

CONVENTION APPLICATION FOR A PATENT

(1) Here insert (in full) Name or Names of Applicant or Applicants, followed by Address (es).

I ⁽¹⁾ EDWARD CALTON SHURTLEFF
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(2) Here insert Title of Invention.

hereby apply for the grant of a Patent for an invention entitled: ⁽²⁾
APPARATUS AND METHOD FOR RECLAIMING WASTE OIL

(3) Here insert number(s) of basic application(s)

which is described in the accompanying complete specification. This application is a
Convention application and is based on the application numbered ⁽³⁾
577,895

(4) Here insert Name of basic Country or Countries, and basic date or dates

for a patent or similar protection made in ⁽⁴⁾ Canada
on 20th September 1988

19/09/89

FO10911

~~My~~ Watermark Patent & Trademark Attorneys
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50 Queen Street, Melbourne, Victoria, Australia.

DATED this 18th day of September 1989

(5) Signature (s) of Applicant (s) or Seal of Company and Signatures of its Officers as prescribed by its Articles of Association.

(5)

EDWARD CALTON SHURTLEFF

by

Stephen K. Plymin

Registered Patent Attorney

To:

THE COMMISSIONER OF PATENTS.

COMMONWEALTH OF AUSTRALIA

THE PATENTS ACT 1952

DECLARATION IN SUPPORT OF A CONVENTION APPLICATION FOR A PATENT

In support of the Convention Application made for a
patent for an invention entitled:

AUSTRALIA
CONVENTION
STANDARD
& PETTY PATENT
DECLARATION SFP 4

Title of Invention

Full name(s) and
address(es) of
Declarant(s)

I/We Edward Calton Shurtleff
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Moores Mills, New Brunswick
CANADA EOG 2L0

do solemnly and sincerely declare as follows:

Full name(s) of
Applicant(s)

1. I am/We are the applicant(s) for the patent
(or, in the case of an application by a body corporate)
~~1. I am/We are authorised by~~

~~the applicant(s) for the patent to make this declaration on
its/their behalf.~~

2. The basic application(s) as defined by Section 141 of the
Act was/were made

Basic Country(ies)

in Canada

Priority Date(s)

on September 20, 1988

Basic Applicant(s)

by Edward Calton Shurtleff

Full name(s) and
address(es) of
inventor(s)

3. I am/We are the actual inventor(s) of the invention referred
to in the basic application(s)
~~(or where a person other than the inventor is the applicant)~~

3-

of

(respectively)

~~is/are the actual inventor(s) of the invention and the facts upon
which the applicant(s) is/are entitled to make the application are
as follows:~~

Set out how Applicant(s)
derive title from actual
inventor(s) e.g. The
Applicant(s) is/are the
assignee(s) of the
invention from the
inventor(s)

4. The basic application(s) referred to in paragraph 2 of this
Declaration was/were the first application(s) made in a Convention
country in respect of the invention(s) the subject of the application.

Declared at *St Stephen NB.* this *21* day of *September* 19 *88*
Canada

Signature of Declarant(s)

11/81

To: The Commissioner of Patents

(12) PATENT ABRIDGMENT (11) Document No. AU-B-41462/89
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 628079

- (54) Title
APPARATUS AND METHOD FOR RECLAIMING WASTE OIL
- International Patent Classification(s)
(51)⁴ **B01D 003/02 C10G 007/00**
- (21) Application No. : **41462/89** (22) Application Date : **19.09.89**
- (30) Priority Data
- (31) Number (32) Date (33) Country
577895 20.09.88 CA CANADA
- (43) Publication Date : **29.03.90**
- (44) Publication Date of Accepted Application : **10.09.92**
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- (56) Prior Art Documents
DE 3121246
FR 2467880
FR 2434865
- (57) Claim

1. A single stage apparatus for reclaiming a useful oil product from waste oil, comprising:

oil feed means, by which waste oil is fed to said apparatus;
a boiler, fluidly connected to said oil feed means and adapted to receive waste oil therefrom;
a heater, to heat waste oil in said boiler to substantially atmospheric pressure, and to a temperature such that lighter hydrocarbons of the waste oil volatilize, but such that heavier hydrocarbons do not volatilize thereby trapping the contaminants therewith;
separating means fluidly connected to said boiler, to separate the volatilized lighter hydrocarbons from the unvolatilized heavy hydrocarbons and contaminants, and including a first discharge conduit for the volatilized lighter hydrocarbons and a second discharge conduit for the unvolatilized heavy hydrocarbons.

