# United States Patent

**VanPool**

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[54] **PRODUCTION OF LOW-METAL CONTENT GAS OIL FROM TOPPED CRUDE OIL**


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**Related U.S. Application Data**

[63] Continuation-in-part of Ser. No. 687,800, Dec. 4, 1967, abandoned.

[52] **U.S. Cl.** ............................................**208/251**, 208/309

[51] **Int. Cl.** ....................................................**C10g 17/00**

[58] **Field of Search** ........................................208/309, 251



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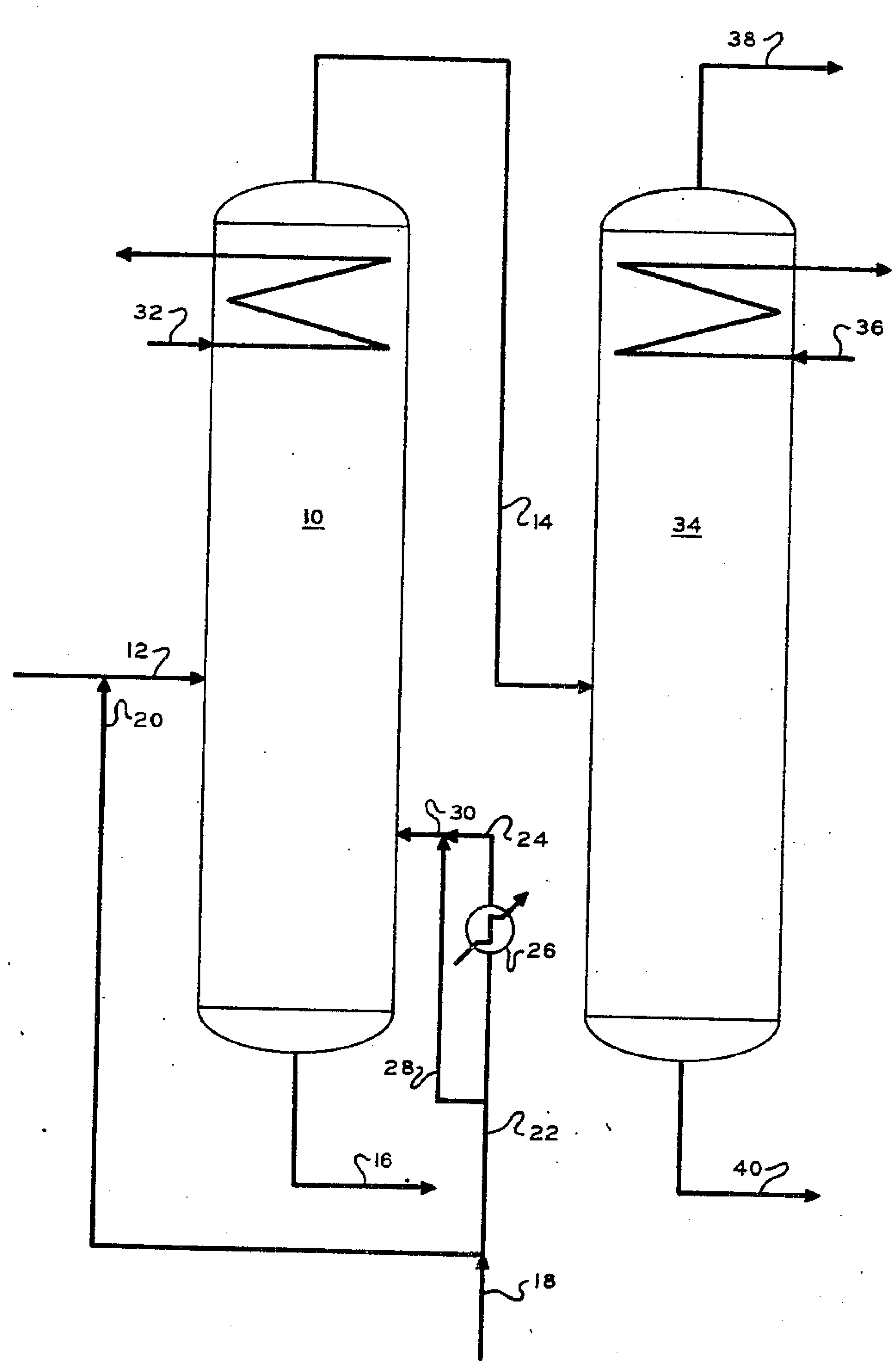
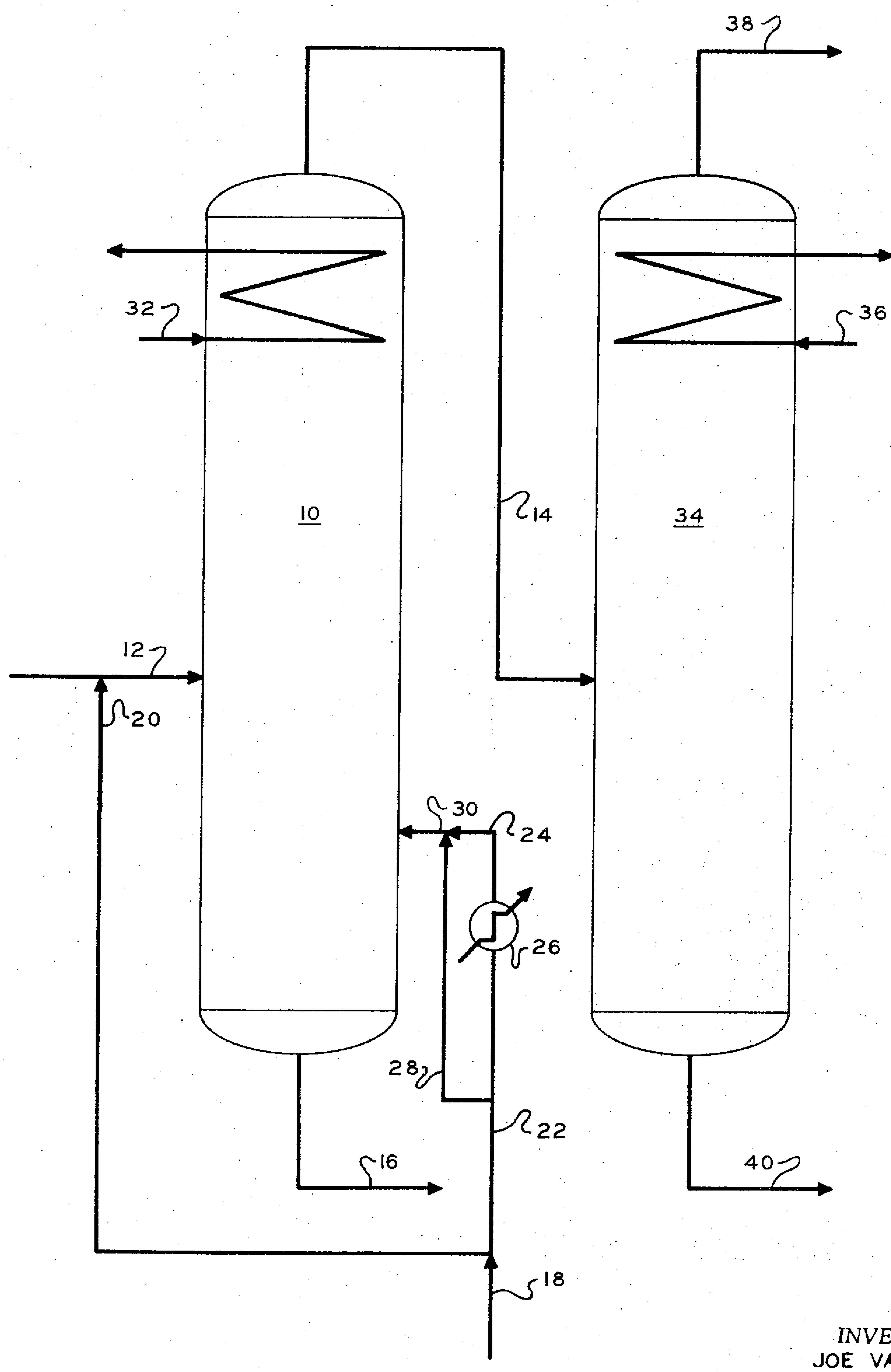
[57] **ABSTRACT**

