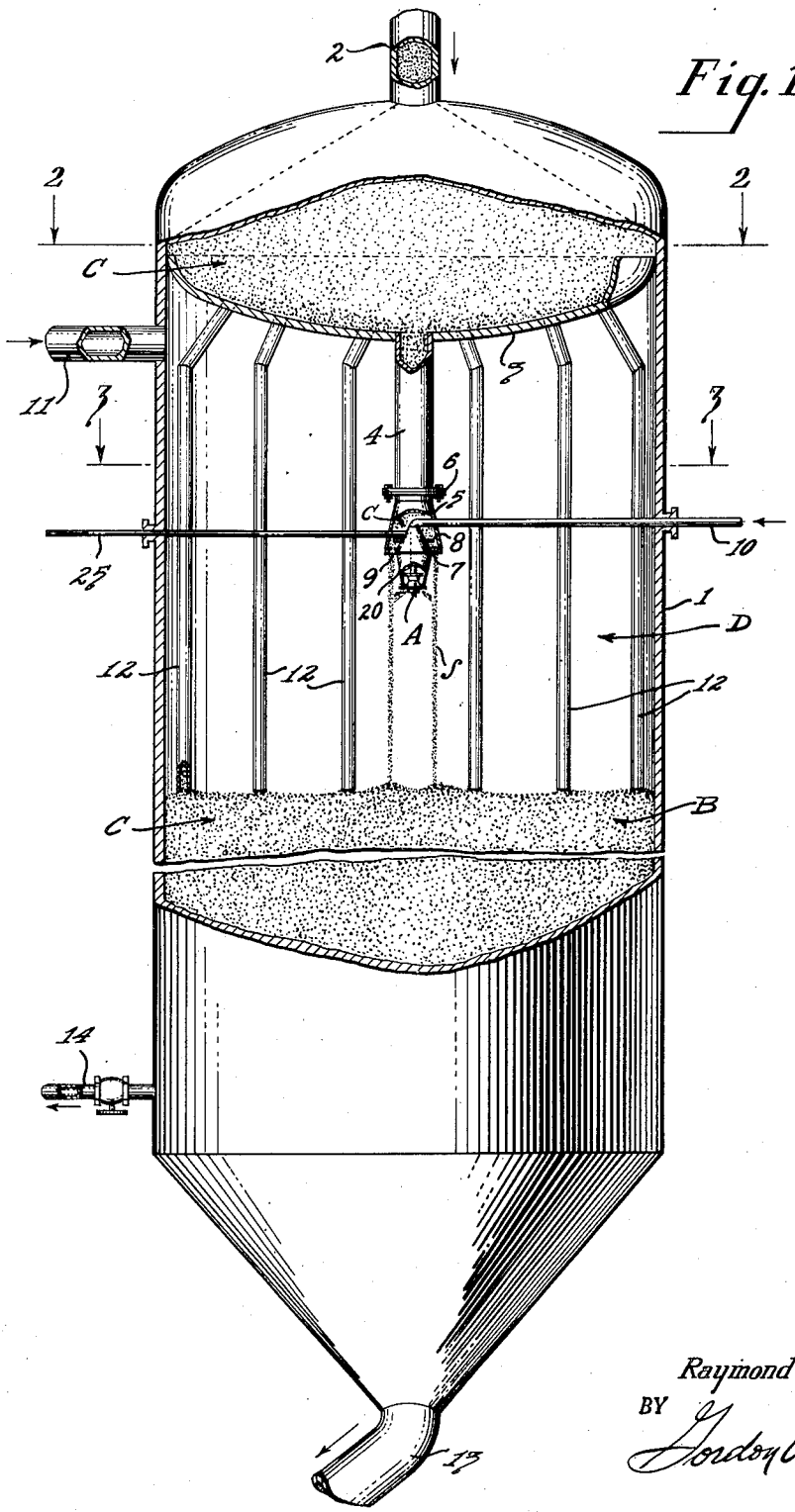
Jan. 3, 1950 R. C. LASSIAT 2,492,999

METHOD OF AND APPARATUS FOR MINIMIZING DEPOSITION OF CARBONACEOUS MATERIAL

Filed Sept. 26, 1947 3 Sheets-Sheet 1

Fig. 1



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Filed Sept. 26, 1947 3 Sheets-Sheet 2