19. A method for treating waste oil containing contaminants, the method being carried out in a single stage and comprising the steps of:

heating said waste oil at substantially atmospheric pressure, and in a boiler to a temperature in the range of 600 to 800°F, such that lighter hydrocarbons of the waste oil volatilize, but such that heavier hydrocarbons do not, thereby trapping the contaminants therewith;

and then separating said volatilized lighter hydrocarbons from said unvolatilized heavier hydrocarbons and contaminants.

25. A method for treating waste oil containing contaminants, the method being carried out in a single stage and comprising the steps of:

- (a) heating said waste oil in a vessel to a temperature of 600 to 800°F and at substantially atmospheric pressure;
- (b) volatilizing a first portion of said waste oil, said first portion containing primarily the lighter hydrocarbons of said waste oil;
- (c) separating the volatilized first portion from the remaining unvolatilized portion of said waste oil, said remaining portion containing primarily the heavier hydrocarbons and the contaminants of said waste oil;
- (d) recondensing said separated, volatilized first portion; and
- (e) recovering said condensed first portion as a useful oil product, substantially reduced in contaminants, and recovering said remaining portion as a sludge.

628079

Form 10

COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952-69

COMPLETE SPECIFICATION

(ORIGINAL)

Class

Int. Class

Application Number:
Lodged:

Complete Specification Lodged:
Accepted:
Published:

Priority:

Related Art:

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Complete Specification for the invention entitled:

APPARATUS AND METHOD FOR RECLAIMING WASTE OIL

The following statement is a full description of this invention, including the best method of performing it known to : US

This invention relates generally to an apparatus and a method for reclaiming waste oil, more particularly for removing various contaminants present in waste oil which make it unsuitable for re-use as a heating fuel, diesel
5 fuel, and so forth.

In this specification, the term "waste oil" refers to oil which has been used as motor oil or some other lubricating oil, or as hydraulic oil or in some other such
10 application. In use, these oils are changed periodically. The drained and recovered waste oil typically contains substantial amounts of contaminants, which may include dirt, metallic particles (including heavy metals, such as molybdenum, chromium, cadmium, vanadium, copper and so
15 forth), oxides and salts, gasoline and gasoline additives (such as tetraethyl lead), as well as detergents and performance additives.

Many millions of gallons of such waste oil are produced annually in North America. In the past, waste oil
20 has been used on dirt roads for dust control, or simply dumped in sanitary sewers or land fill sites. However, increasingly such methods of disposal are seen as being unacceptable causes of hydrocarbon pollution to the environment. Re-refining of waste oil is practised to a
25 certain extent. However, known methods for re-refining waste oil require complex chemical treatments and generally do not produce a high grade product. Transportation costs further

detract from the economic viability of this manner of dealing with waste oil.

In the past, it has also been proposed that waste oil be used as a heating fuel. However, furnaces of the known type for burning such oil have met with limited success. During conventional combustion of waste oil, a residue accumulates in the burner. The residue is formed of the various contaminants and the heavier hydrocarbons which form a hard binding resin. As a result, the burner must frequently be cleaned of the accumulated hard residue, typically twice per day. In order to clean the burner, the furnace must be turned off and allowed to cool. This is extremely inconvenient and represents a major inefficiency. Furthermore, removal of the cooled and hardened residue from the burner is a difficult task, typically requiring strenuous physical labour.

It is an objective of the present invention to obviate or mitigate the disadvantages of the prior art in this field.

In accordance with a first aspect of the present invention, there is provided an apparatus for reclaiming a useful oil product from waste oil. The apparatus comprises an oil feed means, a boiler, a heater and separating means. The oil feed means is used to feed waste oil to the apparatus. The boiler is fluidly connected to the oil feed means and is adapted to receive waste oil therefrom. The

heater is used to heat the waste oil in the boiler to a temperature such that lighter hydrocarbons of the waste oil volatilize, but such that heavier hydrocarbons remain unvolatilized, trapping the contaminants therewith. The separating means separates the volatilized lighter hydrocarbons from the unvolatilized heavier hydrocarbons and contaminants. Surprisingly, it has been found that such an apparatus provides a simple and effective means for removing the contaminants from the waste oil and producing a clean oil product suitable for recycling in a variety of uses, particularly for use as a heating fuel or as a diesel fuel.

