

No. 836,732.

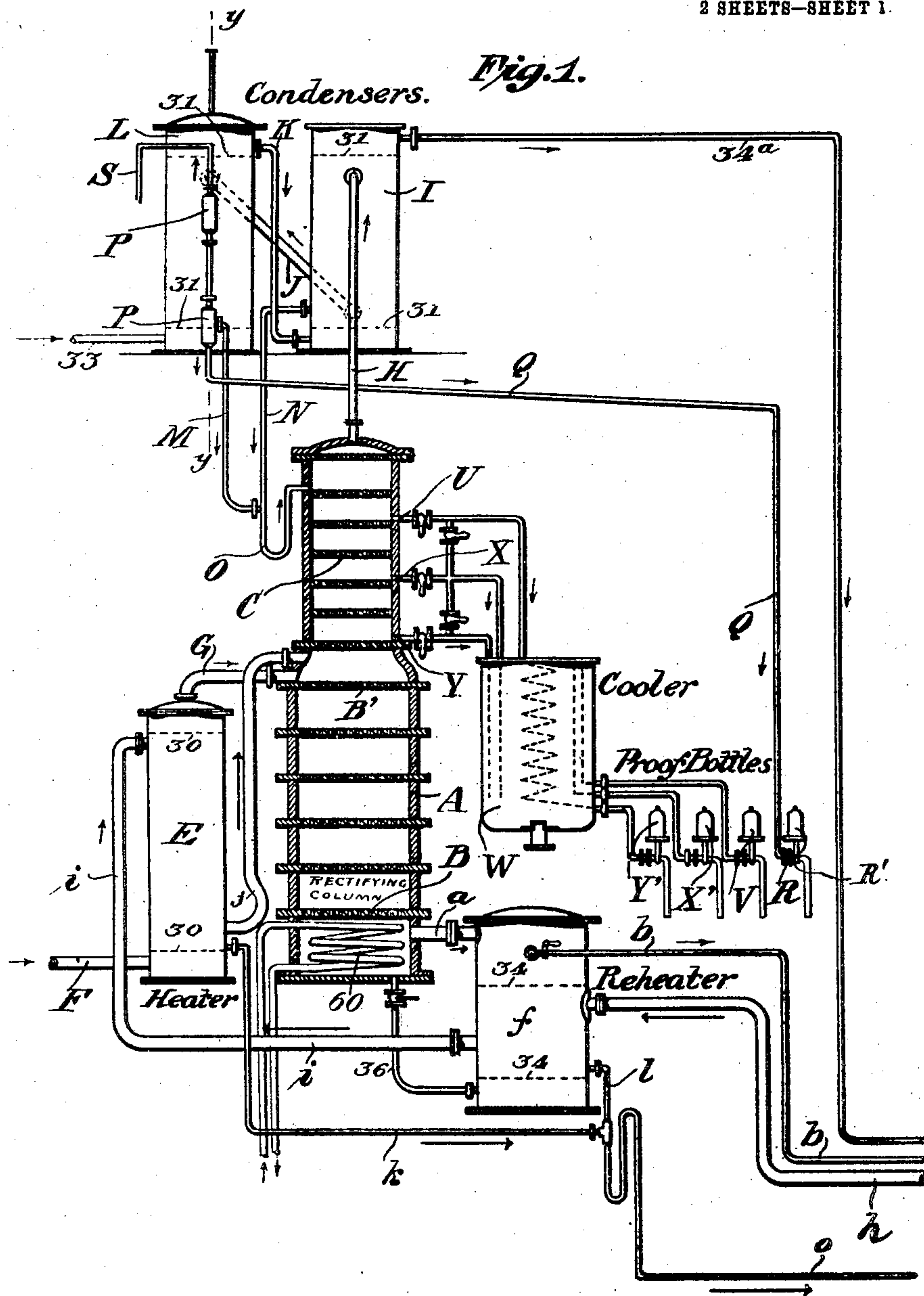
PATENTED NOV. 27, 1906.