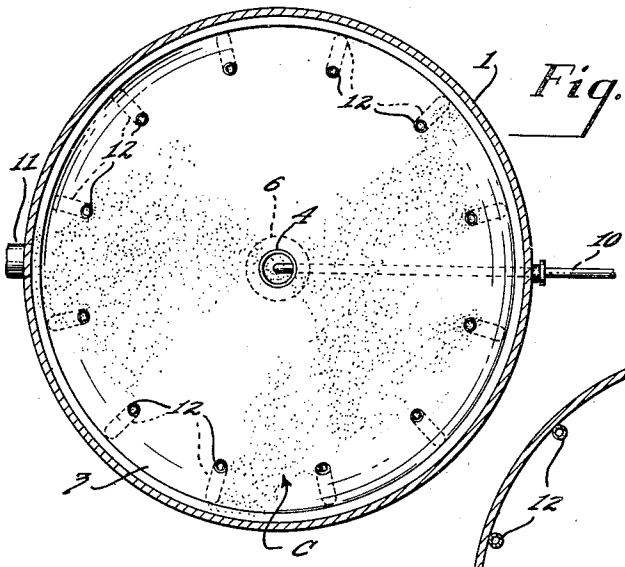

Fig. 2

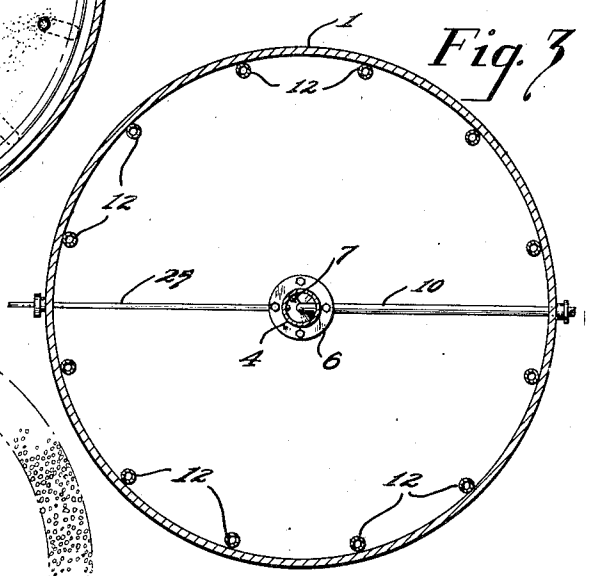

Fig. 3

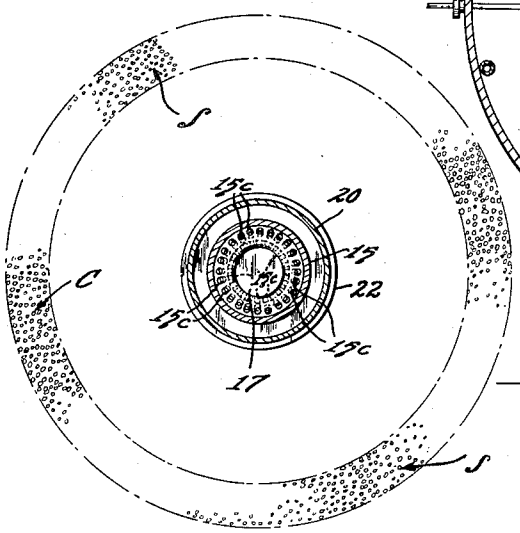

Fig. 5

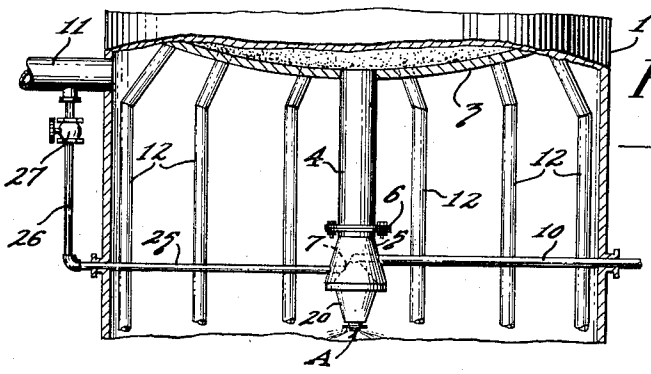

Fig. 7

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Fig. 4

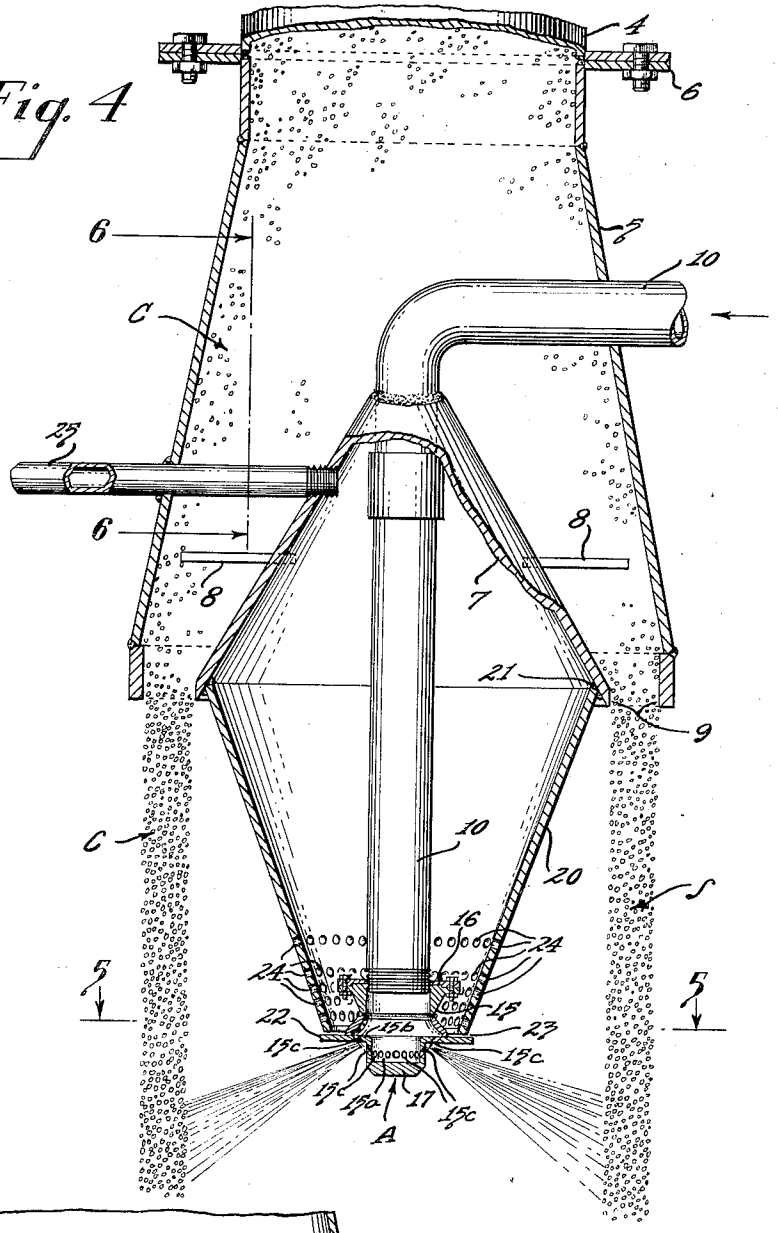
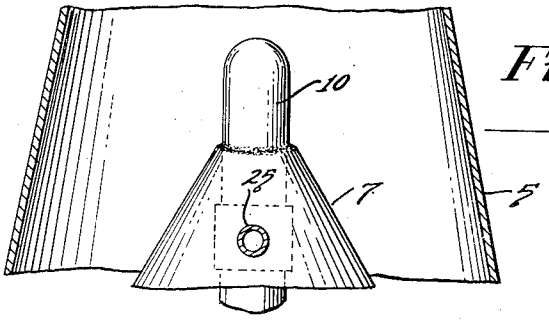


Fig. 6



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Patented Jan. 3, 1950

2,492,999

UNITED STATES PATENT OFFICE

2,492,999

METHOD OF AND APPARATUS FOR MINIMIZING DEPOSITION OF CARBONACEOUS MATERIAL

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Application September 26, 1947, Serial No. 776,202

6 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 one or more mechanical parts extending into an atomizing zone forming a part of said system.

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, forms undesired deposits of carbonaceous material on the atomizer casing and/or associated parts.

