(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 593 827 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
04.09.1996 Bulletin 1996/36

(51) Int Cl.[6]: **C10G 11/18**

(21) Application number: **92309716.6**

(22) Date of filing: **23.10.1992**

(54) **Disengager stripper containing dissipation plates for use in an FCC process**

Dissipationsplatten enthaltenden Abflussabstreibeinrichtung für FCC-Verfahren

Dispositif de dépouillement d'effluent contenant des plaques de dissipation pour procédés FCC

(84) Designated Contracting States:
AT BE DE ES FR GB GR IT NL PT SE

(43) Date of publication of application:
27.04.1994 Bulletin 1994/17

(73) Proprietor: **UOP**
Des Plaines, Illinois 60017-5017 (US)

(72) Inventor: **Cetinkaya, Ismail Birkan**
Palatine, Illinois 60074 (US)

(74) Representative: **Brock, Peter William et al**
Urquhart-Dykes & Lord
1 Richfield Place
Richfield Avenue
Reading RG1 8EQ Berkshire (GB)

(56) References cited:
EP-A- 0 169 008
US-A- 4 414 100
US-A- 4 500 423
US-A- 4 572 780
US-A- 4 988 430
US-A- 5 043 145
US-A- 5 158 669

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 0 593 827 B1

Description

FIELD OF THE INVENTION

This invention relates generally to methods and apparatus for fluidized catalytic cracking (FCC) units. More specifically this invention relates to methods for separating catalyst from product vapors in an FCC reaction zone.

BACKGROUND OF THE INVENTION

The fluidized catalytic cracking of hydrocarbons is the main stay process for the production of gasoline and light hydrocarbon products from heavy hydrocarbons such as vacuum gas oils. Large hydrocarbon molecules associated with the heavy hydrocarbon feed are cracked to break large hydrocarbon chains thereby producing lighter hydrocarbons. These lighter hydrocarbons are recovered as product and can be used directly or further processed to raise the octane barrel yield relative to the heavy hydrocarbon feed.

The basic equipment or apparatus for the fluidized catalytic cracking of hydrocarbons has been in existence since the early 1940's. The basic component of the FCC process include a reactor, a regenerator and a catalyst stripper. The reactor includes a contact zone where the hydrocarbon feed is contacted with a particulate catalyst and a separation zone where product vapors from the cracking reaction are separated from the catalyst. Further product separation takes place in a catalyst stripper that receives catalyst from the separation zone and removes entrained hydrocarbons from the catalyst by countercurrent contact with steam or another stripping medium. The FCC process is carried out by contacting the starting material, whether it be vacuum gas oil, reduced crude or another source of relatively high boiling hydrocarbons with a catalyst made up of a finely divided or particulate solid material. The catalyst is transported like a fluid by passing gas or vapor through it at sufficient velocity to produce a desired regime of fluid transport. The contact of the oil with fluidized material catalyses the cracking reaction. During the cracking reaction coke is deposited on the catalyst.

Coke is comprised of hydrogen and carbon and can include other materials in trace quantities such as sulfur and metals that enter the process with the starting material. Coke interferes with the catalytic activity of the catalyst by blocking active sites on the catalyst surface where the cracking reactions take place. Catalyst is transferred from the stripper to a regenerator for purposes of removing the coke by oxidation with an oxygen-containing gas. An inventory of catalyst having a reduced coke content, relative to the catalyst in the stripper, hereinafter referred to as regenerated catalyst, is collected for return to the reaction zone. Oxidizing the coke from the catalyst surface releases a large amount of heat, a portion of which escapes the regenerator with gaseous products of coke oxidation generally referred to as flue gas. The balance of the heat leaves the regenerator with the regenerated catalyst. The fluidized catalyst is continuously circulated from the reaction zone to the regeneration zone and then again to the reaction zone. The fluidized catalyst, as well as providing a catalytic function, acts as a vehicle for the transfer of heat from zone to zone. Catalyst exiting the reaction zone is spoken of as being spent, i.e., partially deactivated by the deposition of coke upon the catalyst. Specific details of the various contact zones, regeneration zones, and stripping zones along with arrangements for conveying the catalyst between the various zones are well known to those skilled in the art.

The rate of conversion of the feedstock within the reaction zone is controlled by regulation of the temperature of the catalyst, activity of the catalyst, quantity of the catalyst (i.e., catalyst to oil ratio) and contact time between the catalyst and feedstock. The most common method of regulating the reaction temperature is by regulating the rate of circulation of catalyst from the regeneration zone to the reaction zone which simultaneously produces a variation in the catalyst to oil ratio as the reaction temperatures change. That is, if it is desired to increase the conversion rate an increase in the rate of flow of circulating fluid catalyst from the regenerator to the reactor is effected. Since the catalyst temperature in the regeneration zone is usually held at a relatively constant temperature, significantly higher than the reaction zone temperature, any increase in catalyst flux from the relatively hot regeneration zone to the reaction zone affects an increase in the reaction zone temperature.

The hydrocarbon product of the FCC reaction is recovered in vapor form and transferred to product recovery facilities. These facilities normally comprise a main column for cooling the hydrocarbon vapor from the reactor and recovering a series of heavy cracked products which usually include bottom materials, cycle oil, and heavy gasoline. Lighter materials from the main column enter a concentration section for further separation into additional product streams.

The catalyst particles employed in an FCC process have a large surface area, which is due to a great multitude of pores located in the particles. As a result, the catalytic materials retain hydrocarbons within their pores and upon the external surface of the catalyst. Although the quantity of hydrocarbon retained on each individual catalyst particle is very small, the large amount of catalyst and the high catalyst circulation rate which is typically used in a modern FCC process results in a significant quantity of hydrocarbons being withdrawn from the reaction zone with the catalyst.

Therefore, it is common practice to remove, or strip, hydrocarbons from spent catalyst prior to passing it into the regeneration zone. It is important to remove retained spent hydrocarbons from the spent catalyst for process and economic reasons. First, hydrocarbons that enter

the regenerator increase its carbon-burning load and can result in excessive regenerator temperatures. Stripping hydrocarbons from the catalyst also allows recovery of the hydrocarbons as products. Avoiding the unnecessary burning of hydrocarbons is especially important during the processing of heavy (relatively high molecular weight) feedstocks, since processing these feedstocks increases the deposition of coke on the catalyst during the reaction (in comparison to the coking rate with light feedstocks) and raises the combustion load in the regeneration zone. Higher combustion loads lead to higher temperatures which at some point may damage the catalyst or exceed the metallurgical design limits of the regeneration apparatus.

The most common method of stripping the catalyst passes a stripping gas, usually steam, through a flowing stream of catalyst, countercurrent to its direction of flow. Such steam stripping operations, with varying degrees of efficiency, remove the hydrocarbon vapors which are entrained with the catalyst and hydrocarbons which are adsorbed on the catalyst.

The efficiency of catalyst stripping is increased by using vertically spaced baffles to cascade the catalyst from side to side as it moves down a stripping apparatus and countercurrently contacts a stripping medium. Moving the catalyst horizontally increases contact between the catalyst and the stripping medium so that more hydrocarbons are removed from the catalyst. In these arrangements, the catalyst is given a labyrinthine path through a series of baffles located at different levels. Catalyst and gas contact is increased by this arrangement that leaves no open vertical path of significant cross-section through the stripping apparatus. The typical stripper arrangement comprises a stripper vessel, a series of baffles in the form of frusto-conical sections that direct the catalyst inwardly onto a baffle in a series of centrally located conical or frusto conical baffles that divert the catalyst outwardly onto the outer baffles. The stripping medium enters from below the lower baffle in the series and continues rising upward from the bottom of one baffle to the bottom of the next succeeding baffle.

As the development of FCC units has advanced, temperatures within the reaction zone were gradually raised. It is now commonplace to employ temperatures of about 975ºF (525ºC) . At higher temperatures, there is generally a loss of gasoline components as these materials crack to lighter components by both catalytic and strictly thermal mechanisms. At 525ºC, it is typical to have 1% of the potential gasoline components thermally cracked into lighter hydrocarbon gases. As temperatures increase, to say 1025ºF (550ºC), most feedstocks can lose up to 6% or more of the gasoline components to thermal cracking. However, the loss of gasoline can be offset by the often more desirable production of light olefins.

One improvement to FCC units, that has reduced the product loss by thermal cracking, is the use of riser cracking. In riser cracking, regenerated catalyst and starting materials enter a pipe reactor and are transported upward by the expansion of the gases that result from the vaporization of the hydrocarbons, and other fluidizing mediums if present upon contact with the hot catalyst. Riser cracking provides good initial catalyst and oil contact and also allows the time of contact between the catalyst and oil to be more closely controlled by eliminating turbulence and backmixing that can vary the catalyst residence time. An average riser cracking zone today will have a catalyst to oil contact time of 1 to 5 seconds. A number of riser reaction zones use a lift gas as a further means of providing a uniform catalyst flow. Lift gas is used to accelerate catalyst in a first section of the riser before introduction of the feed and thereby reduces the turbulence which can vary the contact time between the catalyst and hydrocarbons.

