# Canadian Patents Database

01/09/2002 - 17:10:25

(12) **Patent:** (11) **CA 521055**

(54) APPARATUS FOR STRIPPING SUSPENDED CATALYST

(54) APPAREIL POUR LE DEPOUILLEMENT DE CATALYSEUR SUSPENDU

| | |
|---|---|
| (72) Inventors (Country): | **LLOYD A. NICOLAI** (Not Available)<br>**BURON V. MOLSTEDT** (Not Available)<br>**HOWARD G. CODET** (Not Available)<br>**EGER V. MURPHREE** (Not Available)<br>**ARNOLD F. KAULAKIS** (Not Available) |
| (73) Owners (Country): | **ESSO RESEARCH AND ENGINEERING COMPANY** (United States) |
| (71) Applicants (Country): | |
| (74) Agent: | |
| (45) Issued on: | **Jan. 24, 1956** |
| (22) Filed on: | |
| (43) Laid open on: | |
| (52) Canadian Class (CPC): | **196/125 23/422** |
| (51) International Class (IPC): | **N/A** |
| Patent Cooperation Treaty (PCT): | **No** |
| (30) Application priority data: | **None** |
| Availability of licence: | **N/A** |
| Language of filing: | **Unknown** |

ABSTRACT:

CLAIMS: Show all claims

*** Note: Data on abstracts and claims is shown in the official language in which it was submitted.

View or Download Images :

Cover Page Image

Abstract Image

Claims Image

This invention pertains to an improved apparatus for carrying out catalytic reactions wherein finely divided catalyst particles are held in suspension in the reactant materials and particularly to the stripping of adsorbed and/or entrained fluidal materials from the solid catalyst particles utilized in the catalytic conversion of hydrocarbons.

There has been developed in recent years in certain catalytic operations, a method which is commonly referred to as the fluid catalyst method or technique in which finely divided solid catalyst particles are carried through a reaction zone in a stream of vapors undergoing reaction. This method or technique is applicable to a wide variety of catalytic reactions and while for purposes of illustration this invention will be specifically described in connection with the catalytic cracking of hydrocarbons, it is to be understood that the invention is not limited thereto but may be used in other catalytic processes or in other catalytic conversions of hydrocarbons where it is desired to remove vapors or gases from dense, fluidized, liquid-simulating mixtures of solid catalyst particles and gaseous fluids.

In general, in the fluid catalyst method the vaporous reactants and catalysts are introduced into the bottom of the reaction vessel, passed upwardly therethrough and are discharged into separation equipment in which the catalyst particles are separated from the vaporous products and returned to the reaction vessel preferably after regeneration. In a modified or improved design of catalytic cracking unit, the finely divided catalysts or contact particles are continuously introduced into the reaction vessel with the hydrocarbon materials to be cracked and the velocity of the vapors is so controlled that the catalyst particles are maintained in a dense, dry, fluidized, liquid-simulating condition in the lower portion of the reaction zone. The hydrocarbon vapors or gases pass upwardly through the dense, fluidized mixture of catalyst particles at controlled velocities as indicated and the vaporous products are taken overhead from the reaction zone.

During the cracking of hydrocarbons and also in other catalytic conversions of hydrocarbon materials, coke or carbonaceous materials are deposited on the catalyst or contact particles thereby reducing or destroying their catalytic activity. The contaminated or spent catalyst particles must be regenerated before being reused in the cracking or other catalytic operation. In the regeneration, the contaminated or spent catalyst particles are withdrawn as a dense, fluidized mixture from the lower portion of the reaction zone and the carbon or other combustible deposits are contacted with air or other regenerating gas which burns off the carbonaceous deposits.

The contaminated, spent catalyst or contact particles withdrawn from the lower portion of the reaction zone contain entrained hydrocarbon vapors or gases and before regenerating the particles it is preferred practice to remove the entrained hydrocarbons in a stripping or purging operation. The efficient stripping of hydrocarbon vapors from the spent catalyst remains an important and pressing problem even after several years of commercial operation of fluid catalyst cracking plants. Most of the commercial units are limited in their throughput by the capacity of their carbon burning systems, yet 10 to 30% of the oxygen supplied to the regenerative system goes to the combustion of gaseous or strippable hydrocarbons carried to the regenerator by the spent catalyst. Besides greatly reducing the feed throughput, these strippable hydrocarbons, amounting to anywhere from 0.5 to 1.5 wt. % on feed, represent a sizable loss of potential products. The present invention relates to an improved design for a stripping or purging section or zone for a fluidized solids reactor.

In accordance with the present invention the mixture of catalyst or contact particles and the hydrocarbons or other reactants are introduced into the bottom portion of a reaction zone wherein the catalyst is maintained as a dry, dense, liquid-simulating fluidized bed and catalyst is continuously withdrawn from the fluidized bed and passed through a stripping zone wherein the catalyst particles are contacted with steam or other stripping agent in order to remove the strippable hydrocarbons that are adsorbed upon or carried by the catalyst particles from the reaction bed into the stripping section. The stripping zone or section is preferably of annular form and arranged adjacent the wall of the lower portion of the reaction zone. The stripping zone may be a continuous annulus or it may be subdivided into a large number of cells by means of radial baffles and the single annulus or the individual cells may be provided with suitable baffles for increasing contact of catalyst particles and stripping gas which is introduced at the bottom of the stripping zone.

Since the efficacy of a stripping zone is determined by the ratio of the length to the effective diameter of the zone, subdividing the annular stripping section into a plurality of long, narrow sections or cells should give improved stripping. It was found, however, that the efficacy of such cellular strippers was not nearly as good as had been expected. It is believed that the relatively poor performance characteristic of the cellular stripper is attributable to the fact that distribution of the catalyst to the cells and flow through the cells is not uniform particularly during reactor surges and during periods of variations of flow of gases in the stripper and/or the reactor and that under some extreme conditions upflow of catalyst occurs in a number of the cells.

It has now been found that distribution and flow of catalyst through the cells can be made more uniform, upflow of catalyst in the stripping zones can be avoided and the efficiency of cellular strippers can be substantially improved if an orifice is provided at the entrance to or in each of the long, narrow stripping zones. By providing for a pressure drop of about 0.1 to about 5 lbs. per square inch across such orifices, positive flow of the catalyst particles downwardly in each of the stripping zones can be assured and flow of catalyst through each of the cells during reactor surges and gas flow variations in the stripper cells can be made substantially uniform.

According to one form of the present invention separate catalyst entrance ports and separate stripping gas exit ports are provided in the stripping zone, the catalyst entrance ports being arranged below the level of the dense, fluidized bed-dilute phase interface and the stripping gas exit ports being arranged well up into the dilute phase. By means of this arrangement recycling of vapors and catalyst at the entrance to the stripper is decreased and introduction of steam or other stripping gas into the active reaction zone or dense fluidized bed is avoided. If desired, steam or other stripping agent may be injected into the catalyst entrance ports to the stripping zone. In view of the relatively high catalyst velocity in these ports, good mixing of catalyst and stripping agent can be attained by injecting the stripping agent into the catalyst entrance ports. Narrow stripping cells extend from substantially the bottom of the reaction vessel to a point well above the maximum dense bed level in the reactor. Inlet ports for the discharge of catalyst from the dense bed into the long narrow stripping cells are arranged at any desired level between the perforated distribution plate and the minimum dense bed level. These inlet ports may be any desired form such as circular, semicircular, rectangular or triangular and are of such dimensions that a pressure drop through the port of about 0.2 to 3.0 lbs. per sq. in. is produced. The catalyst level in the stripping cells is ordinarily a little lower than the dense bed level in the reactor and the cells extend a sufficient distance above the dense bed level to provide a catalyst disengaging space. The provision of a pressure drop between the dense bed and the stripping cell avoids recirculation of the catalyst from the stripping cell back into the dense bed or active reaction zone and extension of the cells upwardly into the dilute phase results in the discharge of the stripping vapors into the dilute phase rather than into the dense bed.

The stripper zones in accordance with the present invention insure equal distribution of the catalyst to the several cells by reason of the fact that the catalyst inlet orifices exert a leveling effect upon the flow of catalyst to the cells during reactor surges or steam failures in the stripper cells and extension of the radial baffles which divide the annular space into long, narrow cells upwardly at least as high as the maximum catalyst bed level in the stripping zone prevents flow or mixing of catalyst from cell to cell. If the baffles or the cells only extended to some point below the level of catalyst in the stripping section, a common reservoir of catalyst would be formed at the upper part of the stripping section and, if the flow of stripping agent to a particular cell should stop for any reason, flow of catalyst through that cell would become excessive and the common reservoir would be rapidly drained through that cell without any stripping occurring.