Preferably, the heater of such an apparatus comprises an oil burner which is fluidly connected to the separating means and adapted to receive therefrom and to burn the reclaimed portion of the waste oil derived from the volatilized lighter hydrocarbons. Advantageously, the separating means is integral to the boiler, the boiler comprising a first discharge conduit adapted to discharge the volatilized lighter hydrocarbons, and a second discharge conduit adapted to discharge the unvolatilized heavy hydrocarbons and contaminants. Most preferably, the apparatus further comprises a condenser for condensing the volatilized lighter hydrocarbons to produce a reclaimed liquid petroleum product and also comprises a reclaimed oil reservoir for accumulating and storing same, and a sludge tank for accumulating the separated unvolatilized heavier



hydrocarbons and contaminants to facilitate periodic removal.

In accordance with a second aspect of this invention, there is provided a method for treating waste
5 oil, comprising the steps of heating the waste oil in a boiler at a pressure not substantially different from atmospheric pressure and to a temperature such that lighter hydrocarbons of the waste oil volatilize, but such that heavier hydrocarbons do not, trapping the
10 contaminants therewith, and subsequently, separating the volatilized lighter hydrocarbons from the unvolatilized heavier hydrocarbons and contaminants. Preferably, the temperature is in the range of from about 600°F to 800°F. Advantageously, the temperature is about 650°F. Most
15 advantageously, the volatilized lighter hydrocarbons are subsequently condensed to produce a reclaimed liquid oil product, at least a portion of which is then burned to heat more waste oil in the boiler.

The present invention provides a safe, efficient
20 and versatile means for treating waste oil, reclaiming therefrom a useful petroleum product which can be used in a number of ways, particularly as a heating fuel or as a diesel fuel. The sludge by-product derived from the heavier hydrocarbons and contaminants must still be
25 disposed. However, it should typically represent approximately only one-tenth of the volume of the waste oil fed to the apparatus. In some cases it may be possible to reclaim valuable metals from the sludge



The apparatus of the present invention can be manufactured and operated at a small fraction of the cost of a re-refining plant. Thus, industrial and commercial establishments (such as automobile service stations) and
5 others who accumulate large quantities of waste oil can utilize the waste oil as a valuable by-product, rather than having to pay to have it disposed.

In order that the invention may be more clearly understood, reference will now be made to the accompanying
10 drawings which illustrate the invention and in which:

Fig. 1 is a schematic representation of one embodiment of the apparatus of the present invention;

Fig. 2 is a cross-sectional side view representation of an alternative embodiment of the apparatus of the
15 present invention.

Fig. 3 is a top view representation of a portion of the apparatus of Fig. 2, taken along the plane indicated by line 3-3.

Referring first to Fig. 1, the apparatus comprises
20 a containment structure 10 having a first substantially enclosed chamber 11 and a second substantially enclosed chamber 12 the first chamber 11 and the second chamber 12 are substantially separated from each other by a common wall 13, but they fluidly communicate with each other through an
25 opening 14 in the wall 13. A fire box 15 in the first chamber 11 comprises a separate fire chamber 16, including a

burner 17, and a distillation boiler 18 in which the waste oil is heated. Waste oil is fed from a storage tank 19 through a float chamber 20 to the boiler 18. The oil level within the boiler 18 is controlled by the float chamber 20.

5 The float chamber 20 is sealed but a breather tube 21 passes between the boiler 18 and the float chamber 20 to equilibrate pressure. The boiler 18 is located above the fire chamber 16 and the distance between them within the fire box 15 is such that while the apparatus is operating
10 (i.e., burning oil) the temperature at the height of the boiler 18 is approximately 650°F. At this temperature, the lighter hydrocarbons are volatilized and cracked and they exit the boiler 18 through a discharge 25. A sludge consisting of the unvolatilized heavier hydrocarbons and
15 contaminants gradually builds up in the bottom portion 23 of the boiler 18. This sludge is emptied via a drain 22 into a sludge tank 24, and is ultimately disposed. In the event that the sludge is not emptied, the level of the sludge and oil in the boiler 18 rises to the cut off level of the float
20 chamber. 20 and no further waste oil enters the boiler 18 and the apparatus is ultimately automatically shut down.