In most reactor arrangements, catalysts and conversion products still enter a large chamber for the purpose of initially disengaging catalyst and hydrocarbons. The large open volume of the disengaging vessel exposes the hydrocarbon vapors to turbulence and backmixing that continues catalyst contact for varied amounts of time and keeps the hydrocarbon vapors at elevated temperatures for a variable and extended amount of time. Thus, thermal cracking can be a problem in the disengaging vessel. A final separation of the hydrocarbon vapors from the catalyst is performed by cyclone separators that use centripedal acceleration to disengage the heavier catalyst particles from the lighter vapors which are removed from the reaction zone.

In order to minimize thermal cracking in the disengaging vessel, a variety of systems for directly connecting the outlet of the riser reactor to the inlet of a cyclone are suggested in the prior art. A majority of the hydrocarbon vapors that contact the catalyst in the reaction zone are separated from the solid particles by ballistic and/or centrifugal separation methods within the reaction zone. Directly connecting the inlet of a first cyclone and the outlet the first cyclone to the inlet of a second cyclone in what has been termed a "direct connected cyclone system" can greatly reduce thermal cracking of hydrocarbons. Unfortunately in most cases direct connected cyclones will increase the complexity of operating an FCC unit. When the cyclones are directly connected to the riser any pressure surges that normally occur in the FCC unit can cause the cyclones to malfunction and lead to the carry-over of catalyst into the main column and separation facilities for the recovery of the product. A number of different riser and cyclone arrangements are shown in the prior art to increase the reliability of the cyclone operation when the riser is directly connected thereto.

One way in which to overcome the problem of pressure surges and catalyst carry over is to connect a separation device having a large capacity to the outlet of the riser. Such a separation device is shown in Figure 8 of U.S.-A-4,689,206. This separation device provides a disengagement of the catalyst and product vapor mix-

ture before the mixture enters the relatively small volume of an ordinary cyclone. Due to its large volume the separation device is not easily overloaded and ordinary pressure surges will not interrupt its operation. However such large separation devices suffer from low separation efficiencies that increase the particle load on the downstream cyclones or require the use of two stage cyclones or must have a relatively long length to provide a high separation efficiency. Reduced efficiencies are in large part caused by the reentrainment of catalyst particles with the gas as it flows out of the separation device. The present invention thus provides a unique solution to this problem of direct connection to cyclones.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a catalyst separation system for use inside a reactor vessel in an FCC unit which system will provide a quick disengagement between catalyst and product vapors and be simple and reliable to operate.

It is a second object of this invention to provide a disengaging system for reactor products and catalysts in an FCC unit which system is not susceptible to overload from pressure surges and is relatively compact.

A third object of this invention is to provide a cyclone type separation vessel that can receive the entire effluent from an FCC reactor riser and provide a high separation efficiency without a susceptibility to overload from pressure surges.

A fourth object of this invention is to provide an FCC process that provides a quick separation of catalyst from product vapors and thus minimizes overcracking and is not susceptible to overload from pressure surges or changes in operation of the reactor system.

The objects of this invention are realized by a separation system that is directly connected to the outlet of the riser in an FCC unit and provides a high degree of separation by using a basic cyclone operation within a disengaging vessel and partition or dissipator plates below the disengaging vessel to improve catalyst separation and prevent catalyst reentrainment. These partitions or dissipators are located immediately below the outer vortex that is formed in most cyclone operations. Ordinarily, a tangential velocity is introduced by the vortex, and if not dissipated will create turbulence that will reentrain free catalyst. Contact with the plates dissipates these tangential velocities and reduces turbulence immediately below the vortex. The dissipator plates can also be arranged to trap catalyst particles as they fall from the vortex to reduce the particle velocity and prevent reentrainment.

Accordingly, in one embodiment, this invention is a fluid catalytic cracking apparatus that includes a reactor vessel, a tubular riser having an inlet end for receiving feed and catalyst and an outlet end. An elongated disengaging vessel is located in the reactor vessel and has an upper and a lower end. The upper end of the disengaging vessel has a tangential inlet in direct communication with the outlet end of the riser and a central gas outlet at the top. The lower end has an open bottom wherein the outermost portion of the open bottom is unoccluded to permit unobstructed fluid and particulate flow. A stripping vessel is located directly below the disengaging vessel. The stripping vessel has an inlet that communicates directly with the open bottom of the disengaging vessel and an outlet for withdrawing catalyst from the stripping vessel. Means are provided for adding stripping gas to the stripping vessel. A segregation zone is located in the stripping vessel and includes at least two vertical partition or dissipation plates spaced below the open bottom of the disengaging vessel.

In a more limited embodiment, this invention comprises a fluid catalytic cracking apparatus that includes a reactor vessel and a tubular riser having an inlet end for receiving feed and catalyst and an outlet end. An elongated disengaging vessel is located in the reactor vessel and has upper and lower ends. The upper end of the disengaging vessel has a tangential inlet in direct communication with the outlet end of the riser and a central gas outlet at the top. The lower end has a vertically extending sidewall, an open bottom and a plurality of circumferentially spaced ports at the bottom of the vertically extending sidewall. A stripper vessel having an upper end located in the reactor vessel and into which the lower end of the disengaging vessel extends is located immediately below the disengaging vessel. At least two dissipator plates are located inside the stripper vessel. The dissipator plates extend inwardly from the walls of the stripper vessel with each dissipator plate lying in a common plane with the centerline of the stripper vessel. The dissipator plates have a central portion, the top of which is spaced below the lower end of the disengaging vessel. The stripper vessel also has a catalyst outlet at its lower end and at least one inner and at least one outer stripping baffle located between the top of the central portion of the dissipator plates and the catalyst outlet and means for introducing a stripping fluid into the stripping vessel. A vortex stabilizer extends into the lower end of the disengaging vessel. Means are provided for withdrawing gas from the open volume of the reactor vessel.

In a yet more limited embodiment, this invention is a fluid catalytic cracking apparatus that includes a reactor vessel and a tubular riser having an inlet end for receiving feed and an outlet end. An elongated disengaging vessel is located in the reactor vessel and has an upper end and a lower end. The upper end has a tangential inlet in direct communication with the outlet end of the riser and a central gas outlet at the top of the disengaging vessel. The lower end has a vertically extending sidewall, an open bottom and a plurality of circumferentially spaced slots bordering the bottom of the vertically extending sidewall. A stripper vessel having upper and lower sections is at least partially located in the reactor vessel. The upper section of the stripper vessel

is fixed to the lower end of the disengaging vessel and the lower section of the stripper is fixed to the lower end of the reactor vessel. A slip joint between the upper and lower sections of the stripper vessel joins the two stripper sections. The stripper vessel also includes means for communicating the interior of the stripping vessel with the interior of the reactor vessel. The upper section of the stripping vessel also has a larger diameter than the lower end of the disengaging vessel and at least two dissipator plates extending inwardly from the walls of the stripper vessel with each dissipator plate lying in a common plane with the centerline of the stripper vessel. The dissipator plates have a central portion spaced below the lower end of the disengaging vessel and an outer portion that extends vertically from the top of the central portion above the open bottom of the disengaging vessel. At least one stripping baffle is located at the bottom of the dissipator plates. The lower section of the stripping vessel has an upper end located in the reactor vessel and a lower end located outside of the reactor vessel. The lower end of the stripping vessel lower section has a catalyst outlet and a distributor for adding stripping gas to the stripping vessel. The upper end of the lower section has at least one stripping baffle located therein. A vortex stabilizer extends into the lower end of the disengaging vessel. Means are provided for adding a fluidizing gas to the bottom of the reactor vessel. A cyclone separator receives product vapors and catalyst from the gas outlet of the disengaging vessel. The cyclone has a dip leg that returns catalyst to the reactor vessel. A first conduit communicates product vapors directly from the gas outlet to the cyclone separator. A second conduit communicates product vapors from the cyclone to product recovery facilities. The apparatus includes means for venting fluidizing gas out of the reactor vessel.

In an alternate embodiment this invention is a process for the fluidized catalytic cracking of an FCC feedstream which utilizes the FCC apparatus described in any of the previous embodiments. The process includes the steps of passing an FCC catalyst and the FCC feedstream to a riser reaction zone and contacting the feedstream with the FCC catalyst in the riser reaction zone to convert the feedstream to product vapors, discharging a mixture of the product vapors and the spent FCC catalyst from the riser directly to the inlet of a disengaging vessel, and directing the mixture from the inlet tangentially into the disengaging vessel to form an inner and outer vortex of product gases in the disengaging vessel, stabilizing the inner vortex with a vortex stabilizer in the disengaging vessel, emptying catalyst particles from the bottom of the disengaging vessel directly into the top of a subadjacent stripping vessel. The process includes injecting a stripping gas into the stripping vessel and contacting the catalyst particles with the stripping gas to desorb hydrocarbons from the catalyst particles, discharging a gaseous stream of desorbed hydrocarbons and stripping gas upwardly through the stripping vessel past a plurality of vertical disengaging plates into the disengaging vessel through an open volume of the stripping vessel located above a central portion of the disengaging plates and below the bottom of the disengaging vessel and out of the top of the stripping vessel and into the bottom of the disengaging vessel; maintaining a relatively dense bed of catalyst in the stripping vessel below the central portion of the dissipator plates; withdrawing the product vapors and the gaseous stream from the top of the disengaging vessel through a central outlet; passing the product vapor and the gaseous stream from the central outlet to a separator to recover additional catalyst particles; recovering a product stream from the separator; transferring catalyst particles from the separator to a lower portion of the stripping vessel; removing spent catalyst from the lower end of the stripping vessel and transferring spent catalyst to a regeneration zone; regenerating the FCC catalyst in the regeneration zone by the oxidative removal of coke; and transferring FCC catalyst from the regeneration zone to the riser reaction zone.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a sectional elevation of a reactor riser, reactor vessel and regenerator arrangement that incorporates the separation system of this invention.