Steam or other inert stripping gas is introduced into the bottom portion of each stripping zone preferably at more than one point or in more than one direction so that the distribution of the stripping agent is substantially uniform over the entire cross-section of the stripping cell. The individual stripping cells may, if desired, be provided with baffles for improving or increasing the contact of catalyst particles and stripping agent.

Embodiments of the invention are illustrated in the accompanying drawings in which:

Figure 1 represents a vertical cross section of the lower portion of the reaction vessel embodying the invention.

Figure 2 is a transverse cross section taken substantially on the line 2-2 of Figure 1.

Figure 3 is an enlarged cross section of a single cell of the stripping section showing a suitable baffle and stripping agent inlet arrangement.

Figure 4 is a sectional view of the bottom portion of a stripper cell showing means for distributing the stripping steam.

Figure 5 is a sectional view of a catalyst-flow restriction orifice provided with stripping steam distributor means in close proximity thereto.

Figure 6 is a plan view of the orifice and steam distributor shown in Figure 5.

Figure 7 represents a vertical elevation partly in section of a preferred form of apparatus embodying the invention and having separate catalyst inlet ports and separate stripping gas outlet ports.

Figure 8 is a vertical cross section of a stripper cell provided with another form of baffle suitable for forming separate catalyst inlet ports and separate stripping gas outlet ports for the stripper cell, and

Figure 9 is a cross section of a different form of baffle.

Referring now to Figure 1 of the drawing, the reaction vessel (10) comprises an upper hemispherical dome section (11), a large cylindrical section (12) and a frustro conical bottom section (13) and is provided with an inlet line (14) for introducing a mixture of reactants and catalyst or contact particles. The catalyst particles are introduced into line (14) from a standpipe or the like (15) which is equipped with a valve (16) for controlling the rate at which the catalyst particles are supplied to line (14) from the standpipe (15).

The suspension of solid catalyst or contact particles in reactant vapors is passed through feed line (14) into an inlet chamber (17) comprising an upwardly flared wall member (18) and a grid member or perforated distribution plate (19) at its upper end. In the form of the apparatus shown in the drawing, the reaction vessel is circular in cross section and the grid member (19) is circular and centrally arranged in the reaction vessel. The diameter of the grid member (19) is less than the internal diameter of the reaction vessel to provide an annular passageway for the withdrawal of catalyst particles from the lower portion of the reaction vessel as will be hereinafter described in greater detail.

The velocity of the gaseous reactant fluid passing upwardly in the reaction vessel (10) is preferably so controlled as to maintain the solid contact or catalyst particles as a dense fluidized liquid-simulating dry mixture or bed (20) having a level indicated at (21). The vaporous reaction products leaving the dense bed (20) entrain a small amount of solid catalyst particles forming a dilute phase or suspension designated at (22) in the upper portion of the reaction vessel (10).

The reaction products and entrained catalyst particles are passed through separating means (23) arranged in the upper portion of the reaction vessel. This separating means, which may be a cyclone separator or the like, separates most of the entrained solid catalyst particles from the vaporous reaction products. The solid catalyst particles separated in the cyclone (23) are returned to the dense bed (20) through the dip leg or pipe (24) which extends below the upper level (21) of the dense bed (20). A valve for controlling return of catalyst particles to the dense bed and means for introducing steam or other fluidizing gas may be provided in the dip leg (24). The vaporous reaction products leaving the separating means (23) pass overhead through line (25) and may then be passed to any suitable equipment to effect further removal of entrained solids and to recover the desired products. In the catalytic cracking or conversion of hydrocarbons the vaporous reaction products are passed to a fractionating system to separate gasoline or motor fuel from gases and higher boiling hydrocarbon constituents.

3 /Removal of catalyst particles from the dense phase or bed (20) is effected through the stripping zone generally indicated at (26) which is formed between the inner wall of the cylindrical shell (12) and a smaller diameter concentric vertically arranged sleeve (27) which surrounds the distribution

plate (19) and extends some distance above and also below the said distribution plate. The upper end of the conical wall member (18) is secured as by welding to the distribution plate (19) as well as the sleeve member (27). Secured to the bottom of sleeve member (27) is a conical baffle or wall member (28) for reducing the effective volume below the inlet chamber (17). The conical member (28) is arranged substantially equidistant from the lower conical section (13) of the reactor and is provided with a vent hole (29). A steam bleeding line (30) is provided for supplying steam or the like, to the chamber (31) formed between walls (18) (27) and (28) in order to prevent the accumulation of catalyst particles in said chamber.

The annular space (26) formed between the inner wall of cylindrical shell (12) and the cylindrical sleeve (27) is subdivided into a plurality of long and narrow stripping zones or sections by means of radial baffles (32) which are substantially the same height as the cylindrical sleeve (27) and which extend from the outer wall of cylindrical sleeve (27) to the inner wall of cylindrical shell (12). The number of baffles (32) and accordingly the number of stripping zones provided may be varied as desired. Commercial units having an internal diameter of 25-30 feet may, for example, have the annular stripping section divided into about 40 to 70 or even more stripping zones or cells. An inlet (33) for the supply of steam or other stripping agent is arranged at the bottom of each of the stripping cells, the several inlets being in turn connected to a manifold (34) which is connected by line (35) to a source of supply of stripping gas. The stripping cells are preferably provided with suitable inclined baffles (36) in order to increase the mixing or contact of the upflow of stripping or purging gas and the downflowing spent or contaminated catalyst particles. As shown, the inclined baffles extend alternately from the outer and inner cylindrical wall member (12) and (27) in order to force the catalyst particles to follow a sinuous course down through the stripper cells. The baffles could also be in the form of alternate disc and donut baffles.

An orifice plate (37) is provided at the bottom of each of the stripper cells. The plates (37) are so designed as to give a pressure drop of from 0.1 to 5.0 lbs. per square inch across the orifice. By providing this pressure drop the flow of catalyst through the several cells is rendered more uniform and the amount of catalyst and vapor recycled from the bottom of one cell up through an adjacent cell is reduced if not completely eliminated. Flow of catalyst through cells which are not provided with a flow restricting orifice in accordance with this invention is subject to wide fluctuation during reactor surges when the dense bed catalyst level varies and particularly during failures of fluctuations in the flow of stripping steam through one or more of the cells.

The catalyst particles discharged from the stripping cells through the orifice plates (37) flow downwardly in the annular conical passageway (38) and are discharged into standpipe (39) which leads to a regenerator or the like for revivifying the spent stripped catalysts in known manner

Figures 2 and 3 show in somewhat more detail the arrangement of stripping cell. As there shown the radial baffles (32) are secured to the inner wall of the cylindrical outer shell (12) and to the outer wall of the inner cylindrical sleeve (27) as by welding at (40). The inclined baffles (36) arranged in each of the stripper cells are secured to the radial baffles (32) or to the cylindrical sleeve (27) or the outer cylindrical wall (12). Other baffle arrangements such as alternate disc and donut baffles could be provided in order to increase the contact of the catalyst particles and stripping agent. The orifice plates (37) are preferably secured to the bottoms of the radial baffles (32). The orifice plates can be located at places other than the bottom of the stripper cells but placing them at higher points reduces the effective length of the stripper cell. As indicated above, the orifice plate should be designed to give a pressure drop of from 0.1 to 5.0 lbs. per square inch. This pressure drop suffices to even out the flow through the several cells and to prevent upflow or recycling of stripped catalysts from the bottom of one stripping cell upwardly through an adjoining cell.

The steam inlet (39) to the bottom of the stripper is shown in Fig. 1 as a single nozzle. By providing for the discharge of the stripping gas or steam at a plurality of points or in several directions it is possible to improve materially the contact of catalyst particles and stripping gas. The stripping gas inlet means can take many forms. For example, it can comprise an elongated pipe having a plurality of holes drilled therein or it can be provided with one or more side arms of the same or different size with one or more outlet holes therein or it could comprise a ring-shaped member with a plurality of openings for the discharge of stripping gas. Uniform distribution of the stripping agent can also be achieved as shown in Fig. 4 by arranging a suitable baffle such as a disc (43), provided with a plurality of openings (44) over the outlet of a single nozzle in order to break up or disperse the stream of stripping gas.

A preferred arrangement is shown in Figures 5 and 6. In this embodiment, the stripping gas distributor is in the form of a ring (42) arranged directly above the catalyst restricting orifice plate (37). By making the distributor member in this form, even distribution of the stripping gas is achieved and by arranging the distributor directly adjacent the orifice, the catalyst particles are maintained in a fluidized condition right up to the catalyst outlet port.

