

May 15, 1934.

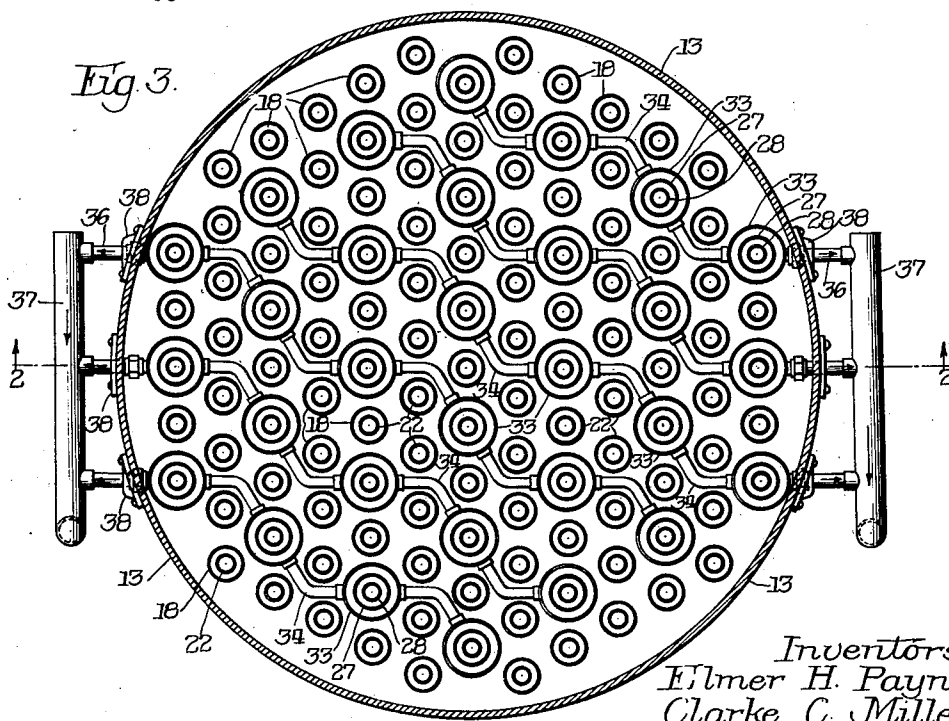
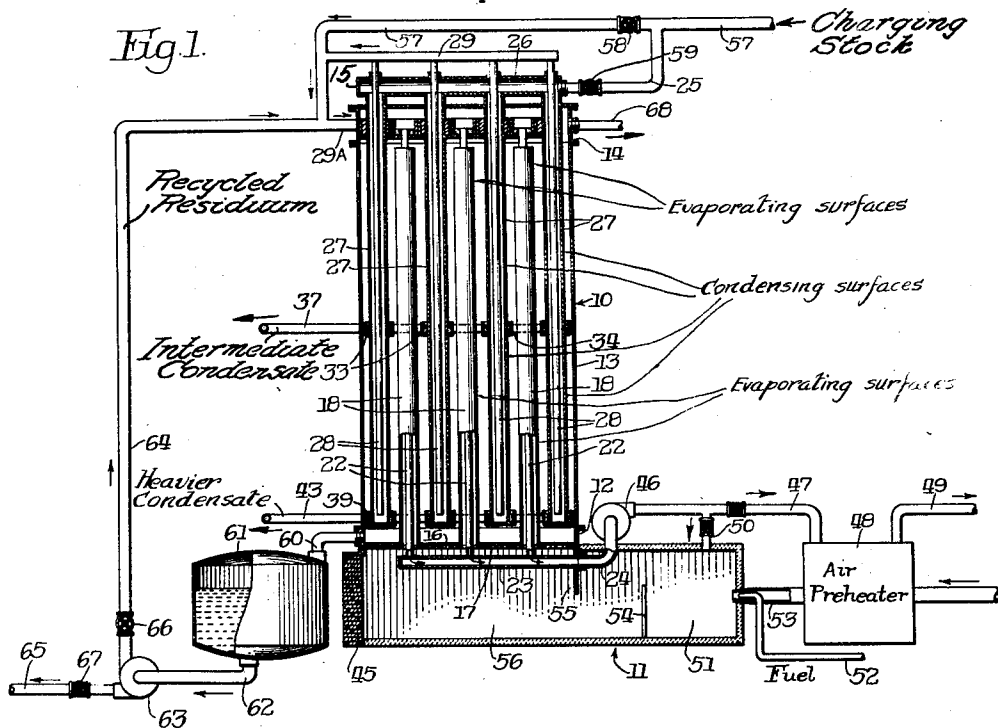
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1,958,547