A gas oil of low metal content for catalytic cracking is produced by treating a topped crude oil with solvent in a deasphalting zone to produce a bottoms stream comprising asphalt and solvent, and an overhead stream which is essentially free of asphalt and comprising gas oil and solvent, treating the overhead stream of gas oil and solvent without the addition of more solvent in a solvent extraction zone at a slightly higher temperature than in the deasphalting zone so as to produce a minor bottoms stream of heavy gas oil containing most of the metal in the gas oil feed stream to the extraction zone and a major overhead stream of solvent and essentially asphalt-free light gas oil of substantially lower metal content than that of said feed stream.


**8 Claims, 1 Drawing Figure**



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# PRODUCTION OF LOW-METAL CONTENT GAS OIL FROM TOPPED CRUDE OIL

This is a continuation-in-part of my application, Ser. No. 687,800, filed Dec. 4, 1967now abandoned.

This invention relates to a process for treating a topped crude oil containing a substantial concentration of metal to produce as essentially asphalt-free gas oil which is substantially free of said metal for catalytic cracking to motor fuel.

The treatment of crude oil to produce asphalt and gas oil which is essentially free of asphalt is a conventional procedure in the petroleum industry. According to this conventional procedure crude oil is generally subjected to atmospheric distillation to recover separate streams of gases, gasoline, kerosene, and gas oil. This atmospheric distillation also produces a stream of residual material, referred to in the art as topped crude oil, which amounts, for example, up to about 40 percent by volume of the original crude oil. This residual material can then be treated with solvent or it can be subjected to vacuum distillation to recover additional quantities of gas oil. This vacuum distillation also produces a residuum, which can be referred to as topped crude oil although perhaps more specifically it is referred to in the art as vacuum reduced crude oil, which amounts to about 5 to 10 percent by volume of the original crude oil. For purposes of this application, the term "topped crude oil" shall refer to the materials above defined as "residual material" and "residuum." The topped crude oil is then solvent treated (extracted) to produce as asphalt of low wax content which is suitable as an asphalt cement for road construction and similar applications and a gas oil which is essentially free of asphalt. The essentially asphalt-free gas oil recovered in this manner is frequently subjected to catalytic cracking to produce lighter hydrocarbons suitable for motor fuel.

Usually, crude oil contains in the range of about 20 to 8,500 p.p.m. (parts per million by weight) metal contaminants such as compounds of nickel, vanadium, and the like which are retained principally in the topped crude oil, and which appear in sufficient concentration in the gas oil, solvent extracted from the topped crude, to interfere with the subsequent catalytic cracking of the gas oil by poisoning or greatly reducing the life span of the catalyst.

This invention is concerned with a process for reducing the metals content of a gas oil produced from a topped crude oil so as to improve the catalytic cracking of the gas oil.

Accordingly, it is an object of my invention to provide a process for the treatment of topped crude oil to produce a gas oil which is essentially asphalt-free and relatively free of contaminating metal present in the topped crude oil.

Another object of my invention is to provide a process for more efficiently producing an essentially asphalt-free, low metal content gas oil by solvent extraction of a metal-contaminated topped crude oil.

Other objects, aspects, and the several advantages of my invention will become apparent to one skilled in the art upon consideration of the accompanying disclosure.