Referring to Fig. 7 of the drawing, the reaction vessel (105) comprises an upper hemispherical dome section (106) a large cylindrical section (107) a frustro conical section (108) a small cylindrical section (109) and a frustro conical bottom section (110) and is provided with inlet lines (111) for introducing a mixture of reactants and catalyst or contact particles. The catalyst particles are introduced into line (111) from a standpipe or the like (112) which is equipped with a valve (113) for controlling the rate at which the catalyst particles are supplied to line (111) from the standpipe (112).

The suspension of solid catalyst or contact particles in reactant vapors is passed through feed lines (111) into an inlet chamber (114) comprising an upwardly flared wall member (115) and a grid member or perforated distribution plate (116) at its upper end. The discharge ends of the feed lines (111) are preferably flared as at (117) and a conical baffle (118) is arranged over each outlet in order to distribute the charge in the inlet chamber (114). A vent hole (119) is provided at the apex of the conical baffle plates (118) in order to prevent accummulation and stagnation of catalyst in said baffles. In the form of the apparatus shown in the drawing, the reaction vessel is circular in cross section and the grid member (116) is circular and centrally arranged in the reaction vessel. The diameter of the grid member (116) is less than the internal diameter of the smaller cylindrical section (109) of the reaction vessel to provide an annular passageway for the withdrawal of catalyst particles from the lower portion of the reaction vessel as will be hereinafter described in greater detail.

The velocity of the gaseous reactant fluid passing upwardly in the reaction vessel (105) is preferably so controlled as to maintain the solid contact or catalyst particles as a dense, fluidized, liquid-simulating, dry mixture or bed (120) having a level indicated at (121). The vaporous reaction products leaving the dense bed (120) entrain a small amount of solid catalyst particles forming a dilute phase or suspension designated at (122) in the upper portion of the reaction vessel (105) namely in the upper portions of the large cylindrical section (107) and in the dome-shaped section (106).

The reaction products and entrained catalyst particles are passed through separating means (123) arranged in the upper portion of the reaction vessel. This separating means which may be a cyclone separator or the like, separates most of the entrained solid catalyst particles from the vaporous reaction products. The solid catalyst particles separated in the cyclones (123) are returned to the dense bed (120) through the dip legs or pipes (124) which extend below the upper level (121) of the dense bed (120). Valves (125) for controlling the return of catalyst particles to the dense bed and steam lines (126) for fluidizing the separated catalyst particles may be provided in the dip legs (124). The vaporous reaction products leaving the separating means (123) pass overhead through line (127) and may then be passed to any suitable equipment to effect further removal of entrained solids and to recover the desired products. In the catalytic cracking or conversion of hydrocarbon the vaporous reaction products are passed to a fractionating system to separate gasoline or motor fuel from gases and higher boiling hydrocarbon constituents.

Removal of catalyst particles from the dense phase or bed (120) is effected through the stripping zone generally indicated at (128) which is formed between the inner wall of the small cylindrical section (109) and a smaller diameter concentric vertically arranged sleeve (129) which surrounds the distribution plate (116) and extends some distance above and also below the said distribution plate. The upper end of the wall member (115) is preferably secured as by welding to the grid plate (116) as well as the sleeve member (129). Secured to the bottom of sleeve member (129) is a conical baffle member (130) for reducing the effective volume below the inlet chamber (114). The conical member (130) is arranged substantially equidistant from the lower conical section (110) of the reactor and is provided with a vent hole (131). A steam bleed line (132) is provided for supplying steam or the like, to the chamber (133) formed between walls (115), (129) and (130) in order to prevent the accumulation of fine catalyst particles in said chamber.

The annular space (128) formed between the inner wall of cylindrical section (109) and the cylindrical sleeve (129) is subdivided into a plurality of long and narrow stripping zones or cells by means of radial baffles (134). In accordance with the present invention these stripping zones or cells are extended upwardly well above the maximum dense bed catalyst level in the reaction zone. This may be readily accomplished by extending the sleeve (129) surrounding the distributor plate (116) upwardly the desired distance above the dense bed catalyst level (121) such as to (134). This extension of the sleeve (129) can be made in one or more sections and it may conform to the shape of the inner walls of the reaction vessel and be spaced a uniform distance therefrom as shown in Fig. 7, or it may, if desired, be arranged at different distances from the inner wall by making it of uniform size and shape. It could, for example, be tapered gradually to provide a relatively narrow stripping gas exit port at the top of the cells or that portion of the inner wall of the cell extending above the dense bed catalyst level could be flared outwardly to reduce the cross-sectional area of the stripping cells or flared inwardly to increase the cross-sectional area of the cells. The radial baffles which divide the annular space (128) into relatively long and narrow stripping cells or zones are also extended upwardly generally to the same height as the inner wall member (129) although any height greater than the dense bed level in the stripper cells will suffice. Ordinarily the dense bed catalyst level in the stripping cells is a little lower than the dense bed catalyst level in the reactor.

Inlet ports (135) are arranged in the walls (129) at a point above the distributor plate (116) and below the minimum dense bed catalyst level for the discharge of catalyst particles from the dense bed (120) into the stripping cells. The openings or inlet ports (135), which may be of any desired shape are of such size as to produce a pressure drop through the port of from about 0.2 to 3.0 lbs. per sq. in. By providing this pressure drop through the inlet ports and extending the stripping cells above the dense bed catalyst level substantially uniform distribution of catalyst to the several cells and more uniform stripping of the catalyst can be achieved. This is due to the fact that the restricted catalyst inlet ports even out the flow of catalyst to the strippers under abnormal conditions such as surges in the reactor bed level or failure of supply of stripping agent to one or more stripper cells.

The number of baffles and accordingly the number of stripping zones or cells provided may be varied as desired. A commercial unit having an overall height of 59 feet from the bottom of the smaller cylindrical section to the center line of the cyclone inlet and having an internal diameter at the said smaller cylindrical section (109) of 30 feet, has been divided into 44 stripping zones. However, 70 or even more stripping zones may be provided if desired. Inlets (137) for the supply of steam or other stripping agent are arranged at the bottom of each of the stripping cells. The stripping cells may if desired be provided with suitable baffles (138) and (139) in order to increase the mixing or contact of the upflow of stripping or purging gas and the downflowing spent or contaminated particles as shown in the right hand stripping cell of Fig. 7. Although adequate stripping can be obtained in an unbaffled cell such as is shown in the left hand stripping cell of Fig. 7, particularly if the stripping gas inlet (137) is provided with a number of nozzles (140) to distribute the stripping agent uniformly over the cross-section of the stripping cell, disc and donut baffles can be provided as shown in the right hand stripping cell of Fig. 7.

The catalyst particles discharged from the stripping cells flow downwardly in the annular conical section (142) and are discharged into standpipe (143) which leads to a regenerator or the like for revivifying the spent, stripped catalysts in known manner.

The baffle member (129) need not conform to the shape of the reactor vessel since other forms are equally if not more suitable. Other forms of baffles which may be used are shown in Fig. 8 and Fig. 9. In Fig. 8, only a portion of the perforated distribution plate (151) and modified form of conical wall member (152) are shown. The baffle for providing separate catalyst inlet ports and stripping gas outlet ports comprises an upper cylindrical portion (153) and a lower, inwardly flared or inverted frusto-conical portion (154) the smaller portion of which has a diameter substantially the same as the diameter of the cylindrical skirt or sleeve (155), the bottom of the baffle member being arranged in close proximity to the top of the cylindrical sleeve to form the restricted inlet port (156). As shown in this figure, the annular stripping zone or section (157) is subdivided into a plurality of cells by means of radial baffles of substantially the same height as the cylindrical sleeve (155) and the cell shown is further provided with baffles such as donut baffles (158) and disc baffles (159) in order to increase the contact of catalyst particles and stripping agent. The form of baffle shown in Fig. 8 has the advantage over the baffle of Fig. 7 of making considerably more reactor volume available for useful work. The simplest form of baffle would be the inverted frustro-conical baffle (160) shown partially in Fig. 9 having its smallest diameter substantially equal to the diameter of the cylindrical sleeve (161) and its largest diameter slightly smaller than the diameter of the shell (162), the overall length of the baffle being sufficient to extend the upper edge thereof above the maximum level (163) of the dense bed (164) or (165) well up into the dilute phase.

