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(54) Method and apparatus for fractionating heavy hydrocarbons.

(57) A method and apparatus are provided for high temperature distillation of heavy hydrocarbon oil. The oil is heated to a high temperature, close to a coking temperature, then flashed in a first distillation zone into liquid and vapor. The liquid is withdrawn, reheated, then returned to a second distillation zone and separated into vapor and liquid. This increases distillable products recovery. Preferably a divider separates liquid in the first and second distillation zones, beneath a common vapor space.

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METHOD AND APPARATUS FOR FRACTIONATING HEAVY HYDROCARBONS

This invention relates to a method and apparatus for fractional distillation of heavy hydrocarbons. In general, the higher the heat input, and the hotter the feed, the higher the desired product yield will be. Heat is usually added by heating the feed or reboiling the column.

In some distillation towers, the feed inlet temperature is limited by the coking tendency of the feed. The coking threshold temperature depends on the system involved, i.e., whether it is an atmospheric distillation tower, a vacuum tower, etc. Usually the feed temperature is somewhat lower than the coking threshold temperature. The feed temperature drops some in the inlet piping, resulting in less vapor and more light ends remaining in the liquid portion at the tower inlet. This reduces flashing and increases liquid loading in the tower.

The other major source of heat for the fractionator is the reboiler. With heavy feeds, there are problems in reboiling the bottoms liquid, as the high temperatures required promote coking. Repeated passage of bottoms liquid through the reboiler promotes coke formation.

It would be beneficial if a way were available to add more heat to a distillation column, without coking up the column.

A way has now been discovered to add more heat to a heavy oil distillation column without causing undue coke formation.

Accordingly, the present invention provides a distillation process for recovering distillable hydrocarbons from a feed comprising a heavier residual hydrocarbon fraction by heating the feed and charging it to a distillation column characterized by introducing heated feed into a first zone of a distillation means and flashing the heated feed in the first zone into a vapor fraction and a descending liquid fraction which collects in the first zone; withdrawing at least part of the liquid from the first zone and reboiling in a reboiler; discharging the reboiler into a second zone which is separated from the first zone by a divider means which segregates liquid in the first zone from liquid in the second zone and flashing in the second zone reboiler effluent into a vapor fraction comprising distillable hydrocarbons and a descending liquid fraction which collects in the second zone; and removing reboiled resid liquid with a reduced content of distillable hydrocarbons as a product of the process from the second zone.

In another embodiment, the present provides an apparatus which may be used to carry out the above process.

Fig. 1 illustrates one embodiment of the invention, a distillation column with a reboiler return line connected to the flash zone;

Fig. 2 illustrates an embodiment where the reboiler return line connects to a lower stripping section below the flash zone;

Fig. 3 illustrates a third embodiment where the distillation column has parallel lower stripping sections and the reboiler return line is connected to the flash zone;

Fig. 4 illustrates a fourth embodiment with a distillation column having a lower stripping section and a separate flash drum, with the reboiler return line connected to the flash drum; and

Fig. 5 illustrates a fifth embodiment including a flash zone, a lower stripping section and a section distillation zone comprising a stripper with the reboiler return life connected to the stripper, with stripper overhead fed to the distillation column.

Fig. 1 shows a vacuum flash tower 10, the invention is applicable to other types of columns or towers, e.g., atmospheric distillation towers.

In Fig. 1, hydrocarbon feed is heated in furnace 1 and discharged via line 17 into flash zone 3, which extends across vacuum tower 10. Tower 10 is maintained at low pressure, e.g., 50 mm Hg, via steam ejectors (not shown). In a first distillation zone 81 of flash tower 10, the feed flashes into a descending liquid containing relatively heavy hydrocarbons and an ascending vapor portion containing lighter hydrocarbons as shown by reference symbols l_1 and v_1. The vacuum tower includes conventional equipment (not shown) to minimize entrainment of pitch in the vapor.

