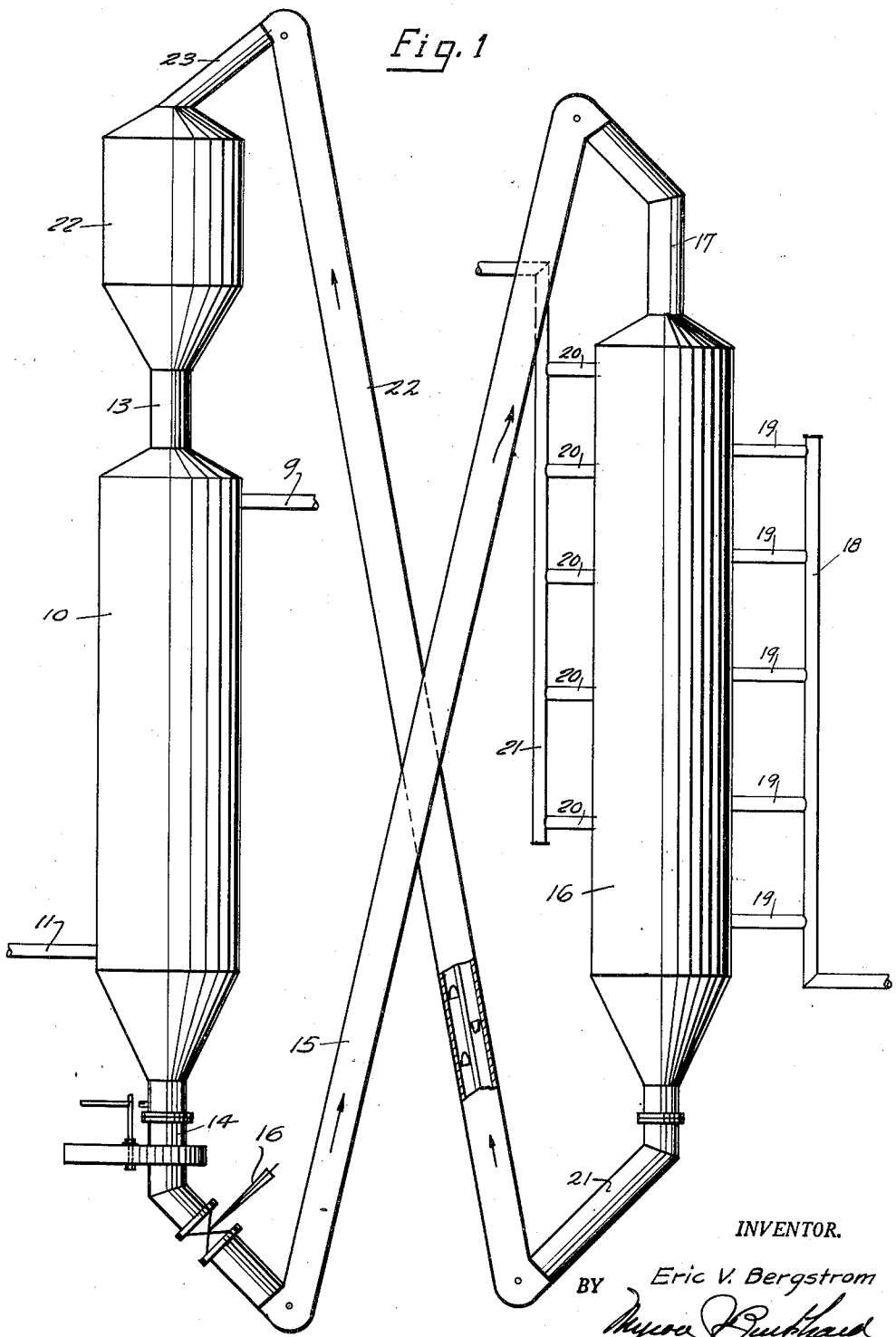
April 3, 1951 E. V. BERGSTROM 2,547,900

FLUIDIZED CATALYTIC CRACKING SYSTEM WITH ROTATING DISK SLIDE VALVE

Filed March 3, 1948 3 Sheets-Sheet 1

Fig. 1



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FLUIDIZED CATALYTIC CRACKING SYSTEM
WITH ROTATING DISK SLIDE VALVE

Filed March 3, 1948 3 Sheets-Sheet 2

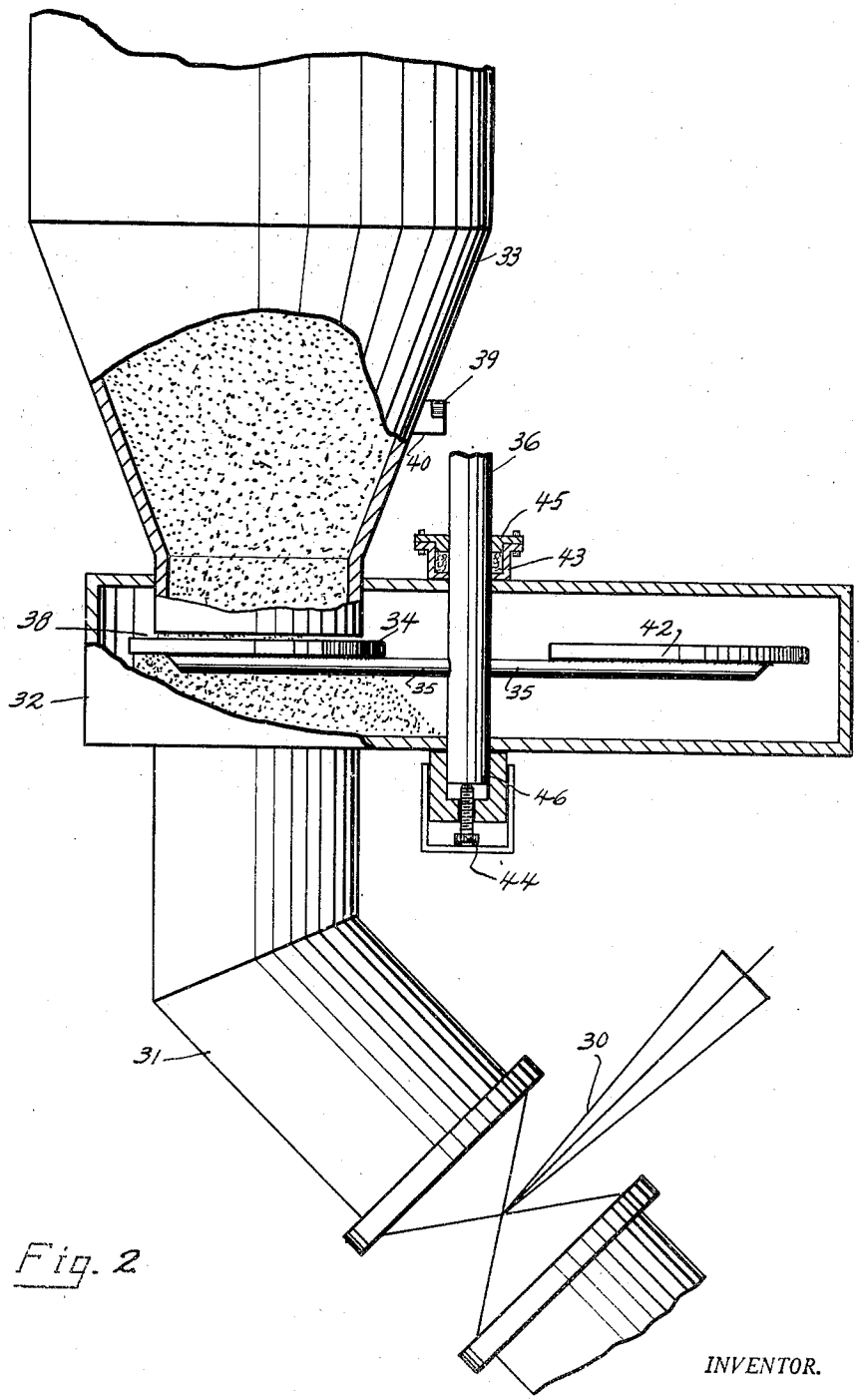


Fig. 2

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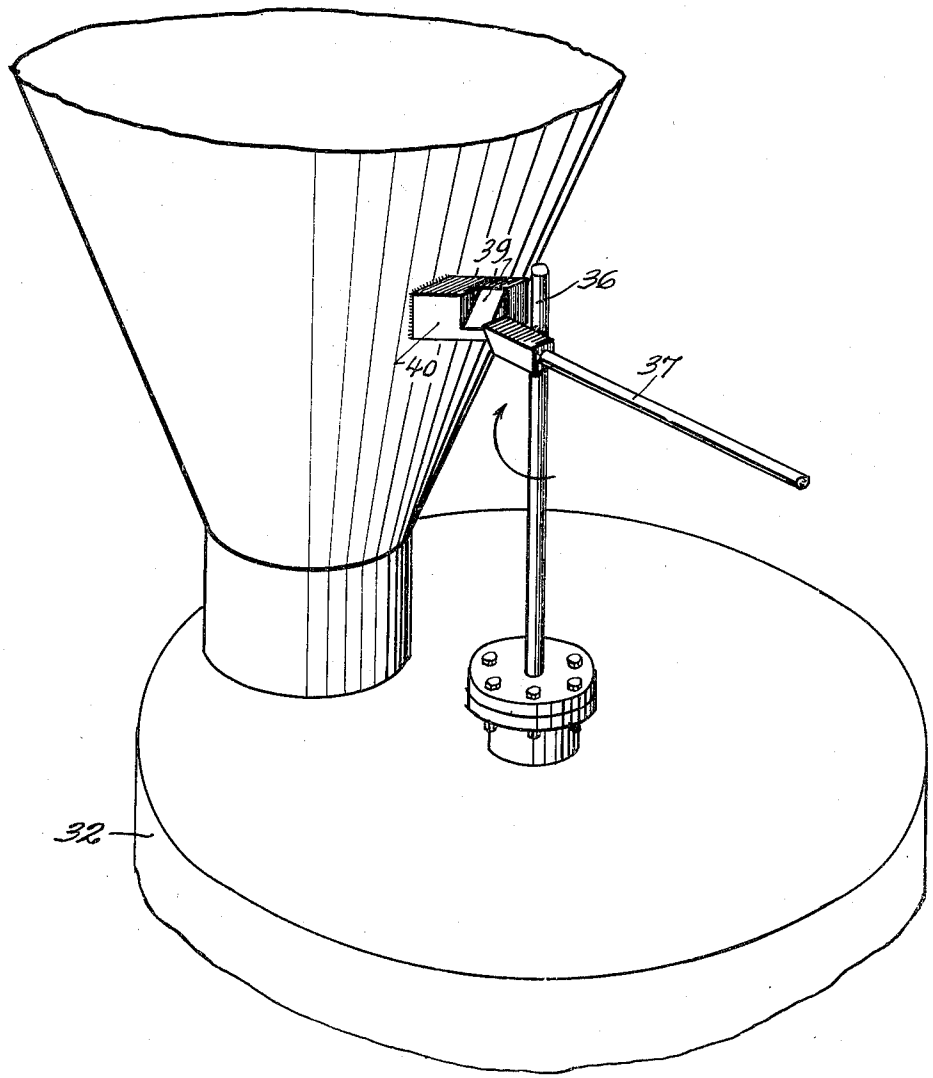


Fig. 3

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FLUIDIZED CATALYTIC CRACKING SYSTEM WITH ROTATING DISK SLIDE VALVE

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3 Claims. (Cl. 23—288)

1

This invention is concerned with the handling of a moving bed of particle-form material. It is particularly concerned with the handling of solid catalyst in a continuous hydrocarbon conversion process.

The development and universal acceptance of the high speed internal combustion engine as a source of power in such popular forms of transportation as the automobile, truck, bus