A broad aspect of the invention comprises contacting a metal contaminated topped crude oil in a primary solvent deasphalting zone with about 3 to 15 volumes of liquid hydrocarbon solvent per volume of topped crude oil at an elevated temperature below the critical temperature of the solvent and at a pressure sufficient to maintain the solvent in liquid phase to thus produce a stream comprising asphalt and solvent and an extract phase comprising a solution of gas oil and solvent which is essentially free of asphalt; treating the extract phase of gas oil and solvent in a secondary solvent extraction zone by subjecting the extract phase in the secondary extraction zone to a slightly but effectively higher temperature than the temperature in the primary solvent deasphalting zone to produce a two-phase liquid system comprising a minor stream of heavy gas oil and solvent containing most of the metal in the feed to the secondary solvent extraction zone and a major stream of solvent and light gas oil having a lower concentration of metal than the gas oil solvent feed to the secondary solvent extraction zone; separating most of the solvent from the light gas oil stream, and recovering the resulting low metal content light gas oil.



The solvent generally used to treat topped crude oil to produce a gas oil which is essentially, if not completely, free of asphalt comprises liquid $C_3$ to $C_6$ aliphatic hydrocarbons such as propane, butane, pentane, hexane, isobutane, isopentane, isohexane, and mixtures thereof. Propane, alone, or in mixture with one or more of the above mentioned light hydrocarbon solvents is frequently utilized in the deasphalting zone.

Temperatures in the range of about 90° to 400° F. and superatmospheric pressures sufficient to maintain the solvent in liquid phase are generally utilized in the deasphalting zone.

The invention is applicable to topped crude oil containing at least 20 p.p.m. and up to about 8,500 p.p.m. of metal, usually present as metallic compounds, such as organo-metallic compounds, principally nickel but also containing iron and vanadium. Generally, the metal concentration in topped crude oil ranges from about 50 p.p.m. to 1,000 p.p.m.

The temperature in the second treating, i.e., secondary solvent extraction, zone is in the range of 1° to 5° F. higher than the temperature of the extract phase gas oil-solvent stream from the primary solvent deasphalting zone. Operating the secondary solvent extraction zone at this slightly higher temperature and without adding or removing solvent has the effect of producing a stream of heavy gas oil which amounts to about 2 to 10 volume percent of the topped crude oil charged to the primary solvent deasphalting zone. The slight rise in temperature has the effect of rendering the heavy gas oil, or heaviest portions of the gas oil, less soluble in the gas oil-solvent solution. When the metal concentration in the gas oil-solvent extract phase from the primary solvent deasphalting zone is relatively low, the heavy gas oil bottom stream from the secondary solvent extraction zone is maintained relatively low in the range of 2 to 10 volume percent of the crude oil charge. This control is effected by maintaining temperature control in the secondary solvent extraction zone in the lower portion of the above mentioned 1° to 5° F. range.

A temperature gradient is produced across both primary and secondary zones with the highest temperature being maintained in the upper portion of each of the two zones. For example, where the solvent is a 65 propane to 35 n-butane by volume mixture, the temperature in the lower portion of the primary solvent deasphalting zone is in the range of about 175° to 195° F. while the temperature in the upper portion of the zone is in the range of about 25° to 40° F. higher (200° to 235° F.). Under these conditions the extract phase from the primary solvent deasphalting zone is at least essentially, if not completely, free of asphalt.

A more complete understanding of the invention may be had by reference to the accompanying drawing which is an elevation of one arrangement of apparatus for effecting the process of the invention.