A divider means, shown as vertical baffle 25 in flash zone 3, separates first and second distillation zones 81 and 83. Baffle 25 keeps most, and preferably all, descending liquid l_1 in zone 81 prior to withdrawal via line 27. Vertical baffle 25 can also be slanted, cylindrical, or any other shape which divides flash zone 3 into separate liquid sections 81 and 83. Some liquid may not be retained and will enter second distillation section 83 of flash zone 3, across divider 25. Line 27 removes liquid L_1 remaining after the feed flashes. This liquid is pumped via pump 29 to reboiler 31 and discharged to second distillation zone 83 of flash zone 3 via line 53. Reboiled liquid separates into a descending liquid, l_2, and an ascending vapor, v_2, as shown. Steam is preferably injected via line 37 upstream of reboiler 31 to add heat and minimize coking in furnace 31.

Reboiled liquid enters lower stripping section 7 which contains trays 9. Stripping steam, from line 5, and hydrocarbon vapors rise and contact descending liquid l_2. Each tray contains a layer of liquid through which the vapors bubble. Liquid flows from one tray to the next and becomes progressively heavier, i.e., stripper 7 shows conventional fractional distillation.

Above flash zone 3 are packed beds 11 and 13 of inert material which enhance contact between rising vapors and hydrocarbon liquid.

Either packed beds or trays may be used in any section of the distillation column.

Light gases passing through upper fractionation section 11 exit tower 10 via line 15. Vacuum gas oil product is removed via line 23.

Relatively heavy liquid is removed via line 19 for recycling back to heater 1, via pump 21.

The bottoms liquid removed via line 27 has less light ends than the feed in line 17. This heavy liquid is heated in reboiler 31. From heater 31 to tower 10 there is a relatively low pressure drop, and low temperature drop, as compared to the tower feed line 17. Because of the lower pressure drop, reboiler 31 can operate at lower pressure, preferably lower than the outlet of preheater 1. Lower pressure promotes vaporization, improving distillable product yield. The maximum allowable temperature to avoid coking in line 53 might be greater than the temperature limit in line 17. These factors, higher temperature and lower pressure, improve recovery of light ends in tower 10.

Using the system shown in Fig. 1, the heavy oil is gently heated; and there is no recycle of reboiler liquid to the reboiler 31. Reboiler 31 acts almost like one perfect equilibrium tray. Maximum recovery of valuable distillable products is obtained, with no increase in entropy due to mixing l_1 and l_2, which have different compositions.

Fig. 2 illustrates a second embodiment. The first distillation zone comprises the entire flash zone 3. Reboiler 31 has a return line 43 to second distillation zone 85 at the bottom or lower stripping section 7 of tower 10. Heated feed enters via line 17 and flashes in first distillation zone 3. Trays 9 strip descending liquid, from flash zone 3, in stripping zone 7. Heavy liquid, after stripping, collects on one side of vertical baffle or draw box 49 and then is charged to reboiler 31 via line 47 and pump 129.

Reboiled resid in line 43 flashes in second distillation zone 85. Liquid collects on the side of divider 49 opposite the side at which line 47 is located. Reboiled resid is removed without further heating, via pump 39 and line 51.

Trays 9 are arranged so that all or at least most of the liquid from zone 3, after stripping, flows to the side of baffle 49 on which exit line 47 is located.

In the Fig. 2 embodiment, the vapors generated in reboiler 31 are rectified by the flash zone 3 liquid, thus providing a cleaner separation between vacuum gas oil and resid. This results in a higher quality hydrocarbon product in the upper regions of the tower, but less of it, as compared to the Fig. 1 embodiment.

Fig. 3 illustrates a third embodiment. Tower 20 has parallel lower strippers 61 and 63. Hot feed from line 17 enters first distillation zone 87 of flash zone 65. Feed separates into liquid which flows down and vapor which flows up. Divider means 67 in flash zone 65 directs all or most of this feed liquid into steam stripper 61. Stripped liquid is removed via line 67 and pump 29 and passed through reboiler 31. Reboiled liquid is returned via line 69 to second distillation zone 89 of flash zone 65 on the other side of divider 67. The reboiler liquid separates into a descending liquid and an ascending vapor. This liquid is stripped in steam stripping section 63. Stripped reboiled resid is withdrawn via line 51.

In the above embodiments separation of vapor and liquid generated in the reboiler occurs in the distillation tower. This lowers equipment costs and pressure drop from the reboiler to the tower.

