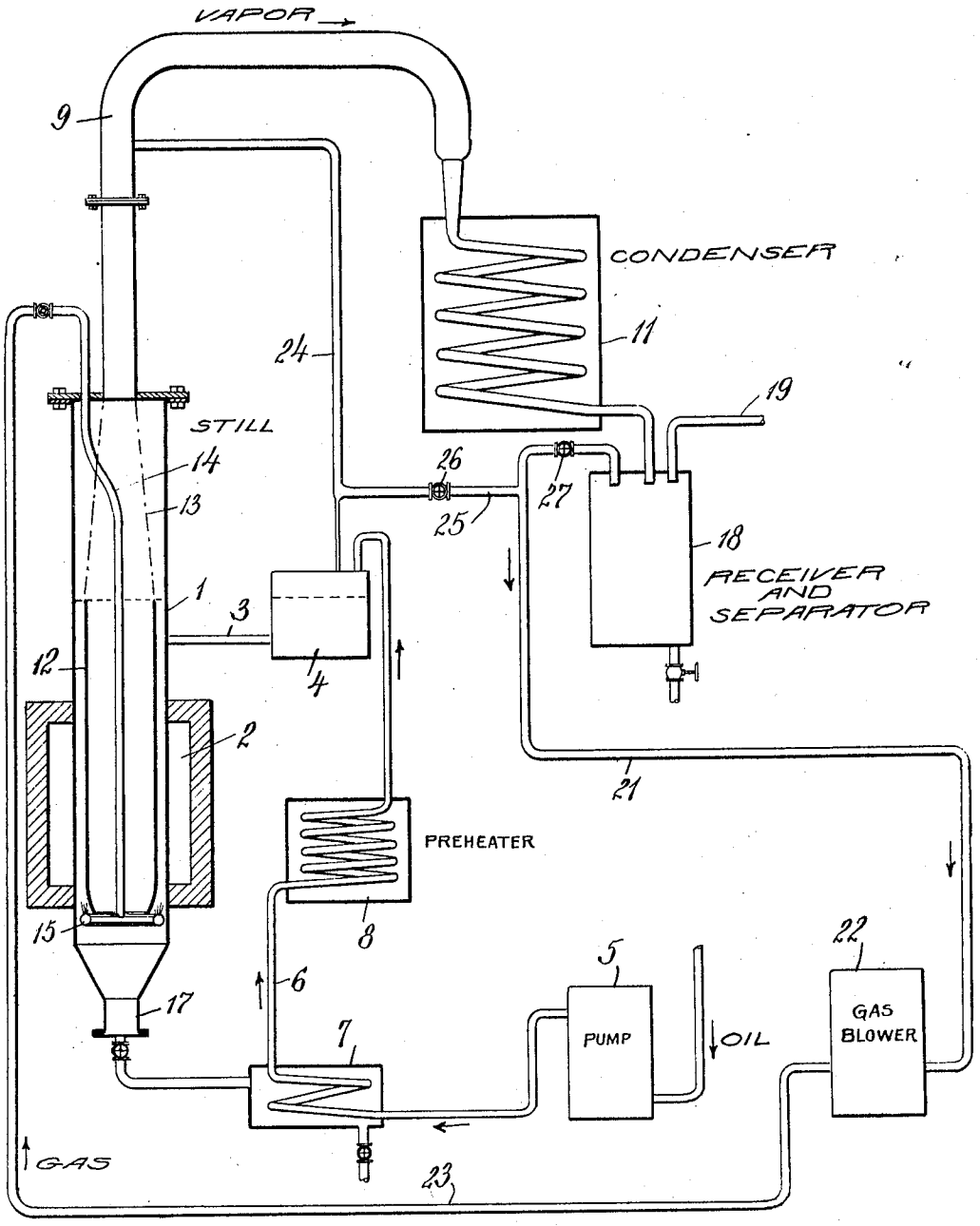
Oct. 5, 1926. 1,601,729

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PROCESS OF DISTILLATION

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Fig. 1.