E. A. BARBET.

APPARATUS FOR THE RECTIFICATION OF PETROLEUM.

APPLICATION FILED JUNE 20, 1902.

2 SHEETS—SHEET 1.



Witnesses  
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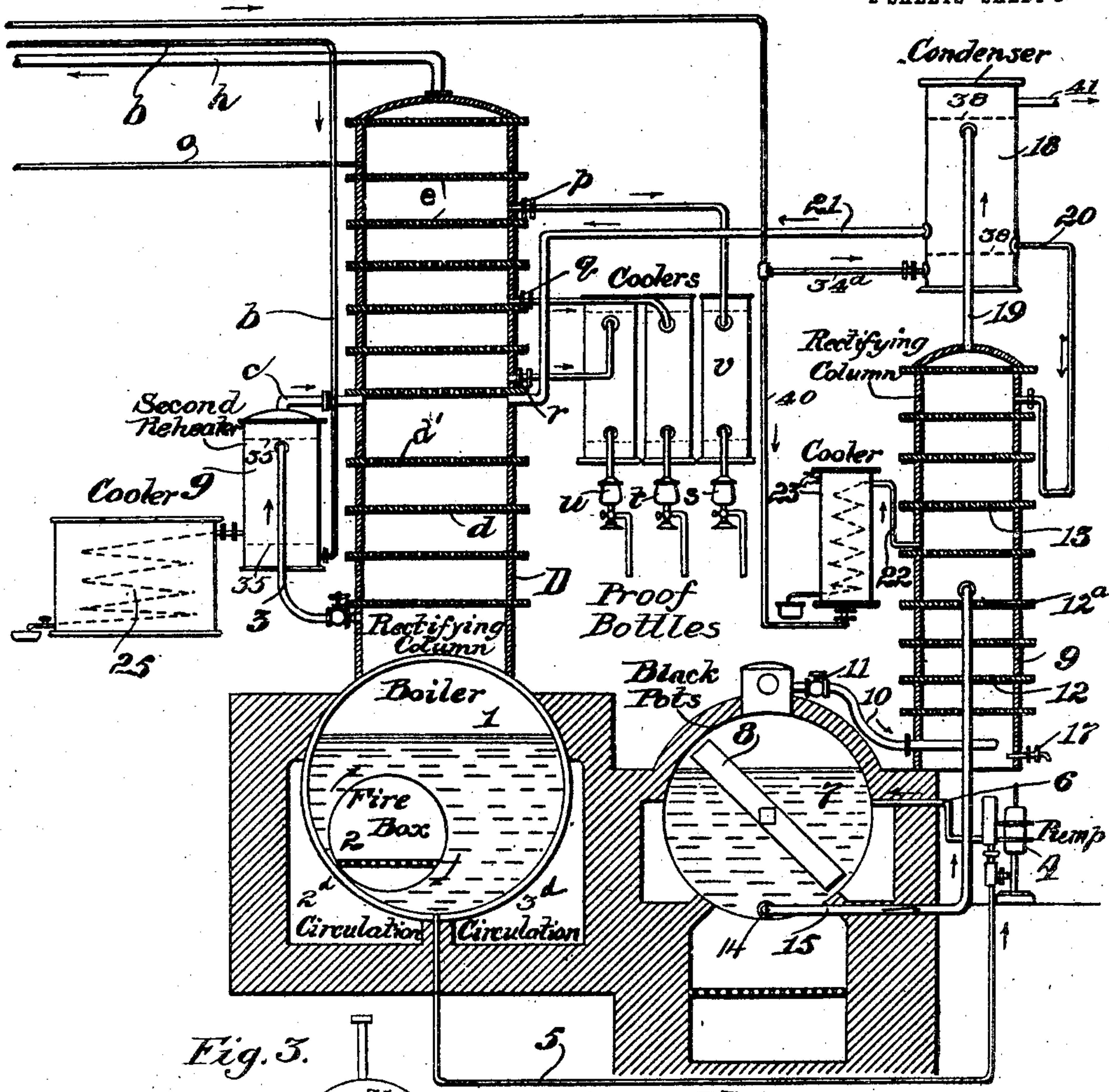


Fig. 3.

