

May 22, 1951

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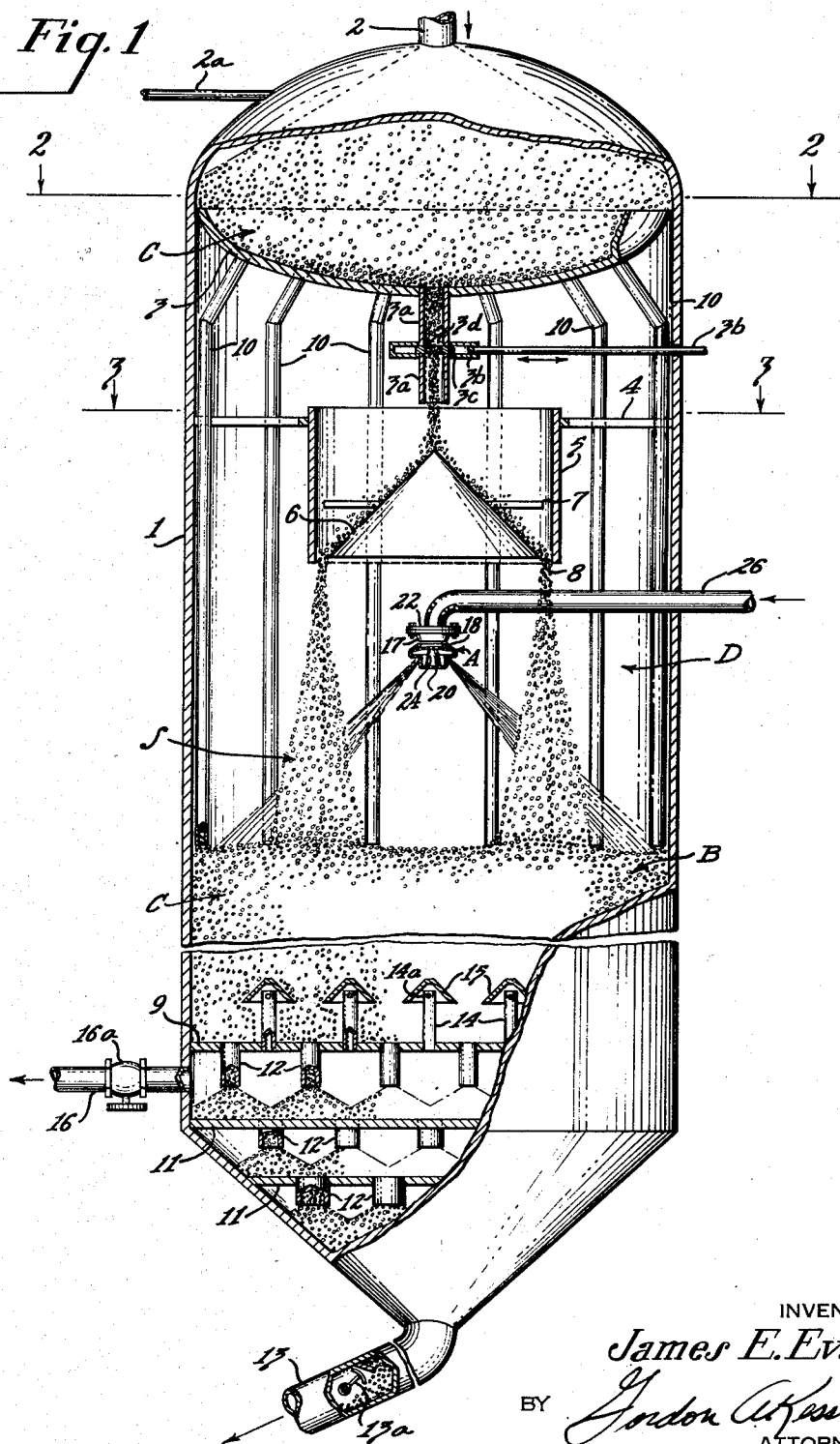
2,553,561