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Fig. 2,

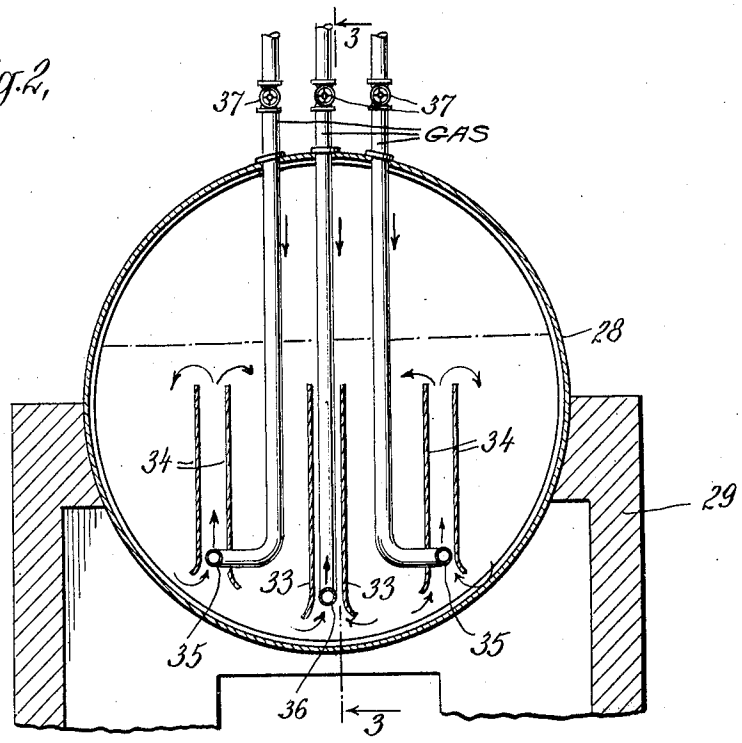
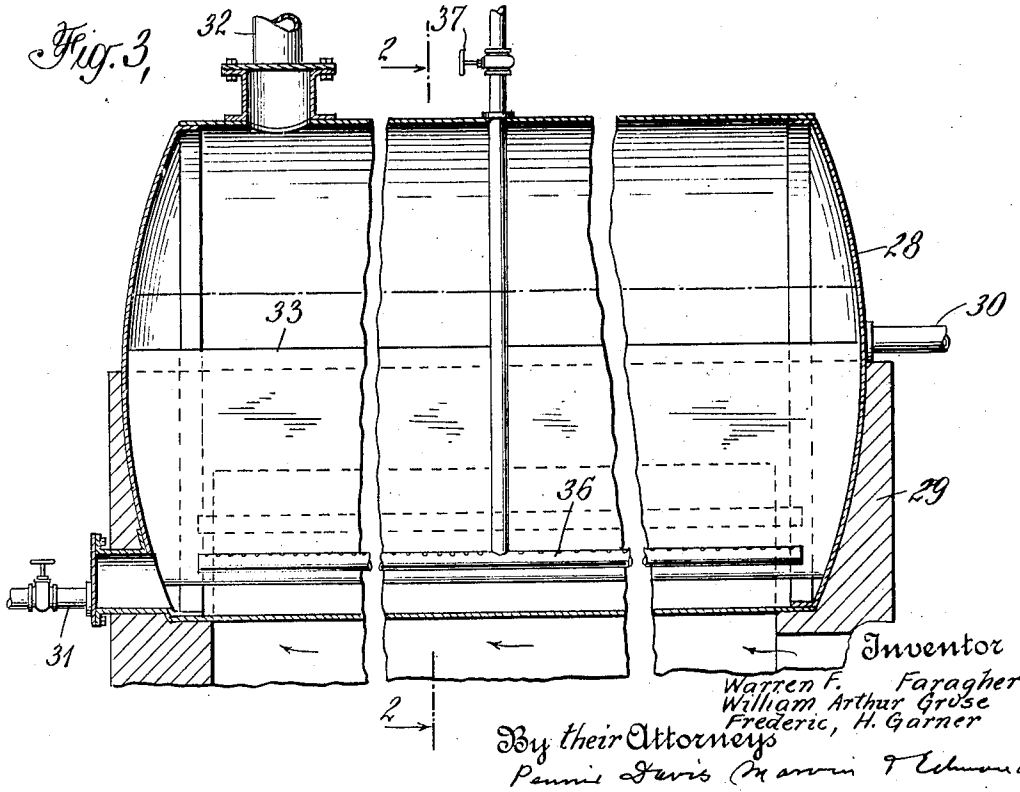