The volatilized lighter hydrocarbons from the boiler 18 pass through the discharge 25 then through a heat exchanger 26, positioned in front of a blower^{means} 27, where they
25 are cooled and condensed. The heat given off by the heat exchanger 26 passes along in the air stream created by the



blower ^{means} 27 through the second chamber 12, and through the opening 14 into the first chamber 11, thus being recaptured for heating.

The condensed lighter hydrocarbons thus form a reclaimed liquid oil product which passes to a holding tank 28. From there the reclaimed oil can be emptied for use elsewhere or transferred to the burner 17, via a pump 30. The fire chamber 16 is similar to a fire chamber of a conventional oil furnace. Heat from the fire box 15 is transferred through the first chamber 11 to a heating duct 31 which connects to a building heating system. Combustion fumes pass out through a flue 32.

The furnace burner 17 may be a simple pot type burner. Alternatively, a gun type burner may be used. If a gun type burner is used, the reclaimed oil should be fed by means of a hydraulic pump maintained at a temperature of about 165°F in a heated water bath, and an in-line heater should be used to maintain the nozzle temperature about 130°F, due to the viscosity of the reclaimed oil.

Fig. 1 shows a simple embodiment of the apparatus of the present invention in order to illustrate the basic operating principle. Turning to Figs. 2 and 3, a preferred embodiment of an apparatus of the present invention will now be described. For the sake of simplicity and brevity, like parts are given the same reference numbers as used for the simple embodiment of Fig. 1 and a description of these parts is not repeated.



In this embodiment, the feed storage tank 19 is mounted within the containment structure 10. When the level of waste oil in the feed storage tank drops below a pre-set level, a float switch 40 activates a motorized pump to deliver more waste oil from external receiving-storage-settling tanks. When the power is turned on to start up the apparatus, a valve 43, preferably a solenoid valve is opened to permit flow from the feed storage tank and a motorized feed pump 45 is activated. Waste oil from the feed storage tank 19 first passes a "Y" strainer 41 which removes dirt particles and entrained water. Most of the water entrained with typical waste oils can be removed while the oil is being held in the external receiving-storage-settling tanks. The remaining entrained water which is diverted by the "Y" strainer drains into a water trap tank 42 from which it can be periodically removed via a water drain 35 by opening a valve 36.

When the valve 43 is opened, waste oil is delivered via the feed pump 45 and also through a needle valve 44 to a pre-heater tank 46. The needle valve 44 can deliver waste oil at a rate of up to six gallons per hour. The feed pump delivers waste oil at a rate of approximately four gallons per hour, regardless of the flow rate through the needle valve. Thus, during operation, the feed rate of the waste oil varies from about four to about ten gallons per hour.

During operation, the pre-heater tank 46 heats the waste oil to about 200 to 300°F. From the pre-heater tank



46, the waste oil is transferred to the boiler 18. In this embodiment, the boiler 18 has an inclined base which rests on sliders 47 so that the boiler 18 can be removed from the fire box 15 like a drawer to facilitate periodic cleaning and so forth. Two inclined barriers 48 extend upwardly from the base and inwardly from the opposing sides of the boiler 25 such that the sludge which accumulates at the bottom 23 of the boiler 18 flows from side to side down the inclined base around the barriers 48. The volatilized lighter hydrocarbons exit through a raised portion 49 and thence through the discharge 25.

When the level of the waste oil in the boiler 18 reaches a pre-set height determined by a low level float 72 in the float chamber 20, a switch is activated to turn on the burner 17 and the fuel pump 30. The burner 17 thus begins to fire and to heat up the fire box 15, including the boiler 18. The burner 17 is held in a refractory fire pot 57 which is supported by a fire pot support 58. The burner 17 can burn reclaimed oil from the holding tank 28 or from an external reserve of conventional fuel oil. Valve 51 for reclaimed oil and valve 52 for conventional fuel oil are manually opened and closed to select the fuel. The pump 30 is held in a water immersion tank 53 heated with an electric heating coil 54 to maintain the temperature in the immersion tank at approximately 165°F. Power to the heating coil 54 and to an in-line heater next to the nozzle of burner 17 is

provided by an independent source so that the temperature of the fuel supply line, pump and burner is always maintained high enough to handle the apparatus' own reclaimed oil which has a higher viscosity than conventional furnace fuel oils.