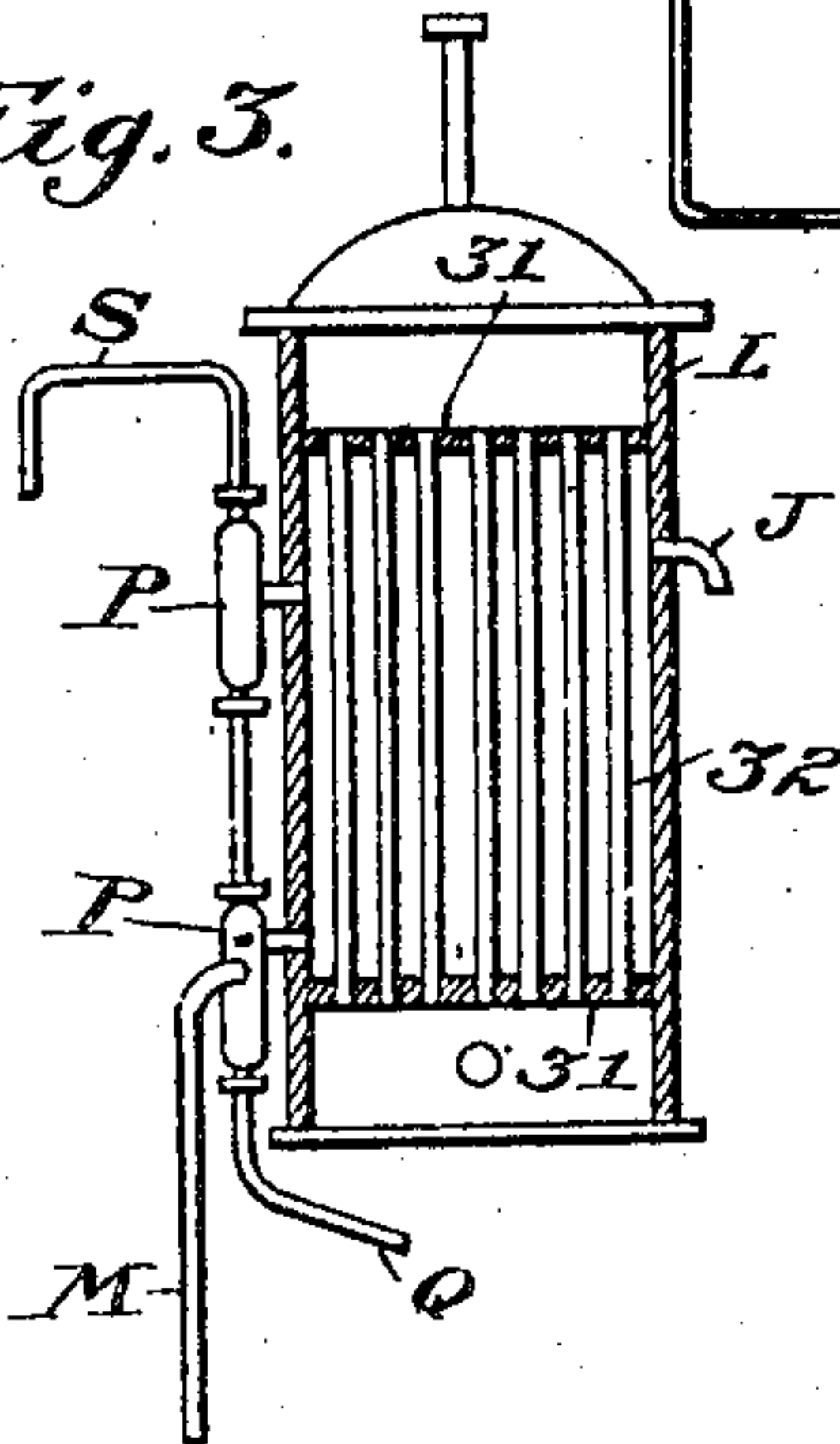


Fig. 2.