Separation of reboiled vapor and liquid may also occur in a flash drum 77, as shown in Fig. 4, or a separate stripper 78 as shown in Fig. 5.

Fig. 4 shows an external flash drum 77. A bottoms liquid stream is withdrawn, reboiled via reboiler 31 and passes via line 71 into a second distillation zone 93, flash drum 77. The overhead vapor is removed via line 73 and discharged to flash zone 3 of the main distillation column 30. Reboiled resid liquid from flash drum 77 is withdrawn via line 75. Flash drum vapor may also be passed into the bottom of the stripping section 7 of tower 30, by means not shown.

Fig. 5 shows an external stripper. Tower 30 has a flash zone 3 and a lower stripping section 7. Stripped bottoms liquid withdrawn via line 47, is pumped to reboiler 31 and discharged via line 43 into a second distillation zone 95 in stripper 78. Overhead vapor from stripper 78 passes via line 44 to tower 30. A side draw liquid stream from tower 30 passes via line 19 to stripper 78. Divider 82, at the bottom of stripper 78, segregates distillable liquid from reboiled resid. An overflash liquid product is recovered via line 84. The reboiled resid enters stripper 78 on the other side of divider 82 from overflash products line 84. Reboiled, flashed, vacuum resid is removed via line 86. Ascending vapors, generated in the reboiler 31, contact descending liquid in stripper 78. Descending liquid is directed by trays 86 and divider 82 to bottom region 88 to exit via overflash products line 84.

By-pass valves 55 (Fig. 1), 57 (Fig. 2), 59 (Fig. 3), 60 (Fig. 4) and 62 (Fig. 5) permit bypassing the resid reboiler, if desired.

The embodiments shown in Figs. 1-5 are all once-through resid reboiler systems. Because coking is a function of residence time, once-through reboiler operation minimizes resid residence time throughout the system, to minimize coking.

The examples discussed below are all based on computer simulations.

Example I

In the Fig. 1 embodiment, using Arab light crude, the total vacuum resid production decreases by at least 3.4% over the prior art system, 3.4 m^3/day more vacuum gas oil product per 100 m^3/day feed to the vacuum tower.

Example II

In the Fig. 2 embodiment, resid production decreases by at least 2.3%. In this simulation, for the same VGO, vacuum gas oil yield, the vacuum gas oil Conradsen carbon residue (CCR) and metal content are approximately 3.2% less in the Fig. 2 embodiment, as compared to vacuum towers without a resid reboiler as in Fig. 2. The VGO is better quality (less metal, lower CCR) because the vapors from the resid reboiler are rectified by the flash zone liquid. This provides a cleaner separation between VGO and resid.

Example III

In this example, it is assumed that the pressure drop through the resid reboiler transfer line is less than that through the feed transfer line. An Arab light crude is used in the Fig. 1 system, to produce lube distillates rather than vacuum gas oil. Also, overflash products are drawn off from the vacuum tower. A 7.2% reduction in resid product is achieved and 69% of the recovered hydrocarbons are lube distillates and the remainder overflash products.

The data in all three examples above are based on the same quantity of steam flow to the vacuum tower as a conventional system. Examples I and II assume the pressure drop through the resid reboiler and feed transfer lines are equal, a conservative assumption because the pressure drop through the resid heater transfer line is smaller due to smaller flow. Thus, the resid heater could be operated at even lower pressures than assumed here, which means the vacuum gas oil yield could increase further in practice.

Claims

1. A distillation process for recovering distillable hydrocarbons from a feed comprising a heavier residual hydrocarbon fraction by heating the feed and charging it to a distillation column characterized by

(a) introducing heated feed into a first zone of a distillation means and flashing the heated feed in the first zone into a vapor fraction and a descending liquid fraction which collects in the first zone;

(b) withdrawing at least part of the liquid from the first zone and reboiling in a reboiler;

(c) discharging the reboiler into a second zone which is separated from the first zone by a divider means which segregates liquid in the first zone from liquid in the second zone and flashing in the second zone reboiler effluent into a vapor fraction comprising distillable hydrocarbons and a descending liquid fraction which collects in the second zone; and

(d) removing reboiled resid liquid with a reduced content of distillable hydrocarbons as a product of the process from the second zone.