PROCESS OF CONVERTING LIQUID PHASE HYDROCARBON MATERIAL

Filed June 20, 1947

3 Sheets-Sheet 1

Fig. 1



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3 Sheets-Sheet 2

Fig. 2

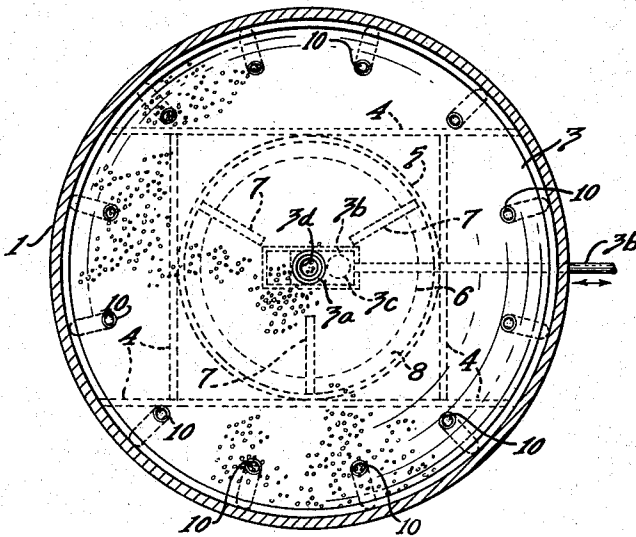
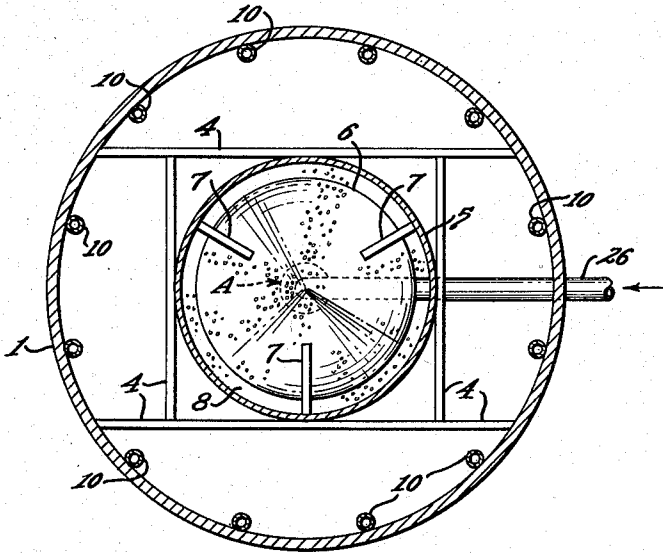