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# UNITED STATES PATENT OFFICE.

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## APPARATUS FOR THE RECTIFICATION OF PETROLEUM.

No. 836,732.

Specification of Letters Patent.

Patented Nov. 27, 1906.

Application filed June 20, 1902. Serial No. 112,523.

*To all whom it may concern:*

Be it known that I, EMILE AUGUSTIN BARBET, a citizen of France, residing at Paris, France, have invented certain new and useful  
5 Improvements in Apparatus for the Rectification of Petroleum, of which the following is a specification accompanied by drawings.

This invention relates to improvements in apparatus for the continuous rectification of  
10 petroleum; and its objects are to improve upon such apparatus, dispense with the costly and unsafe boilers hitherto used, and enable the crude petroleum to be readily separated into its different compounds.

15 Other objects of the invention will hereinafter appear; and to these ends the invention consists of the apparatus for carrying out the above objects embodying the features of construction, combinations of elements, and  
20 arrangement of parts having the general mode of operation substantially as hereinafter fully described and claimed in this specification and shown in the accompanying drawings, in which—

25 Figure 1 is a side elevation, partly in section, of a portion of the apparatus embodying the invention. Fig. 2 is a side elevation, partly in section, of another portion of the apparatus. Figs. 1 and 2 are shown dia-  
30 grammatically, and they should be read placing the sheets side by side, so that the piping may be traced from one figure to the other. Fig. 3 is a detail vertical sectional view of the condenser L on the line *y y* of  
35 Fig. 1, showing the connections of the piping thereto and the interior construction of the condenser.

Referring to the drawings, A represents a suitable rectifying-column for the oil, pro-  
40 vided with perforated plates B and C. The column A may be heated in any suitable manner, as by means of the steam-coil 60, preferably arranged in the lower portion of the column, which coil may be supplied with  
45 steam from any suitable source.

E represents a tubular heater in which the oil to be supplied to the column A is first heated. The heater E comprises a suitable cylindrical casing and tube-sheets in the top  
50 and bottom, (represented by the dotted lines 30.) The interior of the heater E is constructed like the tubular condenser L. (Shown in detail sectional view in Fig. 3.) The heating fluid circulates around the out-

side of the tubes of the heater connected be- 55  
tween the tube-sheets 30, while the oil passes into the bottom of the heater beneath the lower tube-sheet 30 by means of the pipe F, passes upward through the tubes and out at the top of the heater through the pipe G, 60  
which communicates with the rectifying-column A at a point above the upper plate B' of the lower series of plates B.

I and L represent tubular condensers constructed like Fig. 3, which is a sectional view 65  
of condenser L. Each condenser comprises a casing provided with tube-sheets 31, which carry the vertical tubes 32. The cooling liquid enters the lower portion of condenser L by means of the pipe 33, passes up through 70  
the tubes 32 into the upper portion of the condenser, then down through the connecting-pipe K to the lower portion of condenser I, thence upward through tubes 32 in said  
condenser and out by the pipe 34<sup>a</sup>. 75

The upper portion of column A is connect- 80  
ed by a vapor-pipe H with the space around the tubes 32 in condenser I, and said space is connected by a pipe J with the space around the tubes in condenser L.

Pipe connections P are provided for con- 85  
denser L, connected to the space around the condenser-tubes, as illustrated in Fig. 3, and these pipe connections communicate with each other, and from the upper connection P  
a pipe S extends. From the lower connec- 90  
tion P pipes Q and M extend downwardly, pipe Q leading to a proof-bottle R, while pipe M connects with a pipe N, leading from the space around the tubes of condenser I. Pipes  
M and N terminate in a common pipe O, 95  
which leads to the upper portion of the upper part of the column A above the plates C.