5 The fuel line pressure can be adjusted by means of a pressure relief valve 56 and can be monitored by means of a pressure gauge 55. It has been found that an operating pressure of approximately 120 p.s.i. is desirable.

When the burner 17 and fuel pump 30 are activated
10 by the low level float switch 72, a coil relay also automatically shuts off the feed pump 45 and closes the solenoid valve 43. Thus, for the time being, no further waste oil is delivered to the apparatus. The waste oil already in the boiler 18 is gradually heated up by the heat
15 from the burner 17 until it reaches the distilling temperature of approximately 650°F. At this temperature, lighter hydrocarbons are volatilized and pass out through the discharge 25 to the heat exchanger 26, while sludge builds up in the bottom 23 of the boiler 18 and gradually
20 exits through the drain 22. As the volatilized lighter hydrocarbons are discharged and enter the heat exchanger 26, the temperature of the heat exchanger 26 rises. Increasing temperature of the heat exchanger 26 thus indicates that the waste oil in the boiler 18 has reached volatilization
25 temperature. This is used as a signal to indicate that the apparatus is ready for steady state operation. A

thermocouple mounted midway on the heat exchanger 26 responds when the temperature reaches 130°F by activating a coil relay to transfer the power to the burner 17 and fuel pump 30 to a different path for steady state operation. This path includes a sail switch which will turn off the power if the blower ^{means} 27 stops operating for any reason. The thermocouple also opens the ~~solenoid~~ valve 43 and starts the feed pump 45 so that waste oil resumes flowing from the feed storage tank 19 through the pre-heater 46 and into the boiler 18. The oil level in the boiler 18 rises to a level pre-set by a float 70 of the float chamber 20. Float 70 controls the operating level in the boiler 18 by opening and closing the needle valve 44 to adjust the total feed rate. Typically, the apparatus runs at a steady state of about six to ten gallons per hour. The thermocouple on the heat exchanger 26 also turns on a sludge removal pump 66.

The holding tank 28 is provided with a pan 50 on the underside of its top where the condensed lighter hydrocarbons collect. A second tube extends from this region and connects to the flue 32 so that any remaining uncondensed volatiles entering the holding tank 28 are sucked away with the flue gases. In operation, only minute traces of volatiles have been found. A float switch 59 in the holding tank 28 activates a motorized pump which drains a portion of the reclaimed liquid oil from the holding tank 28 to an external storage tank if the depth in the holding



tank 28 exceeds a pre-set level.

The sludge passes from the drain 22 into a settling-cooling tank 60 and from there past a heat exchanger 64 and a solenoid valve 65 to a sludge pump 66.

5 The sludge pump 66 drains sludge to an external sludge storage tank at a rate of about 0.5 to 0.7 gallons per hour. The solenoid valve 65 directs the flow through one of two emanating branches. The solenoid valve 65 is biased to direct the flow normally through the branch leading to the
10 sludge pump 66. However, it may be activated to direct the flow to a shut down pump 67 instead. A "T" connects into the sludge draining line between the settling-cooling tank 60 and the heat exchanger 64, and leads to a transfer tank 61 and thence to the float chamber 20. The transfer tank 61 has
15 an air release tube 62 with a valve 63 to release entrapped air and is included to reduce heat transfer to the float chamber.

When the apparatus is manually switched off, power is cut to the feed pump 45 and the sludge pump 66, and
20 ~~solenoid~~ valve 43 is closed. The apparatus continues to operate, however, until the oil level in the boiler 18 is reduced to the level of the low level float switch 72. At this point, the low level float switch cuts power to the burner 17 and to the fuel pump 30. The apparatus then sits
25 cooling for approximately two hours. When the temperature of the sludge in the drain 22 just upstream of the



settling-cooling tank 60 has cooled to 140°F, a thermocouple activates solenoid valve 65, closing the branch leading to the sludge pump 66 and opening the branch leading to the shut down pump 67, and turns on the shut down pump 67. The
5 sludge and any remaining oil is then completely drained from the apparatus by the shut down pump 67 to the external sludge storage tank. When the temperature of the sludge drain 22 just upstream from the first settling-cooling tank 60 has cooled to 100°F, indicating that the line is empty, a
10 thermocouple reverses solenoid valve 65 and turns off shut down pump 67.