The operation of the apparatus in accordance with the present invention will now be described in connection with the catalytic cracking of hydrocarbons. In such catalytic cracking operations the reactant fluid or feed stock comprise hydrocarbons such as, gas oil, reduced crude, petroleum oil, whole crude and heavy naphtha in liquid or vapor form or partly in liquid and partly in vapor form. The catalyst or contact particles may comprise acid treated bentonitic clay, synthetic silica-alumina or silica-magnesia gels or mixtures thereof with activators and promoters such oxides as zinc, calcium, thorium, boron, zirconium, vanadium, chromium, molybdenum and the like or any other suitable cracking catalyst. The catalyst particles may be of any desired form, micro spherical particles being particularly convenient. The major proportion of the catalyst particles are ordinarily from about 20 to 200 microns in diameter.

Hot powdered catalyst such as a silica-alumina or silica-magnesia cracking catalyst supplied from standpipe (13) and relatively heavy hydrocarbon oil such as, gas oil supplied through the feed inlet in vaporized or partially vaporized condition are passed through inlet line (14) into the inlet chamber (17) at temperatures between 800 and 1100°F. preferably at about 975°F. The catalyst to oil ratio may vary between about 5:1 and about 30:1 by weight. The mixtures of powdered catalyst and hydrocarbon vapors are passed from the inlet chamber (17) through the distribution plate or grid (19) into the reactor proper to form a fluidized dry liquid simulating mixture or dense bed (20) in the reaction vessel. Velocity of the vaporized hydrocarbon materials through the bed is from about 0.6 to 2.0 ft. per second and the density of the catalyst in the dense bed (20) varies from about 10 to 30 lbs. per cu. ft.

The vaporous reaction products leaving the dense bed (20) carry along small amounts of the catalyst fines forming a dilute phase (22). The reaction products are discharged through the cyclone separators (23) for separating catalyst fines which are returned to the dense bed (20) through dip leg (24) while vaporous reaction products pass overhead through line (25) to suitable recovery or treating equipment.

During the cracking operation the catalyst particles become spent by the deposition of coke or carbonaceous material thereon. The spent or contaminated catalyst particles in fluidized condition and containing adsorbed and entrained hydrocarbon vapors and gases are withdrawn continuously through the annular stripping space (26). As the spent catalyst particles descend through the stripping cells they are contacted countercurrently with steam or other suitable stripping gas supplied through line (37). By discharging the catalyst from the stripping cell through the orifice plates (37) a substantial pressure drop is taken and uniform distribution and flow of catalyst through the several cells is achieved and the danger of upflow occuring to carry stripped catalyst particles back into the dense bed is obviated. The stripped catalyst particles pass into the conical passageway (38) and then into standpipe (39) whence they are discharged into a regenerator wherein the coke or carbonaceous deposits are burned off rendering the catalyst particles suitable for recycling to standpipes (15) and thence into the reaction vessel (10). Steam or other aerating gas may be introduced into passageway (38) through lines (41) in order to fluidize the catalyst particles.

While the improved stripper arrangement has been specifically described in connection with the catalytic cracking of hydrocarbons it is to be understood that the apparatus may be used for removing volatile material from other solid contact particles in other reactions such as the dehydrogenation of butane or butylene fractions, aromatization of naphtha fractions, coking of heavy residues and the like; and also may be used generally in other reactions involving contact of solid particles with gaseous or vaporous reactants. For example, the apparatus could also be applied in the treatment of known hydrocarbon materials such as, the oxidation of alcohol to aldehydes or acids or to the preparation of anhydrous hydrogen chloride.

While the best known form of apparatus has been described above, it is to be understood that this is by way of illustration only and that various changes and modifications may be made without departing from the spirit of this invention.

What is claimed:

1. An apparatus including a cylindrical vessel for contacting gasiform materials with finely divided solids adapted to be maintained as a dense, dry, liquid-simulating fluidized bed in the lower portion of said vessel, an inlet chamber in the bottom portion of said vessel for the supply of gasiform materials and solids thereto, a circular perforated distribution plate arranged substantially horizontally at the upper portion of said inlet chamber, said plate being concentric with said vessel but of smaller diameter, a vertically disposed cylindrical member surrounding said distribution plate and extending above it, said cylindrical member being spaced from the inner wall of said vessel to provide an annular passageway for the withdrawal of solids from the dense fluidized bed adapted to be maintained in said vessel, radial baffles extending between the inner wall of said vessel and the outer wall of said cylindrical member dividing said annular passageway into a plurality of long narrow stripping sections, means for introducing a stripping agent into the lower portion of each of said stripping sections, a cylindrical baffle member arranged adjacent to the upper end of said cylindrical member and extending upwardly above the maximum level of the dense, dry, liquid-simulating bed adapted to be maintained in said vessel, the lower end of said cylindrical baffle member being coextensive with the upper end of said cylindrical member and being uniformly spaced therefrom to provide a restricted opening from the dense fluidized bed adapted to be maintained in said vessel into said annular passageway, said cylindrical baffle member comprising an inverted frustoconical section, the smallest diameter of which is substantially the same as the diameter of said cylindrical member and the largest diameter of which is a little less than the internal diameter

1 (Cont'd.) of said vessel, and a cylindrical section provided on the upper end of said inverted frusto-conical section and of substantially the same diameter as the upper end of said frusto-conical section, the lower and smaller diameter of said baffle member being arranged in close proximity to the upper end of said cylindrical member to provide said restricted opening from the dense fluidized bed adapted to be maintained in said vessel directly into said annular passageway for the withdrawal of solids directly from the dense fluidized bed adapted to be maintained insaid vessel into said annular passageway, said baffle member being spaced from the inner wall of the vessel to provide an outlet port well above the maximum level of the dense fluidized bed adapted to be maintained in said vessel for the discharge of stripping agent and stripped-out material released in said annular passageway, an outlet for gasiform material in the upper portion of said vessel and an outlet for solids in the lower portion of said vessel.

2. An apparatus including a cylindrical vessel for contacting gasiform materials with finely divided solids adapted to be maintained as a dense, dry, liquid-simulating fluidized bed in the lower portion of said vessel, an inlet chamber in the bottom portion of said vessel for the supply of gasiform materials and solids thereto, a circular perforated distribution plate arranged substantially horizontally at the upper portion of said inlet chamber, said plate being concentric with said vessel but of smaller diameter, a vertically disposed cylindrcal member surrounding said distribution plate and extending above it, said cylindrical member being spaced from the inner wall of said vessel

2 (Cont'd.) to provide an annular passageway for the withdrawal of solids from said dense fluidized bed adapted to be maintained in said vessel, radial baffles extending between the inner wall of said vessel and the outer wall of said cylindrical member dividing said annular passageway into a plurality of long narrow stripping sections, means for introducing a stripping agent into the lower portion of each of said stripping sections, a baffle member arranged adjacent to the upper end of said cylindrical member and extending upwardly above the maximum level of the dense, fluidized bed, adapted to be maintained in said vessel, the lower end of said baffle member being coextensive with the upper end of said cylindrical member and being uniformly spaced therefrom to provide a restricted opening from the dense fluidized bed adapted to be maintained in said vessel directly into said annular passageway for withdrawal of solids directly from the dense fluidized bed adapted to be maintained in said vessel into said annular passageway, said baffle member comprising an inverted frusto-conical member, the smallest diameter of which is substantially the same as the diameter of said cylindrical member and the largest diameter of which is a little less than the internal diameter of said vessel, the lower end of said inverted frusto-conical member being in sufficiently close proximity to the upper end of said cylindrical member to provide said restricted opening for the withdrawal of solids directly from the dense fluidized bed adapted to be maintained in said vessel into said annular passageway and to produce a pressure drop through said restricted opening of from 0.5 to 5.0 lbs. per square inch, said baffle member being spaced from the inner wall of the vessel to provide an outlet port well above the maximum level of the dense fluidized bed adapted to be maintained in said vessel for the discharge of stripping agent and stripped- out material released in said annular passageway,

2. (Cont'd.) an outlet for gasiform material in the upper portion of said vessel.