According to the construction described the oil entering column A through pipe G 95  
passes to the bottom of the column from plate to plate and is deprived of its most volatile parts. The vapor above the top or feed-  
ing plate B' contains some of the heavier products, which are gotten rid of in the upper 100  
portion of the column A and in the condensers I and L. The vapors rising from the top of the column A pass first to the condenser I, where a portion of them are condensed, the lighter products passing through pipe J to 105  
the condenser L, where further condensation takes place, and some gases, such as cymogene and rhigolene, escape by means of the upper



pipe connection P and pipe S to be used in any desired manner. Some of the volatile products condensed in condenser L may pass off through the lower pipe connection through pipe Q to the proof-bottle R, which is provided with a regulating-valve R'. When the regulating-valve is adjusted to only permit a portion of the liquid condensed in condenser L to pass, the remaining portion I term the "excess." All the excess of liquid condensed in condenser L is returned through pipes M and O to the upper portion of the column A, and the vapors condensed in condenser I are returned by pipes N and O to the top of said column. This liquid returning to column A is heated in the upper part of the column on the plate C, whereby most of the volatile parts are volatilized, so that the liquid on said plates is almost entirely freed from its volatile parts, and if from two to four per cent. of the liquid is extracted at the point U, for instance, through the piping, as shown, controlled by suitable valves, and through cooler W, a liquid having a low boiling-point and very simple composition will be obtained at the proof-bottle V.

No difference of temperature will be shown from the beginning to the end of the distillation of this product. If some of the liquid is extracted several plates lower down, as at the points X or Y, homogeneous liquids having well-marked differences in specific gravities and boiling-points will be obtained at the proof-bottles X' or Y'.

It is of course possible to increase the number of products into which the petroleum is separated and obtain liquids having special industrial uses, and these liquids are perfectly clean and transparent, for they have been produced by the condensation of vapors. When the liquid reaches the bottom of column A, it has been entirely deprived of its light constituents, and its composition will vary according to the composition of the crude oil. It is possible to obtain an oil at the point X having the composition and character of illuminating-oil if sufficient heat is supplied to the apparatus.

D represents another rectifying-column provided with perforated plates *d* and *e*.

*f* represents what I term a "reheater," because the oil is reheated therein. This reheater *f* in this instance is of tubular form, constructed substantially like the condenser shown in Fig. 3, and is provided with tube-sheets 34, to which the tubes are connected. The upper portion of reheater *f* is connected by pipe *a* with the lower portion of column A. Another pipe *b* connects the upper chamber of the reheater *f* with the lower portion of a second tubular reheater *g*, having tube-sheets 35. (Represented, as in the other instances, by dotted lines.) The upper portion of the second reheater *g* is connected

to the column D above the plate *d'* by means of pipe *c*. Suitable means are also provided for circulating the heating liquid around the tubes in the second reheater *g* and also around the tubes between the tube-sheets in the first reheater *f*. As shown, a pipe 3 connects the lower portion of the column D with the space around the tubes in the reheater *g*, and this space is also connected with the coil 25 of a suitable cooler. The top of column D is connected by means of a pipe *h* with the space around the tubes in the reheater *f*. Said space is connected by another pipe *i* with the space around the tubes in the oil-supply heater E. Said space in heater E is connected by one pipe *j* with the column A above plate B', while another pipe *k* connects the space around the tubes in heater E with a pipe *l*, which pipe communicates with the space around the tubes in reheater *f*. The pipes *l* and *k* connect with pipe *o*, which leads back to the top of column D. Another pipe 36, having a valve, connects the lower part of column A with the lower portion of reheater *f*, forming a by-pass.