In accordance with my invention, a stream of vapors having suitable velocity for deflecting purposes are passed into the path followed by the aforesaid atomized liquid material which, as stated, tends to form undesired deposits of carbonaceous material. These vapors deflect at least a substantial portion of such atomized liquid material from said path and effectively prevent engagement thereof with the atomizer casing together with the feed pipe therefor whereby these parts are maintained substantially free from a deposit of carbonaceous material.

In a more restricted sense, my invention relates to a hydrocarbon conversion system wherein at least a substantial portion of the gravitating contact material is controlled for movement as a freely falling curtain or stream of contact material having tubular configuration, the atomizer being disposed interiorly of the aforesaid tubular curtain and the atomized liquid material being engaged with a circumferentially complete, interior surface thereof. With a system of this character, the aforesaid stream of deflecting vapors may be passed generally in a horizontal direction into the path followed by any upwardly moving atomized liquid material and, more particularly, a suitable housing, located interiorly of the tubular curtain of contact material and enclosing the upper portion of the atomizer casing together with the feed pipe therefor, defines a

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chamber into which the vapors are admitted prior to passage thereof substantially in a horizontal direction as noted above.

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

My invention resides in the method of and apparatus for minimizing deposition of carbonaceous material in an atomizing zone, features and arrangements of the character hereinafter 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 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 an enlarged, vertical sectional view, partly in elevation, showing an important feature of the invention;

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

Fig. 6 is a vertical sectional view, partly in elevation, taken on the line 6—6 of Fig. 4; and

Fig. 7 is a vertical sectional view, partly in elevation, showing a modification of the invention.

In an application of Reuben T. Savage, Serial No. 766,714, filed August 6, 1947, there is disclosed a hydrocarbon conversion process involving utilization of an arrangement for engaging atomized liquid hydrocarbon material with a freely falling stream or curtain of contact material. For purposes of explanation as regards my invention, I have included in this application a general disclosure of the subject matter illustrated and described in the aforesaid Savage 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.

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. If desired, the lower end of the pipe 4 may have a frusto-conical pipe 5 suitably secured thereto, as by a flange-and-bolt connection 6. With an arrangement of this character, the lower end of the pipe 5 has diameter somewhat greater than that of the lower end of the pipe 4. Obviously, the pipes 4 and 5 may be replaced by a single pipe having desired uniform diameter throughout the length thereof.

Disposed interiorly of said discharge pipe 5, immediately adjacent the lower end thereof, is a frusto-conical member 7, the lower surface of which, preferably but not necessarily, is positioned in the same horizontal plane as the lower surface of the pipe 5, said conical member 7 being suitably supported in the position shown, as by a plurality of bars 8 secured thereto and to said pipe 5. The external diameter of the lower surface of the conical member 7 is suitably less than the internal diameter of the lower surface of the pipe 5 and, accordingly, these two surfaces define an annular passage 9 utilizable as hereinafter described. The pipe 5 and the conical member 7 should be symmetrically related to each other and, if so, the width of the annular passage 9 is uniform throughout the circular length thereof. Preferably, the arrangement is such that tht exterior sloping surface of the conical member 7 forms with the interior sloping surface of the pipe 5 a path which diverges in a direction leading upwardly from the aforesaid annular passage 9.

A pipe 10, adapted to be traversed by hydrocarbon material, which is either partially or entirely in the liquid phase, extends from the exterior of the housing 1 to the interior thereof and, if desired, this pipe 10 may enter the aforesaid pipe 5 at any suitable level and pass downwardly therethrough in coincidence with the longitudinal axis thereof. If so, the pipe 10 passes through the aforesaid conical member 7 to which it is welded or othervise suitably secured in sealed relation and terminates a suitable distance below said conical member 7 where it communicates with and supports an atomizer A of any suitable character but which, preferably although not necessarily, is of the general character disclosed in the pending application of James E. Evans, Serial No. 756,032, filed June 20, 1947. A pipe 11 adapted to be traversed by hydrocarbon vapors extends from the exterior of the housing 1 to the interior thereof and, preferably, this pipe 11 is positioned at a higher level than the aforesaid pipe 10.

As shown, the pipe 4, the pipe 5, the conical member 7 and the atomizer A should be so related to each other that their respective longitudinal axes are in coincidence with each other and also with the longitudinal axis of the housing 1.