Fig. 3,



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Fig. 4,

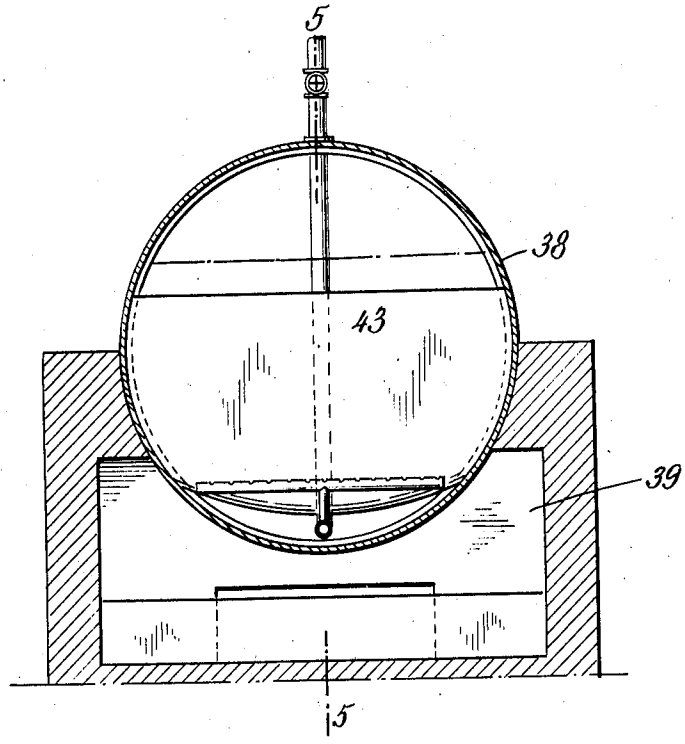
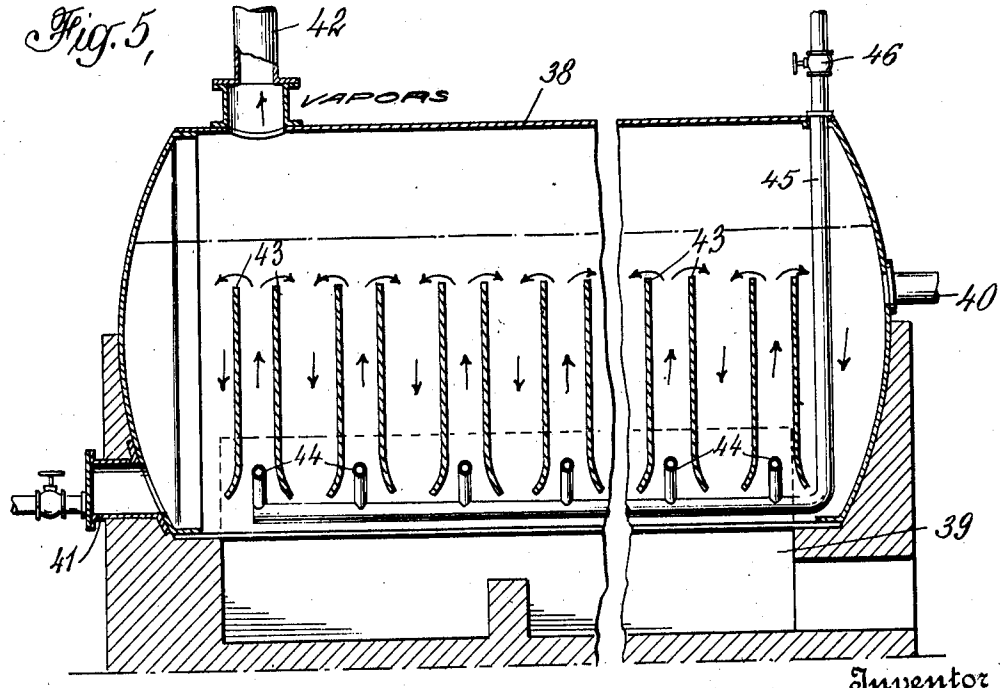


Fig. 5,



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UNITED STATES PATENT OFFICE.

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PROCESS OF DISTILLATION.

Application filed May 25, 1921. Serial No. 472,385.

Our invention is an improvement in methods of distillation of petroleum, etc.

In the distillation of an unstirred, or inefficiently stirred body of petroleum, etc., there is always a certain amount of local superheating, where the body of liquid is large and the heating is externally supplied. In addition there is a more or less sharp temperature gradient from the heating walls to the center of the body of liquid, so that, when the center of the body attains the desired temperature, the portions near the heating surface are much hotter. From this results the simultaneous vaporization of fractions having different boiling points where the liquids are thick and viscous, or tarry, such as heavy petroleum fractions and residua, or heavy tars and pitches from coal, and the like, and the liability of undesired cracking and carbonization is increased.