The purified oil or oil deprived of its light products passes from the lower portion of the column A by means of pipe *a* to the upper portion of reheater *f*, and thence it passes directly by means of the pipe *b* to and through the second reheater *g*, and thence by pipe *c* to the column D. The temperature of the oil is raised in each reheater *f* and *g*. The boiling on the different plates of column D causes total vaporization of all the illuminating-oil and even of some of the paraffin-oil, and the separation of these vapors takes place on the plates *e*, as hereinbefore described in connection with the plates C of column A. The vapors from the upper portion of column D may be conducted to a condenser, if desired, but preferably, as shown, these vapors are led by means of pipe *h* to and through reheater *f*, around the tubes therein, and out by pipe *i*, thereby supplying the necessary heat for the reheater. These vapors also supply the heat for the heater E by passing around the tubes in said heater. Some gases may be formed in the oil-heater E, and these escape through the pipe *j* to the column A. If a small excess of the heavier vapors, as illuminating-oil vapors, is not condensed in the heater E, this excess also passes through pipe *j* to column A and there meets the reflux from the plate C. The two refluxes from heater E and reheater *f* return by pipes *k* and *l*, respectively, and the common pipe *o* to the top of column D.

Different grades of illuminating-oil may be extracted from the points *p q r* in the upper portion of column D and led to proof-bottles *s t u* after cooling in the coolers *v*. Suitable thermometers may be used to indicate the operations carried on, and the extraction is



regulated in such manner as to obtain the desired temperatures, which are kept constant.

In this instance a boiler 1 is provided for heating column D. 2 represents the fire-box, preferably arranged eccentrically to the boiler in order to create a circulation. According to this arrangement the left side of the boiler is heated more strongly than the right, because hotter gases forming the second circulation pass through the left-hand flue, and what may be termed the "third" circulation passes through the right-hand flue. Circulation of the liquid thus obtained is in the direction of the arrows in the boiler and prevents the deposit of solid substances and avoids superheating. A small portion of the vapors produced in the boiler 1 may be utilized to heat the reheater *g* by means of the pipe connections described—namely, through pipe 3 and cooler 25. It is advantageous that the purified oil entering column D be as near as possible at the boiling-point or even be boiling. The boiler 1 should contain a stock of liquid sufficient to regulate the vaporization.

The liquid from the boiler 1 may be pumped into the usual "black pots," but even "cracking," which furnishes more illuminating-oil, may be made continuous. As shown, there is another cylindrical boiler 7, provided in this instance with a stirrer 8, and the exhaust-oil is pumped from boiler 1, through pipe 5, by pump 4, through pipe 6, into the boiler 7. Preferably a pressure of five or six atmospheres is maintained in the boiler 7, and by means of the stirring and this pressure of five or six atmospheres the cracking takes place more rapidly than in the black pots at an ordinary pressure.

9 represents a third rectifying-column connected with the boiler 7 by means of pipe 10. Said pipe is provided with a valve, and, as shown, connection is made with the lower portion of column 9. Said column is also provided with perforated plates 12 and 13.

In the operation of the apparatus the valve 11 is left slightly open in order to permit some of the vapors to be conducted to the bottom of rectifying-column through pipe 10, and at the same time the exhaust-valve 14 in pipe 15, leading to the column above plate 12<sup>a</sup>, is left open in order that the liquid may be conducted through pipe 15 to said feeding-plate 12<sup>a</sup>. The superheated liquid is partially transformed into vapors, which rise into the upper portion of the column. This formation of vapors produces a cooling, so that the vapors coming from the boiler 7 through pipe 10 are utilized to boil the paraffin-oil in the lower portion of the column, and thus expel all that can be volatilized. The liquid passes out through pipe 17 in the lower portion of column 9, whence it may be conducted to suitable paraffin-presses or to

the fire-box to be burned. The separation of the vapors in the upper portion of column 9 takes place as hereinbefore described in connection with the other columns.