VACUUM DISTILLATION

Filed April 17, 1930

2 Sheets-Sheet 1



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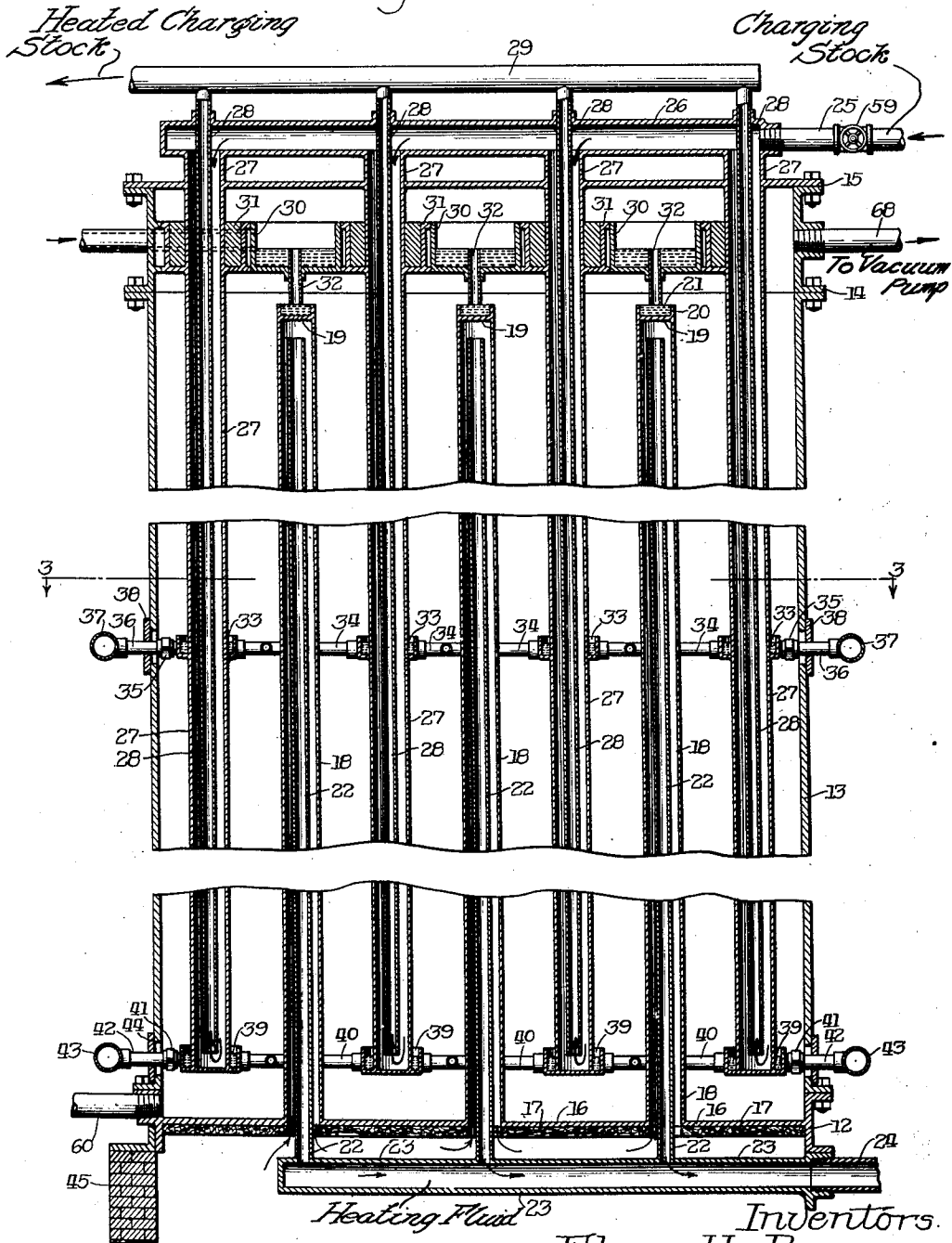
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Fig. 2.



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UNITED STATES PATENT OFFICE

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VACUUM DISTILLATION

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Application April 17, 1930, Serial No. 444,905

6 Claims. (Cl. 196—128)

This invention relates to the distillation of hydrocarbon oils and pertains more particularly to the vacuum distillation of lubricating oils.

The object of our invention is to provide a commercial system of vacuum distillation whereby lubricating oils may be effectively distilled and fractionated without cracking.

A further object is to provide a new and improved arrangement of evaporator and condenser elements in a still whereby the pressure drop of vapors passing from one element to the other is reduced to a minimum and whereby condensation occurs almost simultaneously with evaporation.

A further object is to pass the charging stock through closed condenser elements in close proximity to evaporator elements whereby the charging stock cools the condenser surfaces and is, at the same time, preheated substantially to its boiling point, the temperature gradient between evaporator and condenser surfaces being comparatively small.

