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COKING IN A FLUIDIZED STATE

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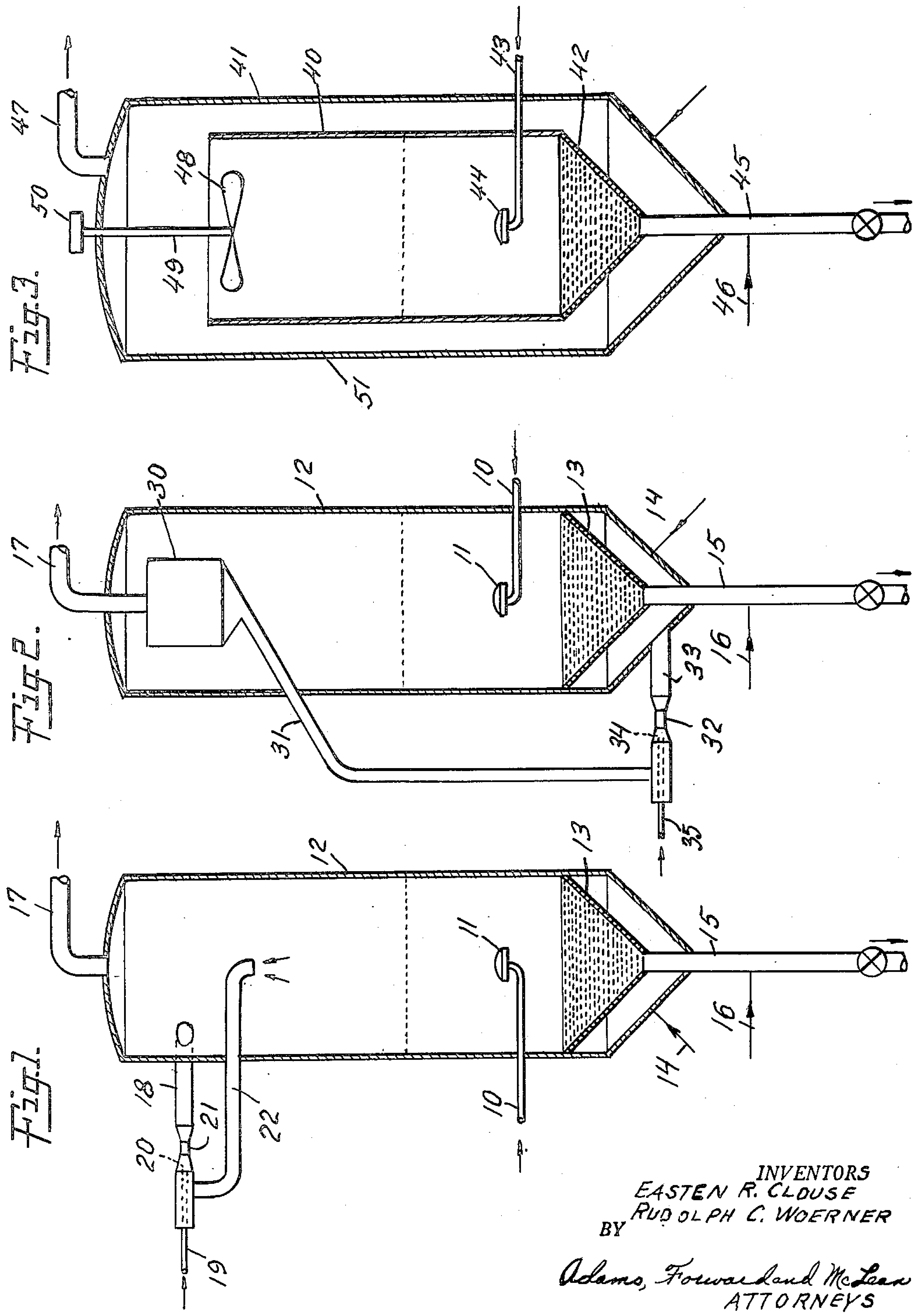

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COKING IN A FLUIDIZED STATE

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2 Claims. (Cl. 202—23)