3. An apparatus including a cylindrical vessel for contacting gasiform materials with finely divided solids adapted to be maintained as a dense, dry, liquid-simulating fluidized bed in the lower portion of said vessel, an inlet chamber in the bottom portion of said vessel for the supply of gasiform material and solids thereto, a circular perforated distribution plate arranged substantially horizontally at the upper portion of said inlet chamber, said plate being concentric with said vessel but of smaller diameter, a vertically disposed cylindrical member surrounding said distribution plate and extending above it, said cylindrical member being spaced from the inner wall of said vessel to provide an annular passageway for the withdrawal of solids from said dense fluidized bed adapted to be maintained in said vessel, radial baffles extending between the inner wall of said vessel and the outer wall of said cylindrical member dividing said annular passageway into a plurality of long narrow stripping sections, means for introducing a stripping agent into the lower portion of each of said stripping sections, a baffle member arranged adjacent to the upper end of said cylindrical member and extending upwardly above the maximum level of the dense, fluidized bed adapted to be maintained in said vessel, the lower end of said baffle member being coextensive with the upper end of said cylimdrical member and being uniformly spaced therefrom to provide a restricted opening from the dense fluidized bed adapted to be maintained in said vessel directly into said annular passageway for the withdrawal of solids directly from the dense fluidized bed adapted to be maintained in said vessel into said annular passageway, said baffle member comprising of

3. (Cont'd.) an inverted frusto-conical section, the smallest diameter of which is substantially the same as the diameter of said cylindrical member and the largest diameter of which is a little less than the internal diameter of said vessel, and a cylindrical section provided on the upper end of the inverted frusto-conical section and of substantially the same diameter as said upper end of said frusto-conical section, the lower and smaller diameter end of said baffle member being arranged in sufficiently close proximity to the upper end of the cylindrical member to provide said restricted opening into said annular passageway giving a pressure drop of about 0.5 to 5.0 lbs. per square inch for the withdrawal of solids directly from the dense fluidized bed adapted to be maintained insaid vessel into said annular passageway, said baffle member being spaced from the inner wall of the vessel to provide an outlet port above the maximum level of the dense fluidized bed adapted to be maintained in said vessel for the discharge of stripping agent and stripped out material released in said annular passageway, an outlet for gasiform material in the upper portion of said vessel and an outlet for solids in the lower portion of said vessel.

4. An apparatus including a cylindrical vessel for contacting gasiform materials and finely divided solids adapted to be maintained as a dense, dry, liquid-simulating bed in the lower portion of said vessel with a dilute phase thereabove in the upper portion of said vessel, an inlet chamber in the bottom portion of said vessel for the supply of gasiform material and solids thereto, a circular perforated distribution plate arranged

A.

4. (Cont'd.) substantially horizontally at the upper portion of said inlet chamber, a vertically disposed cylindrical member surrounding said distribution plate and extending above said distribution plate and spaced from the inner wall of the vessel to provide an annular passageway for the withdrawal of solid particles from the dense fluidized bed adapted to be maintained in said vessel, a multiplicity of spaced inlet lines arranged entriely around said vessel for introducing stripping gas into the lower portion of said annular passageway at a multiplicity of spaced points entirely around said annular passageway, an annular baffle member forming an extension of the upper end of said cylindrical member and extending upwardly above the maximum level of the dense, dry, liquid-simulating bed adapted to be maintained in said vessel, said cylindrical member above said distribution plate being provided with a multiplicity of spaced restricted openings arranged entirely around said members and leading from the dense fluidized bed adapted to be maintained in said vessel directly into said annular passageway for the withdrawal of solids directly from the dense bed adapted to be maintained in said vessel into said annular passageway, said restricted openings being of such size to effect a substantial pressure drop from the dense fluidized bed adapted to be maintained in said vessel into said annular passageway, said annular baffle member being spaced from the inner wall of the vessel to provide an outlet port discharging into the dilute phase in the upper portion of said vessel above the maximum level of said dense fluidized bed adapted to be maintained in said vessel for the discharge of stripping gas and stripped-out material released in said annular passageway, an outlet for gasiform materials in the upper portion of said vessel and an outlet for solids in the lower portion of said vessel.

5. An apparatus according to claim 4 wherein said annular passageway is provided with vertically spaced, horizontally extending baffles to improve contacting between the solids and stripping gas therein.

6. An apparatus including a cylindrical vessel for contacting gasiform materials and finely divided solids adapted to be maintained as a dense, dry, liquid-simulating bed in the lower portion of said vessel with a dilute phase thereabove in the upper portion of said vessel, an inlet chamber in the bottom portion of said vessel for the supply of gasiform material and solids thereto, a circular perforated distribution plate arranged substantially horizontally at the upper portion of said inlet chamber, a vertically disposed cylindrical member surrounding said distribution plate and extending above said distribution plate and spaced from the inner wall of the vessel to provide an annular passageway for the withdrawal of solid particles from the dense fluidized bed adapted to be maintained in said vessel, a multiplicity of spaced inlet lines arranged entirely around said vessel for introducing stripping gas into the lower portion of said annular passageway at a multiplicity of spaced points entirely around said annular passageway, a baffle member arranged adjacent to and extending above the upper end of said cylindrical member and extending upwardly above the maximum level of the dense fluidized bed adapted to be maintained in said vessel, the lower end of said baffle member being substantially uniformly spaced from the upper end of said cylindrical member to provide a restricted opening leading from the dense fluidized bed adapted to be maintained in said vessel directly into said annular passageway for the withdrawal of solids directly from the dense bed adapted to be maintained in said vessel into said annular passageway.

6. (Cont'd.) said restricted opening being of such size to effect a substantial pressure drop from the dense fluidized bed adapted to be maintained in said vessel into said annular passageway, said baffle member being spaced from the inner wall of the vessel to provide an outlet port discharging into the dilute phase in the upper portion of said vessel above the maximum level of said dense fluidized bed adapted to be maintained in said vessel for the discharge of stripping agent and stripped-out material released in said annular passageway, an outlet for gasiform materials in the upper portion of said vessel and an outlet for solids in the lower portion of said vessel.

7. An apparatus including a cylindrical vessel for contacting gasiform materials with finely divided solids adapted to be maintained as a dense, dry, liquid-simulating fluidized bed in the lower portion of said vessel, an inlet chamber in the bottom portion thereof for the supply of gasiform materials and solids thereto, a circular perforated distribution plate arranged substantially horizontally at the upper portion of said inlet chamber, said plate being concentric with said vessel but of smaller diameter, baffle means including a vertically disposed cylindrical member surrounding said distribution plate and extending above said distribution plate, said cylindrical member being spaced from the inner wall of said vessel to provide an annular passageway for the withdrawal of solids from the fluidized bed adapted to be maintained in said vessel, said baffle means also including an upper annular baffle portion forming an extension of the upper end of said cylindrical member and extending upwardly in said vessel above the maximum level of the dense, dry, liquid-simulating bed adapted to be maintained

7. (Cont'd.) in said vessel, said baffle means being provided with a multiplicity of spaced restricted openings arranged in a circle entriely around said baffle means above said perforated distribution plate but below the minimum level of the dense fluidized bed adapted to be maintained in said vessel and leading from the dense fluidized bed adapted to be maintained in said vessel directly into said annular passageway for the withdrawal of solids directly from the dense fluidized bed adapted to be maintained in said vessel into said annular passageway, said restricted openings being of such size to produce a substantial pressure drop through said openings, a multiplicty of spaced inlet lines arranged entriely around said cylindrical vessel for introducing stripping gas at a multiplicity of spaced points into the lower portion of said annular passageway the upper end of said annular baffle portion being spaced from the inner wall of said vessel to provide an outlet port above the maximum level of the dense fluidized bed adapted to be maintained in said vessel for the discharge of stripping agent and stripped out material released in said annular passageway, an outlet for gasiform material in the upper portion of said vessel and an outlet for solids in the lower portion of said vessel.

8. An apparatus according to claim 7 wherein said annular space is provided with vertically spaced, horizontally extending baffles to improve contacting between the solids and stripping gas therein.



A

9. A process for contacting gaseous fluid and finely divided solids which comprises supplying gaseous fluid and finely divided solids to a cylindrical vessel, controlling the velocity of the gaseous fluid passing upwardly through said vessel to form a dense, fluidized, liquid-simulating bed of solids in the lower portion of said vessel with a dilute phase thereabove, removing gaseous fluid substantially free from solid particles from the dilute phase in the upper portion of said vessel, withdrawing solid particles as a multiplicty of separate streams directly from said dense fluidized solids bed at spaced points entirely aroung the periphery thereof and below the upper level thereof and passing the withdrawn solid particles as a multiplicty of streams into the intermediate portion of a confined annular stripping zone surrounding said dense fluidized bed of solids and at a region above the locus of introduction of gaseous stripping fluid hereinafter referred to, causing each of said streams to take a substantiall pressure drop during passage of the streams from the dense fluidized bed into said annular stripping zone thereby equalizing the flow of solids from said dense fluidized bed into said annular stripping zone, contacting solids in said annular stripping zone with upflowing gaseous stripping fluid introduced at a multiplicity of points into the lower portion of said annular stripping zone, said multiplicity of points being arranged in spaced relation entirely around said annular stripping zone, discharging solids from the bottom of said annular stripping zone into a collecting zone at the bottom of said vessel and withdrawing stripped solids from said collecting zone and passing gaseous stripping fluid and stripped out material from the upper portion of said annular stripping zone directly into said dilute phase above the level of the dense fluidized bed of solids in said vessel for removal from the upper portion of said vessel.