2. The process of Claim 1 further characterized in that the first and second zones are physically separated from each other.

3. The process of Claim 1 further characterized in that the first and second zones are in the same distillation column and are separated from each other by divider means causing substantially all the descending liquid in the first zone to remain in the first zone until withdrawn in step (b) and substantially all of the descending liquid in the second zone to remain in the second zone until withdrawn as product.

4. The process in Claim 3 further characterized in that the divider is a vertical baffle in the bottom of the column.

5. The process of Claim 2 further characterized in that the first zone is a flash zone of a distillation column and the second zone is a flash drum and vapor produced in the flash drum is introduced into the distillation column.

6. The process of Claim 2 further characterized in that the first zone is a flash zone of a distillation column and the second zone is a stripper column and a side product of the distillation column is introduced into the stripper column and overhead product of the stripper is introduced into the distillation column.

7. The process of any preceeding claim further characterized in that the distillation column operates at subatmospheric pressure.

8. The process of any preceeding claim further characterized in that the reboiler effluent is hotter than heated feed to the column distillation.

9. A distillation apparatus characterized by:

(a) a distillation means comprising a first zone and a second zone;

(b) a feed inlet for introducing heated hydrocarbon feed into the first zone wherein feed separates into a descending liquid and an ascending vapor;

(c) means for withdrawing liquid from the first zone;

(d) means for reheating withdrawn liquid;

(e) means for introducing reheated liquid into the second zone wherein reheated liquid separates into a descending liquid and an ascending vapor; and

(f) means for withdrawing reheated liquid as a product.

10. The apparatus of Claim 9 further characterized in that the first and second zones are in the bottom of a distillation column and are separated by a vertical baffle segregating liquid in both zones beneath a common vapor zone.

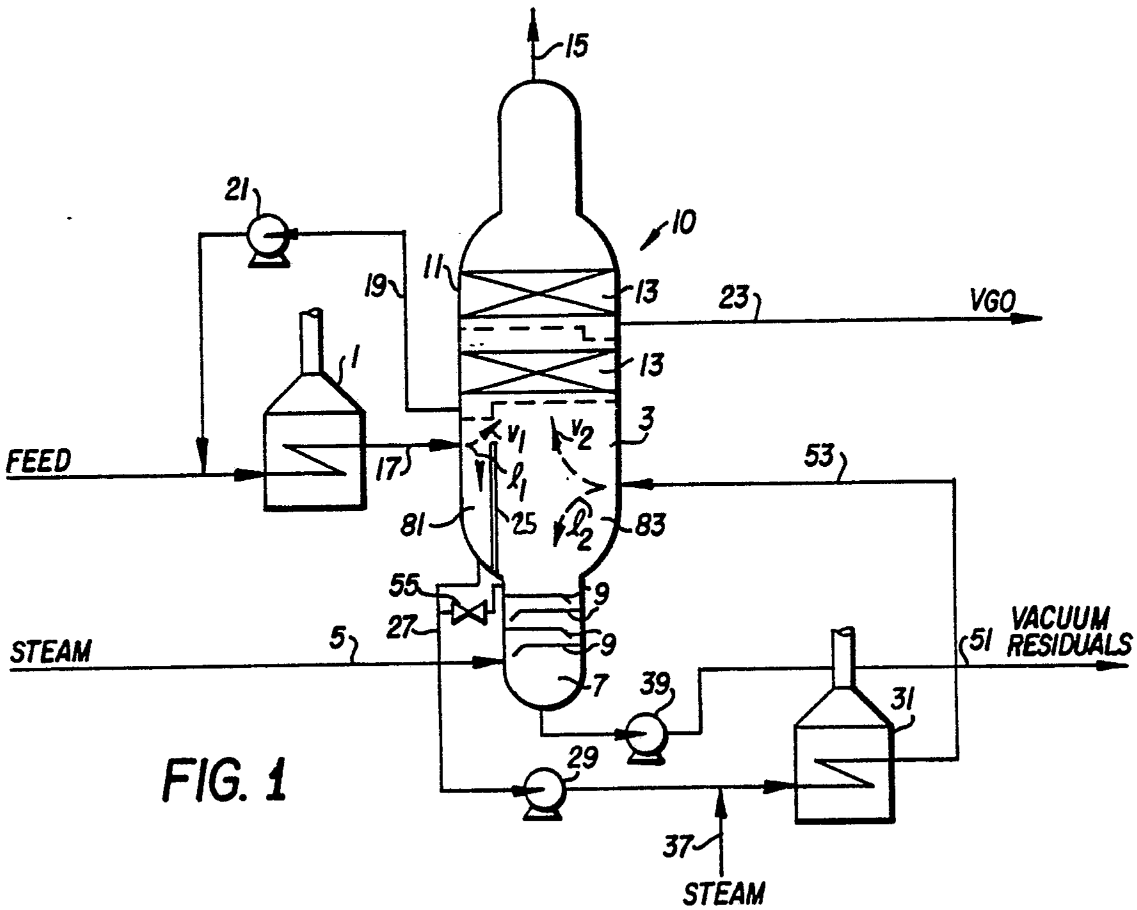
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FIG. 1