A further object is to provide an improved structure for a circulating cooling medium in close proximity to a circulating heating medium, the structure being designed so that all parts are readily removable for cleaning.

Other objects will be apparent as the detailed description of our invention proceeds.

Our invention contemplates a vacuum still in which oil is passed in a thin rapidly moving film down the vertical sides of elements which are heated by hot gases or liquids. The gases may be forced from a furnace to the top of the heater elements and through an inner concentric tube to an exhaust manifold from which they may be directed to an air preheater or to the furnace for recirculation. Depending condenser elements are interposed between the vertical heating elements and in close proximity thereto. A cooling medium is fed downwardly through the condensing element and then upwardly through an inner concentric tube mounted therein to a liquid exhaust manifold. In order to utilize heat most effectively we prefer to use the feed stock as the cooling medium in our condenser elements. The invention will be more readily understood from the following detailed description.

In the drawings wherein similar parts are designated by like reference characters throughout the several views—

Figure 1 is an elevation, with parts shown in section and parts shown diagrammatically, illustrating the arrangement of our improved still with respect to a heating means and a circulating system.

Figure 2 is a vertical section through our improved still taken along the lines 2—2 of Figure 3.

Figure 3 is a horizontal section of our improved still taken along the lines 3—3 of Figure 2.

Referring to Figure 1, our improved still 10 is mounted over one end of a furnace 11. The still may be about 30 to 40 feet in diameter. The still, furnace and pipes will be, of course, properly insulated in accordance with conventional engineering practice.

Referring to the still itself (see Fig. 2), we have shown a structure consisting of a base plate or section 12, a main cylindrical body section 13, an upper cylindrical section 14, and a top section 15. These sections may be secured to each other by bolted flanges having suitable metal gaskets between to hermetically seal the still.

The base plate 12 consists of a perforated plate 16 surrounded by an annular rim. Plate 16 is faced with insulating material 17 so that the bottoms or residues on plate 16 will not be subjected to unduly high temperatures. Heater elements 27 which are preferably long cylindrical tubes are secured to the base plate, their ends being welded in the perforations or holes referred to above. The heater element tubes 18 are closed at their upper end by a plate 19 leaving a cup 20 on top of each element for distributing the oil 21 in a uniform thin film onto the sides of the heater elements. An inner tube 22 is concentrically mounted in each of the heater elements, is open at the top, and is connected at the bottom to a header 23 which discharges into hot gas conduit 24. From the above description it will be apparent that hot furnace gases are drawn upwardly in heater element tubes 18 and thence downwardly through inner pipe 22 and are finally discharged through hot gas pipe 24.

The cooling fluid is introduced through pipe 25 into a header 26 which distributes the cooling liquid into downwardly extending condenser tubes 27, the oil from the bottom of these tubes being discharged through inner concentric pipes 28 which empty into pipe 29. By circulating cooling fluid in the manner described, an effective condenser is provided for hydrocarbon vapors in the still.

The oil which is to be distilled is introduced through pipe 29A into reservoir 30. Reservoir 30 is equipped with a plurality of spacing elements 31 each of which surrounds one of the tubes 27 to prevent contact and undesired heat exchange between the relatively cool charging stock in the tubes 27 and the relatively hot stock in the reservoir 30. A short nipple 32 feeds the oil from the

reservoir 30 into cup 20 on each evaporator tube 18.

At suitable intervals the condenser tubes 27 may be provided with distillate receivers 33 which are connected to each other by conduits 34 and which are connected by unions 35 and pipes 36 to distillate receivers 37. The unions 35 may be tightened or loosened by first removing plates 38 on the side of the still.

In a similar manner other condensate receivers 39 are connected to each other by pipes 40 and are connected by unions 41 and pipes 42 to receivers 43, access to the unions being attainable by the removal of plates 44.

It should be observed that the openings in reservoir 30 which are normally filled by spacers 31 will permit condensate receivers 32 to pass therethrough when said receivers have been disconnected from pipes 34. The apparatus, therefore, may be readily disassembled for repair or for cleaning.

The still hereinabove described may be mounted on a furnace 45 on which is also mounted a blower 46 for circulating the hot combustion gases. These gases may be directed through pipe 47, air pre-heater 48 and pipe 49 to the flue, or part of them may be reintroduced into the furnace by pipe 50. The combustion chamber 51 is supplied by fuel through pipe 52 and with preheated air through pipe 53. The hot combustion gases from chamber 51 pass around baffle plates 54 and 55 to chamber 56 from which they are finally forced into vertical evaporator tubes 18.

As hereinabove described, the cooling fluid for my condenser is preferably the fresh charging stock which is to be distilled and in this case it may be introduced through pipe 57. One branch of this pipe leads through valve 58 to feed inlet 29A and another branch leads through valve 59 into pipe 25. By regulating valves 58 and 59 I may by-pass any desired amount of feed stock through condensing tubes 27.