Fig. 3



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3 Sheets-Sheet 3

Fig. 4

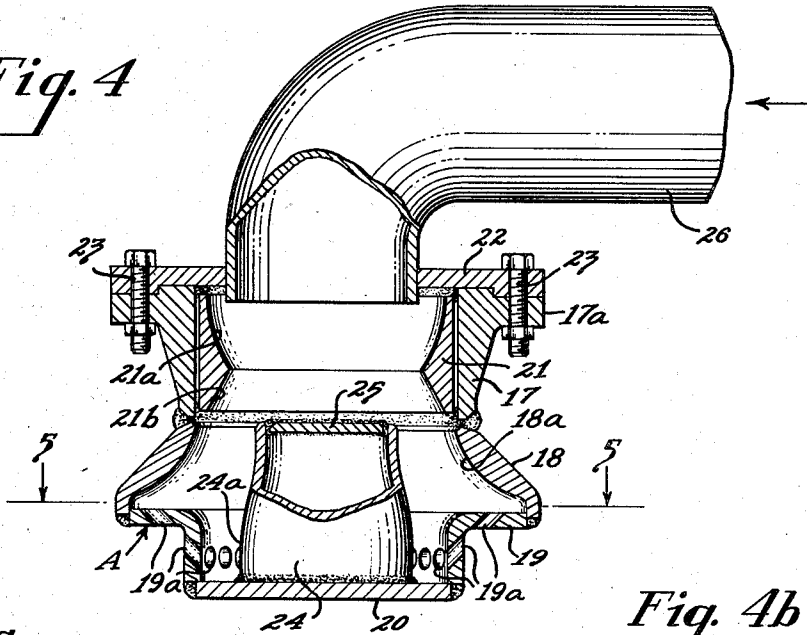


Fig. 4a

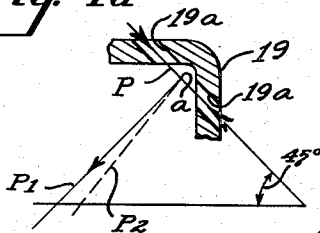


Fig. 4b

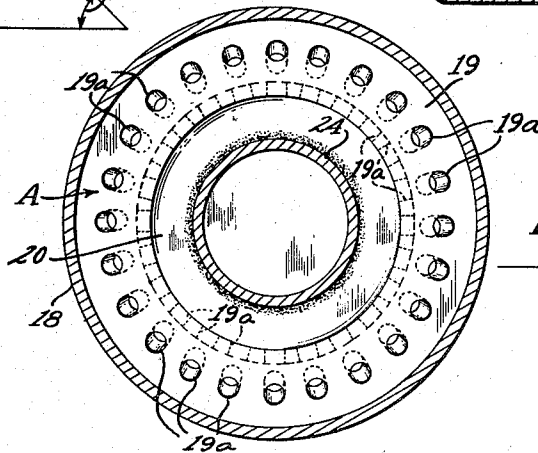
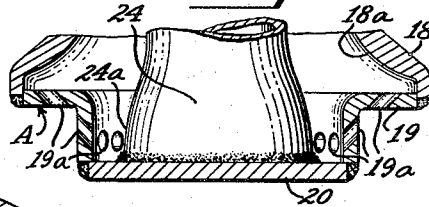


Fig. 5

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PROCESS OF CONVERTING LIQUID PHASE
HYDROCARBON MATERIALJames E. Evans, Wallingford, Pa., assignor to
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Application June 20, 1947, Serial No. 756,031

1 Claim. (Cl. 196—52)

1

In the art of converting hydrocarbons, it is desirable for liquid phase hydrocarbon material to be applied directly to hot contact material as it gravitates downwardly through a reaction housing. This is true particularly when the charging stock contains heavy fraction because the latter, in the presence of the gravitating contact material, are either vaporized and cracked or cracked directly to lower boiling products. In prior practice involving utilization of a bed of gravitating contact material, the hydrocarbon charge material existed solely in the vapor phase upon entrance thereof to the reaction zone. In order to obtain vapors from a heavy liquid-containing charge, it was difficult, if not impossible, to effect complete or substantially complete vaporization of the charge in simple heating equipment without at the same time producing low anti-knock rating gasoline often in substantial quantity. This, as will be understood, is undesirable. Accordingly, in many catalytic cracking operations, it has been preferred in preparation of cracking stock to eliminate from crude petroleum or other source of hydrocarbons their content of heavy difficultly vaporizable components, if any, resultant in loss of charge stock in the cracking process.

On the other hand, application of a charge containing such heavy components directly to hot cracking catalyst gravitating through a conversion zone permits utilization of the entire charge, including its heaviest portions, for the production of gasoline having desired characteristics. If the contact mass is essentially inert catalytically, vaporization and other desired changes of heavy charge components are effected at conditions susceptible of easy control to limit or eliminate undesired reaction processes. In either event, particularly when the hot contact mass and liquid-containing charge are contacted adjacent the upper end of the reaction zone, the vaporization and other changes are initiated under practically ideal conditions of heat transfer between the charge and the contact mass thereby minimizing or even eliminating undesired conversions resulting inevitably from time-temperature treatments of such hydrocarbon charges.

In accordance with my invention, hydrocarbon material, at least partially in the liquid phase, is admitted to a reaction housing and atomized in a chamber above a bed of gravitating contact material, the atomized liquid material being directed downwardly into engagement with the contact material defining the top surface of said

2

bed and, more particularly, the atomized liquid material follows generally a conical path as it approaches the top surface of the bed of contact material.