Furthermore, in the usual process of distillation of petroleum, etc., serious difficulties are encountered due to the deposition of the carbonaceous solid, commonly referred to as "carbon" on the heated walls of the still. Such deposition interferes with the conduction of heat to the oil, and results in increased cost of production, due to the necessity of cleaning the still walls, and the loss of operating time during such cleaning operations. In addition, the life of the still wall is shortened, due to the rapid burning out of the iron.

The object of the present invention is to provide a process wherein the temperature throughout the body of the oil may be kept substantially uniform, with avoidance of local over-heating, thus making possible the sharp cutting of petroleum fractions, and greatly reducing the deposit of carbon on the heating surfaces of the still.

In the drawings:

Figure 1 is a diagrammatic view showing an apparatus for carrying out the improved process; the still being a single tube still;

Figure 2 is a transverse section showing another construction, on the line 2—2 of Figure 3;

Figure 3 is a section on the line 3—3 of Figure 2;

Figure 4 is a view similar to Figure 2 of another construction;

Figure 5 is a section on the line 5—5 of Figure 4.

In Figure 1 there is shown a complete apparatus for carrying out the process, in the form of a single tube still comprising a vertical tubular casing 1 arranged within a suitable furnace 2, and extending above and below the furnace, as shown. Oil is admitted to the still through a pipe 3 from an oil supply vessel 4, in which a constant level is maintained, by any suitable means. The oil to be supplied to the still is supplied to the vessel 4 by a pump 5 arranged in a pipe line 6, leading from a suitable source of oil supply to the vessel 4. Preheaters 7 and 8 are provided in connection with the pipe line for preheating the oil, and the pump 5 is automatically controlled (by means not shown), so that it will maintain a constant level in the supply vessel 4. The still has an outlet pipe 9 which leads to the condenser 11 of usual construction.

Within the still casing there is supported an eduction tube 12, by means of suitable supports 13, and a gas inlet pipe 14, provided with a nozzle 15 in the form of a perforated ring, is arranged within the still, the ring delivering into the annular space between the eduction tube and the still wall. This pipe is designed to deliver a supply of gas under pressure into the still, in such manner that the current of gas flows upwardly in the annular space between the eduction tube and the still wall.

A tar pot 17 is provided at the lower end of the still, and the discharge pipe from the tar pot delivers to the casing of the preheater 7 and thus acts to preheat the oil passing from the pump to the supply vessel 4.

A receiver 18 is provided for the condensate, to which the worm of the still delivers, and this receiver has an outlet pipe 19. A pipe 21 leads from the receiver to a gas blower 22, from which a pipe 23 leads to the gas or vapor inlet pipe 14 before-mentioned. A pipe 24 leads from the vapor pipe 9 to the oil supply vessel 4, and a branch pipe 25 connects this pipe 24 with the pipe 21 before-mentioned. A valve 26 is arranged in the pipe 25, and a valve 27 is arranged in the pipe 21.

With this arrangement the gases intro-

duced into the still through the pipe 14 may be either the fixed gases from the receiver 18, or admixed gases and vapors obtained through the pipes 24 and 25, or a mixture of both in varying proportions.

In the still shown and described, there is a free communication and circulation throughout the body of the oil or other liquid to be distilled, at the top and bottom of the said body, but there is a restricted communication and circulation laterally intermediate the top and bottom. The perforated ring, through which the gas is supplied, imparts to the liquid throughout the area of lateral restriction, a vertical movement. Such vertical movement outside the eduction tube is upward, and there will be a downward movement of the liquid within the eduction tube, and a lateral movement of the liquid below and above the eduction tube, to insure a thorough mixture of the liquid throughout the body of such liquid.

In Figures 2 and 3 there is shown a construction wherein the still is of the horizontal drum type. With this arrangement the still casing 28, arranged in a suitable furnace setting 29, has an oil supply pipe 30, through which a regulated supply of oil can be introduced, either in the form of successive charges, or in a more or less continuous manner, and such supply may be automatically regulated in any suitable manner, to maintain a constant level in the still. The still has a residue outlet 31, and a vapor outlet 32 leading from the top thereof to a condenser (not shown).