If the apparatus should run out of waste oil or develop a blockage in the feed line, the oil level in the boiler 18 will be lowered to the level of the low level
15 float switch 72. This cuts power to the burner 17 and the fuel pump 30, and turns off the feed pump 45 and closes ~~solenoid~~ solenoid valve 43. The apparatus cools and is drained in the manner previously described.

If a blockage were to develop downstream, the oil
20 in the boiler 18 would reach the level of a high level float switch 71. This also cuts power to the burner 17 and the fuel pump 30, and turns off the feed pump 45 and closes the ~~solenoid~~ solenoid valve 43. Again, the apparatus sits and cools and then drains itself.

25 High limit controls on the fire box 15 and on the heat exchanger 26 also similarly automatically shut off the



apparatus if local temperatures exceed pre-set limits, which could occur, for example, if improper petroleum products such as gasoline are inadvertently added to the feed storage tank 19.

5 EXAMPLE 1

This example illustrates the operability and efficiency of the invention.

A prototype apparatus substantially as illustrated in Fig. 1, with a pot burner, was tested according to the following procedure. A 25 gallon sample of a typical used motor oil obtained from an automotive service station was introduced to the feed storage tank, float chamber and boiler. The apparatus was started up using 2 cups (16 oz.) of a conventional No. 1 fuel oil (kerosene). The fire chamber was heated such that the temperature of the boiler approached 650°F, and the apparatus was operated continually for 24 hours. During operation, the apparatus consumed approximately 4.25 Imperial gallons per hour of waste oil. Of this amount, approximately .75 Imperial gallons per hour was consumed by combustion in the fire chamber, producing approximately 150,000 BTU/hour for heating. Approximately 3.1 Imperial gallons/hour of additional reclaimed oil was accumulated in the holding tank, and approximately .4 Imperial gallons/hour of sludge was accumulated in the sludge tank.

EXAMPLE 2

This example further illustrates the operability and efficiency of the invention.

A prototype apparatus substantially as illustrated in Fig. 1 was tested according to a procedure similar to that described in Example 1, under conditions as shown in Table I. Chemical and physical analyses were conducted on the waste oil feedstock, the reclaimed oil and the sludge, and the results are shown in Table II.

The yield of reclaimed oil was approximately ninety percent. The product compared favourably to commercial light fuel oils with respect to elemental composition and calorific value. However, the viscosity, pour point and flash point differed significantly from the corresponding values for commercial light fuels. This was attributed to distinct differences in composition. Commercial light fuels consist essentially of saturated paraffinic aliphatic hydrocarbons with a relatively narrow range of boiling points, while analysis of the reclaimed oil revealed that it contained a mixture of saturated and unsaturated aliphatic paraffinic hydrocarbons, with a very wide range of generally higher boiling points. It should be noted, however, that the cetane number of the reclaimed oil was very high, approximately 56, compared to the typical range of 40 to 45 of North American diesel fuels.

It will of course be appreciated that many variations of the apparatus and method of the present invention are possible.

TABLE I

Operating Conditions for Example 2Times:

start-up to start of reclaimed oil production	=	4 h approx.
time to produce 35 gal of reclaimed oil	=	6 h approx.
Total	=	10 h approx.
production rate	=	3.6 g/h approx.

Temperatures:

boiler during production	=	635°F (335°C)
boiler at end of production	=	645°F (340°C)
stack during production	=	595°F (313°C)

Material Balance:

waste oil feedstock volume	=	40 gal
total volume of reclaimed oil produced	=	36 gal
efficiency (percentage recovery of reclaimed oil)	=	90%
volume of reclaimed oil burned to sustain operation	=	0.7 gal/h approx.
sludge	=	3 gal
lost due to leaks and volatilization	=	1 gal approx.