From another aspect of the invention, the atomized liquid material, which is directed downwardly as described above, is engaged with gravitating contact material which falls freely as a shower of such material prior to engagement thereof with the top surface of the bed of gravitating contact material. More particularly, the density of the aforesaid shower of contact material is such that passage of some or a substantial amount of atomized liquid therethrough is not prevented and, accordingly, from this aspect of the invention, some of the downwardly directed atomized liquid material engages the shower of contact material and some of it engages the contact material defining the top surface of the bed of contact material.

It is desirable for sufficient vapor or gas pressure to be maintained in the described chamber above the bed of gravitating contact material to produce concurrent flow, as the operation proceeds, of the hydrocarbon material with respect to the gravitating contact material, this being desirable in order for the conversion operation to be effected in a satisfactory manner.

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

My invention resides in the process of converting liquid phase hydrocarbon material, the process steps and features hereinafter described and claimed.

The atomizer disclosed herein is described and claimed in an application filed of even date herewith Ser. No. 756,032, filed June 20, 1947.

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 associated mechanism as constructed in accordance with one form of the invention;

Figs. 2 and 3 are horizontal sectional views, partly in plan, taken on the respective lines 2—2 and 3—3 of Fig. 1;

Fig. 4 is a vertical sectional view, partly in elevation, showing one form of atomizer utilizable in accordance with the invention;

Fig. 4a is a diagrammatic view illustrating the operation of my novel atomizer;

3

Fig. 4b is a fragmentary, vertical sectional view, partly in elevation, illustrating a modification of the atomizer shown in Fig. 4; and

Fig. 5 is a horizontal sectional view, partly in plan, taken on the line 5—5 of Fig. 4.

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 there-through 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.

In the form of the invention herein shown, although not necessarily, a shallow receptacle-like member 3 is suitably supported in the upper portion of the housing 1, said member 3 having a central discharge pipe 3a opening there-through and extending downwardly therefrom.

Slidably associated with the discharge pipe 3a is a horizontal valve member 3b having an operating handle extending through and terminating exteriorly of the housing 1. The valve member 3b comprises two spaced passages 3c and 3d, the diameter of the passage 3c being the same as the internal diameter of the pipe 3a and the diameter of the passage 3d being suitably less than said internal diameter of the pipe 3a.

Below the member 3, a horizontal frame is suitably secured to interior surfaces of the housing 1, this frame comprising a plurality of bars 4 secured to each other in right-angular relation, Fig. 3. A tubular member 5 is welded or otherwise suitably secured to the aforesaid bars 4. Disposed interiorly of the tubular member 5 is a conical member 6 which may be supported in the position shown by a plurality of bars 7 secured thereto and to said tubular member 5. The base of the conical member 6 has diameter somewhat less than the interior diameter of the tubular member 5 and, by reason of the fact that these two members are symmetrically related to each other, there is an annular slot or passage 8 there-between at the lower ends thereof. As shown, the longitudinal axis of the conical member 6, the tubular member 5 and the pipe 3a are in coincidence, and this axis coincides, preferably, with the longitudinal axis of the housing 1.

In operation, regenerated or other heated 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 or location of the housing 1. When the valve member 3b is positioned as illustrated, namely, with its passage 3d aligned with the pipe 3a, a desired control is effected on the amount of contact material which gravitates downwardly through the discharge pipe 3a from the receptacle 3. The valve member 3b, then, restricts or "chokes" the downward flow of contact material under the influence of gravity through that part of said pipe 3a above the plane of said valve member 3b. After leaving the valve member 3b, the contact material, in the manner hereinafter described, falls or moves downwardly under the influence of gravity until it comes to rest upon and at least partly defines the upper surface of a bed B of gravitating contact material which constitutes the reaction zone proper, the bottom surface of this bed of contact material engaging a tube sheet 9 horizontally disposed in the housing

4

1 and suitably secured to the interior surface thereof. As the contact material falls freely below the conical member 6, it is engaged by liquid hydrocarbon material after atomization thereof by an atomizer A which is disposed in a chamber D of the housing 1, said chamber D being bounded, at its lower end, by the zone or location defined by the upper surface of the bed B and, at its upper end, by the aforesaid zone or location defined by the receptacle 3.