Within the still is a series of pairs of longitudinally extending baffles, three pairs being provided in the present instance, and they are supported in any suitable manner, as by securing them to the heads of the still. These baffles comprise a central pair 33, and lateral or outer pairs 34, the members of the pairs being spaced apart from each other. The lower edges of the baffles are spaced above the bottom of the still, and they are of such height that they will be submerged at their upper edges below the surface of the oil, so that there may be a free circulation of the oil at the top and bottom of the body of the oil, that is, below and above the baffles.

Between the pairs of baffles there are arranged perforated gas introduction pipes 35, 36, the pipe 36 being between the central pair of baffles, and the pipes 35 between the lateral pairs. These pipes have regulating valves indicated at 37. Gas is supplied to the pipes 35, 36 in any suitable manner, and this gas is discharged into the oil between the baffles, causing an upward movement of the oil between the baffles, and a consequent downward movement outside the baffles. If desired, the space between the baffles may be sub-divided by transverse partitions, so that the lateral flow of the liquid is hindered both laterally and longitudinally of the still.

With this arrangement, shown in Figs. 2 and 3, there is a free communication and circulation at the top and bottom of the still, with restricted communication laterally intermediate the top and bottom. A free mixing is brought about at the top and bottom of the body of liquid, with a sweeping action at the bottom, which avoids a dead layer of oil along the still bottom.

In Figures 4 and 5 there is shown a horizontal type of still 38 arranged in the usual furnace 39. The still has the oil inlet pipe 40 and the residue outlet 41. The usual vapor outlet 42 is provided at the top of the still, from which the vapors are led to the condenser, not shown.

Within the still is a series of transversely arranged baffles 43, which may vary in size, shape and arrangement, but which in the present instance are shown as arranged in pairs. In the alternate spaces between the baffles, transverse perforated pipes 44 are provided, discharging upwardly, and connected with a suitable supply pipe 45, having a regulating valve 46 therein.

With this construction, the operation is much the same as in the constructions previously described. Free communication and circulation are provided above and below the baffles (it being understood that the upper edges of the baffles are submerged), and restricted lateral communication intermediate the top and bottom and a vertical movement of the liquid at such region of restricted communication.

The vertical movement in each construction is due to the "air-lift" circulation, so that there is no necessity for mechanical stirrers. The circulation is in a series of eddies or cycles, each eddy or cycle involving the downward circulation of the oil on one side of a baffle, the flow of the oil beneath the baffle, the upward flow of the oil on the opposite side of the baffle, and the mixing of the oil with the main body at the top. The oil is thus kept effectively agitated and circulated, while those portions of the still wall which are subjected to the direct heat of the furnace are kept substantially free from objectionable carbon deposit, by the scouring action of the rapidly circulating oil, which scours such surfaces in its flow.

With the improved process, there is insured a uniformity of temperature throughout the body of the oil. The oil which is heated at those surfaces of the still wall adjacent to the furnace is forced to move away from said surfaces and is mixed with the body of the oil, while cooler portions of the oil are moved toward such surfaces. Thus local superheating is avoided.

In ordinary steam distillation of lubri-

cating oils, steam is blown against the iron heating surfaces in a manner to form a steam cushion between the oil and the still wall. With the present process, the oil will be given a rapid circulation past such surfaces, so that the amount of steam required for cushioning purposes will be correspondingly reduced or may even be dispensed with. The same is true when gas is substituted for steam. By the maintenance of a uniform temperature, cracking can be substantially avoided, or where a minima cracking is desired, this can be readily obtained, as in the preparation of paraffin-containing oils, for crystallization of wax. In the distillation of gasoline and low boiling materials, the undesired distillation of high boiling fractions is avoided, with the consequent avoidance in motor fuel of an undesirable high dry point, that is, the presence of high boiling material.

In the use of steam as above stated in the treating of lubricating oils to provide a cushion between the body of the oil and the still, there is an agitation, but not a directed agitation. With the improved process, the agitation is a controlled or directed agitation. In the treating of such oils the maintenance of uniform temperature and the avoidance of superheating is of the highest importance, for even incipient cracking often means the destruction of compounds of high lubricating value, as is evidenced by the lower viscosity of a cracked material.

