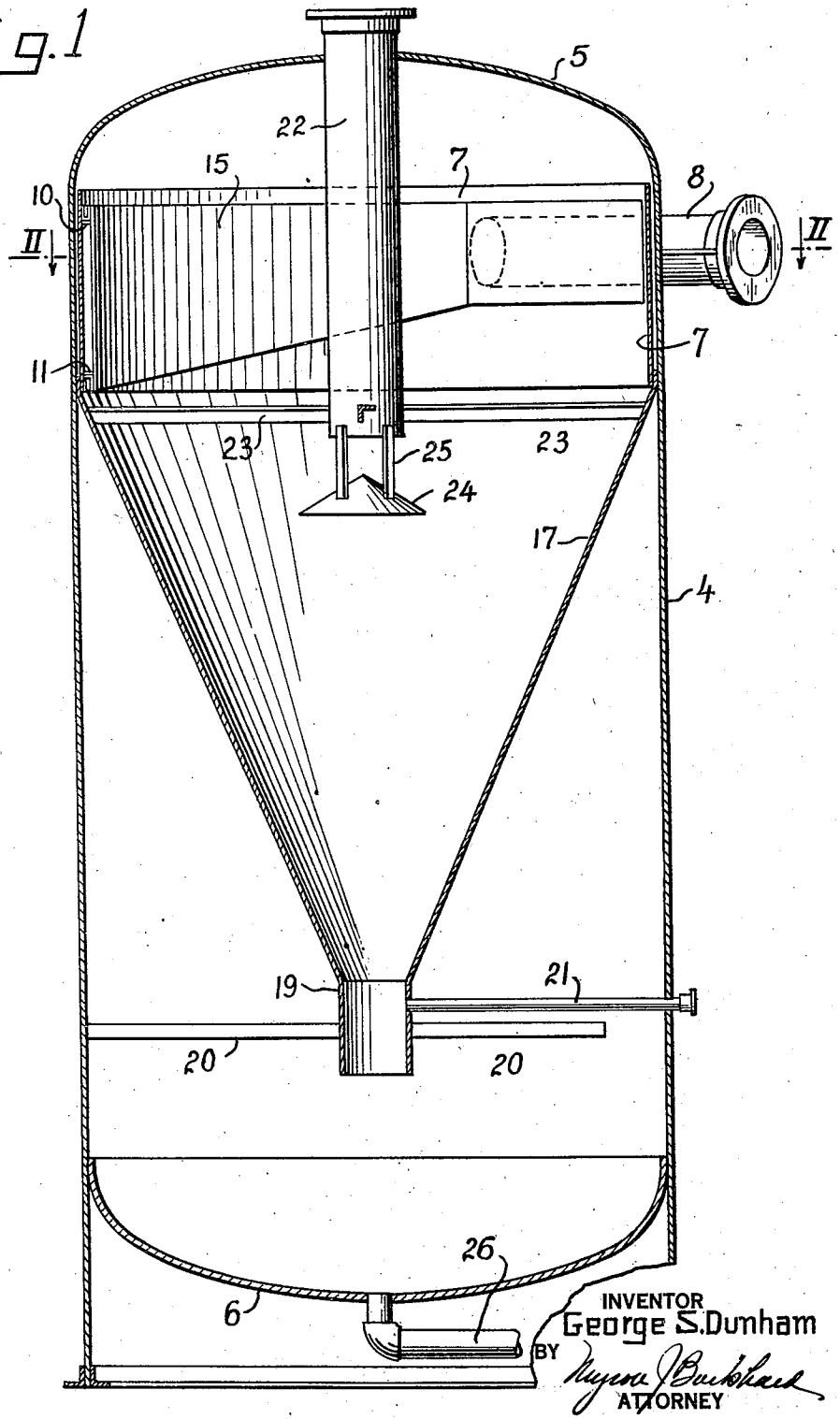
Sept. 8, 1942. G. S. DUNHAM 2,295,101

SEPARATION APPARATUS

Filed Aug. 3, 1940 2 Sheets-Sheet 1

Fig. 1



INVENTOR
George S. Dunham
BY
ATTORNEY

Sept. 8, 1942. G. S. DUNHAM 2,295,101

SEPARATION APPARATUS

Filed Aug. 3, 1940 2 Sheets-Sheet 2

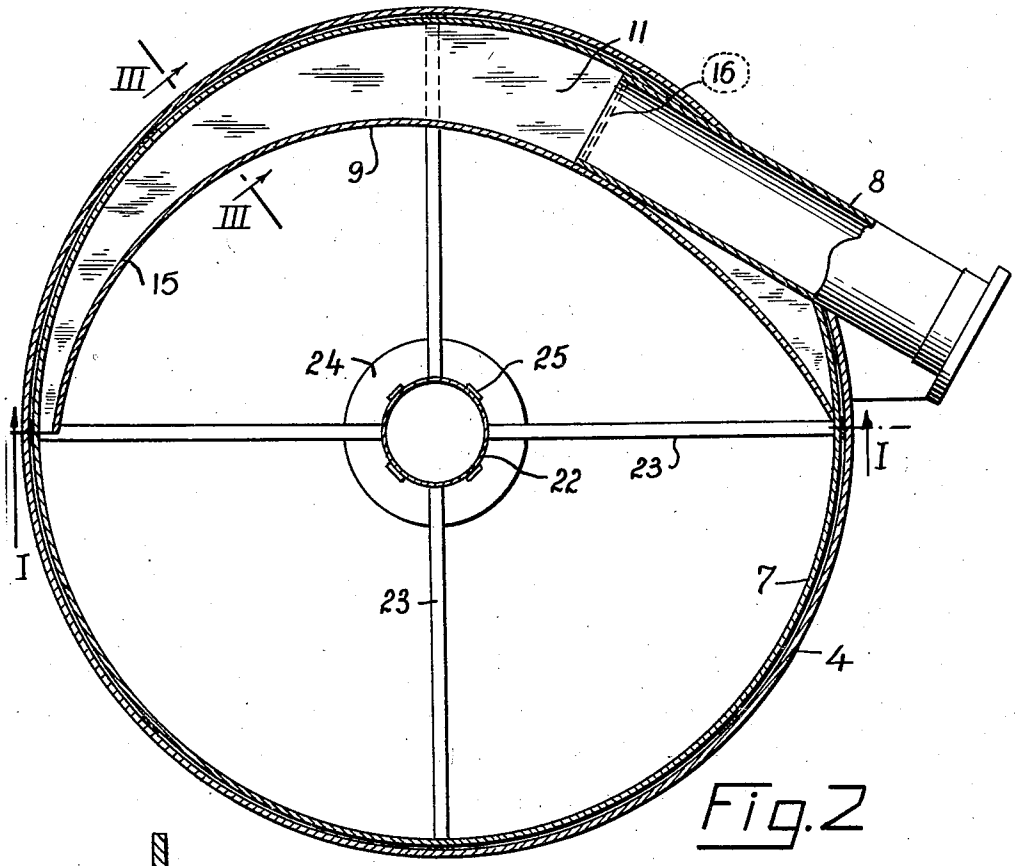


Fig. 2

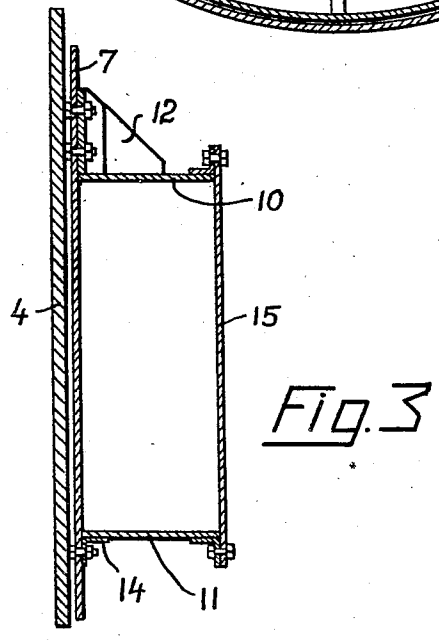


Fig. 3

INVENTOR
George S Dunham
BY
Myron J Burkhard
ATTORNEY

Patented Sept. 8, 1942 2,295,101

UNITED STATES PATENT OFFICE

2,295,101

SEPARATION APPARATUS

George S. Dunham, Ardmore, Pa., assignor to Socony-Vacuum Oil Company, Incorporated, New York, N. Y., a corporation of New York

Application August 3, 1940, Serial No. 350,582

5 Claims. (Cl. 183—83)

This invention relates to apparatus for the preparation of charging stocks with particular reference to improved apparatus for the separation of entrained liquid material such as heavy ends, for instance material of an asphaltic or tar like consistency, from lower boiling material. Products obtained by such procedures are of special utility as charging stocks for cracking especially in vapor phase.

Extremely high boiling materials in charging stocks for vapor phase catalytic cracking are conducive to the deposition of large quantities of a coke like material in the catalyst bed, and, in addition thereto, in the case of many charging stocks, impurities, detrimental to the activity of cracking catalysts, are contained predominantly in the high boiling material. In the separation of such heavy ends by vaporization of the lower boiling material and mechanical removal of the unvaporized heavy ends therefrom, it is desirable to obtain the most rapid action possible between the heating of the charge and quenching of the removed material in order to prevent coking of the material. It is accordingly an object of the present invention to provide apparatus of low initial and operating costs to separate such high boiling heavy ends rapidly and efficiently.

