of the character described, a vertical housing, means for admitting contact material having conversion temperature to said housing for subsequent downward passage therethrough under the influence of gravity, atomizing means disposed in an upper chamber of said housing, a pipe for conducting hydrocarbon material while at least partly in the liquid phase to said atomizing means which serves to engage atomized liquid material with at least a substantial portion of said contact material, a casing dis-

posed in said chamber above said atomizing means and defining a circular row of ports, and means for conducting vapors into said casing from which they are ejected as a circumferentially complete stream into the path followed by some of the atomized liquid material migrating or tending to migrate toward the interior surface of said housing, the velocity of the vapors ejected from said casing being sufficient to deflect at least a substantial portion of the migrating liquid material from said path.

9. In apparatus of the character described, a vertical housing, means for admitting contact material having conversion temperature to said housing for subsequent downward passage therethrough under the influence of gravity in freely falling manner and thereafter as a solid bed of contact material, atomizing means disposed in an upper chamber of said housing, a pipe for conducting hydrocarbon material while at least partly in the liquid phase to said atomizing means which serves to engage atomized liquid



material with at least a substantial portion of said contact material, a casing disposed in said chamber above said atomizing means and defining a circular row of ports, and means for conducting vapors into said casing from which they are ejected as a circumferentially complete stream into the path followed by some of the atomized liquid material migrating or tending to migrate toward the interior surface of said housing, the velocity and direction of the vapors ejected from said casing being such that at least a substantial portion of the migrating liquid material is deflected from said path and swept into engagement with the upper surface of said bed.

REUBEN T. SAVAGE.


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