The non-evaporated residue leaves the bottom of the still through pipe 60 into tank 61 which is connected by pipe 62 to pump 63. This pump may recirculate the residuum through pipe 64 and inlet 29A to distributor reservoir 30 and/or it may pump the oil through pipe 65 to a second distillation unit or to storage. The regulation of the valve 66 in pipe 64, and valve 67 in pipe 65 makes it possible to effectively regulate the amount of recirculation. If evaporator tubes are 40 feet long no recirculation may be necessary, but with shorter evaporator elements, it is necessary to pass the oil through the still several times in order to effectively remove a given fraction without subjecting it to an excessive temperature.

The apparatus is preferably maintained under a vacuum by means of suitable pumps (not shown) acting through vacuum vapor line 68.

The operation of our improved apparatus may be briefly described as follows: All the joints have been made air tight; the gases are removed from the apparatus by pipe 68; the furnace is kindled; hot gases are circulated through tubes 18; and valve 59 is opened to introduce the charging stock. This charging stock cools condenser elements 27 and thence flows upwardly through pipes 28 to pipe 29 and is introduced through pipe 29A to oil reservoir 30 which distributes it through nipples 32 into cups 20. The oil overflows the edges of the cup and flows down the heater tubes in thin films. In actual practice these films are found to pulsate to a certain extent and thereby cause a more even distribution and a more positive wetting of the tubes by the

oil. Non-condensable gases are removed through conduit 68. Vapor condenses on tubes 27, and the condensates run down into receivers 33 and 39 and are withdrawn through pipes 36, 37, 42 and 43. The bottoms or residues are removed through pipe 60 into tank 61 from which they are recirculated by pump 63 through pipe 64 or are discharged into pipe 65.

While we do not limit ourselves to any particular temperatures, pressures, charging stocks or methods of manipulation, the pressure is preferably reduced below 25 mm. (absolute) and the oil in the still is heated to about 600° F. The cooling oil will always be at least 100° cooler than that on the evaporator surface so that efficient condensation may be effected.

It will be seen from Fig. 3 that we have provided about three times as many evaporator tubes as condenser tubes and that each condenser tube is surrounded by evaporator tubes spaced adjacent thereto and equal distances therefrom.

While we have described a preferred embodiment of our invention, it is understood that we do not limit ourselves to the details herein set forth except as defined by the following claims.

We claim:

1. In distillation apparatus a shell, a plurality of vertical, heated elements within said shell, a plurality of vertical condenser elements adjacent thereto and also within said shell, means for distributing the liquid on said heater elements and for causing it to flow in a film on the sides thereof, and means for cooling said condenser elements and means for removing condensate therefrom in separate fractions.
2. In distillation apparatus, a still comprising detachable sections, a plurality of evaporator elements secured to one section, a plurality of condenser elements secured to another section, said condenser elements being normally interposed between said evaporator elements, both evaporator elements and condenser elements being disposed in vertical alignment.
3. In oil distillation apparatus, a shell, a plurality of vertical heated elements within said shell, a plurality of vertical condenser elements adjacent thereto and also within said shell, means for distributing the liquid on said heater elements and for causing it to flow in a film on the sides thereof, means for cooling said condenser elements, means for removing condensate therefrom in separate fractions, means for conveying relatively cool oil to said condenser elements whereby said oil is preheated, and means for conveying said preheated oil to said heated elements.
4. In oil distillation apparatus, a shell, a plurality of vertical heated elements within said shell, means for maintaining said heated elements under sub-atmospheric pressure, a plurality of vertical condenser elements adjacent thereto and also within said shell, means for distributing the liquid on said heater elements and for causing it to flow in a film on the sides thereof, means for cooling said condenser elements, means for removing condensate therefrom in separate fractions, means for conveying relatively cool oil to said condenser elements whereby said oil is preheated, and means for conveying said preheated oil to said heated elements.
5. In oil distillation apparatus, a still comprising detachable sections, a plurality of evaporator elements secured to one section, a plurality of condenser elements secured to another section, said condenser elements being normally interposed between said evaporator elements, both

evaporator elements and condenser elements being disposed in vertical alignment, means for conveying relatively cool oil to said condenser elements whereby said oil is preheated, and means
5 for conveying said preheated oil to said evaporator elements.

6. In oil distillation apparatus, a still comprising detachable sections, a plurality of evaporator elements secured to one section, means for main-
10 taining said evaporator elements under sub-atmospheric pressure, a plurality of condenser ele-

ments secured to another section, said condenser elements being normally interposed between said evaporator elements, both evaporator elements and condenser elements being disposed in vertical alignment, means for conveying relatively cool oil
80 to said condenser elements whereby said oil is preheated, and means for conveying said preheated oil to said evaporator elements.

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