TABLE II

Analytical Data for Example 2

	<u>Waste Oil Feedstock</u>	<u>Reclaimed Oil</u>	<u>Sludge</u>
Appearance	Opaque black, mobile liquid	Clear, fluorescent yellow- orange mobile liquid	Opaque, black viscous liquid
Odour	Acrid, penetrating	Acrid, penetrating	Acrid, penetrating
Water (%)	0.7	< 0.05	0.05
Ash (%)*	0.99	< 0.01	7.12
Sulphur (%)	0.36	0.20	1.02
Carbon (%)	83.14	84.62	81.76
Hydrocarbon (%)	12.96	13.27	11.75
Nitrogen (%)	0.12	0.05	0.28
Oxygen (%) by diff.	1.73	1.81	(-1.98)*
Gross Heat of Combustion (BTU/lb)	19159	19548	17957
Specific Gravity			
@77°F/77°F	0.8915	0.8525	0.965
@60°F/60°F	0.8955	0.8565	0.969
API Gravity (calc)	26.5	33.7	14.55
Cloud Point (°F)	T.D.	T.D.	T.D.
Pour Point (°F)	0	-5	+10
Flash Point (°F)**	220	95	>220
Viscosity:			
@40°C (cSt)	68.0	7.42	251.5
@50°C (cSt)	45.9	5.69	156.4
@100°C (cSt)	11.13	2.18	25.14

T.D. = Too dark to observe

* The ash is very high for an oil sample and the ash components would be present as oxides, thereby seriously skewing the equation used to obtain "oxygen, by difference"

** Pensky-Martens Closed Cup

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A single stage apparatus for reclaiming a useful oil product from waste oil, comprising:

oil feed means, by which waste oil is fed to said apparatus;

a boiler, fluidly connected to said oil feed means and adapted to receive waste oil therefrom;

a heater, to heat waste oil in said boiler to substantially atmospheric pressure, and to a temperature such that lighter hydrocarbons of the waste oil volatilize, but such that heavier hydrocarbons do not volatilize thereby trapping the contaminants therewith;

separating means fluidly connected to said boiler, to separate the volatilized lighter hydrocarbons from the unvolatilized heavy hydrocarbons and contaminants, and including a first discharge conduit for the volatilized lighter hydrocarbons and a second discharge conduit for the unvolatilized heavy hydrocarbons.

2. A single-stage apparatus as recited in claim 1, wherein said heater comprises an oil burner fluidly connected to said separating means and adapted to receive therefrom and to burn said volatilized lighter hydrocarbons.

3. A single-stage apparatus as recited in claim 2, wherein said separating means is provided by said boiler.

4. A single-stage apparatus as recited in claim 3, wherein said boiler is located over said oil burner at a distance such that in operation, the temperature of said boiler is in the range of 600 to 800°F.

5. A single-stage apparatus as recited in claim 4, further comprising a condenser for condensing said volatilized lighter hydrocarbons, fluidly connected to said separating means and adapted to receive said volatilized lighter hydrocarbons therefrom, and fluidly connected to said oil burner and adapted to feed said recondensed volatilized lighter hydrocarbons thereto.

6. A single-stage apparatus as recited in claim 5, further comprising valve means to control the flow of waste oil from said oil feed means to said boiler.



7. A single-stage apparatus as recited in claim 6, further comprising a reclaimed oil reservoir fluidly connected to said condenser, and further comprising a sludge reservoir fluidly connected to said separating means and adapted to receive a sludge product comprising the heavier hydrocarbons and contaminants.

8. A single-stage apparatus as recited in claim 7, wherein said valve comprises a float chamber.

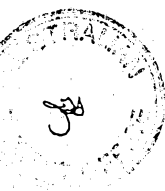
9. A single-stage apparatus as recited in claim 8, wherein said condenser comprises a heat exchange conduit, and further comprises a blower means for blowing cooling air on said heat exchange conduit.

10. A single-stage apparatus as claimed in claim 9, wherein the heat exchange conduit comprises a plurality of layers of ducts, with each layer being inclined and the ducts in each layer extending generally parallel to one another and being connected so that condensate flows generally down through the heat exchange conduit and alternatively from side to side within each layer of ducts.

11. A single-stage apparatus as claimed in claim 10, wherein the ducts include extended heat transfer surfaces.

12. A single-stage apparatus as claimed in anyone of claims 7, 8, 9, 10 or 11, wherein the reclaimed oil reservoir is connected to the oil burner.