and aircraft has placed unprecedented and ever-increasing demands upon the petroleum industry for high quality fuel, boiling in the gasoline range. It was recognized, at an early date, that in order to keep supply on a par with demand for gasoline fractions, the yield of gasoline hydrocarbons from each barrel of crude petroleum must be increased. This need was met by the development of the hydrocarbon cracking art. For the most part, petroleum fractions, heavier than the gasoline stocks, were subjected to appropriate treatment, whereby a substantial portion of the material was converted to fuel boiling in the gasoline range. The art has continually advanced through the years to the present complicated systems of continuous, catalytic cracking. A constantly-increasing percentage of the fuel used in internal combustion engines is obtained from the various systems of catalytic cracking.

In one favored system, named the thermofor catalytic cracking system, the particle-form catalytic material is passed downwardly, at a uniform rate, under the influence of gravity, through the reactor and regenerator. The flow rate of catalyst from both the reactor and regenerator is controlled to produce a solid column of particle-form material extending up through both vessels. The catalyst particles are conducted from the bottom of the reactor through a conduit to the base of an ascending elevator, by which they are transferred to the top of the regenerator. The catalyst particles leaving the bottom of the regenerator, likewise, are conducted through a conduit to the base of a second ascending elevator, by which they are transferred to the storage bin or hopper, located atop the reactor and communicating therewith. Selected, preheated hydrocarbons are admitted to the bottom of the reactor, and are passed upwardly through the reactor. They are maintained in intimate contact with the descending, hot catalyst particles, and as a result, are converted, in appreciable quantity, to lighter hydrocarbons, boiling in the gasoline volatility range. The cracked materials are removed from the top of the reactor for further purification and fractionation.