Figure 2 is an enlarged detail of the separation section located in the reactor vessel of Figure 1.

Figure 3 is a section of the enlarged separation section taken across lines 3/3 of Figure 2.

Figure 4 is a detailed cross-section of a secondary stripper section shown in Figure 1.

Figure 5 is an enlarged view of the upper section of the reactor shown in Figure 1.

DETAILED DESCRIPTION OF THE INVENTION

The typical feed to an FCC unit is a gas oil such as a light or vacuum gas oil. Other petroleum-derived feed streams to an FCC unit may comprise a diesel boiling range mixture of hydrocarbons or heavier hydrocarbons such as reduced crude oils. It is preferred that the feed stream consist of a mixture of hydrocarbons having boiling points, as determined by the appropriate ASTM test method, above about 230°C and more preferably above about 290°C. It is becoming customary to refer to FCC type units which are processing heavier feedstocks, such as atmospheric reduced crudes, as residual crude cracking units, or residual cracking units. The process and apparatus of this invention can be used for either FCC or residual cracking operations. For convenience, the remainder of this specification will only make reference to the FCC process.

The chemical composition and structure of the feed to an FCC unit will affect the amount of coke deposited upon the catalyst in the reaction zone. Normally, the higher the molecular weight, Conradson carbon, heptane insolubles, and carbon/hydrogen ratio of the feed-

stock, the higher will be the coke level on the spent catalyst. Also, high levels of combined nitrogen, such as found in shale-derived oils, will increase the coke level on spent catalyst. Processing of heavier feedstocks, such as deasphalted oils or atmospheric bottoms from a crude oil fractionation unit (commonly referred to as reduced crude) results in an increase in some or all of these factors and therefore causes an increase in the coke level on spent catalyst. As used herein, the term "spent catalyst" is intended to indicate catalyst employed in the reaction zone which is being transferred to the regeneration zone for the removal of coke deposits. The term is not intended to be indicative of a total lack of catalytic activity by the catalyst particles.

The reaction zone, which is normally referred to as a "riser", due to the widespread use of a vertical tubular conduit, is maintained at high temperature conditions which generally include a temperature above 427°C. Preferably, the reaction zone is maintained at cracking conditions which include a temperature of from 480°C to 590°C and a pressure of from 65 to 601 kPa but preferably less than 376 kPa. The catalyst/oil ratio, based on the weight of catalyst and feed hydrocarbons entering the bottom of the riser, may range up to 20:1 but is preferably between 4:1 and 10:1. Hydrogen is not normally added to the riser, although hydrogen addition is known in the art. On occasion, steam may be passed into the riser. The average residence time of catalyst in the riser is preferably less than 5 seconds. The type of catalyst employed in the process may be chosen from a variety of commercially available catalysts. A catalyst comprising a zeolitic base material is preferred, but the older style amorphous catalyst can be used if desired. Further information on the operation of FCC reaction zones may be obtained from U.S.-A-4,541,922 and U.S.-A-4,541,923.

An FCC process unit comprises a reaction zone and a catalyst regeneration zone. This invention may be applied to any configuration of reactor and regeneration zone that uses a riser for the conversion of feed by contact with a finely divided fluidized catalyst maintained at an elevated temperature and at a moderate positive pressure. In this invention, contacting of catalyst with feed and conversion of feed takes place in the riser. The riser comprises a principally vertical conduit and the effluent of the conduit empties into a disengaging vessel. One or more additional solids-vapor separation devices, almost invariably a cyclone separator, is normally located within and at the top of the large separation vessel. The disengager vessel and cyclone separate the reaction products from a portion of catalyst which is still carried by the vapor stream. One or more conduits vent the vapor from the cyclone and separation zone. Alter initial separation the spent catalyst passes through a stripping zone that is located directly beneath the disengaging vessel. It is essential to this invention that the stripping vessel is located below the disengaging zone and that the upper portion of the stripping vessel contain means for dissipating turbulence at the outlet of the disengaging vessel. After the catalyst has passed through the stripping zone it can be transferred to the reactor vessel or pass through one or more additional stages of stripping.

Once stripped, catalyst flows to a regeneration zone. In an FCC process, catalyst is continuously circulated from the reaction zone to the regeneration zone and then again to the reaction zone. The catalyst therefore acts as a vehicle for the transfer of heat from zone to zone as well as providing the necessary catalytic activity. Catalyst which is being withdrawn from the regeneration zone is referred to as "regenerated" catalyst. The catalyst charged to the regeneration zone is brought into contact with an oxygen-containing gas such as air or oxygen-enriched air under conditions which result in combustion of the coke. This results in an increase in the temperature of the catalyst and the generation of a large amount of hot gas which is removed from the regeneration zone and referred to as a flue gas stream. The regeneration zone is normally operated at a temperature of from 600°C to 800°C. Additional information on the operation of FCC reaction and regeneration zones may be obtained from U.S.-A-4,431,749; U.S.-A-4,419,221 and U.S.-A-4,220,623.

The catalyst regeneration zone is preferably operated at a pressure of from 136 to 601 kPa. The spent catalyst being charged to the regeneration zone may contain from 0.2 to 5 wt.% coke. This coke is predominantly comprised of carbon and can contain from 3 to 15 wt.% hydrogen, as well as sulfur and other elements. The oxidation of coke will produce the common combustion products: carbon dioxide, carbon monoxide, and water. The regeneration zone may take several configurations, with regeneration being performed in one or more stages. Further variety in the operation of the regeneration zone is possible by regenerating fluidized catalyst in a dilute phase or a dense phase. The term "dilute phase" is intended to indicate a catalyst/gas mixture having a density of less than 320 kg/m^3. In a similar manner, the term "dense phase" is intended to mean that the catalyst/gas mixture has a density equal to or more than 320 kg/m^3. Representative dilute phase operating conditions often include a catalyst/gas mixture having a density of 15 to 150 kg/m^3.

Figure 1 shows a traditional stacked FCC reactor/regenerator arrangement that has been modified to incorporate the separation system of this invention. In its basic operation, feed enters the lower end of a riser 10 through a nozzle 12 where it is contacted with fresh regenerated catalyst from a regenerated catalyst conduit 14. A valve 16 controls the rate of catalyst addition to riser 10. Steam may also be added with the feed through nozzle 12 in order to achieve the desired feed velocity and help the dispersion of feed into the stream of catalyst particles. Feed hydrocarbons are cracked by contact with the catalyst in the riser and spent catalyst and product vapors exit the upper end of riser 10 through a

horizontal pipe section 18. Pipe section 18 discharges the catalyst and product vapor mixture directly into a disengaging vessel 20. A reactor vessel 19 contains stripping gas, spent catalyst and product vapors. Catalyst disengaged from the stripping gas and product vapors in disengager 20 pass downwardly into a stripping vessel 22. Steam entering stripping vessel 22 through a nozzle 24 countercurrently contacts catalyst particles to strip additional hydrocarbons from the catalyst. Catalyst exits stripping vessel 22 through nozzle 26 and enters a second catalyst stripper 28. Steam entering stripping vessel 28 through nozzle 30 again countercurrently contacts the catalyst particles to remove additional hydrocarbons from the catalyst. Stripping gas and separated hydrocarbons rise upwardly through stripping vessels 28 and 22 and are withdrawn in a manner hereinafter more fully described through disengaging vessel 20 and a central gas outlet 32. A manifold 34 conducts stripping fluid and product vapors into cyclones 36 that effect a further separation of catalyst particles from the stripping fluid and product vapors. A manifold 38 collects stripping fluid and product vapors from the cyclone 36 which are removed from the reactor vessel by conduits 40. Product vapor and stripping fluid are taken from manifold 38 to product separation facilities of the type normally used for the recovery of FCC products.

All of the spent catalyst from the reactor section is directed into the regenerator. Spent catalyst collected by cyclones 36 drops downwardly through dip legs 42 and collects as a dense bed 44 in a space between the wall of reactor vessel 19 and the outside of stripping vessel 22. A plurality of ports 46, hereinafter more fully described, transfer catalyst from bed 44 to the interior of stripping vessel 22. Spent catalyst stripped of hydrocarbons is withdrawn from the bottom of vessel 28 through spent catalyst conduit 48 at a rate regulated by control valve 50.

In a regenerator 52 the catalyst is regenerated by oxidizing coke from the surface of the catalyst particles and generating flue gas that contains H_2O, CO and CO_2 as the products of combustion. The catalyst enters regenerator 52 through a nozzle 54 and is contacted with air entering the regeneration vessel through a nozzle 56. This invention does not require a specific type of regeneration system. The regeneration vessel pictured in Figure 1 ordinarily operates with a dense bed 58 in its lower section. Some form of distribution device across the bottom of the regeneration vessel distributes air over the entire cross-section of the vessel. A variety of such distribution devices are well known to those skilled in the art. Alternatively, this invention can be practiced with a regeneration zone that provides multiple stages of coke combustion. Furthermore, the regeneration zone can achieve complete CO combustion or partial CO combustion. In the dense bed operation, as depicted in Figure 1, flue gas and entrained catalyst particles rise up from bed 58. A first stage cyclone 60 collects flue gas and performs an initial separation of the catalyst particles which are returned to bed 58 by dip leg 62 and the flue gas which is transferred by a conduit 64 to a second cyclone 66. A further separation of catalyst from the flue gas takes place in cyclones 66 with the catalyst particles returning to bed 58 via a dip leg 68 and the flue gas leaving the upper end of cyclone 66 and the regeneration vessel via a collection chamber 70 and a flue gas conduit 72.