Referring now to the drawing, a first contacting column **10** for solvent deasphalting is provided with a feed inlet line **12** for a topped crude oil, an overhead extract line **14** for an essentially asphalt-free gas oil-solvent stream, and a bottoms effluent line **16** for an asphalt-solvent stream which can also contain gas oil. Solvent supply line **18** connects with line **20** which in turn connects with line **12** for contacting the topped crude oil feed with solvent. The major portion of the solvent passes through line **22** from which a portion passes through line **24** containing indirect heat exchanger **26** and another portion passes through line **28** into line **30** which leads into the lower section of contacting column **10**. The flow of solvent through lines **24** and **28** is proportioned so as to introduce the solvent into column **10** from line **30** at the proper temperature, depending upon the temperature of operation of the column. Steam coil **32** in the top of column **10** provides heat for maintaining the proper temperature in the upper end of the column.

An intermediate inlet of a second contacting column **34** is connected with extract line **14** of column **10** for feeding the essentially asphalt-free gas oil-solvent stream from column **10** into column **34**. Column **34** is also provided with a steam heating coil **36** or equivalent heating means. Effluent line **38** connects with the top of column **34** for passing the low metal content essentially asphalt-free gas oil-solvent stream to solvent removal apparatus (not shown). The resulting gas oil, which contains less than 1 p.p.m. of metals, is suitable for cracking or hydrocracking in conventional manner in a catalytic cracking or hydrocracking zone without rapid deterioration of the catalyst and at high conversion rates to hydrocarbons boiling in the motor fuel range.

Line **40** connects with the bottom of column **34** for passing the bottoms stream of essentially asphalt-free gas oil and solvent of relatively high metal content to solvent recovery apparatus (not shown). The resulting gas oil is suitable for use as fuel oil in which the metal content is not deleterious, or for other desirable uses.

The solvent recovered from the streams in lines **38** and **40** as well as that recovered in the stream in line **16** is recycled to line **18** by means not shown.

Columns **10** and **34** can be any liquid-liquid contacting columns known in the art such as rotating disc contactors.

In order to illustrate the invention without unduly restricting the same, the following specific example is presented.

A mixture of crude oils including Rangely, Red Wash, Patrick Draw, and Uintah is treated by atmospheric pressure distillation, to produce a topped crude oil amounting to 17.1 percent by volume of the original crude oil mixture. This topped crude oil has a metal content in the form of unknown nickel and other metal compounds amounting to about 100 p.p.m. expressed as nickel. The topped crude oil is processed in an arrangement of apparatus substantially as shown in the drawing by feeding the topped crude oil at a temperature of about 185° F. through line **12** into first contactor **10** which is controlled at a pressure of 580 p.s.i.g., a bottom temperature of 185° F., and a top temperature of 220° F. The feed rate is 3,000 barrels per day. The solvent fed through lines **20** and **30** is a mixture of propane and n-butane in which the proportions are 65 barrels of propane and 35 barrels of n-butane per 100 barrels of solvent.

The temperature in the bottom of the second contactor **34** is maintained at about 220° F. and the top temperature in the column at about 224° F. with a pressure of 575 p.s.i.g. Data representing the operation are presented in the table below in which all flow rates are in barrels per day.

| Line number | Description | Gas oil, B/D[a] | Asphalt, B/D | Propane, B/D | N-butane, B/D | Metal as nickel, p.p.m.[b] | °API gravity at 60° F.[c] | Total flow, B/D |
|---|---|---|---|---|---|---|---|---|
| 12 | Topped crude oil plus solvent 20 | ([d]) | ([d]) | 325 | 175 | 100 | 18 | 3,500 |
| 14 | Extract phase column 10 | 2,475 | 0 | 25,009 | 13,466 | 5 | ([d]) | 40,950 |
| 16 | Raffinate phase column 10 | ([d]) | 525[e] | 341 | 184 | 510 | 7.0 | 1,050 |
| 20 | Solvent | 0 | 0 | 325 | 175 | 0 | ([d]) | 500 |
| 30 | Do | 0 | 0 | 25,025 | 13,475 | 0 | ([d]) | 38,500 |
| 38 | Extract phase column 34 | 2,300 | 0 | 24,960 | 13,440 | 0.5 | 20.5 | 40,700 |
| 40 | Raffinate phase column 34 | 175 | 0 | 49 | 26 | ------------ | 17.2 | 250 |

[a] B/D means barrels (42 gallons/barrel) per day.
[b] Metal compounds are reported as nickel in parts per million by weight on a solvent-free basis.
[c] Measured with solvent removed.
[d] Not determined.
[e] "Asphalt" can include gas oil components.