2

The catalyst particles become less effective as they descend through the reactor because of the deposition of carbonaceous material on the surface of the particles. The spent catalyst is reactivated in the regenerator by being passed through zones of combustion supporting gas, whereby the deposits are burned from the surface of the material. This process also provides the heat required to raise the temperature of the catalyst to the high temperature required for use in the reactor.

Various emergencies infrequently arise in the operation of such continuous, catalytic cracking processes that require the sealing of the outlet of the reactor or regenerator to prevent the flow of catalyst from either or both of these units. It is desirable, furthermore, that the closure be capable of making a reasonably tight vapor seal.

The object of this invention is to provide a method of sealing the outlet of a vessel containing particle-form material. A further object of this invention is to provide a method of sealing the outlet of a continuous, catalytic cracking reactor or regenerator.

This invention will be described with reference to the attached drawings, in which;

Figure 1 is a diagrammatic sketch of a continuous catalytic cracking apparatus incorporating the instant invention, a portion of which is sectioned; and

Figure 2 is a diagrammatic sketch of a portion of a continuous, catalytic cracking apparatus showing in section the location of the rotating disc slide valve; and

Figure 3 is a fragmentary view, shown in perspective, of a portion of the reactor and the valve actuating mechanism.

Referring to Figure 1, a reacting vessel and regenerating vessel, in conjunction with elevators for raising the catalyst, and the necessary catalyst connecting conduits to complete the system are shown. The vessels may be of any desired shape such as rectangular or circular cross-section, with converging entrance at top and bottom respectively.

Preheated hydrocarbon distillates are admitted to the reactor 10 through pipe 11, from a source not shown. Hot catalyst particles, stored in the storage hopper 12 atop the reactor 10 descend through connecting conduit 13 into the reactor 10. The rising hydrocarbons and descending catalyst are maintained in intimate contact in the reactor 10, resulting in substantial conversion of the hydrocarbon distillates into lighter products boiling in the gasoline range. The

cracked products are removed from the reactor 10 through pipe 9 and conducted to other refinery apparatus not shown, for further purification and fractionation. The spent catalyst is removed from the bottom of the reactor 10 and conducted through conduit 14 to the bottom of ascending elevator 15. Valve 16 in conduit 14 is used to control the flow rate of the catalyst. The elevator 15 transmits the catalyst to the top of the regenerator 16 through the conduit 17. As the catalyst is lowered through the regenerator 16, the deposits are burned from the surface of the catalyst by air admitted to the regenerator through header 18 and conduits 19 from a source not shown. The flue gases are removed from the regenerator through conduits 20 and header 21 and are conducted to other refinery apparatus, not shown. The revivified catalyst, removed from the bottom of the regenerator 16, is conducted through conduit 21 to the bottom of another ascending elevator 22, to be raised thereby and deposited in the hopper 12 through connecting conduit 23. Such catalytic cracking systems are completely described in the various patents on catalytic cracking of hydrocarbons of, for example, Payne, Simpson and Crowley such as No. 2,326,041, and need not be described in detail here.

The control or "chopper" valve 30, shown in Figure 2, a diagrammatic sketch of a portion of a continuous, catalytic cracking apparatus, is used to regulate the catalyst flow rate. In normal operation, the catalyst is piled up in back of the valve 30 in the form of a solid column, extending through the conduit 31, the rotary valve chamber 32 as shown, through the reactor 33, and on into the storage hopper atop the reactor; a solid column of particle size material approximately sixty feet high. The catalyst particles usually have an average diameter of 2–4 m. m. and are cylindrical, granular, or spherical in shape. In many respects, the catalyst follows the laws governing the flow of liquids, but unlike liquids, the particles do not flow to fill a vessel, such as the rotary valve chamber 32 in Figure 2, flowing only until the angle of repose of the solid is reached.

The catalyst in the region of the reactor outlet is seen, therefore, to be under considerable pressure. A valve for shutoff purposes at that location must possess unusual properties enabling it to push through the column and effect a closure. A valve operating in grooves or recesses will not function under these conditions. Such a valve would rapidly be clogged and jammed by the catalyst. Small catalyst particles and fines, being somewhat abrasive, would soon erode the mating metal parts, making a tight seal impossible. Furthermore, the attrition of catalyst particles would be excessive.

In this invention a rotary-operated slide valve, located in a chamber below the reactor, is designed to push aside a segment of the catalyst column when moved to the closed position.