A more complete understanding of the operation and arrangement of disengaging vessel 20 and stripping vessel 22 is obtained by reference to Figure 2. Figure 2 shows disengaging vessel 20 located completely within reactor vessel 19. Disengaging vessel 20 operates with the mixture of spent catalyst and product vapors entering the upper end of disengaging vessel 20 tangentially through horizontal conduit 18. Tangential entry of the gases and solids into disengaging vessel 20 forms the well-known double helix flow pattern through the disengaging vessel that is typically found in the operation of traditional cyclones. Catalyst and gas swirls downwardly in the first helix near the outer wall of vessel 20 and starts back upwardly as an inner helix that spirals through the center of disengaging vessel 20 and exits the top of the disengaging vessel through central gas outlet 32. The spinning action of the gas and catalyst mixture concentrates the solid particles near the wall of vessel 20. Gravity pulls the particles downward along the wall of vessel 20 and out through a lower outlet 74. The efficiency of the disengager is improved by controlling the positioning of the double helix with a vortex stabilizer 76 that is located in the center of disengaging vessel 20. More than 95% of the solids passing through conduit 18 are removed by disengaging vessel 20 so that the gas stream that exits through conduit 32 contains only a light loading of catalyst particles. The vortex shape is also enhanced by giving disengaging vessel 20 a slight frusto-conical shape such that the upper section has a larger diameter than the lower section. It is also preferred that disengaging vessel 20 be designed such that the bottom of the outer helix ends at or about the bottom of opening 74. This design differs from traditional cyclones which are designed such that they will have a much longer length than the outer helix length. The required space for disengaging vessel 20 has been reduced by designing it such that the bottom of the outer helix extends to or only slightly below the outlet 74. The length of the disengager required for a specific helix configuration will depend on its size and the gas velocity. For disengagers of average size, those ranging from 5 to 10 feet (1.5 to 3 m) in diameter, the length of the disengager from the bottom of the gas and catalyst inlet to the outlet 74 will be 2 to 3 times the largest diameter of the disengaging vessel.

As the solids leave disengaging vessel 20 through outlet 74, it tends to be reentrained by gas that is circulating near opening 74 or entering disengaging vessel 20 through opening 74. Locating the outlet 74 near the bottom of the outer helix of the disengaging vessel can

create turbulence that will reentrain additional catalyst. Stripping gas and stripped hydrocarbons flowing upwardly from the stripping vessel into the disengaging vessel can also reentrain catalyst particles. In one embodiment of this invention, a portion of catalyst particles exit outlet 74 radially through a series of slots or ports 78 that extend circumferentially around the lower portion of outlet 74. Typically, the outlet will have 8 to 24 of such slots spaced around the outside. These slots will usually vary from 12 to 24 in (305 to 610 mm) in height and approximately 3 to 6 in (76 to 152 mm) in width. The slots improve the separation efficiency by containing the vortex that is near the outlet 74 while allowing catalyst particles to spray outwardly under the influence of the vortex into the outer portion of stripping vessel 22, thereby clearing the central portion of outlet 74 for the influx of gas.

Disengaging vessel 20 opens directly into the top of stripping vessel 22. Swirling gas flow associated with the cyclonic vortex and the countercurrent flow of gas upwardly from the stripping vessel 22 normally would create a long zone of turbulence below outlet 74. The effect of any turbulence is reduced by a set of plates 80 that function to dissipate any turbulence associated with the swirling action of the helical gas flows. These plates are spaced below the bottom of opening 74 such that an open area 84 provided between the top 82 of the central portion of the dissipator or partition plates 80, and the bottom of outlet 74. The length of this space is indicated by Dimension A and will preferably be equal to approximately half the diameter of the outlet 74. This space is provided and the top 82 of plates 80 is not brought all the way up to the bottom of opening 74 in order to reduce the velocity of the descending vortex before it contacts the dissipator plates.

The dissipator plates 80 are attached to the inner walls of stripper 22 and extend inwardly to the center line of vessel 22. Plates 80 are preferably arranged vertically. In most cases at least four dissipator plates will extend inwardly from the walls of vessel 22 and divide the cross-section of the stripper vessel in the region of the dissipator plates into four quadrants. Plates 80 dissipate any horizontal components of gas flow that extend below the open area 84. The plates 80 also provide a convenient means of locating and supporting vortex stabilizer 76 and stripper baffle 88. The vertical orientation of plates 80 obstruct any tangential or horizontal components of gas velocity such that the effects of any vortex does not extend past upper plate section 82. In addition, the horizontal momentum of any catalyst particles that extend below plate boundary 82 is stopped by plate 80 so that the particles have a more direct downward trajectory and the total distance traveled by the particles through the stripping vessel is reduced. Reducing the travel path of the particles through stripping vessel 22 lessens the tendency of catalyst reentrainment. In a preferred arrangement, at least one dissipator plate bisects the cross-section of the stripping vessel 22. At minimum, the Diameter B of the dissipator plates about the central portion 82 should be at least equal to the diameter of outlet 74. The effectiveness of the dissipator plates is increased by having the Diameter B at least slightly larger than the diameter of outlet 74. The stripping vessel can be arranged such that its outer wall has a diameter equal to Dimension B. The effectiveness of the dissipator plates can be further increased by increasing the diameter of stripping vessel 22 relative to Dimension B and providing the dissipator plates with an outer section 86 that extends outwardly to the region beyond Dimension B and above the central portion 82 of the plates. Outer section 86 preferably extends above outlet 74 and more preferably above the top of slots 78. The additional plate area provided by sections 86 of the dissipator plates 80 serves to further reduce tangential gas velocity components and moreover to provide a relatively stagnant area for collecting catalyst particles that accumulate on the outside wall of stripper vessel 22. Plate sections 86 function to further direct catalyst particles, that would otherwise become entrained in the upflowing stripping gas and swirling gas associated with the cyclonic separation, to flow downwardly into the stripping vessel.

As the catalyst flows downwardly, it is countercurrently contacted with the stripping gas from nozzle 24. In order to improve the stripping efficiency, conical baffles are provided to increase the contact between the solid particles and the stripping gas in the middle or lower sections of the stripping vessel. These stripping baffles have the usual cone arrangement that is ordinarily found in FCC strippers. In one particular arrangement, an uppermost inner cone type baffle 88 is attached to partition plates 80 and a lower outer cone 90 is attached to the wall of stripping vessel 22. These baffles can be of any ordinary design well known to those skilled in the art and commonly used in FCC strippers. Preferably, the stripper baffles will be provided with skirts that depend downwardly from the lower conical portion of the baffle. It is also known that such skirts can be perforated to increase the contacting efficiency between the stripping fluid and the catalyst particles.

Figure 2 depicts an arrangement of the stripping vessel wherein an upper portion 22' is located in the reactor vessel 19 and a lower portion 22" extends below the interior of reactor vessel 19. This arrangement facilitates the location of nozzle 26 for the withdrawal of spent catalyst from the stripping vessel.

The stripping vessel and the disengaging vessel may be supported from the reactor vessel 19 in any manner that will allow for thermal expansion between disengaging vessel 20 and reactor vessel 19. One support arrangement uses a solid stripping vessel fixed to the bottom shell of reactor vessel 19 and a disengaging vessel fixed rigidly thereto. In such an arrangement, thermal expansion of the disengaging vessel and the upper portion 22' of the stripping vessel is provided by expansion joints in the conduit 18 and the central outlet

32 or the manifolds located thereabove.

Figure 2 shows an arrangement wherein the upper portion 22' is fixed to the bottom of disengaging vessel 20 and a slip joint is provided between the upper portion 22' and the lower portion 22" of the stripping vessel.

Catalyst bed 44 surrounds the location of stripper section 22'. The lower portion of reactor vessel 19 must have a catalyst inlet to transfer catalyst from bed 44 to stripper vessel 22. In the arrangement of Figure 2, catalyst drains into the stripper vessel through the slots 46 in the manner previously described. Fluidizing gas, which is generally steam, distributed to the bottom of bed 44 by distributor 98 facilitates the transport of catalyst into the stripping vessel through slots 46 and strips the catalyst discharged from the dip legs of the reactor cyclones.

In addition to the slots for catalyst passage, the slip joint arrangement of Figure 2 shows additional slots in the upper portion of lower stripper section 22'. These slots provide clearance for the dissipator plates as the disengaging vessel and upper stripper section 22 grow downward with respect to the lower stripper section 22'.