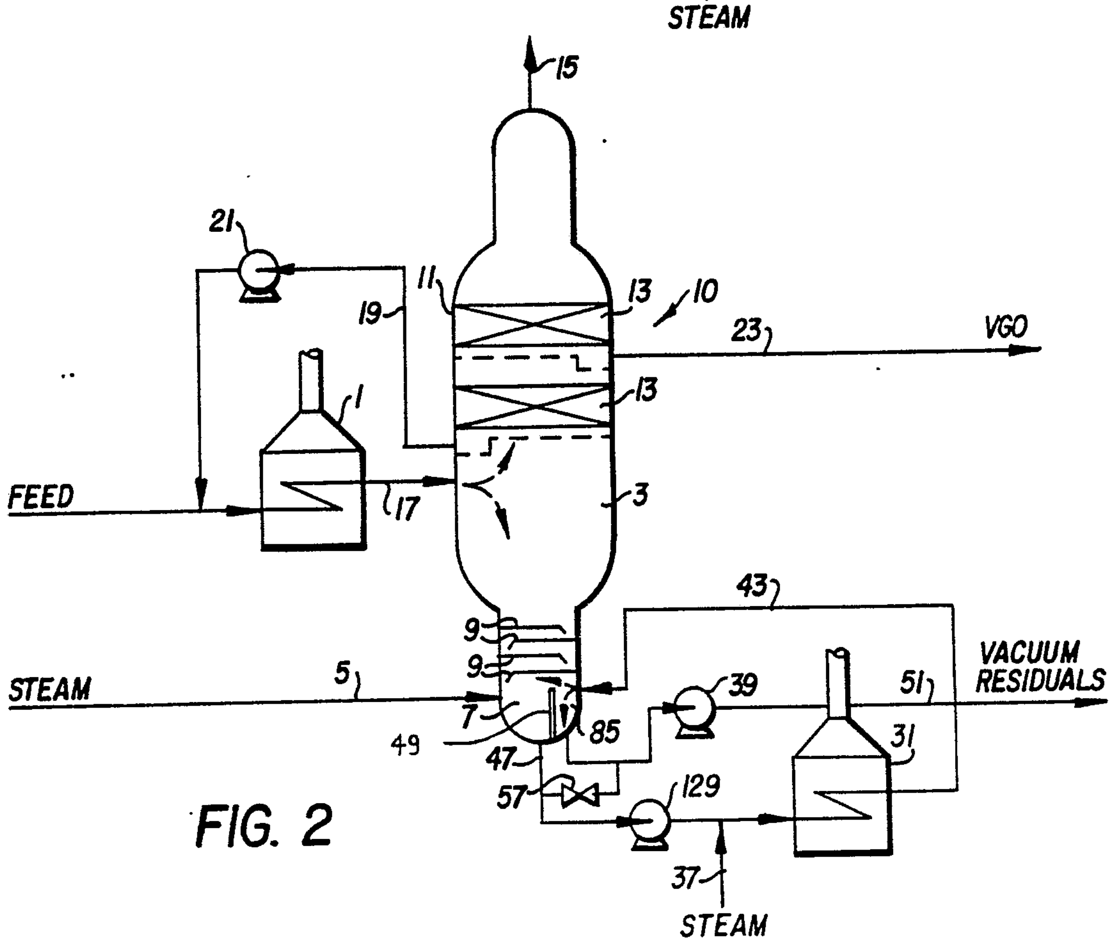
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FIG. 2