Other objects and advantages of the present invention will be obvious from a consideration of the following description taken in conjunction with the accompanying drawings in which is shown a preferred form of the invention and in which:

Fig. 1 is a vertical section through the separator substantially on the line 1—1 in Fig. 2;

Fig. 2 is a horizontal section through the distributor, passing through the axial line of the inlet pipe and substantially on the line 2—2 in Fig. 1;

Fig. 3 is a vertical fragmentary section through the inlet horn on the plane of line 3—3 in Fig. 2.

In the form of the invention shown in the drawings, a casing is provided comprising a cylindrical side wall 4, a top wall 5, and a bottom wall 6, suitably constructed to withstand the pressure under which it is desired to operate. An internal cylindrical shell or wear plate 7 is provided in the upper portion of the casing of a size such that the external surface thereof is in close proximity to the internal surface of the side wall. An inlet pipe 8 extends through the casing and through the cylindrical shell 7 near the upper end of the latter and to a point such that the inner end of the pipe lies in a plane through the central axis of the shell.

From the inner end of the inlet pipe 8 a horn 9 extends partially about the shell to introduce material into the shell in the form of a wide, flat, jet tangentially to and spread vertically along the inner surface of the separating chamber. The horn 9 comprises an upper wall 10 which is substantially horizontal and has one edge thereof shaped to conform to the inner surface of shell 7 and has the other edge shaped to reduce gradually the width of the top wall from substantially the diameter of the pipe 8 to a relatively narrow width at its opposite end remote from pipe 8. The lower wall 11 of horn 9 is placed in an inclined position with one end thereof immediately below inlet pipe 8 and the other end thereof below the small end of wall 10 adjacent the lower end of shell 7. The outer edge of wall 11 is shaped to conform to the inner surface of shell 7. The inner edge of the wall 11 is shaped to lie vertically below the inner edge of the upper wall 10 when both are in their described positions. The walls 10 and 11 are secured to shell 7 as by gussets 12 and angles 14 secured thereto and bolted to shell 7. An inner vertical plate 15 is secured to the inner edges of members 10 and 11 and is shaped to conform thereto. At the juncture of inlet pipe 8 and horn 9, a partition 16 is provided having a circular opening therein in which the pipe is secured and having its outer edge shaped to conform to members 7, 10, 11 and 15 and secured thereto. To form a streamlined covering for inlet pipe 8, thereby to prevent a detrimental effect of the pipe on the flow of a material within the separator and to assist in the downward spiraling of introduced material, the walls 10, 11 and 15 may be extended from the large end of the horn 9 to cover the pipe and to converge as shown without sharp angles into the curve of shell 7.

A downwardly converging truncated conical member 17 is positioned below shell 7, coaxially with the casing and with its upper edge between shell 7 and side wall 4. A collar 19 is secured to and depends from the lower edge of cone 17 with the lower end of the collar spaced a substantial distance from bottom wall 6. Suitable bracing bars 20 for cone 17 may be secured to the side wall 4 and collar 19. A pipe 21 extends through and is secured in side wall 4 and communicates through collar 19 to introduce a cooling flux into separated heavy bottoms to prevent coking thereof.

A vapor outlet pipe 22 is provided in the upper end of the separator, axially thereof, communicating out of top wall 5 and with its lower end

generally at the level of the upper portion of cone 17. Braces 23 are secured to the cone 17 and to the lower end of vapor outlet pipe 22. A conical shield 24 is supported by brackets 25 secured to outlet pipe 22 to prevent entrance of separated liquid into the outlet pipe upon variation of the pressure upon the outlet, as may be produced when shifting the flow of vapors from outlet pipe 22 from one reaction zone to another. A liquid outlet pipe 26 is secured to and communicates through lower wall 6.

In operation, material from which it is desired to separate heavy bottoms is heated to a temperature to vaporize all but the undesired constituents and is introduced into the separator through pipe 8, either in liquid phase or following vaporization.

The temperature and pressure are preferably so regulated that all but a minor percent. of the material will be in vapor phase when introduced into the horn and thereby into the separating zone. If no viscosity breaking is desired the temperature is elevated to a point below that at which cracking will occur and sufficient pressure is maintained to retain the heavy ends in liquid phase. If some viscosity breaking is desired the temperature is maintained higher, whereby limited cracking occurs and the pressure is increased whereby the undesired constituents are present as liquid. Input material is introduced into the separating zone by the pipe 8 and the horn 9. As the horn is curved some of the heavy material may deposit upon the shell 7 within the horn. Flow of this deposited material along the inclined bottom of the horn is assisted by the flow of vapor. In commercial sizes of separators the end of the horn has about one-half to one-third the cross-sectional area of the pipe 8 which is the size normally employed to conduct the desired cubic footage of vapor. At the outlet end of the horn the vapor is introduced into the separating zone at a linear velocity which in accord with this invention is generally sufficient to produce an angular velocity of at least about two revolutions per second, preferably about three revolutions per second. Such a high rate, it has been found, effects particularly rapid separation of heavy liquid ends from vaporized hydrocarbons, though under certain special conditions an angular velocity below about two revolutions per second may be employed. The charge is constricted by the horn to a stream of at least ten times the extent along the cylindrical boundary of the zone as the radial extent thereof, and is introduced into the zone tangentially against the bounding wall of the zone. The horn being downwardly inclined the charge is given thereby a slight downward component. The lower inclined surface of the horn also conduces, by action on vapors, to movement in the zone in downward direction. As the vapors whorl around within the zone the liquid entrained by the vapor is deposited upon the cylindrical and conical walls. Such deposited liquid runs down the walls and is chilled by the flux introduced through pipe 21 sufficiently to prevent coking of the heavy ends in the separator. The vapors, after deposition of heavy ends, move to the center of the separator and are removed through the outlet pipe 22.