The slots are sized to maintain a bed of dense catalyst in the bottom of the reactor vessel. This bed prevents stripped vapors from entering the open volume of the reactor vessel. Figure 3 depicts the dissipator plates, upper stripper baffle, slip joint and slots in plan view. Looking at Figure 3, four dissipator plates are shown spaced 90° apart and extending from the outer wall of the upper stripper section 22' to the outside of vortex stabilizer 76. Vortex stabilizer 76 is centrally supported from the dissipator plates. The slots 92 spaced about the upper end of section 22" lie directly beneath the dissipator plates 80 to prevent interference between the bottom of the dissipator plates and the top of section 22". Slots 46 are spaced regularly about the lower periphery of section 22'. Four to sixteen of such slots 46 are usually provided. The slots are sized to maintain a catalyst level in bed 44 and prevent the leakage of gas outwardly from the stripping vessel into the open area of reactor vessel 19. For a typical arrange-ment, the slots 46 will be 500 to 1000 mm in height and from 300 to 400 mm wide. Slots 92 are sized as necessary to provide adequate clearance for the dissipator plates; for an ordinary arrangement, slots approximately 250 mm x 250 mm will provide adequate clearance.

Catalyst that leaves the stripping vessel through nozzle 26 enters the secondary stripping vessel 28. Stripping vessel 28, shown in more detail by Figure 4, operates in a conventional manner. Catalyst passes downwardly through the stripper and is cascaded side/side through a series of inner baffles 100 and outer baffles 102. Catalyst is withdrawn through ports 104 in a lower portion of a support conduit 106 to which inner stripper baffles 100 are attached. Ports 104 direct the catalyst into conduit 48 for transfer into regenerator vessel 52 in the manner previously described. Stripping baffles 100 and 102 may again be provided with dependent skirts and orifices to increase the contact between catalyst and steam that enters the stripping vessel through nozzle 30. Steam or other stripping fluid that contacts the spent catalyst rises countercurrently to the catalyst and flows out of stripping vessel 28 through nozzle 26.

All of the stripping steam as well as displaced hydrocarbons flow upwardly through the upper stripping vessel and into the disengaging vessel where they are withdrawn with product vapors through the central gas tube 32. Figure 5 shows the upper portion of reactor vessel 19. The top of disengaging vessel 20 extends into the upper section of reactor vessel 19. The disengaging vessel is supported by support lugs (not shown) which are attached to the wall of vessel 19. Central gas nozzle 32 extends upwardly and branches into a manifold that provides transfer conduits 32 having arms 110. Each of arms 110 is connected to a cyclone inlet 112 for cyclones 36. The upper section of the manifold arms and cyclones are supported by gas outlet tubes 40. An expansion joint 114 is provided in the branch arms to accommodate differential thermal expanison between the gas tube and branch arms and the shell of reactor vessel 19.

All of the product vapors, stripped hydrocarbons, stripping fluid and fluidizing gas enter central gas outlet 32 from the disengaging vessel in the manner previously described. Pressure equalizer ports 116 are provided in the sides of central gas tubes 32 and communicate the open area of the reactor vessel with the interior of the gas tube to vent fluidizing gas from the open area of the reactor vessel. The ports 116 are sized to maintain a suitable pressure drop usually less than 0.7 kPa between the open area of the reactor vessel and the central gas conduit 32. Of course, venting of gases from the open area of the reactor can be provided by a vent located in the branch arms 110, the cyclone inlets 112, or even a separate cyclone vessel located within or outside of the reactor vessel 19. In addition, it is clear to those skilled in the art that this invention can be used with any number of secondary cyclones 36.

Claims

1. A fluid catalytic cracking apparatus comprising:

(a) a reactor vessel [19];

(b) a tubular riser [10] having an inlet end for receiving feed and catalyst and an outlet end;

(c) an elongated disengaging vessel [20] located in said reactor vessel [19] having an upper end and a lower end, said upper end having a tangential inlet in direct communication with said outlet end of said riser and a central gas outlet [32] at the top of said disengaging vessel [20] and said lower end having an open bottom [74] wherein the outermost portion of said open

bottom [74] is unoccluded to permit unobstructed fluid and particulate flow;

(d) a stripping vessel [22] located directly below said disengaging vessel [20], said stripping vessel having an inlet in open communication with said open bottom [74] of said disengaging vessel [20] and an outlet [26] for withdrawing catalyst from the stripping vessel [22];

(e) means [24] and [30] for adding stripping gas to said stripping vessel [22]; and,

(f) a segregation zone located in said stripping vessel [22] comprising at least two vertical partition plates [80] spaced below said open bottom [74] of said disengaging vessel [20].

2. The apparatus of claim 1 wherein a vortex stabilizer tube [76] extends upward from said open bottom [74] into said disengagement vessel [20].

3. The apparatus of claim 2 wherein the diameter of said vortex stabilizer [76] is less than 20% of the diameter of the open bottom [74] and said open bottom is unoccluded except for said vortex stabilizer.

4. The apparatus of claim 1, 2 or 3 wherein said vertical plates [80] extend horizontally and vertically and border an unobstructed area located immediately below said open bottom [74] of said disengaging vessel [20].

5. The apparatus of any one of claims 1 to 4 wherein said stripper vessel [22] has a larger diameter than the bottom of said disengaging vessel [20], said vertical plates extend from the wall of said stripping vessel [22] inwardly to define at least two circumferentially extended chambers located below and to the outside of said open bottom [74] of said disengaging vessel.

6. The apparatus of any one of claims 1 to 5 wherein said central gas outlet [32] communicates with at least one cyclone [36], said cyclone has a dip leg [42] for returning catalyst to the reactor vessel [19] and a vapor outlet [40] for discharging a vapor product stream.

7. A process for the fluidized catalytic cracking (FCC) of an FCC feedstream, said process comprising:

(a) passing FCC catalyst and said FCC feedstream to a riser reaction zone [10] and therein contacting said feedstream with said FCC catalyst to convert said feedstream to product vapors;

(b) discharging a mixture of said product vapors and spent FCC catalyst from said riser directly to the inlet of a disengaging vessel [20] and directing said mixture from said inlet tangentially into said disengaging vessel [20] to form an inner and outer vortex;

(c) stabilizing the inner vortex with a vortex stabilizer [76] in said disengaging vessel [20];

(d) emptying catalyst particles in closed communication from the bottom of said disengaging vessel [20] directly into the top of a subadjacent stripping vessel [22];

(e) injecting a stripping gas into said stripping vessel [22] and contacting said catalyst particles with said stripping gas to desorb hydrocarbons from said catalyst particles;

(f) discharging a gaseous stream of desorbed hydrocarbons and stripping gas upwardly from said stripping vessel [22] through a plurality of vertical dissipator plates [80] in said stripping vessel [22], through an open volume [84] of said stripping vessel [22] located above a central portion [82] of said dissipator plates [80] and below the bottom [74] of said disengaging vessel [20] and out of the top of said stripping vessel [22] and into the bottom of said disengaging vessel [20];

(g) maintaining a relatively dense bed of catalyst in said stripping vessel [22] below said central portion [84] of said dissipator plates [80];

(h) withdrawing said product vapors and said gaseous stream from the top of said disengaging vessel [20] through a central outlet [32];

(i) passing said product vapor and said gaseous stream from said central outlet to a separator [36] to recover additional catalyst particles;

(j) recovering a product stream from said separator [36];

(k) transferring catalyst particles from said separator [36] to a lower portion of said stripping vessel [22];

(l) removing spent FCC catalyst from the lower end of said stripping vessel [22] and transferring said spent catalyst to a regeneration zone [52];

(m) regenerating said FCC catalyst in said re-

generation zone [52] by the oxidative removal of coke; and,

(n) transferring FCC catalyst from said regeneration zone [52] to said riser reaction zone [10].

Patentansprüche

1. Katalytische Fluidkrackvorrichtung mit

a) einem Reaktorbehälter (19),

b) einer röhrenförmigen Steigleitung (10) mit einem Einlaßende zur Aufnahme von Beschikkung und Katalysator und einem Auslaßende,

c) einem länglichen Trennbehälter (20), der in dem Reaktorbehälter (19) angeordnet ist und ein oberes und ein unteres Ende hat, wobei das obere Ende einen tangentialen Einlaß in direkter Verbindung mit dem Auslaßende der Steigleitung und einen mittigen Gasauslaß (32) am oberen Ende des Trennbehälters (20) hat und das untere Ende einen offenen Boden (74) hat, worin der äußerste Anteil des offenen Bodens (74) unversperrt ist, um einen ungehinderten Fluid-und Feinstoffluß zu erlauben,

d) einem Ausstreifbehälter (22), der direkt unter dem Trennbehälter (20) angeordnet ist, wobei der Ausstreifbehälter einen Einlaß in offener Verbindung mit dem offenen Boden (74) des Trennbehälters (20) und einen Auslaß (26) zum Abziehen von Katalysator aus dem Ausstreifbehälter (22) hat,

(e) Einrichtungen (24) und (30) für das Zuführen von Ausstreifgas zu dem Aus-streifbehälter (22) und

f) einer in dem Ausstreifbehälter (229 angeordneten Entmischungszone, die wenigstens zwei vertikale Trennplatten (80) umfaßt, die unter dem offenen Boden (74) des Trennbehälters (20) im Abstand angeordnet sind.

2. Vorrichtung nach Anspruch 1, in der sich ein Wirbelstabilisatorrohr (76) aufwärts von dem offenen Boden (74) aus in den Trennbehälter (20) erstreckt.

3. Vorrichtung nach Anspruch 2, in der der Durchmesser des Wirbelstabilisators (76) geringer als 20 % des Durchmessers des offenen Bodens (74) ist und dieser offene Boden mit Ausnahme des Wirbelstabilisators unversperrt ist.