Referring again to Figure 2, catalyst descends through the reactor 33, into the chamber 32, filling the chamber 32 in the manner indicated. The valve plate 34, is mounted on the horizontal arm 35. The vertical axle 36, to which the horizontal arm 35 is attached, is mounted in bearings 45 and 46. One end of the axle 36, which is projected through the wall of the valve chamber 32 is adapted to receive a torque to move the valve plate 34. As the valve plate 34 is shifted to the closed position, a portion of the catalyst

is pushed aside, falling in the clearance space of the valve chamber 32. A counterweight 42 is mounted on the opposite end of the arm 35 from the valve plate 34 to balance the valve and permit smooth operation. A clearance 38 is provided between the bottom of the reactor and the top of the valve plate 34 to prevent heavy catalyst attrition when the valve is being moved. The means of operating the valve is shown in perspective on Figure 3. The handle 37 may conveniently be manually operated or power operated, as desired, to rotate the vertical axle 36, thereby opening or closing the valve in the valve chamber 32. As the closed position of the valve is reached, the wedge 41, cut on the inner end of the handle 37, makes contact with and rides up on the inclined plane 39, cut on the surface of a lug 40, which is welded to the reactor 33, as shown on Figure 3. The wedging action, caused by the relative motion of the mating, inclined planes, causes the valve axle 36 and the valve plate 34, as shown on Figure 2, to lift sufficiently to effectively seal the reactor outlet. This provides a substantially vapor-tight seal of the reactor outlet. The hole in the chamber 32 through which the shaft 36 protrudes is sealed by a seal 43 to prevent the escape of gases from the chamber 32. The clearance 38 between the valve plate 34 and the bottom of the reactor 33 can be adjusted by a set screw 44, which is adapted to raise or lower the entire valve mechanism.

This invention presents the advantage of complete elimination of grooves or recesses, which cause jamming. The absence of guides, furthermore, reduces friction to a minimum, and prevents the catalyst particles from being crushed. The slight raising of the valve at the end of its movement toward the closed position, produced by the mating plane surfaces, lifts the catalyst in the reactor slightly, making a reasonably tight vapor seal.

I claim:

1. In a continuous, catalytic cracking system in which catalyst is passed through a reactor and regenerator and connective means, the flow of catalyst being continuous and in a downward direction through both the reactor and the regenerator, the improvement which comprises valve means for closing the outlet of at least one of said vessels and operative means for closing said valve means, said means comprising a chamber inserted in the system to form a part of the connective means and located below said vessel such that the catalyst outlet of said vessel projects into said chamber and terminates near the top, an axle mounted in said chamber with one end projected through said chamber capable of rotary motion about its longitudinal axis, a cross-member attached to said axle, a valve plate attached to one end of said cross-member disposed immediately below the catalyst outlet of said vessel, a counterweight attached to the opposite end of said cross-member, a handle connected to the external end of said axle capable of being moved to rotate said axle, a first lug shaped in the form of an inclined plane attached to said vessel, a second lug shaped in the form of a mating plane attached to said handle adapted to make contact with said first-named lug as the valve is closed causing the valve to lift sufficiently to prevent the flow of catalyst and gases from said vessel, and means defining an outlet from said chamber connected to said connective means and conducting therewith.

2. In a system in which a particle-form material is discharged from a vessel, an outlet conduit from said vessel, a rotatable axle located adjacent said outlet conduit, a valve plate adapted to be rotated to a position of alignment with the open end of said outlet conduit, the valve plate being located to provide a small clearance between the edge of the outlet conduit and the surface of the plate when the valve is not substantially closed, means connecting said valve plate to said axle, means for rotating said axle, and means for lifting said valve plate toward said outlet conduit as the valve is closed to bring the plate into contact with the edge of the outlet conduit.

3. In a continuous catalytic cracking system for the conversion of hydrocarbons in which a particle-form solid contact material is passed downwardly through a reaction vessel wherein it is contacted with hydrocarbons at reaction conditions and downwardly through a regeneration vessel wherein it is contacted with combustion supporting gas for removing carbonaceous material formed on said contact material during the conversion and through connective means, the improvement which comprises valve means for

closing the outlet of at least one of said vessels, said means comprising a chamber inserted in the system to form a part of the connective means and located below said vessel such that the contact material outlet of said vessel projects into said chamber and terminates near the top, an axle located at least partially within said chamber and adjacent the contact material outlet, a valve plate disposed immediately below and spaced from the contact material outlet of said vessel, means connecting said valve plate to said axle, means for rotating said axle, means for lifting said valve plate as the valve is closed, causing the valve to lift sufficiently to prevent the flow of contact material and gases from said vessel, and means defining an outlet from said chamber.

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