In operation, regenerated or other heated contact material C having suitable reaction 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 downwardly through the pipe 4, the pipe 5 and then through the annular passage 9 which, as hereinafter more fully described, has width such that it restricts or controls the downward flow of contact material under the influence of gravity while moving along the described path above the plane

of the annular passage 9. Below the plane of said annular passage 9, the contact material falls freely under the influence of gravity as a tubular curtain or stream S, which is not necessarily 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, not shown, which is horizontally disposed in the housing 1 and suitably secured to the interior surface thereof. As the contact material falls freely below the plane of the annular passage 9, it is engaged by liquid hydrocarbon material after atomization thereof by the aforesaid atomizer A which, as shown in Fig. 4, is supported interiorly of the tubular curtain S by the aforesaid pipe 10.

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 12 may be spaced uniformly around the interior surface of the housing 1. The upper ends of these pipes 12 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 12 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 12, 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.

As stated, the bed B of contact material gravitates through the housing 1 and any suitable known or other arrangement, not shown, may be utilized for discharging the spent contact material from the housing 1 for passage through a discharge pipe 13. Likewise, any suitable known or other arrangement, not shown, may be provided for disengaging cracked or converted vapors from the contact material C so that they may pass through an outlet pipe 14.

Referring particularly 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 material admitted thereto. As shown, the atomizer A comprises a casing 15 having a top wall 16 through which the lower end of the aforesaid pipe 10 opens and to which said pipe is secured. The casing 15 has a lower wall 17 above which said casing 15 comprises vertical and horizontal circular plate portions 15a and 15b related to each other in right-angle relation. In the form of atomizer herein shown, although not necessarily, a row of ports or passages 15c open through the respective casing portions 15a and 15b, these ports 15c being alined in sets. Hydrocarbon material admitted by the pipe 10 to the casing 15 passes to and through each of said ports 15c. The atomizer A is disposed interiorly of the tubular curtain S a suitable distance below the annular passage 9 and, preferably, said atomizer A is so positioned that its rows of ports 15c, or equivalent are concentrically related, approximately, to the curtain S.

When hydrocarbon material is to be cracked in the housing 1, the contact material C herein-

before 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 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.

During operation with suitable cracking contact material, 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 housing 1 by way of the conduit 11. Simultaneously, 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 10 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 contact material forming the hereinbefore described falling curtain S of contact material. The liquid hydrocarbon material thus traversing the pipe 10 passes through the atomizer casing 15 and the alined atomizer ports 15c of the respective sets thereof are traversed, respectively, by streams of hydrocarbon material which pass toward and engage each other to produce resultant streams of atomized material which, as a mist or fog, pass downwardly in inclined relation and penetrate the curtain S throughout a circumferentially complete inner area thereof, Fig. 4.

As stated, hydrocarbon vapors, which in connection with a cracking operation preferably have temperature substantially higher than that of the liquid hydrocarbon material admitted to the atomizer A, are admitted to the housing 1 by way of the pipe 11. These vapors pass through the housing 1, concurrently as regards the contact material C and in the presence thereof, are converted to cracked products. In so doing, the heat content of these vapors assists as regards vaporization of the liquid hydrocarbon material entering said housing 1 through the atomizer A and provide a desired control on the space velocity of the entire charge traversing the housing 1. Simultaneously, in the manner described above, atomized liquid hydrocarbon material is engaged with the falling curtain S of contact material with resultant vaporization of such atomized liquid material and formation of cracked products while passing through the housing 1 concurrently as regards the contact material C. As regards the total charge entering the housing 1, the ratio of vapors to liquid material may be such as is suitable and desirable. Thus, for example, between 10% and 30% of the charge may be in the liquid phase for passage to the atomizer A and the remainder in the vapor phase for passage through the pipe 11.

The hereinbefore described annular passage 9 serves as a metering passage in the sense that it restricts or chokes the downward flow of contact material under the influence of gravity while moving along its path above the plane of said annular passage 9. The control thus exercised by the annular passage 9 causes the falling curtain S of contact material to have and maintain substantially uniform thickness at least until after it has passed through the zone where the atomized liquid material in engaged therewith. Further, in this zone and in response to the aforesaid control, the thickness of the curtain S and the density of the pieces of contact material forming said curtain S are sufficient to entirely or at least substantially prevent passage therethrough of any of the atomized liquid material which is produced and directed into engagement therewith by the atomizer A. In addition, the operation should be conducted under conditions such that the atomized liquid material penetrates the falling curtain S so that each piece of contact material, with the exception perhaps of those at the extreme outer curtain surface, receives a charge of the atomized liquid material.