10. An apparatus including a cylindrical vessel for contacting gasiform materials and finely divided solids adapted to be maintained as a dense, dry, liquid-simulating bed in the lower portion of said vessel with a dilute phase thereabove in the upper portion of said vessel, an inlet chamber in the bottom portion of said vessel for the supply of gasiform material and solids thereto, a circular perforated distribution plate arranged substantially horizontally at the upper portion of said inlet chamber, a vertically disposed cylindrical member surrounding said distribution plate and extending above said distribution plate and spaced from the inner wall of the vessel to provide an annular passageway for the withdrawal of solid particles from the dense fluidized bed adapted to be maintained in said vessel, radial baffles extending between the inner wall of said vessel and the outer wall of said cylindrical member for subdividing said annular passageway into long narrow stripping sections, a multiplicity of spaced inlet lines arranged around said vessel for introducing stripping gas into the lower portion of each stripping section, an annular baffle member forming an extension of the upper end of said cylindrical member and extending upwardly above the maximum level of the dense, dry, liquid-simulating bed adapted to be maintained in said vessel, the junction of the lower end of said baffle member and the upper end of said cylindrical member being provided with a plurality of spaced restricted openings arranged around said members and leading from the dense fluidized bed adapted to be maintained in said vessel directly into said annular passageway for the withdrawal of solids directly from the dense bed adapted to be maintained in said vessel into said annular passageway, said restricted openings being of such size to effect a substantial pressure drop from the dense fluidized bed adapted to be maintainted in said vessel into said annular passageway, said

10. (Cont'd.) annular baffle member being spaced from the inner wall of the vessel to provide an outlet port discharging into the dilute phase in the upper portion of said vessel above the maximum level of said dense fluidized bed adapted to be maintained in said vessel for the discharge of stripping gas and stripped-out material released in said annular passageway, an outlet for gasiform materials in the upper portion of said vessel and an outlet for solids in the lower portion of said vessel.

11. An apparatus including a cylindrical vessel for contacting gasiform materials with finely divided solids adapted to be maintained as a dense, dry, liquid-simulating fluidized bed in the lower portion of said vessel, an inlet chamber in the bottom portion thereof for the supply of gasiform materials and solids thereto, a circular perforated distribution plate arranged substantially horizontally at the upper portion of said inlet chamber, said plate being concentric with said vessel but of smaller diameter, baffle means including a vertically disposed cylindrical member surrounding said distribution plate and extending above said distribution plate, said cylindrical member being spaced from the inner wall of said vessel to provide an annular passageway for the withdrawal of solids from the fluidized bed adapted to be maintained in said vessel, said baffle means also including an upper baffle member forming an extension of the upper end of said cylindrical member and extending upwardly in said vesselabove the maximum level of the dense, dry, liquid-simulating bed adapted to be maintained in said vessel, said baffle means beingorovided with a multiplicity of restricted openings arranged around said vessel above said perforated distribution plate but below the minimum level of the dense fluidized bed adapted to be maintained in said vessel and leading from the dense fluidized bed adapted to be maintained insaid vessel directly into said annular passageway for the withdrawal of solids directly from the dense fluidized bed adapted to be maintained in said vessel into said annular passageway, said restricted openings being of such size to produce

11. (Cont'd.) a substantial pressure drop through said openings, said annular passageway being provided with radial baffles for subdividing said annular passageway into long narrow stripping sections, a multiplicity of inlet lines arranged around said cylindrical vessel for introducing stripping gas into the lower portion of each of said stripping sections, the upper end of said baffle member being spaced from the inner wall of said vessel to provide an outlet port above the maximum level of the dense fluidized bed adapted to be maintained in said vessel for the discharge of stripping agent and stripped out material released in said annular apassageway, an out outlet for gasiform material in the upper portion of said vessel and an outlet for solids in the lower portion of said vessel.



A

12. An apparatus of the character described including a vessel adapted to contain a fluidized bed of solid particles and for contacting gaseous fluid and finely divided solid particles and having a top outlet for gaseous fluid and a bottom outlet for solid particles, an inlet chamber in the bottom portion of said vessel for the supply of gaseous fluid and finely divided solids to said vessel, a horizontally arranged perforated member at the upper portion of said inlet chamber, said perforated member being concentric with said vessel and of smaller diameter, a vertically disposed sleeve extending above said perforated member and secured to the periphery thereof, said sleeve extending a substantial distance upwardly in said vessel above the maximum level of the dense fluidized bed of solid particles adapted to be maintained in said vessel and being spaced from the inner wall of said vessel to provide an annular space for the withdrawal of solids, a multiplicity of radial baffles of substantially the same height as said sleeve and arranged between the outer wall of said sleeve and the inner wall of said vessel for dividing said annular space into a multiplicity of elongated narrow parallel cells, said vertical sleeve being provided with a multiplicity of inlet ports arranged entirely around said vertical sleeve and above said horizontally arranged perforated member but below the minimum level of the dense fluidized bed of solids adapted to be maintained in said vessel for the discharge of solids directly from the dense fluidized bed adapted to be maintained in said vessel into each of said cells, each of said inlet ports being of such size to produce a substantial pressure drop through the ports to effect substantial uniform distribution of the solids to each of said cells, means for introducing a stripping agent

into the lower portion of each of said cells below the locus of said inlet ports whereby solid particles passing down through said cells are stripped of volatile material by the upflowing stripping agent and the stripping agent and stripped-out material are conducted by each of said cells into the upper portion of said vessel above the maximum level of the fluidized bed of solid particles adapted to be maintained in said vessel, the bottom of said cells communicating with said bottom outlet in said vessel for removal of solid particles from said vessel.

13. An apparatus according to claim 12 wherein baffle means are provided in each of said cells for increasing the contacting between the upflowing stripping agent and the downflowing solids in each of said cells.

14. Apparatus as defined in claim 12 wherein the dimensions of said inlet ports in said sleeve are such as to produce a pressure drop through said ports of from 0.2 to 3.0 lbs. per sq. inch.

15. Apparatus as defined in claim 13 wherein the dimensions of said inlet ports in said sleeve are such as to produce a pressure drop through the ports of from 0.2 to 3.0 lbs. per sq. inch.

16. An apparatus of the character described including a vessel, an inlet chamber in the bottom portion thereof for the supply of gasiform fluid and finely divided solids to said vessel, an outlet for gasiform fluid in the upper part of said vessel, an outlet for solids in the bottom portion of said vessel, a horizontally arranged perforated member at the upper portion of said inlet chamber, said perforated member being concentric with said vessel and of smaller diameter, a vertically disposed sleeve extending above said perforated member and secured to the periphery thereof, said sleeve being spaced from the inner wall of said vessel to provide an annular space for the withdrawal of solids, radial baffles arranged between the outer wall of said sleeve and the inner wall of said vessel for dividing said annular space into a plurality of long narrow stripping cells, means for introducing a stripping agent into the lower portion and substantially uniformly over the entire cross-section of each of said cells, an orifice plate horizontally arranged in the bottom portion of each of the said stripping cells below said means for introducing the stripping agent, said orifice plate being constructed to produce a substantial pressure drop across said orifice to control the flow of solids through the cells into the bottom outlet for solids.

17. An apparatus according to claim 16 wherein each of said cells is provided with baffle means to increase contacting between the solids and the stripping agent in said cells.

18. An apparatus of the character described including a vessel, an inlet chamber in the lower portion of said vessel for the supply of gasiform fluid and finely divided solids to said vessel, an outlet for gasiform fluid in the upper part of said vessel, a horizontally arranged perforated member at the upper portion of said inlet chamber for distributing the gasiform fluid and finely divided solids to the vessel, a cylindrical sleeve surrounding said inlet chamber, said sleeve being spaced from the inner wall of said vessel to provide an annular space for the withdrawal of solids from the vessel, radial baffles arranged between the outer wall of said cylindrical sleeve and the inner wall of said vessel for dividing said annular space into a plurality of long narrow stripping cells, means for introducing a stripping gas into the lower portion of each of said cells, a chamber at the bottom of said vessel for receiving the solids discharged from the bottom of said cells, an outlet line for the discharge of solids connected to said last named chamber and an orifice plate horizontally arranged in the bottom portion of each of said cells below said means for introducing stripping agent, said orifice plate being constructed to produce a substantial pressure drop across said orifice to control the flow of solids through said cells into said bottom chamber.