4. Vorrichtung nach Anspruch 1, 2 oder 3, in der sich die vertikalen Platten (80) horizontal und vertikal erstrecken und einen unversperrten Bereich begrenzen, der unmittelbar unter dem offenen Boden (74) des Trennbehälters (20) angeordnet ist.

5. Vorrichtung nach einem der Ansprüche 1 bis 4, in der der Ausstreifbehälter (22) einen größeren Durchmesser als der Boden des Trennbehälters (20) hat, sich die vertikalen Platten von der Wand des Ausstreifbehälters (22) nach innen erstrecken, um wenigstens zwei sich am Umfang erstreckende Kammern zu begrenzen, die unter dem offenen Boden (74) des Trennbehälters und an dessen Außenseite angeordnet sind.

6. Vorrichtung nach einem der Ansprüche 1 bis 5, in der der mittige Gasauslaß (32) in Verbindung mit wenigstens einem Zyklon (36) steht, wobei dieser Zyklon einen Tauchleitungsabschnitt (42) für das Rückführen von Katalysator zu dem Reaktorbehälter (19) sowie ein Dampfauslaß (40)zur Abgabe eines Dampfproduktstromes hat.

7. Verfahren zum fluidisierten katalytischen Kracken (FCC) eines FCC-Beschickungsstromes, bei dem man

a) FCC-Katalysator und den FCC-Beschikkungsstrom zu einer Steigleitungsreaktionszone (10) führt und darin den Beschickungsstrom mit dem FCC-Katalysator in Berührung bringt, um den Beschickungsstrom in Produktdämpfe umzuwandeln,

b) ein Gemisch dieser Produktdämpfe und von verbrauchtem FCC-Katalysator aus der Steigleitung direkt zu dem Einlaß eines Trennbehälters (20) überführt und das Gemisch von diesem Einlaß tangential in den Trennbehälter (20) richtet, um einen inneren und einen äußeren Wirbel zu bilden,

c) den inneren Wirbel mit einem Wirbelstabilisator (76) in dem Trennbehälter (20) stabilisiert,

d) Katalysatorteilchen in geschlossener Verbindung vom Boden des Trennbehälters (20) direkt in das obere Ende eines darunter benachbarten Ausstreifbehälters (22) entleert,

e) ein Ausstreifgas in den Ausstreifbehälter (22) einspritzt und die Katalysatorteilchen mit diesem Ausstreifgas in Berührung bringt, um Kohlenwasserstoffe von den Katalysatorteilchen zu desorbieren,

f) einen gasförmigen Strom von desorbierten Kohlenwasserstoffen und Ausstreifgas aufwärts von dem Ausstreifbehälter (22) durch mehrere vertikale Dissipationsplatten (80) in dem Ausstreifbehälter (22), durch ein offenes Volumen (84) des Ausstreifbehälters (22) oberhalb eines mittigen Teils 82) der Dissipationsplatten (80) und unterhalb des Bodens (74) des Trennbehälters (29) und aus dem oberen Ende des Ausstreifbehälters (22) und in den Boden des Trennbehälters (20) führt,

g) ein relativ dichtes Katalysatorbett in dem Ausstreifbehälter (22) unter dem mittigen Abschnitt (84) der Dissipationsplatten (80) aufrechterhält,

h) die Produktdämpfe und den gasförmigen Strom vom oberen Ende des Trennbehälters (20) durch einen mittigen Auslaß (32) abzieht,

i) den Produktdampf und den gasförmigen Strom von dem mittigen Auslaß zu einer Trenneinrichtung (36) führt, um zusätzliche Katalysatorteilchen zu gewinnen,

j) einen Produktstrom aus der Trenneinrichtung (36) gewinnt,

k) Katalystorteilchen von dieser Trenneinrichtung (36) zu einem unteren Abschnitt des Ausstreifbehälters (22) überführt,

l) verbrauchten FCC-Katalysator von dem unteren Ende des Ausstreifbehälters (22) entfernt und diesen verbrauchten Katalysator zu einer Regenerierzone (52) überführt,

m) diesen FCC-Katalysator in der Regenerierzone (52) durch oxidative Entfernung von Koks regeneriert und

n) FCC-Katalysator aus der Regenerierzone (52) zu der Steigleitungsreaktionszone (10) überführt.

Revendications

1. Dispositif de craquage catalytique fluidisé, comprenant :

(a) une enceinte de réacteur [19];
(b) une colonne montante tubulaire [10] possédant une extrémité d'entrée destinée à recevoir la charge d'alimentation et le catalyseur, et une extrémité de sortie;
(c) un récipient allongé de séparation [20] située dans l'enceinte de réacteur [19] et comportant une extrémité supérieure et une extrémité inférieure, ladite extrémité supérieure possédant une entrée tangentielle en communication directe avec ladite extrémité de sortie de ladite colonne montante, et une sortie centrale [32] pour le gaz, située à la partie supérieure dudit récipient de séparation [20], et ladite extrémité inférieure possédant un fond ouvert [74], la partie la plus extérieure dudit fond [74] étant non fermée de manière à permettre une circulation libre du fluide et des particules;
(d) un récipient d'extraction [22] situé directement au-dessous dudit récipient de séparation [20], ledit récipient d'extraction possédant une entrée communiquant librement avec ledit fond ouvert [74] dudit récipient de séparation [20], et une sortie [26] pour retirer le catalyseur du récipient d'extraction [22];
(e) des moyens [24] et [30] pour ajouter un gaz d'extraction dans le dit récipient d'extraction [22]; et
(f) une zone de ségrégation située dans ledit récipient d'extraction [22], comprenant au moins deux plaques verticales de séparation [80] situées à distance au-dessous dudit fond ouvert [74] dudit récipient de séparation [20].

2. Dispositif selon la revendication 1, dans lequel un tube [76] de stabilisation de tourbillon s'étend vers le haut à partir dudit fond ouvert [74] à l'intérieur dudit récipient de séparation [20].

3. Dispositif selon la revendication 2, dans lequel le diamètre dudit dispositif de stabilisation de tourbillon [76] est inférieur à 20 % du diamètre du fond ouvert [74], et ledit fond ouvert n'est pas fermé hormis pour ledit dispositif de stabilisation de tourbillon.

4. Dispositif selon la revendication 1, 2 ou 3, dans lequel lesdites plaques verticales [80] s'étendent horizontalement et verticalement et délimitent une zone non obstruée située directement au-dessous dudit fond ouvert [74] dudit récipient de séparation [20].

5. Dispositif selon l'une quelconque des revendications 1 à 4, dans lequel ledit récipient d'extraction [22] possède un diamètre supérieur à celui du fond dudit récipient de séparation [20], lesdites plaques verticales s'étendent vers l'intérieur à partir de la paroi dudit récipient d'extraction [22] de manière à définir au moins deux chambres circonférentielles situées au-dessous et à l'extérieur dudit fond ouvert [74] dudit récipient de séparation.

6. Dispositif selon l'une quelconque des revendications 1 à 5, dans lequel ladite sortie centrale [32]

pour le gaz communique avec au moins un cyclone [36], ledit cyclone possède une branche d'immersion [42] pour renvoyer le catalyseur à l'enceinte de réacteur [19], et une sortie [40] de vapeur servant à évacuer un courant de produit à l'état de vapeur.

7. Procédé pour le craquage catalytique fluidisé (FCC) d'un courant d'alimentation FCC, ledit procédé consistant à :

(a) envoyer le catalyseur FCC et ledit écoulement d'alimentation FCC à une zone de réaction [10] de la colonne montante et, à l'intérieur de cette zone, amener ledit écoulement d'alimentation en contact avec ledit catalyseur FCC pour convertir ledit courant d'alimentation en vapeurs d'un produit;
(b) évacuer un mélange desdites vapeurs du produit et le catalyseur FCC épuisé depuis ladite colonne montante directement à l'entrée d'un récipient de séparation [20] et diriger ledit mélange tangentiellement depuis ladite entrée dans ledit récipient de séparation [20] pour former un tourbillon intérieur et un tourbillon extérieur;
(c) stabiliser le tourbillon intérieur à l'aide d'un dispositif de stabilisation de tourbillon [76] dans ledit récipient de séparation [20];
(d) évacuer des particules de catalyseur par passage direct à partir du fond dudit récipient de séparation [20] pour les introduire directement dans la partie supérieure d'un récipient sous-jacent d'extraction [22];
(e) injecter un gaz d'extraction dans ledit récipient d'extraction [22] et amener les particules de catalyseur en contact avec ledit gaz d'extraction pour désorber des hydrocarbures à partir desdites particules de catalyseur;
(f) décharger un courant gazeux d'hydrocarbures désorbés et du gaz d'extraction vers le haut, à partir dudit récipient d'extraction [22], au moyen d'une pluralité de plaques verticales de dissipation [80] situées dans ledit récipient d'extraction [22], dans un volume ouvert [84] dudit récipient d'extraction [22] situé au-dessus d'une partie centrale [82] desdites plaques de dissipation [80] et au-dessous du fond [74] dudit récipient de séparation [20] et à l'extérieur de la partie supérieure du récipient d'extraction [22] et pour les introduire dans le fond dudit récipient de séparation [20];
(g) maintenir un lit relativement dense du catalyseur dans ledit récipient d'extraction [22] au-dessous de ladite partie centrale [84] desdites plaques de dissipation [80];
(h) prélever lesdites vapeurs du produit et ledit courant gazeux à partir de la partie supérieure dudit récipient de séparation [20] par l'intermédiaire d'une sortie centrale [32];
(i) transférer ladite vapeur du produit et ledit courant gazeux depuis ladite sortie centrale jusqu'à un séparateur [36] pour récupérer des particules additionnelles de catalyseur;
(j) récupérer du produit provenant dudit séparateur [36];
(k) transférer des particules de catalyseur depuis ledit séparateur [36] jusqu'à une partie inférieure dudit récipient d'extraction [22];
(l) éliminer le catalyseur FCC retiré de l'extrémité inférieure dudit récipient d'extraction [22] et transférer ledit catalyseur épuisé dans une zone de régénération [52];
(m) régénérer ledit catalyseur [FCC] dans ladite zone de régénération [52] au moyen de l'élimination du coke par oxydation; et
(n) transférer le catalyseur FCC depuis ladite zone de régénération [52] jusqu'à ladite zone de réaction [10] de la colonne montante.