The falling curtain S of contact material functions in the manner described to substantially or entirely prevent passage of atomized liquid material therethrough. This curtain, then, positively prevents or almost entirely minimizes migration of atomized liquid material to interior surfaces of the housing 1 and the pipes 12 in the event that the latter are utilized. Consequently, formation of carbonaceous material on the metallic housing and pipe surfaces is entirely or substantially prevented. This is highly desirable by reason of fact that, if there is any substantial formation of carbonaceous material in the locations stated, chunks thereof separate from the main mass and move into and through the bed B of contact material with resultant partial or complete plugging of the outlets, not shown, at the bottom of the housing. Should this happen to any substantial extent, it is necessary for operation of the system to be discontinued for cleaning purposes and this, of course, is undesirable.

In view of the foregoing, it will be understood that hydrocarbon material admitted to the housing 1 by way of the pipes 10 and 11 is converted in the presence of the contact material C and, as described in the aforesaid Savage application, this hydrocabon material passes through the housing 1 in concurrent relation as regards the gravitating contact material from which the cracked products are disengaged and passed to any suitable destination by way of the pipe 14. 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 14 and under pressure above that existing at the level thereof, to prevent passage of hydrocarbon vapors through the pipe 13. Simultaneously, spent contact material leaves the housing 1 by way of the pipe 13 and, after regeneration, is returned to the inlet pipe 2 for readmission to said housing 1.

In accordance with my invention and in order to at least substantially prevent undesired migration of atomized liquid material, such migra-

tion being caused principally by the splashing effect occurring when the atomized liquid material engages the interior surface of the tubular curtain S, a frusto-conical member 20 has its larger, upper end welded or otherwise suitably secured, as at 21, in sealed relation to the lower interior surface of the aforesaid conical member 7, Fig. 4. Projecting horizontally from the hereinbefore described horizontal plate portion 15b of the atomizer A and integrally or otherwise suitably secured thereto is a circular plate 22 from which the smaller, lower end of the member 20 is spaced to form a narrow, annular passage 23. As indicated at 24, the lower portion of the member 20 may comprise one or more horizontal rows of small ports 24 which together with the passage 23 are utilized as hereafter described.

As shown in Fig. 1, a pipe 25 extends from the exterior of the housing 1 to the interior thereof where the inner end of said pipe 25 opens through the upper conical member 7, Fig. 4. In view of the foregoing description, it will be understood that the conical members 7 and 20 constitute a boundary, housing or casing which defines a chamber that is sealed except for the pipe 25, the passage 23 and the ports 24, this boundary, housing or casing defining a zone within the chamber D from which atomized liquid material should be excluded and the atomizer A being disposed in the lower area of said zone.

While hydrocarbon material is undergoing conversion in the housing 1 as hereinbefore described, suitable vapors, such as steam, which may be superheated to approximately 600° F. or higher are passed continuously by way of the pipe 25 into the chamber defined by the aforesaid members 7, 20 and the atomizer casing under pressure somewhat exceeding that existing in the chamber D of the housing 1. As a result, a stream of vapors pass continuously in generally a horizontal direction from the aforesaid circular passage 23 toward and into engagement with the interior surface of the hereinbefore described curtain S of contact material throughout a circumferentially complete inner area thereof. Simultaneously, streams of vapors pass continuously from the respective ports 24 and move toward and then into engagement with said interior surface of the curtain S along paths that incline slightly downwardly. As a result, there is a relatively thick stream of vapors moving continuously from the periphery of the lower portion of the lower conical member 20 toward and into engagement with the adjacent interior surface of the curtain S. The pressure interiorly of the chamber defined by the members 7 and 20 should be sufficient to cause the stream of vapors last mentioned to have velocity high enough to cause them to reach the interior surface of the curtain S but not high enough to cause any substantial transverse movement or undesired dislodgement of the pieces of contact material forming said curtain.