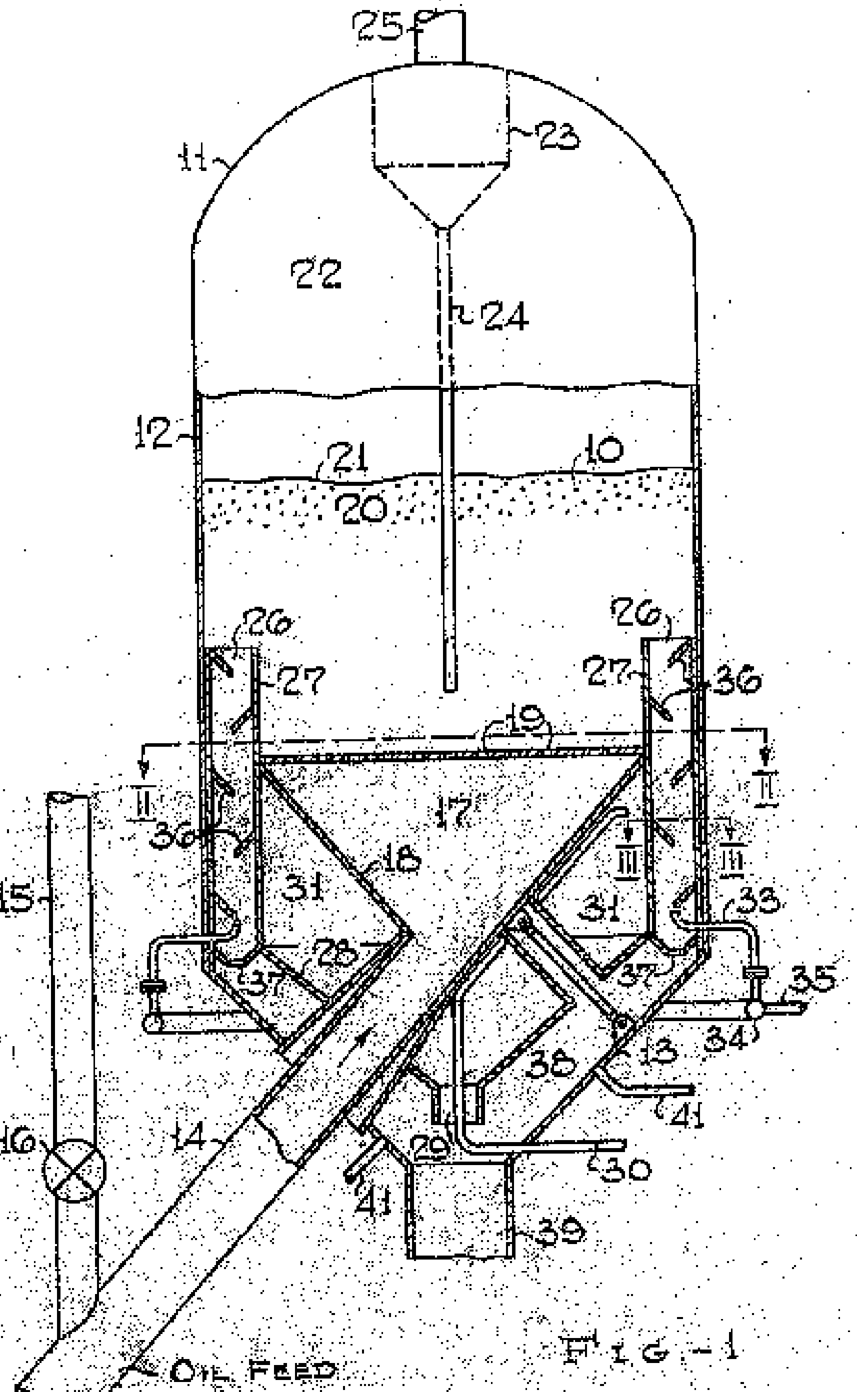


FIG. - 1

L. A. Nicolai
B. V. Molstedt
A. F. Kaulakis
H. G. Codet
E. V. Murphree
Mocks & Clark
ATTORNEYS

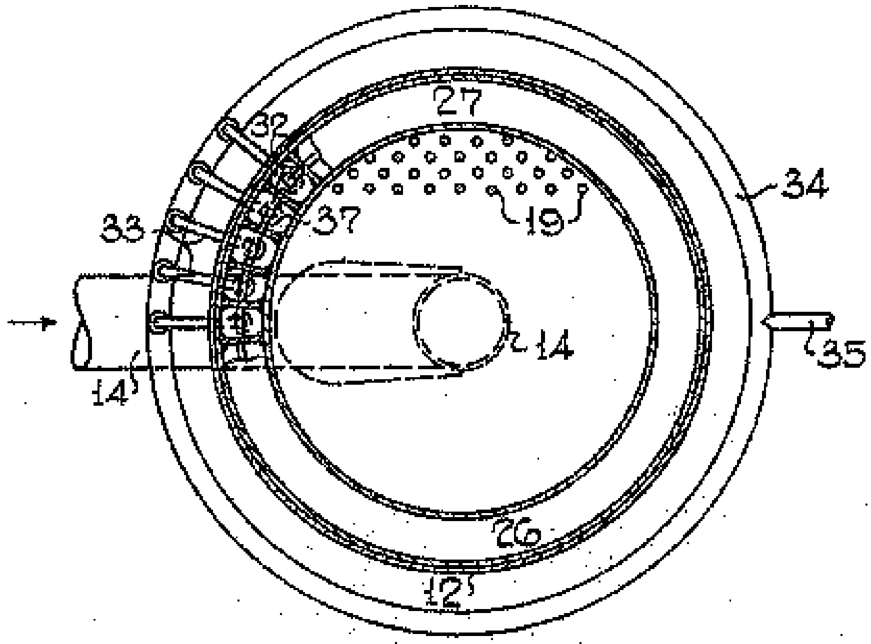


FIG.-2

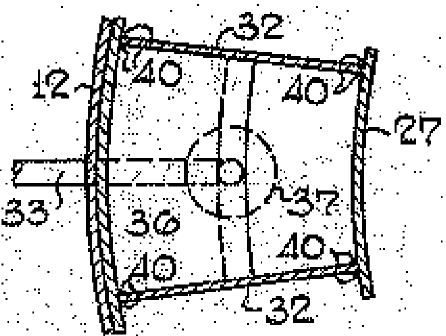


FIG.-3

L. A. Nicolai
B. V. Molstedt
A. J. Kadakis
N. G. Codet
E. V. Murphree

Marks & Clerk ATTORNEYS

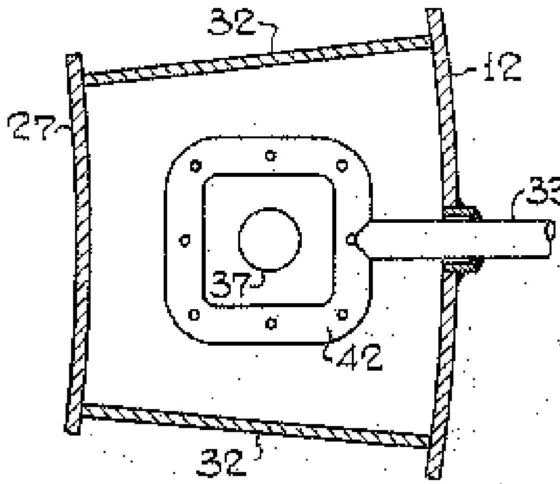


FIG.-6

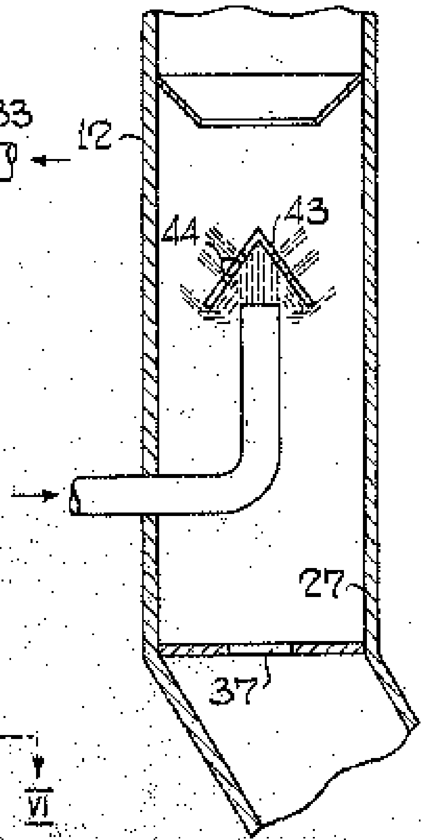


FIG.-4