It has been found advantageous to employ an outer casing surrounding the conical portion. Such a construction allows a body of cooled separated material to be held in close proximity to the completely separated material so that the hot material can be effectively cooled immediately following separation, thus avoiding formation of coke which otherwise would deposit in the lower end of the apparatus.

I claim as my invention:

1. A separator for removing entrained liquid from vapors comprising a cylindrical casing including a cylindrical wall and closures for the upper and lower ends thereof, truncated conical means within said casing having its larger upper end contiguous to said cylindrical wall and at a point below the upper end of the wall and with the smaller lower end of the means spaced both from the cylindrical wall and from the closure for the lower end of the casing, thereby to define a separating zone, cylindrical in its upper portion and conical in its lower portion, a curved inlet duct extending at least partially about the cylindrical portion of said zone and having an open end communicating with said zone, said duct decreasing in width and increasing in height along its length toward said open end sufficiently that the opening in said end is at least ten times as high as it is wide, and an inlet pipe communicating with said duct for introducing charge thereinto.

2. A separator for removing entrained liquid from vapors, comprising a vertical cylindrical wall, a closure for the upper end of said wall, and a downwardly converging truncated conical means located axially within said cylindrical wall and engaged thereto below the top thereof, these three named members forming a separating chamber, and an inlet duct for introducing material to be separated thereinto, said duct having a closed end connected with the exterior of the separator through a feed pipe, and an open end communicating with the interior of the separator, said duct having a rectangular vertical cross-section, the vertical dimension of said duct being continuously increased and the horizontal dimension being continuously decreased while passing along said duct from closed to open end, the duct being placed against the inner periphery of the cylindrical wall and extending a substantial distance along said wall.

3. A separator for removing entrained liquid from vapors, comprising a vertical cylindrical wall, a closure for the upper end of said wall, and a downwardly converging truncated conical means located axially within said cylindrical wall and engaged thereto below the top thereof, these three named members forming a separating chamber, and an inlet duct for introducing material to be separated thereinto, said duct having a closed end connected with the exterior of the separator through a feed pipe, and an open end communicating with the interior of the separator, said duct having a rectangular vertical cross-section, the vertical dimension of said duct being continuously increased and the horizontal dimension being continuously decreased while passing along said duct from closed to open end, said open end being about ten times as high as wide, the duct being placed against the inner periphery of the cylindrical wall and extending a substantial distance along said wall.

4. A separator for removing entrained liquid from vapors comprising a cylindrical casing including a cylindrical wall and closures for the upper and lower ends thereof, truncated conical means within said casing having its larger upper end contiguous to said cylindrical wall and at a point below the upper end of the wall and with the smaller lower end of the means spaced both

from the cylindrical wall and from the closure for the lower end of the casing, thereby to define a separating zone, cylindrical in its upper portion and conical in its lower portion, a curved inlet duct extending at least partially about the cylindrical portion of said zone and having an open end communicating with said zone, said duct decreasing in width and increasing in height along its length toward said open end sufficiently that the material flowing therefrom is disposed as a thin sheet about the inner periphery of the separator, and an inlet pipe communicating with said duct for introducing charge thereinto.

5. A separator for removing entrained liquid from vapors, comprising a vertical cylindrical wall, a closure for the upper end of said wall, and a downwardly converging truncated conical means located axially within said cylindrical wall and engaged thereto below the top thereof, these three named members forming a separating chamber, and an inlet duct for introducing material to be separated thereinto, said duct having a closed end connected with the exterior of the separator through a feed pipe, and an open end communicating with the interior of the separator, said duct having a rectangular vertical cross-section, the vertical dimension of said duct being continuously increased and the horizontal dimension being continuously decreased while passing along said duct from closed to open end, the upper boundary of said duct being located substantially horizontally, the duct being placed against the inner periphery of the cylindrical wall and extending a substantial distance along said wall.

GEORGE S. DUNHAM.