If desired, a plurality of pipes 10 may be spaced uniformly around the interior surface of the housing 1. The upper ends of these pipes 10 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. They are adapted to be traversed by a portion, preferably a minor portion, as 20% more or less of the total amount of contact material gravitating downwardly through the housing 1. The pipes 10, 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.

Any suitable arrangement may be utilized for discharging the contact material C from the housing 1. To this end and as diagrammatically indicated, a plurality of spaced horizontal tube sheets 11 may be secured to the interior surface of the lower end portion of the housing 1 below the aforesaid tube sheet 9, the extreme lower end portion of the housing 1, preferably, being conical as illustrated. A plurality of suitably spaced tubes or pipes 12 open through and depend from each of the tube sheets 9 and 11. As known in the art, the tubes 12 on successively lower tube sheets progressively decrease in number and the internal diameter thereof progressively increases whereby the contact material passes through the lower conical end portion of the housing 1 so as to reach and traverse a main discharge pipe or conduit 13 which should be inclined as illustrated. In known manner, a suitably controlled valve 13a is associated with the pipe 13 to restrict the flow of contact material therethrough and cause the bed B to be a "choked" bed by reason of the fact that downward movement, under the influence of gravity, of the contact material forming said bed B is restricted or impeded.

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 9 may support a plurality of tubes 14 which upstand therefrom and open there-through, the tubes 14 supporting a plurality of suitably arranged channel members 15, 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 14 by way of passages 14a formed, respectively, therein. A pipe 16 opens through the wall of the housing 1 below the tube sheet 9 and communicates with the space above the adjacent conical piles of contact material. This pipe 16 may have associated therewith a control valve 16a and is adapted to receive and conduct the converted vapors to any suitable destination.

Referring to Fig. 4, 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

5

material admitted thereto. As shown, the atomizer A comprises a casing which may be formed from separate members 17, 18 and 19 secured together in end-to-end relation by welded joints or otherwise as may be suitable. The member 17 is generally tubular and defines a circular passage in horizontal section. At its upper end, said member 17 comprises a circular flange 17a. The member 18 has general frusto-conical configuration, the interior surface thereof being convexly curved as indicated at 18a. The member 19 comprises horizontal and vertical portions related to each other in right-angular relation, the lower vertical portion being closed by a plate 20 which is welded or otherwise suitably secured thereto.

Disposed interiorly of the member 17 is a passage-defining member 21, the upper surface of which may be welded or otherwise suitably secured to a plate 22 which may be secured to the aforesaid flange 17a by bolts 23. The upper interior surface of the member 21, as indicated at 21a, may be defined by a curved surface having parabolic or other suitable configuration. The lower interior surface of said member 21, as indicated at 21b, may have conical configuration. Seated upon the plate 20 and welded or otherwise suitably secured thereto is a member 24 which may be tubular and which, at its upper end, is closed by a plate 25 secured in suitable manner to said member 24, as by a welded joint, or equivalent. The lower exterior surface of the member 24 flares outwardly to some extent as indicated at 24a. As clearly appears, the longitudinal axis of each of the members 21 and 24 should coincide with the longitudinal axis of the casing defined by the members 17, 18 and 19 and, further, the surfaces 21a, 21b of member 21 together with the surface 24a of member 24 should be symmetrical with respect to said longitudinal axis.

In accordance with the invention, each of the horizontal and vertical portions of the aforesaid member 19, in the form of the invention herein shown although not necessarily, comprises a plurality of passages or ports 19a which are spaced apart preferably in uniform relation, the number of these passages or ports 19a being selected so that the atomized mixture is distributed on the contact material preferably in a uniform manner. As hereinafter more particularly described, the passages 19a in the horizontal portion are alined with the respective passages 19a in the vertical portion in straight-line relation or in the sense that each set of alined passages has a common longitudinal axis.