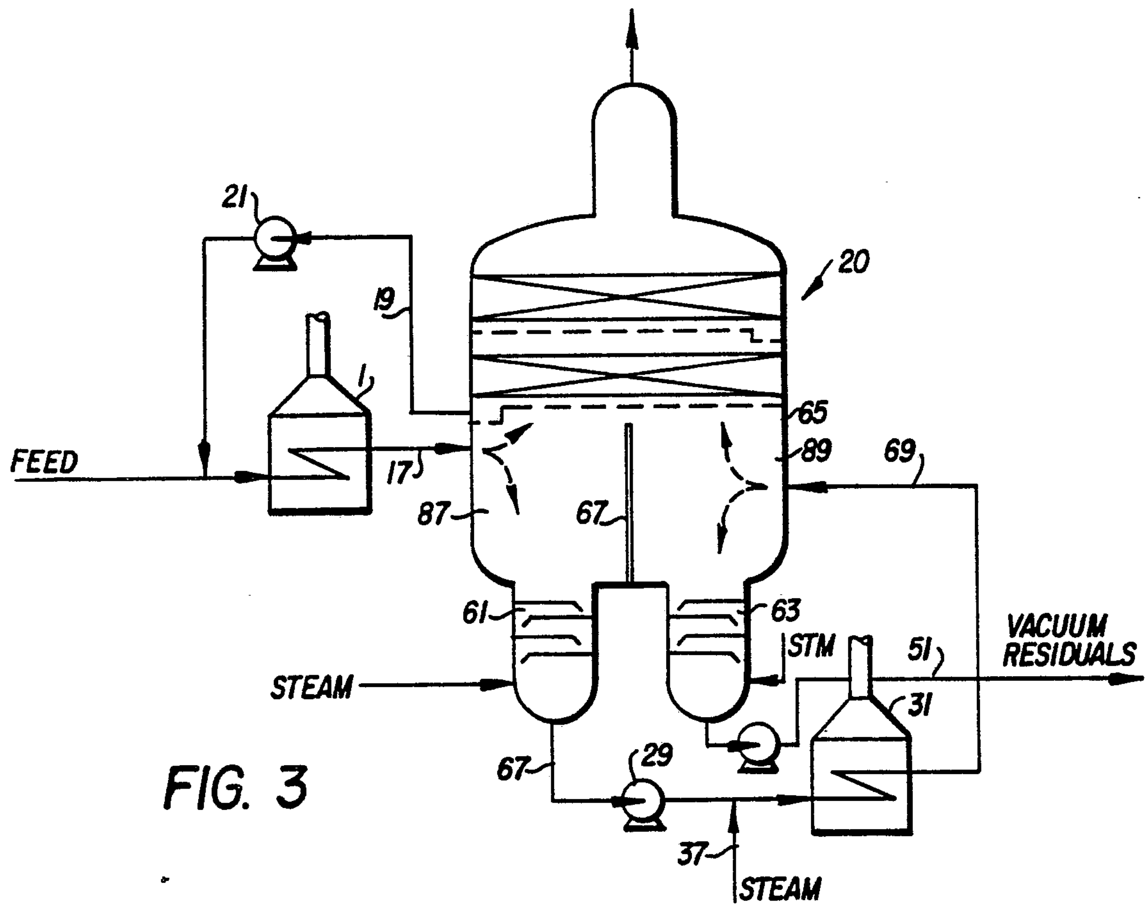
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FIG. 3