8 represents a condenser constructed like the other condensers described with tubes and tube-sheets 38. A pipe 19 connects the upper part of column 9 with the space around the tubes in condenser 18, and said space is also connected by a liquid-return pipe 20 with the upper portion of column 9. Another pipe 21 connects said space around the tubes with the space above the plate *d'* in column D. The condenser 18 should be fed with hot water, for cold water would solidify some of the paraffin. If necessary, some steam could be introduced in the bottom of the condenser. As shown, the pipe 34<sup>a</sup>, leading from condenser I, conducts the condensing liquid to the lower portion of condenser 18, thence through the tubes and out at the outlet 41. The vapors not condensed in condenser 18 pass through the pipe 21 to column D. The paraffin or the oil condensed in 18 returns through pipe 20 to the upper portion of column 9, and having been entirely deprived of illuminating-oil is extracted at the pipe 22 and partially cooled in the condenser 23, which is supplied with condensing fluid by means of the pipe 40, connected to the pipe 34<sup>a</sup>. As in the condenser 18, the water in the condenser 23 should be about 70° centigrade in order to avoid the solidification of the paraffin, and the paraffin thus extracted may be afterward bleached and purified.

Some condensation may have occurred in the reheater *g*, and this condensation is cooled in the cooler 25, where care must be taken to avoid solidification of the products. The products of condensation may be sold directly either as vaseline or paraffin or may be returned into the apparatus at the top of the column D.

According to the apparatus described the oil has been separated into ten different lots; but it is of course possible to obtain as many lots as there are plates in the different columns, and the separation may be controlled in accordance with the demands of the trade.

The liquids obtained on the different plates will have a perfectly defined and stable composition, provided that the amount of liquid extracted at the various proof-bottles is just equal in quantity to the feed. A state of equilibrium is thus obtained, provided that the feed is of a constant composition. When this equilibrium is obtained, the separation takes place on the different plates.

The course of the oil in its several fractions is as follows: Oil enters the column A from the heater E, and some of the oil passes to the bottom of the column, while the more volatile parts pass through pipe H to condenser I, whence the lighter products pass through



pipe J to condenser L, where some gases escape by means of the upper pipe connection P and pipe S, and some of the volatile products condensed pass off through the lower pipe connection P through pipe Q to the proof-bottle R. The remaining liquid condensed in condenser L is returned through pipes M and O to the upper portion of column A, and the vapors condensed in condenser I are returned by pipes N and O to the top of said column. From the lower portion of column A the oil passes through pipe *a* to the reheater *f* and from thence by pipe *b* to a second reheater *g*, then by pipe C to the column D, and from the top of said column D the vapors pass by pipe *h* back to the first reheater *f*, thence by pipe *i* to the heater E and by pipe *j* back to column A. Some may pass by pipe *k* to pipe *l*, connected to reheater *f*, and from thence a pipe *o* leads back to the column D. From boiler 1 for heating column D the oil is pumped into the boiler 7, through pipes 5 and 6, by pump 4. From boiler 7 the oil passes through pipe 10 to a third column 9 and also through pipe 15 to said column. The liquid passes out through pipe 17 in column 9, and the vapors pass through pipe 19 to condenser 18, and the condensation returns by pipe 20 to column 9. The uncondensed vapors pass from condenser 18 by pipe 21 to column D. Some oil passes by pipe 22 from column 9 to cooler 23.

Obviously some features of this invention may be used without others, and the invention may be embodied in widely-varying forms.

Therefore, without limiting the invention to the construction shown and described nor enumerating equivalents, I claim, and desire to obtain by Letters Patent, the following:

1. In apparatus for the continuous fractional distillation of crude petroleum, the combination of a rectifying-column having a series of upper and lower perforated plates upon which the crude petroleum is partially evaporated, an oil-heater for supplying heated oil to said column at a point between said series of upper and lower plates, means for heating said column, a condenser connected to the upper portion of the column in which the more volatile vapors are condensed, a second condenser connected to the first condenser, connections for leading the condensed products back from both condensers to the upper portion of the column whereby the vaporization of said products is aided by the heat of the uncondensed vapors rising in the column from the oil distilled on the lower series of plates and means for withdrawing the different products from different points in the height of the column.