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Our invention relates to improvements in the coking of hydrocarbon oils in systems where the coking charge stock is contacted at a coking temperature with a body of adsorbent coke particles maintained in a fluidized state in a coking vessel. Such a system has been described in Kenneth M. Watson's application Serial No. 121,575 of October 15, 1949. According to the Watson invention, the body of coke particles is maintained in the fluidized state and reactor coking is avoided by selectively withdrawing large coke particles as they are built up by adsorption and reaction by means of elutriation. The operation requires a large volume of vaporous fluidizing medium, usually steam, in addition to the vaporous elutriating medium in order to keep the body of coke particles in a fluidized condition. In the operation, appreciable amounts of coke fines are produced by attrition, and under the fluidizing velocities obtaining within the coking vessel tend to be entrained in the reaction vaporous stream withdrawn overhead. The carryover of coke fines is undesirable because they tend to plug the vapor lines and condenser tubes and tend to adversely effect the color of the distillate liquid products produced in the process.

According to our invention, fines carryover is suppressed by imposing a whirling motion upon the stream of reaction vapors rising from the body of coke particles maintained in the coking vessel prior to their withdrawal overhead as the vapor product stream. In an especially advantageous aspect of our invention, a substantial portion of the whirling vapor stream is recirculated to beneath the body of coke particles to assist in fluidization. By our invention, process improvement is accomplished by reducing the danger of plugging condenser tubes and in improving the quality of the liquid products. The maintenance of the equilibrium of the system is assisted by return of the coke fines to the main body of coke particles to act as seed nuclei in the coking reaction. The body of coke particles is kept in a well-energized state essential for maintenance of the reaction without wall coking or solidification of the bed while effecting substantial reduction in the quantity of fluidizing medium required. Our invention will be further described with reference to the accompanying drawing wherein Figures 1, 2 and 3 respectively show in schematic form various reactor forms which may be employed in the application of our invention.

In Figure 1, the preheated coking charge stock is introduced into the body of coke particles by means of connection 10 and injection nozzle 11.

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The body of coke particles is contained in coking vessel 12 over perforated conical grid 13. A fluidizing medium, e. g. steam, is introduced below the conical grid as by connection 14. Large coke particles are selectively removed from the body of coke particles in coking vessel 12 through elutriator 15 opening into the bed through the bottom of conical grid 13. An elutriating medium, e. g. steam, is introduced to elutriator 15 through connection 16 at a rate sufficient to withdraw the net coke make in the form of the larger particles. Steam and reaction vapors separating from the body of coke particles rise upwardly through a fines disengaging space in the upper portion of coking vessel 12 and are removed overhead through line 17. A whirling motion is imposed on the column of rising vapors by tangential injection of steam through pipe 18 into the upper portion of the coking vessel 12. The rotation and centrifugal force imposed on the rising vapors drop the coke particles out of the vapors and assist in their return to the body of coke particles maintained in the lower portion of the coking vessel 12.

In order to avoid vapor overloading of the coking vessel 12, the requirements of steam for imparting the whirling motion to the vapors by tangential injection is substantially reduced by drawing vapors from the reactor for this purpose. Thus the net steam employed is injected through line 19 and jet 20 into the throat of venturi 21. The draft side of the venturi is connected to pipe 22 which is in open communication with the vapors rising in the coking vessel 12. The open end of vapor and recirculating pipe 22 faces downwardly and is positioned slightly below the point of tangential entry so as to draw as coke-free gas as possible.

In Figure 2, the general reactor plan including the coking vessel 12, the coking charge stock entry means 10 and 11, and the elutriating means 15 and 16 are similar. Steam and reaction vapors rising through the fines disengaging zone of the coking vessel 12 to overhead vapor line 17 for removal to the conventional fractionating system pass first through large cyclone separator 30. The cyclone separator is conventionally sized and located in the top of the coking vessel 12, and a single separator or a multiple system depending upon size considerations may be employed. Instead of the conventional cyclone dipleg or standpipe, internally dropping to below the surface of the body of coke particles, a drop leg 31 is employed which is connected to the draft side of a steam jet Venturi system 32.

Fluidizing steam is injected to the Venturi throat through steam line 35 and nozzle 34. The Venturi discharge pipe 33 opens into the coking vessel 12 below the conical grid 13. The flow of steam pulls by vacuum about 30 to 100 per cent of the steam volume in vapors recirculated from the fines disengaging space of the coking vessel 12. The whirling motion imparted to the vapor stream entering the cyclone 30 drops out entrained coke particles which are carried with the recirculated gas flow through line 31, venturi 32 and discharge pipe 33 to below the body of coke particles.