With heavy oils and pitches, where it is desirable to control the extent to which liquid and low melting constituents are removed, in order to produce a product with any desired hardness and range of melting point, and to insure a uniform temperature while the oil is being carried down to the pitch stage, in order to avoid the formation of coke, the improved process of the present invention is of especial advantage in that the agitation through the "air-lift" stirring will avoid undesirable coking, prevent or minimize the formation of carbonaceous material in the pitch and will facilitate the controlling of the amount of soft and relatively low boiling constituents left in the pitch.

In the distillation of petroleum hydrocarbons, it is often important to prevent, as much as possible, the decomposition and cracking of the petroleum during the distillation. It is also of importance to carry out the distillation with sharp cuttings of the fractions so that constituents of higher and lower boiling points will be kept separate to the desired extent. The improved process of the present invention makes possible such regulated distillation without objectionable cracking or decomposition, and with progressive removal of fractions of progressively increasing boiling point, owing to the uniform circulation and heating of the entire body of oil, and the consequently increased uniformity of the distillate produced at any particular point.

So also, owing to uniformity of heating and circulation, the fractional distillation can be continued even up to the point where lubricating oils are distilled over, with a minimum of cracking and decomposition.

Furthermore, the improved process of the present invention can advantageously be carried out by passing the oil successively through a series of stills, each maintained at a progressively increased temperature, or under a progressively increasing degree of vacuum, so that the fractions of different boiling points will be successively removed in the successive stills, and so that the fractions obtained from each still of the series will be of the desired uniformity of composition and of regulated boiling point.

The normal distillation due to the heating of the oil is supplemented by the action of the vapors which are introduced into the body of oil, and the vapors produced by the distillation will also be diluted by the gases introduced. The gases introduced will thus tend to sweep the vapors from the still and increase the rate of their removal.

The gas employed for bringing about the circulation of the oil, in the manner described, may be a fixed or permanent gas, such as natural gas, for example, which is inert to the oil undergoing distillation, and from which the distillate can be readily separated in the condensate. Such a gas can be used over and over again, so that the amount required is not large. It will be evident that various gases can be used in the process, including even steam, which can be condensed with the distillate, and the resulting water separated from the condensed distillate.

It will be evident that variations and modifications can be made from the exact structure illustrated and described. For example, in the still illustrated in Fig. 1, instead of introducing the gas between the annular pipe and the still wall, the gas may be introduced within the central pipe to cause flow of the oil upwardly therethrough and downwardly between the annular pipe and the still wall, thus bringing about a similar and uniform circulation of the oil and resulting in substantially uniform temperature of the body of oil as a whole. So also, while the gas is shown as being introduced into the oil in an upward direction, it is to be understood that the introduction means may be so constructed and arranged as to direct the gas streams downward against the bottom of the still; for example, in the apparatus shown in Figs. 2, 3, 4 and 5, so as to cause an added sweeping effect upon the

bottom walls of the still to aid in the removal of carbonaceous deposits and dead layers of oil. The gas would then rise through the appropriate channel or channels and cause circulation in much the same way as though directed upward in the manner illustrated.

Tars, such as coal tar, gas tar, etc. can be subjected to distillation in much the same manner as petroleum oils, and with similar advantages of uniformity of temperature of the body of tar undergoing distillation, uniformity of distillate taken off at any one time, etc.

We claim:

1. The method of fractionally distilling petroleum oils and the like, which comprises externally heating a body of the oil in a still below the cracking temperature, dividing the body of oil in the still into a plurality of vertical sections freely communicating at their adjacent upper and lower ends, introducing an upwardly directed gaseous current acting on the "air-lift" principle into some but not all of the vertical sections and thereby circulating the oil upwardly from the point of gas introduction in the vertical sections into which gas in introduced and downwardly in the remaining sections, whereby the temperature of the body of oil in the still is maintained substantially uniform and local superheating and cracking is avoided, and collecting the distilled vapors.

2. The method of fractionally distilling petroleum oil and the like, which comprises externally heating a body of the oil in a still below the cracking temperature causing the oil to circulate over vertically directed paths between the top and bottom parts of the body of oil and laterally at the top and bottom parts of the body, by introducing upwardly directed gaseous currents acting on the air-lift principle, the oil circulating upwardly from the point of gas introduction, whereby the formation of dead layers of oil is prevented and effective mixing throughout the body of oil is promoted to maintain substantial uniformity of temperature throughout the oil body, and collecting the distilled vapors.

In testimony whereof we affix our signatures.

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