13. A single-stage apparatus as recited in claim 9, further comprising a containment structure, having a first substantially enclosed chamber wherein are disposed said oil burner and said boiler, and a second substantially enclosed chamber wherein are disposed said float chamber, said heat exchange conduit and said blower means, said first and second chambers being substantially separated by a common wall but fluidly communicating with each other through a vent hole in said wall, and further comprising a heating duct fluidly connected to said first chamber for discharging heated air, a fire box in the first chamber in which fire box is located said oil burner, and a flue fluidly connected to said fire box, for expelling combustion fumes therefrom.



14. A single-stage apparatus as recited in anyone of claims 3, 4 or 10, wherein said boiler has an inclined base with barriers extending upwardly therefrom such that the unvolatilized heavy carbons flow from side to side down said inclined base around said barriers while the volatilized lighter hydrocarbons pass over said barriers.

15. A single-stage apparatus as recited in anyone of claims 8, 9, or 10, wherein said float chamber comprises a first operating level float acting upon said valve means, a second low level float acting upon said valve means and said oil burner, and a third high level float acting upon said valve means and upon said oil burner.

16. A single-stage apparatus as recited in claim 10 further comprising a tube extending between and fluidly connecting the upper portion of said reclaimed oil reservoir and said flue, for expelling any uncondensed volatiles entering said reclaimed oil reservoir.

17. A single-stage apparatus as recited in claims 2, 5 or 10, wherein said oil burner is a gun type burner with an in-line heater to heat its nozzle, and further comprising a hydraulic pump maintained in a heated water bath to feed said oil burner.

18. A single-stage apparatus as recited in anyone of claims 8, 9 or 10, wherein said oil feed means includes a feed pump which delivers waste oil to said boiler at a substantially constant rate, and also comprises a needle valve which permits delivery of additional waste oil to said boiler at a variable rate responsive to said float chamber.

19. A method for treating waste oil containing contaminants, the method being carried out in a single stage and comprising the steps of:

heating said waste oil at substantially atmospheric pressure, and in a boiler to a temperature in the range of 600 to 800°F, such that lighter hydrocarbons of the waste oil volatilize, but such that heavier hydrocarbons do not, thereby trapping the contaminants therewith;

and then separating said volatilized lighter hydrocarbons from said unvolatilized heavier hydrocarbons and contaminants.

20. A method as recited in claim 19, wherein the temperature is 650°F.

21. A method as recited in claims 19 or 20, further comprising the step of recondensing said volatilized lighter hydrocarbons.



22. A method as recited in claim 21, including the further step of burning at least a portion of said recondensed volatilized lighter hydrocarbons, the heat of combustion from which is used to heat the waste oil in said boiler.

23. A method as recited in claim 19, wherein the temperature is in the range of 635 to 650°F.

24. A method as recited in claim 23, further comprising the steps of recondensing and recovering said separated, volatilized lighter hydrocarbons.

25. A method for treating waste oil containing contaminants, the method being carried out in a single stage and comprising the steps of:

- (a) heating said waste oil in a vessel to a temperature of 600 to 800°F and at substantially atmospheric pressure;
- (b) volatilizing a first portion of said waste oil, said first portion containing primarily the lighter hydrocarbons of said waste oil;
- (c) separating the volatilized first portion from the remaining unvolatilized portion of said waste oil, said remaining portion containing primarily the heavier hydrocarbons and the contaminants of said waste oil;
- (d) recondensing said separated, volatilized first portion; and
- (e) recovering said condensed first portion as a useful oil product, substantially reduced in contaminants, and recovering said remaining portion as a sludge.

26. The method of claim 25, wherein said temperature is in the range of 635 to 650°F.

27. The method of claim 25, wherein said temperature is 650°F.

28. The method of claim 25, wherein said temperature is effective such that said volatilized first portion is nine-tenths of said waste oil.

29. The method of any one of claims 25, 27 or 28, wherein steps (a), (b) and (c) are conducted in a single vessel.

30. The method of any one of claims 25, 27 or 28, wherein steps (a), (b) and (c) are conducted in a single vessel having an inclined base with barriers extending

upwardly therefrom such that said volatilized first portion passes over said barriers, while said remaining portion flows down said inclined base around said barriers.

31. The method of any one of claims 25, 27 or 28, further comprising the step of burning part of said useful oil product recovered in step (e), to accomplish at least a part of the heating of step (a).

DATED the 23rd day of April, 1992

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