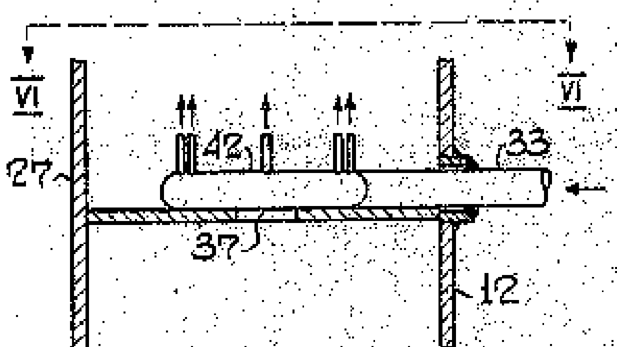


FIG.-5

L. A. Nicolai
B. V. Molstedt
A. F. Kaulakis
H. G. Lodet
E. V. Murphree

Marks + Clerk
ATTORNEYS

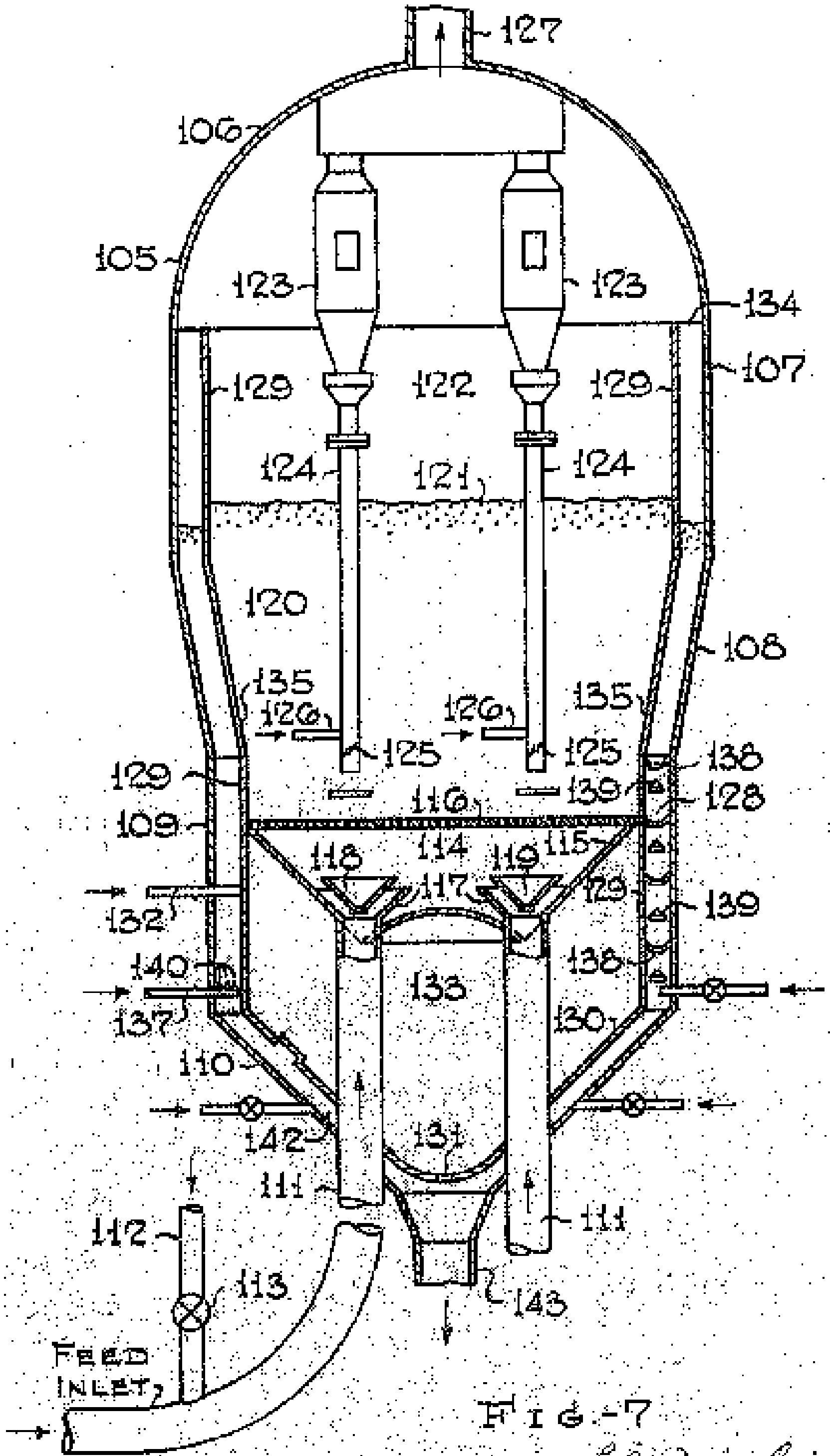


FIG-7

L.A. Nicolai
B.V. Molstedt
A.T. Kaulakis
H.G. Codet
E.V. Murphree
Marks & Clerk
ATTORNEYS

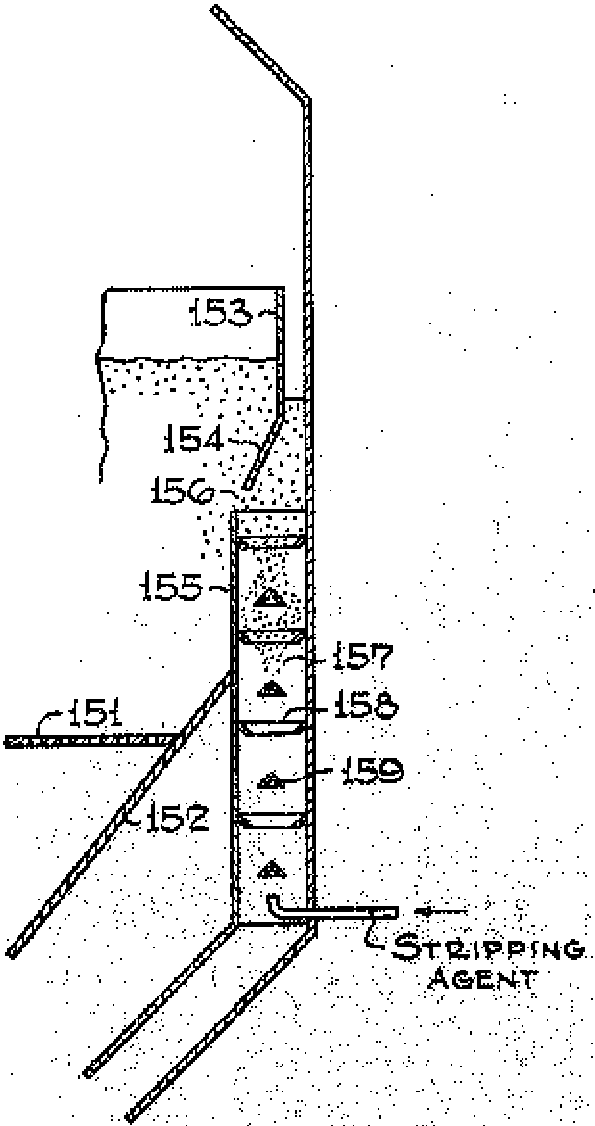


FIG-8

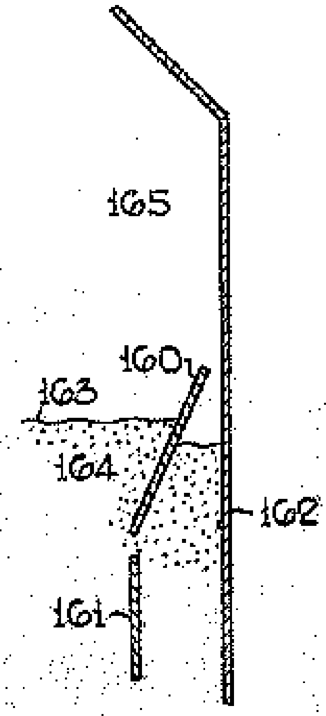


FIG-9

L. A. Nicolai
A. V. Molstedt
A. F. Kaulakis
H. G. Cadet
E. V. Murphree
Marks & Clerk
ATTORNEYS