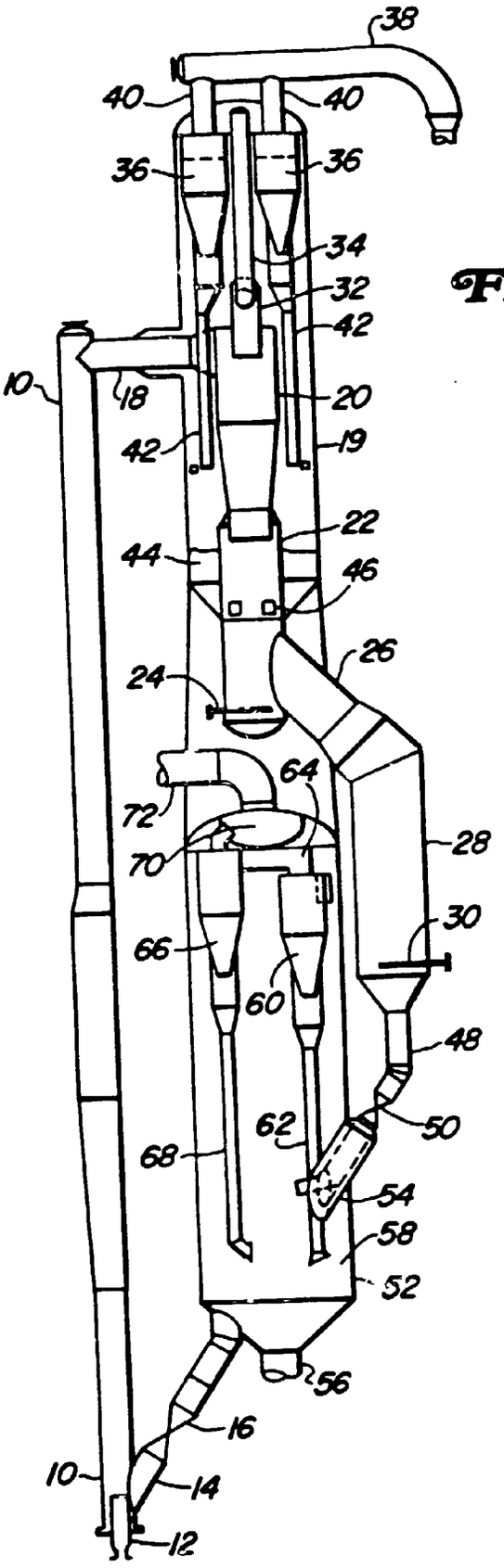

38
40
40
36
36
34
32
42
10
18
20
42
19
22
44
46
26
24
64
72
28
70
30
66
60
48
62
50
68
54
58
52
56
16
10
14
12