Referring to Figs. 1 and 4, the aforesaid plate 22 is shown as comprising a central opening adapted to receive one end of a pipe 26 which extends horizontally through the wall structure of the housing 1. The pipe 26 may support the atomizer A and, as hereinafter described, is traversed by hydrocarbon material. As indicated, the longitudinal axis of the atomizer A should be in substantial coincidence with the longitudinal axis of the housing 1.

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

6

pellets or beads, etc. having suitable major dimensions such as between $\frac{1}{16}$ and $\frac{3}{4}$ of an inch. Other suitable catalysts 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.

Hydrocarbon material having suitable temperature such, for example, as in a range from 800° F. to 900° F. and in any desired proportion of suitable vapor phase and suitable liquid phase material such as a charge having approximately 70% to 90% more or less in the vapor phase and the remainder in the liquid phase is supplied continuously to the pipe 26 under superatmospheric pressure ranging, for example, from 10 lbs. to 200 lbs. per square inch gauge or otherwise as may be required for causing the atomized hydrocarbon mixture to reach its intended destination while minimizing engagement thereof with the interior surface of the housing 1, such engagement causing undesired formation of carbonaceous material on said housing surface. This hydrocarbon material passes downwardly through the casing defined by the members 17, 18, 19 and then through the sets of alined passages 19a. The aforesaid vapor phase material may be a suitable vaporized gas oil, naphtha or lighter hydrocarbon and the aforesaid liquid phase material may be a suitable residual stock, topped or reduced crude.

As regards each set of aligned passages 19a, streams of hydrocarbon material pass, respectively, in opposite directions along substantially a straight-line path as indicated at P, Fig. 4a, which is related to a horizontal plane by an angle of approximately 45° or otherwise as may be suitable. These streams engage each other in head-on relation in a zone as indicated at a, Fig. 4a, and, due to such engagement and also due to the presence of the barrier defined by the horizontal and vertical portions of the member 19, there is a resultant stream of atomized material which passes downwardly in an inclined direction along a path having an axis substantially as indicated at P₁, Fig. 4a, which may be and preferably is related to the path P in approximately right-angle relation. The atomized material, after it leaves the zone a, exists preferably as a mist or fog and, as it moves from the atomizer A, there is substantial divergence thereof as regards the axis P₁. With an arrangement of the character described, efficient and satisfactory atomization of the liquid material results by reason of the fact that the aforesaid streams of material for each set of aligned passages 19a engage each other in head-on relation as specified and, further, by reason of the deflecting effect exercised on the material by said horizontal and vertical portions of the member 19.

It will be understood that a corresponding stream of atomized material passes from each of the other sets of aligned passages 19a. Accordingly, in the form of the invention herein

shown, although not necessarily, 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. Due to the convergence of each stream, all of the streams quickly lose their density as such and merge to form a combined stream wherein the atomized particles are distributed more or less uniformly, this combined stream, in diverging relation, being directed downwardly along generally a conical path.

The contact material C, except for the deflecting action thereon of the conical member 6, moves or falls freely downward under the influence of gravity while travelling along the path from the valve member 3b to the top of the bed B, the velocity of the contact material constantly increasing while it travels along said path. The tubular member 5 is provided solely to prevent undesired bouncing movement of the contact material toward the wall structure of the casing 1 after engagement thereof with the conical member 6 and the horizontal dimension of the annular passage 8 defined in part by said tubular member 5 is such that it does not restrict or choke downward movement of the contact material. Therefore, at and below said annular passage 8, the contact material falls freely as a shower S of such material which, in horizontal section, may be approximately circular, the longitudinal axis thereof coinciding generally with the vertical axis of the housing 1. By reason of the foregoing and further by reason of the fact that the base diameter of the conical member 6 is substantial, for example, approximately or nearly one-half the internal diameter of the housing 1, it follows that the individual pieces of contact material C, while falling below said conical member 6, are spaced from each other to substantial extent. Thus, the density or compactness of this falling shower of contact material is such that it does not prevent or bar passage therethrough of some or even a substantial portion of the atomized liquid material which is directed downwardly in an inclined direction by the atomizer A and engaged with an inner, circumferentially complete area thereof, said atomizer A, with this end in view, being supported by the pipe 25, or equivalent, interiorly of and generally concentrically with respect to said shower of contact material. The atomized liquid material which thus passes through the freely falling shower S of contact material continues on its downward course and, as shown in Fig. 1 is deposited on the contact material defining a portion of the upper surface of the bed B which, as hereinbefore stated, forms the reaction zone proper. More particularly, the atomized liquid material is thus engaged with the bed B at least throughout the outer bed area.