As hereinbefore described, during a hydrocarbon conversion operation, streams of atomized liquid hydrocarbon material pass downwardly in inclined relation and at high velocity from the respective sets of alined atomizer ports 15c, substantially all of this atomized liquid material engaging the tubular curtain S throughout a circumferentially complete inner area thereof. However, particularly by reason of this high velocity condition, some of this atomized liquid material, either alone or having fines of the contact material entrained therein, migrates or tends to

migrate upwardly within the area enclosed by the upper portion of the tubular curtain S. This action is prevented at least substantially, in accordance with the invention, by the aforesaid vapor stream from the chamber defined by the members 7 and 20 which has velocity sufficient to deflect upwardly migrating atomized liquid material for movement generally in a horizontal direction into engagement with the inner surface of the curtain S. The thickness of the vapor stream is adequate for this purpose and, in effect, said vapor stream forms a deflecting barrier within said curtain S substantially preventing upward movement of atomized liquid material above the atomizer ejection zone defined by the sets of ports 15c.

As stated above, the stream of deflecting vapors are produced in response to flow thereof through the passages defined by the conical member 20. In the form of the invention herein shown, although not necessarily, this member 20 is interposed in the path of such atomized liquid material as might migrate upwardly toward the upper part of the atomizer casing 15 and the lower portion of the feed pipe 10. Hence, this member, unaided by the stream of deflecting vapors, is effective to prevent this upwardly migrating atomized liquid material from reaching and forming a carbonaceous deposit on the parts last named. However, as will be obvious, this function of the member 20 would be futile if the conditions were such that the upwardly migrating atomized liquid material formed a carbonaceous deposit on the exterior surface thereof, this being true, by reason of the fact that such a deposit, if formed, would interfere with proper operation of the system for the reasons hereinafter stated. It will be understood, then, as regards the disclosed form of the invention, that the direct function of the disclosed deflecting stream of vapors is that of at least substantially preventing formation of a carbonaceous deposit on the exterior surface of said member 20.

In the event that some of the upwardly migrating atomized liquid material does pass through the aforesaid stream of deflecting vapors, 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, even as regards this last named atomized liquid material, the described vaporization thereof minimizes the amount of liquid material reaching the exterior surface of the member 20 with consequent decrease in the quantity of carbonaceous material which is formed thereon.

It will be understood, then, that in the absence of the arrangement comprising the lower conical member 20, or equivalent, for producing the described stream of deflecting vapors, a part at least of any upwardly migrating atomized liquid material would be deposited on the upper portion of the atomizer casing 15 and on the adjacent vertical portion of the pipe 10 with resultant production of carbonaceous material which, in the course of time, forms hanging or other adherent deposits of such carbonaceous material having sufficient length either to interfere with proper operation of the atomizer or, as hereinbefore stated with respect to the interior housing surface, to break into chunks which move into and through the bed B of contact material with resultant partial or complete plugging of the out-

lets, not shown, at the bottom of the housing 1. An operation of this character, of course, is undesired and is at least substantially prevented, in accordance with the disclosed form of my invention, by utilization of the arrangement comprising the conical member 20 which forms the aforesaid barrier stream of deflecting vapors.

Referring to Fig. 7, I have shown a modification of the invention wherein a pipe 26 branches from the hereinbefore described inlet pipe 11 for hydrocarbon vapors and forms the sole connection leading to the above described pipe 25. A suitable valve 27, associated with the pipe 26, is utilized to control the passage therethrough of hydrocarbon vapors so that they are delivered into the chamber defined by the members 7 and 20 at pressure and in quantity sufficient to form a stream of deflecting vapors which function, in lieu of the desired gaseous medium, to at least substantially prevent the described undesired upward movement or migration of atomized liquid material ejected from the atomizer A.

Although I have shown a present preferred arrangement for preventing deposition of upwardly moving atomized liquid hydrocarbon material on the pipe and atomizer casing traversed by such material, it shall be understood that my invention is not to be so limited. Other equivalent arrangements may thus be utilized and, particularly, the invention is not to be limited, except as set forth in the appended claims, to a member such as the member 20 which is interposed in the path of the aforesaid upwardly moving atomized liquid material. Obviously, the member 20 may be omitted in favor of any suitable arrangement which produces a stream of vapors passing downwardly or in other suitable direction and utilizable to effectively prevent deposition of atomized liquid material on the atomizer casing 15 and the adjacent lower end of the pipe 10, or equivalent.

Further, when a portion of the contact material is engaged by atomized liquid material while freely falling under the influence of gravity, it shall be understood that such freely falling contact material need not necessarily form a tubular curtain having thickness and density characteristics as described herein. Thus, if desired, the contact material may fall as a shower of such material having density or compactness insufficient to prevent passage therethrough of a substantial amount of atomized liquid material which may be produced by the atomizer A herein described, for example.