It should be noted that treatment of a topped crude oil containing 100 p.p.m. of metal calculated as nickel, in accordance with the invention, produces as asphalt-free gas oil fraction **38** in which the metal content is only 0.5 p.p.m. This compares with a metal concentration of 5.0 p.p.m. in the asphalt-free gas oil stream **14** from the first contactor **10** which has heretofore been treated to remove solvent and fed directly to a catalytic cracking zone to convert the gas oil to hydrocarbons boiling in the motor fuel range. However, operating the catalytic cracking zone with gas oil of 0.5 p.p.m. metal, as compared with gas oil of 5.0 p.p.m. metal, reduces catalyst consumption by approximately 50 percent by weight, and permits an increased conversion of gas oil to motor fuel by approximately 16 percent by volume. Thus, the invention represents a substantial contribution to the art.

Certain modifications of the invention will become apparent to those skilled in the art and the illustrative details disclosed are not to be construed as imposing unnecessary limitations on the invention.

That which is claimed is:

**1.** A liquid solvent extraction process for separating a low metal content gas oil from a metal contaminated topped crude oil which comprises:

a. introducing a metal contaminated topped crude oil comprising gas oil and asphalt into a primary solvent extraction zone wherein said topped crude oil is contacted with a solvent to produce an extract phase comprising a solution of gas oil and solvent which is essentially free of asphalt and a raffinate phase comprising asphalt and solvent;

b. separating said extract phase into a solution of light gas oil and solvent and a solution of heavy gas oil and solvent by treating said extract phase in a secondary extraction zone, said treatment comprising subjecting said extract phase to a slightly higher temperature than that present in said primary solvent extraction zone to produce a two-phase liquid system;

c. withdrawing from said secondary extraction zone a minor stream of high metal content heavy gas oil and solvent, and a major stream of low metal content light gas oil and solvent;

d. and, thereafter, recovering said light gas oil from said solution of light gas oil and solvent.

**2.** The process of claim **1** wherein the temperature of said solution of light gas oil and solvent in said secondary extraction zone is in the range of 1° to 5° F. higher than the temperature of said extract phase in said primary solvent extraction zone.

**3.** The process of claim **1** wherein the conditions in said secondary extraction zone are controlled to produce an ultimate heavy gas oil stream in the range of about 2 to 10 volume percent of said topped crude oil stream, and a metal content in said light gas oil, after recovery, of less than 1 part per million.

**4.** The process of claim **1** wherein the metal content of said topped crude oil is no less than 20 parts per million.

**5.** The process of claim **4** wherein the temperature in said primary solvent extraction zone is below the critical temperature of said solvent and the pressure in said primary solvent extraction zone is sufficient to maintain said solvent in liquid phase.

**6.** The process of claim **5** wherein said solvent comprises 3 to 15 volumes of liquid aliphatic hydrocarbon per volume of topped crude oil and is selected from the group of said aliphatic hydrocarbons having from three to six carbon atoms per molecule.

**7.** The process of claim **5** wherein the temperature in said primary solvent extraction zone is in the range of 90° to 400° F.

**8.** The process of claim **2** wherein said solvent comprises propane in at least major volume proportion, the temperature of said extract phase in said primary solvent extraction zone is in the range of 25° to 40° F. higher than the temperature of said raffinate phase which is in the range of 175° to 195° F. and the pressure in said primary solvent extraction zone is sufficient to maintain said solvent in liquid phase.

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