When liquid hydrocarbon material is to be engaged with contact material for conversion purposes, it is highly desirable for such liquid material to be in atomized condition in order to obtain satisfactory distribution thereof on the contact material. Further, it is desirable for the operation to be conducted under conditions such that atomized liquid material directly engages the top surface of the bed B rather than the interior surface of the housing 1 because, by so doing, deposition of carbonaceous material on said interior housing surface is prevented. With the arrangement of my invention, a substantial portion of the atomized liquid material

ejected from the atomizer A does engage said top bed surface and, hence, deposition of carbonaceous material, as aforesaid, is minimized. By my invention, all of the atomized liquid material has been engaged with the contact material C at least as soon as gravitating movement thereof through the bed B is initiated. Therefore, engagement is effected while the contact material is at maximum conversion temperature thereby obtaining maximum benefit from the heat contact of the contact mass and maximum duration of the period of engagement therewith during gravitating movement thereof.

Accordingly, in view of the foregoing, it will be understood that atomized liquid hydrocarbon material is applied to the falling shower of contact material and also to the contact material forming the top surface of the bed B. As the operation proceeds, hydrocarbon vapors, principally, fill the aforesaid chamber D under pressure determined by the pressure existing in the hereinbefore described outlet conduit 16. In known manner, a suitable sealing medium, such as a stream of flue gases, is admitted to the top of the housing 1 by a pipe 2a, Fig. 1, this sealing medium being maintained under pressure slightly greater than that of said hydrocarbon vapors in order to prevent passage of these hydrocarbon vapors upwardly through the pipe 2. Due to this pressure relation which exists in the chamber D, hydrocarbon material admitted thereto through the atomizer A is caused to pass downwardly concurrently as regards the contact material forming the bed B, this hydrocarbon material being cracked in the presence of said contact material and the resulting cracked vapors being disengaged therefrom at the channel members 15. Thereafter, in the form of the invention herein shown, these cracked vapors enter the tubes 14 by way of the respective passages 14a, pass downwardly through said tubes and enter the space below the tube sheet 9, said cracked vapors passing to any suitable destination by way of the hereinbefore described pipe 16.

As the operation proceeds, the spent contact material C passes through the groups of tubes 12 in succession and then leaves the housing 1 by way of the pipe 13. Thereafter, in suitable manner, said spent contact material is regenerated and then returned to the inlet pipe 2 for re-admission to said housing 1.

The atomizer A herein described functions in a highly satisfactory manner to produce desired atomized material when mixed phase hydrocarbon material is passed thereto by way of the pipe 26. During operation, the mixed phase material passes through the pipe 26 and then traverses the casing defined by the members 17, 18 and 19. While passing through the member 21, the curved surface 21a thereof establishes a desired turbulent condition of the mixed phase material so that it does not move axially of the aforesaid casing into direct engagement with the plate 25. By so doing, deposition of liquid hydrocarbon material in this area is minimized.