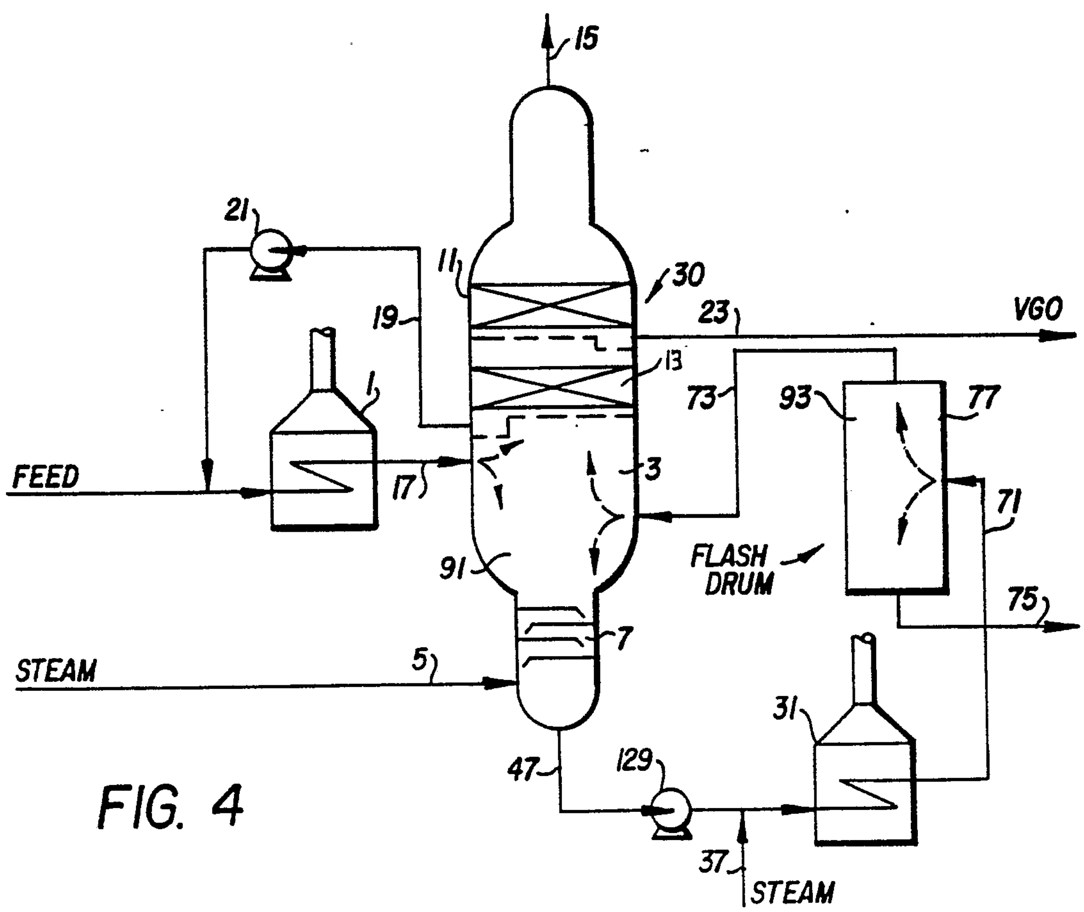
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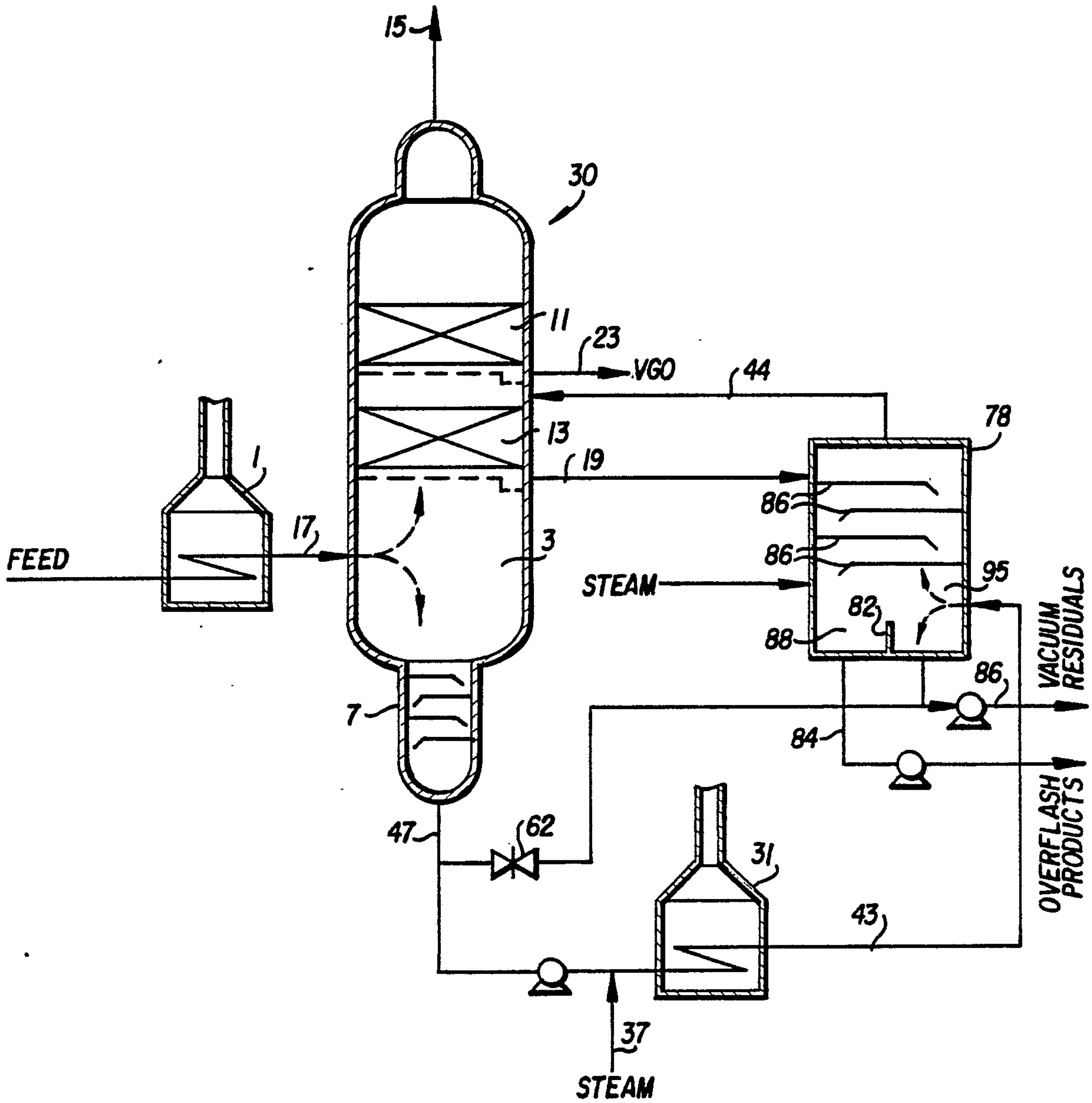
FIG. 4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86
7
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OVERFLASH PRODUCTS
62
47
31
43
37
STEAM

FIG. 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 87 30 3864

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X Y	GB-A-2 151 151 (MOBIL OIL) * Figure; claim 1 *	1,2,7,9 3,4,8,10	C 10 G 7/00 C 10 G 7/06
Y	US-A-3 110 663 (MILLER) * Figure 1; claims 1,2 *	3,4	
Y	US-A-3 314 879 (LACY et al.) * Figure; claim 1; column 1, line 70 - column 2, line 4 *	3,4,10	
Y	FR-A- 799 594 (BPM) * Figures *	3,4,10	
Y	US-A-3 301 778 (CABBAGE) * Figure; claims *	6	
Y	EP-A-0 019 400 (MOBIL OIL) * Figure; claims *	8	**TECHNICAL FIELDS SEARCHED (Int. Cl.4)**
A	GB-A- 728 234 (LUMMUS) * Figure *		C 10 G
A	US-A-4 274 944 (BANNON) * Figures; claim 1 *		
A	US-A-3 567 628 (VAN POOL) * Figure 1 *	5	
E	US-A-4 664 784 (HARANDI) * Whole document *	1-10	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	06-01-1988	MICHIELS P.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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