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 to 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 11 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 residuums, 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 1 while having temperature within a range between 800° F. and 1250° F. and the heavy hydrocarbon 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 14.

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 having conversion temperature and adapted to gravitate through a chamber as a tubular curtain of freely falling contact material, the method which comprises atomizing liquid hydrocarbon material in the lower area of a zone within said tubular curtain, directing a circumferentially complete stream of the atomized material into engagement with the curtain contact material, passing a stream of vapors into the path followed by atomized material migrating or tending to migrate toward the boundary of said zone, and maintaining said stream of vapors at velocity sufficient to deflect migrating atomized material from said path.

2. In the art of converting hydrocarbons in the presence of contact material having conversion temperature and adapted to gravitate through a chamber as a tubular curtain of freely falling contact material, the method which comprises atomizing liquid hydrocarbon material in the lower area of a zone within said tubular curtain and having a boundary adapted to exclude atomized material therefrom, directing a circumferentially complete stream of the atomized material into engagement with the curtain contact material, passing a plurality of streams of vapors into the path followed by atomized material migrating or tending to migrate toward the boundary of said zone, and maintaining said streams of vapors at velocity sufficient to deflect migrating atomized material from said path.

3. In apparatus of the character described, a conversion housing, means disposed interiorly thereof and comprising inner and outer concentric conical members forming an annular metering passage adapted to cause gravitating contact material to form a tubular curtain of contact material freely falling below a plane extending horizontally through said metering passage, an atomizer supported interiorly of said curtain below said horizontal plane, a member enclosing a portion of said atomizer and forming a chamber with said inner conical member, and means for passing a stream of vapors into said chamber and thence from the lower portion thereof toward and into engagement with said curtain of contact material throughout a circumferentially complete inner area thereof.

4. In apparatus of the character described, a conversion housing, means disposed interiorly thereof and comprising inner and outer concen-

tric conical members forming an annular metering passage adapted to cause gravitating contact material to form a tubular curtain of contact material falling freely below a plane extending horizontally through said metering passage, an atomizer supported interiorly of said curtain below said horizontal plane, a member enclosing a portion of said atomizer and forming a chamber with said inner conical member, and means for passing a stream of vapors into said chamber and thence generally in a horizontal direction from the lower portion thereof toward and into engagement with said curtain of contact material throughout a circumferentially complete inner area thereof, said last named means comprising an annular passage formed between the lower end of said enclosing member and a plate projecting horizontally from the atomizer casing.

5. In apparatus of the character described, a conversion housing, means disposed interiorly thereof and comprising inner and outer concentric conical members forming an annular metering passage adapted to cause gravitating contact material to form a tubular curtain of contact material falling freely below a plane horizontally through said metering passage, an atomizer supported interiorly of said curtain below said horizontal plane, a member enclosing a portion of said atomizer and forming a chamber with said inner conical member, and means for passing a stream of vapors into said chamber and thence generally in a horizontal direction from the lower portion thereof toward and into engagement with said curtain of contact material throughout a circumferentially complete inner area thereof, said last named means comprising an annular passage formed between the lower end of said

enclosing member and a plate projecting horizontally from the atomizer casing, said last named means further comprising a plurality of horizontal rows of small ports formed in the lower portion of said enclosing member above the lower end thereof.

6. In apparatus of the character described, a conversion housing, means disposed interiorly thereof and comprising inner and outer members forming an annular metering passage adapted to cause gravitating contact material to form a tubular curtain of contact material freely falling below a plane extending horizontally through said metering passage, an atomizer supported interiorly of said curtain below said horizontal plane, a member enclosing a portion of said atomizer and forming a chamber with said inner conical member, and means for passing vapors into said chamber, said enclosing member being constructed and arranged for the passage therethrough of a plurality of streams of vapors at different horizontal levels, respectively.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,429,545	Bergstrom	Oct. 21, 1947

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"Commercial T.C.C. Operations on Partially Vaporized Charge Stock," by Noll et al., Houdry Pioneer, Oct., 1946.

Certificate of Correction

Patent No. 2,492,999 January 3, 1950

RAYMOND C. LASSIAT

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 9, line 19, for the word "desired" read *described*;

and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 13th day of June, A. D. 1950.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.