The recirculation of the reaction vapors increases the centrifugal force developed in the cyclone system so as to improve fines recovery as seed nuclei for the coking reaction and so as to minimize fines carry-over from the coking vessel 12 to the liquid products recovery system. At the same time, the net requirements for fluidizing steam are materially reduced. For example, in a 15,000 barrel per day coking unit employing about 40,000 pounds per hour of fluidizing steam, only about 14,000 pounds per hour of 550 p. s. i. g. steam is required as fresh make-up. If desired, a portion of the net fluidizing steam provided may be separately introduced as by line 14.

In the system of Figure 3, a double wall coking vessel is employed. The body of adsorbent coke particles is contained within internal cylindrical column 40 disposed within coking vessel 41. The body of coke particles is supported by perforated conical grid 42 and the internal cylindrical column 40 is open at the top. The coking charge stock is introduced to a lower portion of the body of coke particles by means of line 43 and discharge means 44. Coke make is selectively withdrawn from the bottom of the bed through elutriator 45 against the pressure of elutriating steam introduced through connection 46. Steam and reaction vapors separating from the body of coke particles rise out of internal cylindrical column 40 into the upper section of the coking vessel 41 from which they are withdrawn through overhead vapor line 47 to a conventional liquid products recovery system. Carry-over of coke fines from reactor internal cylindrical column 40 is suppressed by a whirling motion imposed upon the rising vapors by rotating impeller 48 connected by shaft 49 to a conventional electric motor or other power device 50. The rotation of impeller 48 not only assists in eliminating coke fines carry-over but effects a recirculation of steam and reaction vapors down through the annulus 51 formed between internal cylindrical column 40 and the external wall of coking vessel 41 and back into the body of coke particles through conical grid 42. In this way, the quantity of fluidizing medium required to keep the bed in a well energized state is significantly reduced.

Because of the reduction in the net requirements for fluidizing medium, a larger diameter bed can be economically employed. Without an economical and efficient means for recirculating fluidizing vapors, undesirably tall towers of small diameter are ordinarily necessary to keep the requirements of fluidizing medium within reasonable limits. The relatively shallow beds of small L/D permitted by operation according to our invention are advantageous with respect to better top-to-bottom mixing so that improved uniformity of contacting is obtained and particle size segregation is avoided.

The form of the impeller employed according to our invention may be varied considerably. A simple propeller type form may be employed having the blades pitched so as to effect a centrifugal and downward force during rotation. Advantageously, a solid disc with Francis type impeller blades on its lower side may be employed. The speed of rotation depends largely upon the velocity of the rising vapors and the mass of the entrained particles. Relatively low R. P. M.'s may be employed, e. g. about 50 to 800 R. P. M.

In operation, the coking vessel is charged with a body of adsorbent coke particles, ordinarily obtained from a previous run, approximating, for example, 10- to 30-mesh in size range. Fluidizing steam at a rate sufficient to maintain a vapor velocity in the vessel of about 2 to 3 feet per second is employed. A coking temperature within the range of about 800° to 1200° F., advantageously 875° to 1050° F., is maintained in the coking reaction vessel. The heat is provide by preheating the feed by heat exchange and by conventional fired heaters. Additional heat is supplied by superheating the elutriating and fluidizing media. The pressure in the coking vessel is usually kept low, e. g. usually about atmospheric pressure and within the range of about 10 to 150 p. s. i. Elutriating steam is introduced at a rate sufficient to withdraw the net coke make in the form of the larger coke particles.

We claim:

1. In the coking of hydrocarbon oils by contacting a coking charge stock at a coking temperature with a body of coke particles maintained in a fluidized state in a coking vessel from which large coke particles are selectively withdrawn by elutriation and from which reaction vapors are withdrawn overhead, the improvement which comprises suppressing entrainment of coke fines in the overhead vapors by tangentially injecting steam into the upper portion of the coking vessel whereby a whirling motion is imposed upon the stream of vapors rising from the body of coke particles in the coking vessel prior to withdrawal overhead of the vapor stream.

2. The improvement of claim 1 in which vapors rising from the body of coke particles are drawn from the vessel and are tangentially injected into the upper portion of the coking vessel with the steam.

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