The member 24 is provided in order to restrict the path leading to the passages 19a in the vertical portion of the member 19 so that the width thereof is substantially the same as the width of the path leading to the passages 19a in the horizontal portion of said member 19. The curved surface 18a of the member 18 and the flared surface 24a of the tubular member 24 serve as a refinement for the purpose last noted. When the aforesaid paths have substantially the same width

as stated, each resultant stream of atomized material passes along a path substantially as indicated at P₁, Fig. 4a, which, as stated, is related to the path P approximately in right-angle relation.

As indicated in Fig. 4b, the tubular member 24 may be so constructed that the width of the path leading to the passages 19a in the vertical portion of the member 19 is substantially less than the width of the path leading to the passages 19a in the horizontal portion of said member 19. If so, a greater amount of hydrocarbon material traverses the passages last named and, accordingly, each resultant stream of atomized material passes along a path, for example, as indicated at P₂, Fig. 4a, which is more vertical than the path P₁. It will be understood that a result the reverse of that described immediately above is obtained if the arrangement is such that the width of the path leading to the passages 19a in the horizontal portion of the member 19 is less than the width of the path leading to the passages 19a in the vertical portion of said member 19.

By reference to Fig. 4a, it was hereinbefore stated that, as regards each pair of aligned passages 19a, the impinging or engaging streams of hydrocarbon material move in opposite directions along the same straight-line path or substantially so. This is desirable because, with this condition of atomization, the resulting atomized material more closely approximates actual fog or mist than is the case when angularly related streams of material engage each other in impinging relation. Hence, by my invention, the impinging streams may have desired high velocity in order to obtain adequate dispersion of the atomized mixture and effective absorption thereof by the contact material. However, such high velocity of the impinging streams of material causes improved atomization as described above and does not effect proportionate increase in the resulting velocity of the fog or mist. Therefore, resulting from the described impingement and, in addition, the deflecting effect of the plate portions 19a, there is a reduced tendency of the latter to migrate to the interior wall surface of the housing 1.

In view of the foregoing, it will be understood that an important feature of the invention relates to the application of atomized liquid hydrocarbon material to freely falling contact material and the contact material forming the top surface of the bed of such material. One form of an atomizer suitable for accomplishing this purpose has been illustrated and described but it shall be understood that this phase of the invention is not to be limited to an atomizer of any particular form. Obviously, for this purpose, various equivalent atomizing arrangements may be utilized as desired.

The atomizer A herein disclosed is adapted particularly for the reception of mixed phase hydrocarbon material from the pipe 26. However, in accordance with the invention, the hydrocarbon material transversing the pipe 26 may be entirely in the liquid phase or substantially so. If so, it is desirable for the disclosed atomizer to have reduced dimensions and for the members 21 and 24 to be omitted therefrom.

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 $\frac{1}{4}$ to $\frac{3}{4}$ of an inch, for example. With contact material of this character, 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 residuums, etc., all of which contain heavy, difficultly vaporizable fractions or components such as tar, asphalt or the like in various proportions. If vapor phase material is supplied to the atomizer A, this material may be hydrocarbon vapors, steam or the like. Inert contact material of the character described should gravitate through the housing 1 while having temperature within a range between 800° F. and 1250° F. and the partly liquid material should be supplied to the atomizer A while 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 the example shown, 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 16.

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 claim.

I claim as my invention:

In a process wherein hydrocarbon material undergoes conversion in the presence of a bed of particles of contact material, which bed gravitates downwardly through a conversion zone and is formed, at least in part, by particles of contact material falling freely downward onto the upper surface of said bed as a curtain of contact material laterally enclosing and bounding a zone above said bed: the method of dispersing liquid hydrocarbons on the particles of contact material in said curtain which comprises introducing hydrocarbon material at least partially in the liquid phase to the interior of the zone bounded by said curtain; flowing paired high velocity streams of said hydrocarbon material upwardly and downwardly, respectively, at a location substantially axial with respect to the zone bounded by said curtain; and engaging said upwardly and downwardly directed streams in head-on relationship so as to atomize liquid hydrocarbons in said streams by the force of collision of oppositely flowing streams and so as to thereafter flow thus atomized liquid hydrocarbons from said location unobstructedly toward said curtain at resulting reduced velocity.

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