2. In apparatus for the continuous fractional distillation of crude petroleum, the combination of a rectifying-column having

two series of upper and lower perforated plates, means for heating the column, means for supplying heated oil to said column at a point between the series of plates, a condenser connected to the upper portion of the column, a second condenser connected to the first condenser, connections for leading the condensed products back from both condensers to the upper series of plates in the column, means for withdrawing the products from different points in the column, a reheater connected to the lower portion of said column for raising the temperature of the oil which has been deprived of its lighter products, a second rectifying-column having upper and lower series of plates, a second reheater, connections for leading the heated oil from the first reheater to the second reheater and from thence to a point in the second column between the series of plates, a connection from the top of the second column to the first reheater, a connection for leading the liquids from the first reheater back to the upper series of plates in the second column and means for withdrawing the products from different points in the height of the second column.

3. In apparatus for the continuous fractional distillation of crude petroleum, the combination of a rectifying-column having two series of upper and lower perforated plates, means for heating the column, means for supplying heated oil to said column at a point between the series of plates, condensers connected to the upper portion of the column, connections for leading the condensed products back to the upper series of plates in the column, means for withdrawing the products from different points in the column, a reheater connected to the lower portion of said column for raising the temperature of the oil which has been deprived of its lighter products, a second rectifying-column having upper and lower series of plates, connections for leading the heated oil from the reheater to a point in the second column between the series of plates, a connection from the top of the second column to the reheater, a connection for leading the liquids from the reheater back to the upper series of plates in the second column and means for withdrawing the products from different points in the height of the second column, a boiler for heating the second column, said boiler having a circulation of oil, a third rectifying-column having upper and lower series of plates, connections for leading the exhaust-oil from the boiler to a point between the series of plates in the third column, a condenser connected to the upper portion of said third column, a connection between the upper portion of the boiler and the lower portion of the third column, connections for leading condensed products from the last-named condenser



back to the upper portion of the third column, a connection between said last-named condenser and the second column and means for withdrawing the products from the third column.

4. In apparatus for the continuous fractional rectification of crude petroleum, the combination of a rectifying-column having a series of upper and lower perforated plates, an oil-heater for supplying heated oil to said column at a point between said series of upper and lower plates, means for heating said column, a condenser connected to the upper portion of the column, connections for leading the condensed products back to the upper portion of the column, means for withdrawing the different products from different points in the height of the column, a first reheater connected to the first column, a second rectifying-column having upper and lower series of plates, a second reheater, connections for leading the heated oil from the first to the second reheater and from thence to a point in the second column between the series of plates, a connection from the top of the second column to the first reheater, a connection from said reheater to the oil-heater for the first column, connections for leading liquids from the said oil-heater and from the first reheater back to the upper series of plates in the second column and means for withdrawing the products from different points in the height of the second column.

5. In apparatus for the continuous fractional distillation of crude petroleum, the combination of a rectifying-column having two series of upper and lower perforated plates, means for heating the column, means for supplying heated oil to said column at a point between the series of plates, condensers connected to the upper portion of the column, connections for leading the con-

densed products back to the upper series of plates in the column, means for withdrawing the products from different points in the column, a reheater connected to the lower portion of said column for raising the temperature of the oil which has been deprived of its lighter products, a second rectifying-column having upper and lower series of plates, connections for leading the heated oil from the reheater to a point in the second column between the series of plates, a connection from the top of the second column to the reheater, a connection for leading the liquids from the reheater back to the upper series of plates in the second column and means for withdrawing the products from different points in the height of the second column, a boiler for heating the second column, said first boiler having a circulation of oil, a second boiler under a pressure of about five or six atmospheres connected to the first boiler, a third rectifying-column having upper and lower series of plates, connections for leading the exhaust-oil from the second boiler to a point between the series of plates in the third column, a condenser connected to the upper portion of said third column, a connection between the upper portion of the second boiler and the lower portion of the third column, connections for leading condensed products from the last-named condenser back to the upper portion of the third column, a connection between said last-named condenser and the second column and means for withdrawing the products from the third column.

Signed this 6th day of June, 1902, at Paris, France.

EMILE AUGUSTIN BARBET.

Witnesses:

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EDWARD P. MACLEAN.