Fig. 1

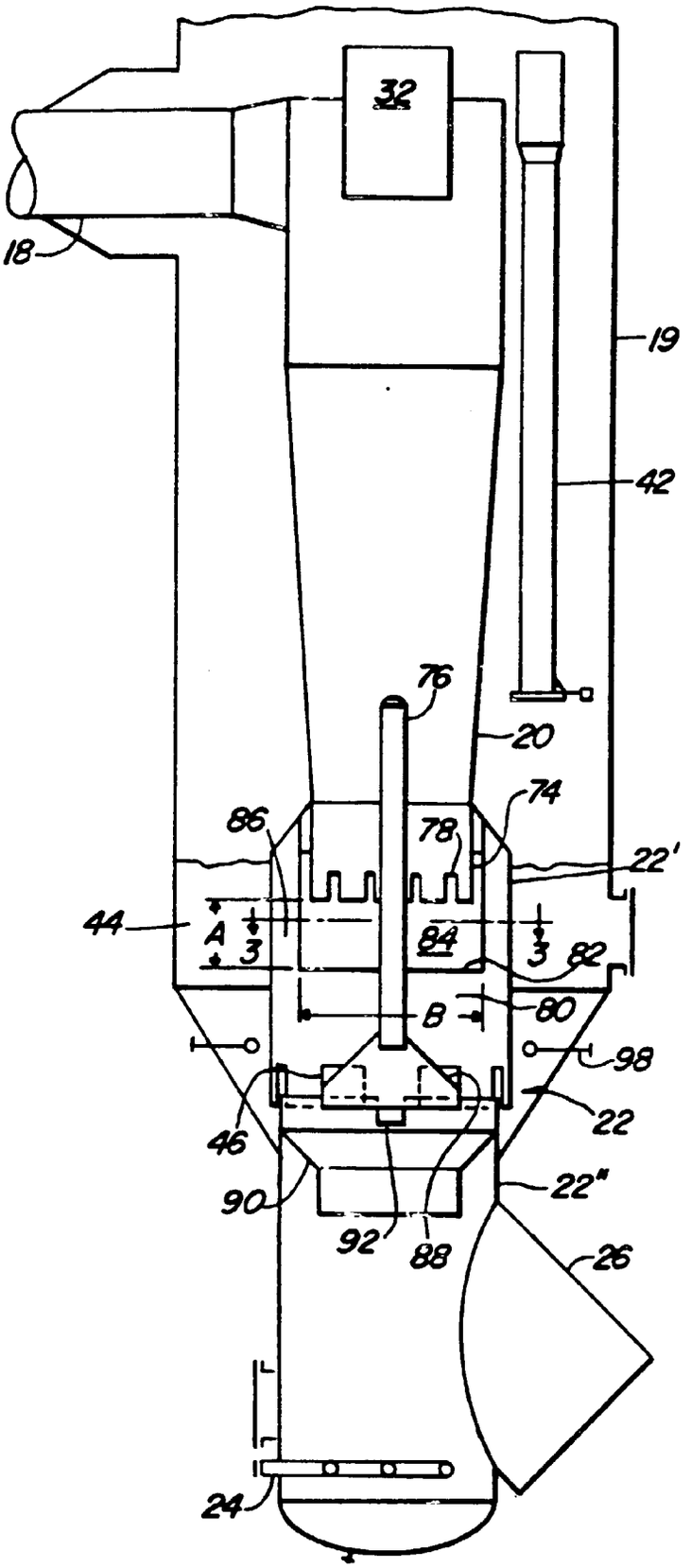

32
18
19
42
76
20
74
86
78
22'
44
A
3
84
3
82
B
80
98
22
46
90
92
88
22"
26
24

Fig. 2

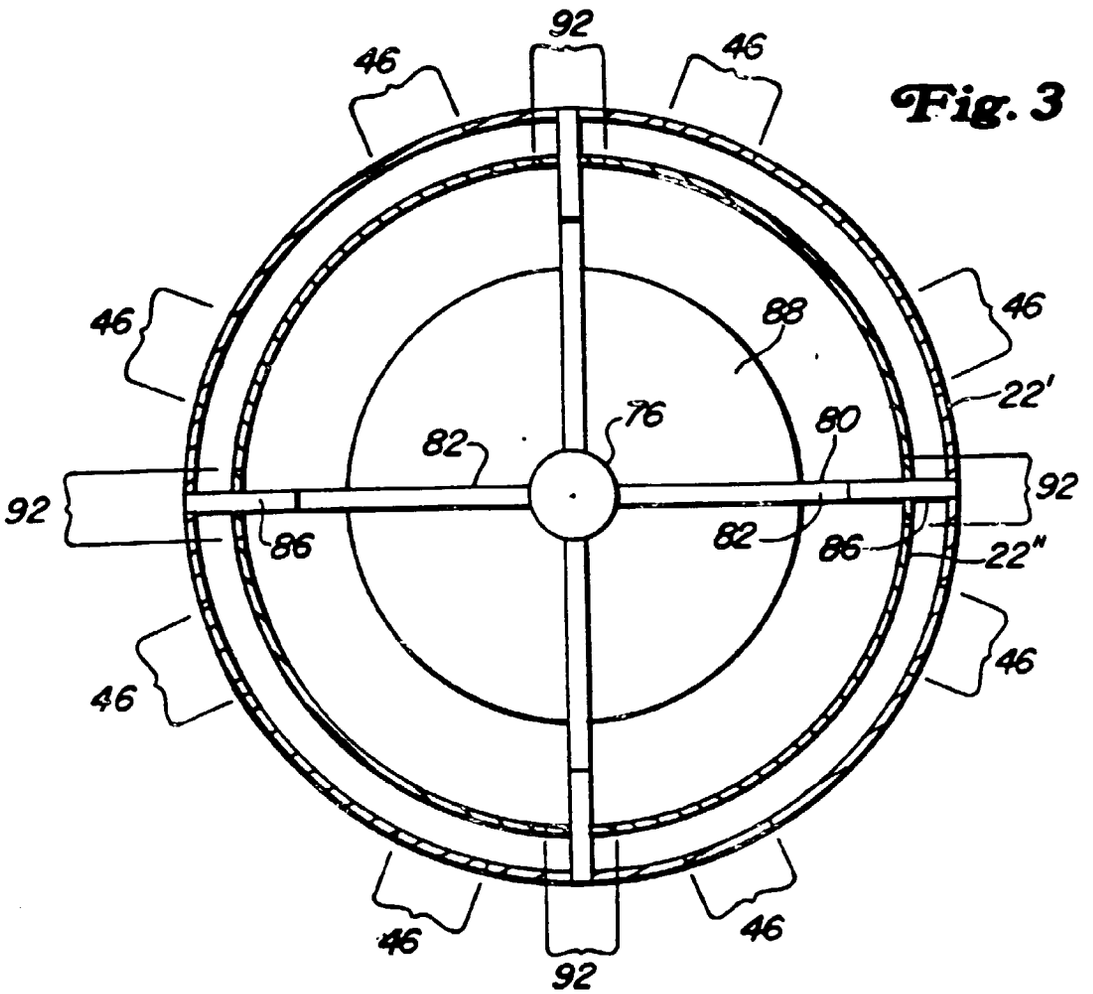


Fig. 3

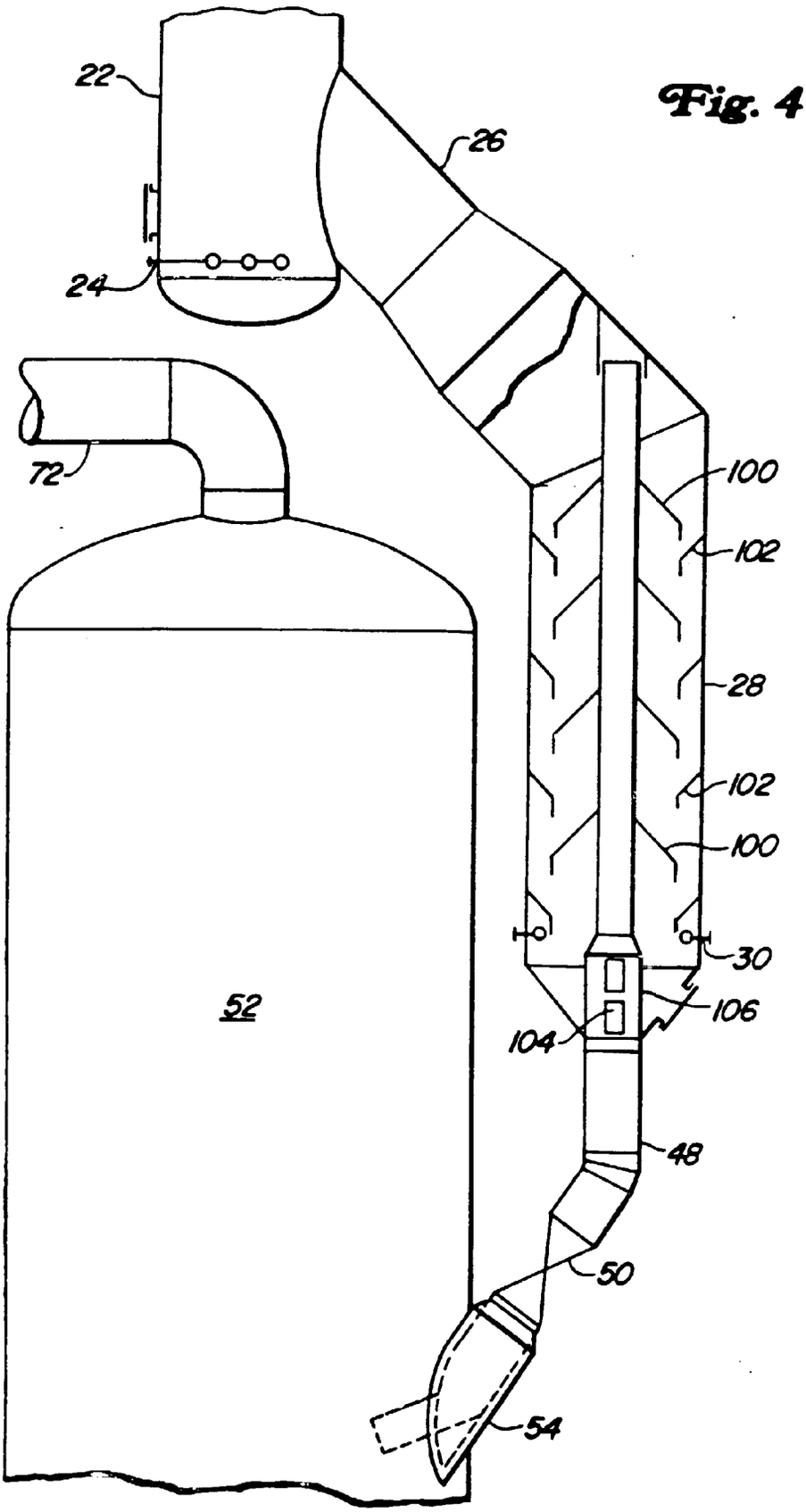


Fig. 4

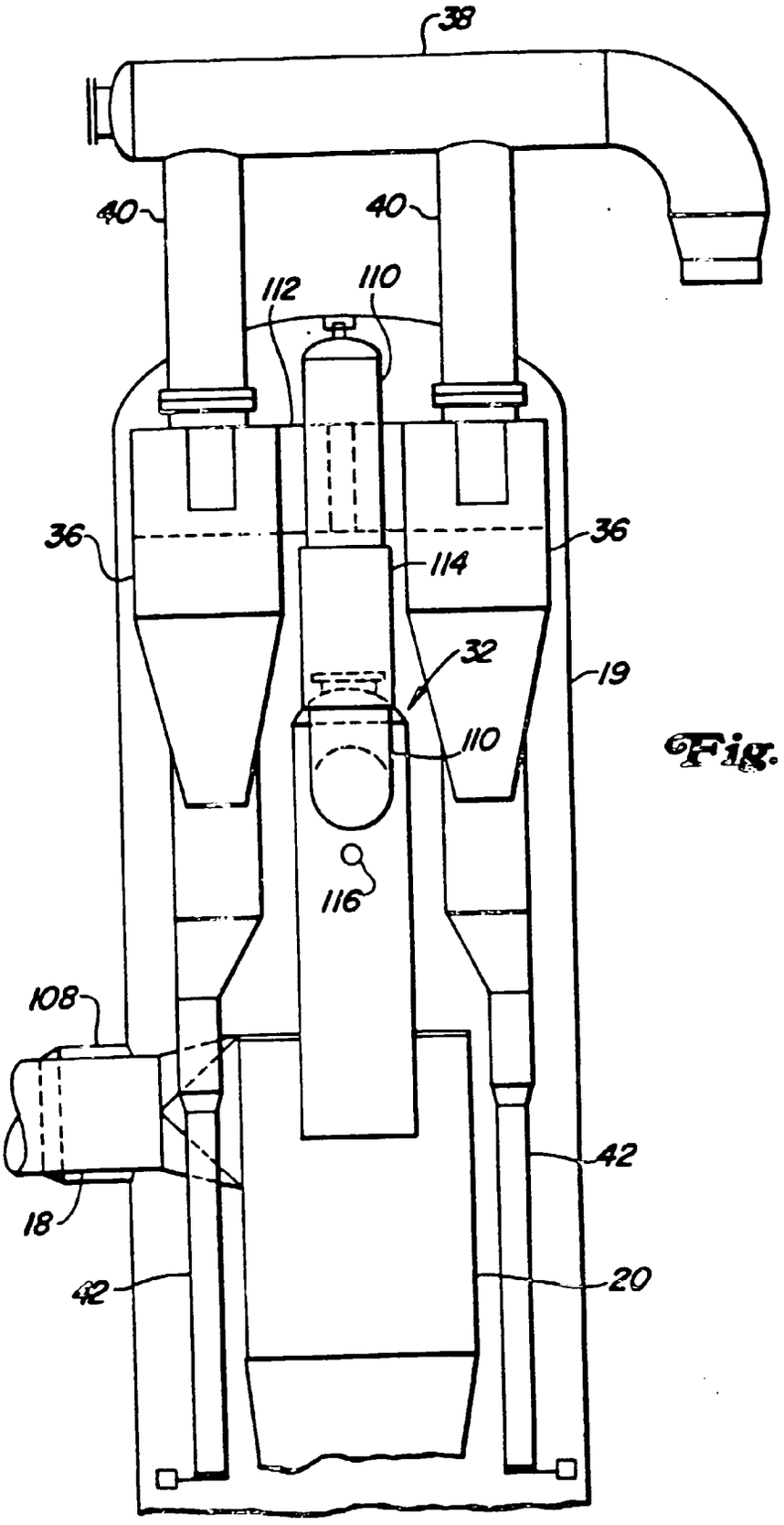


Fig. 5