

Feb. 22, 1938.

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2,109,201

PROCESS AND APPARATUS FOR STABILIZING HYDROCARBONS

Filed July 10, 1933

Fig. 1.

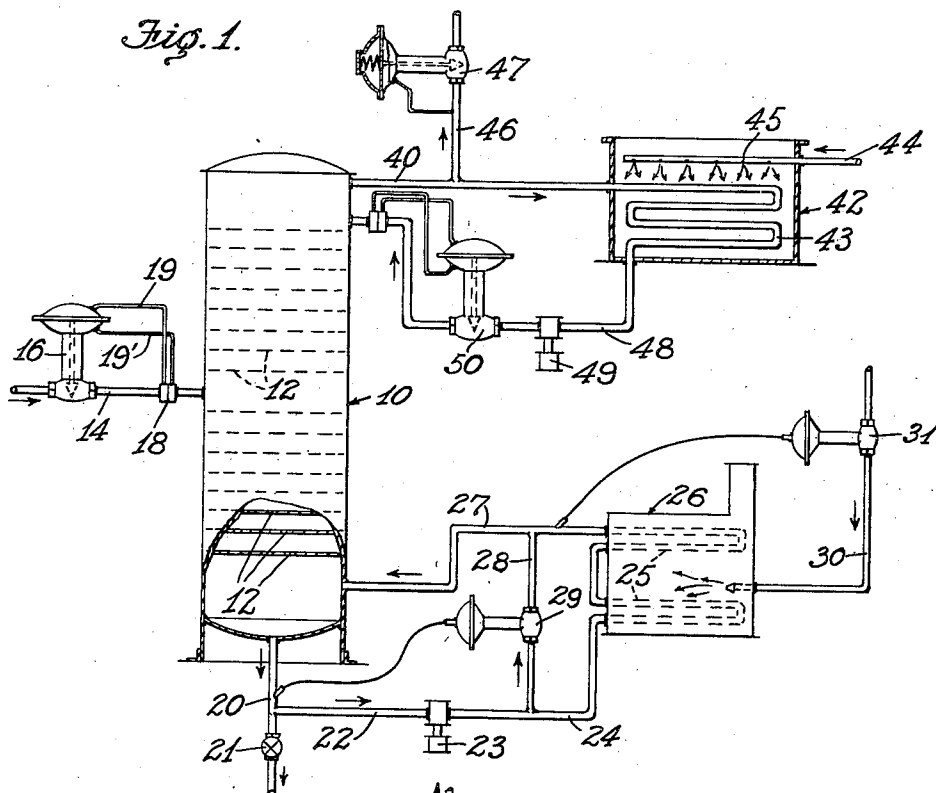
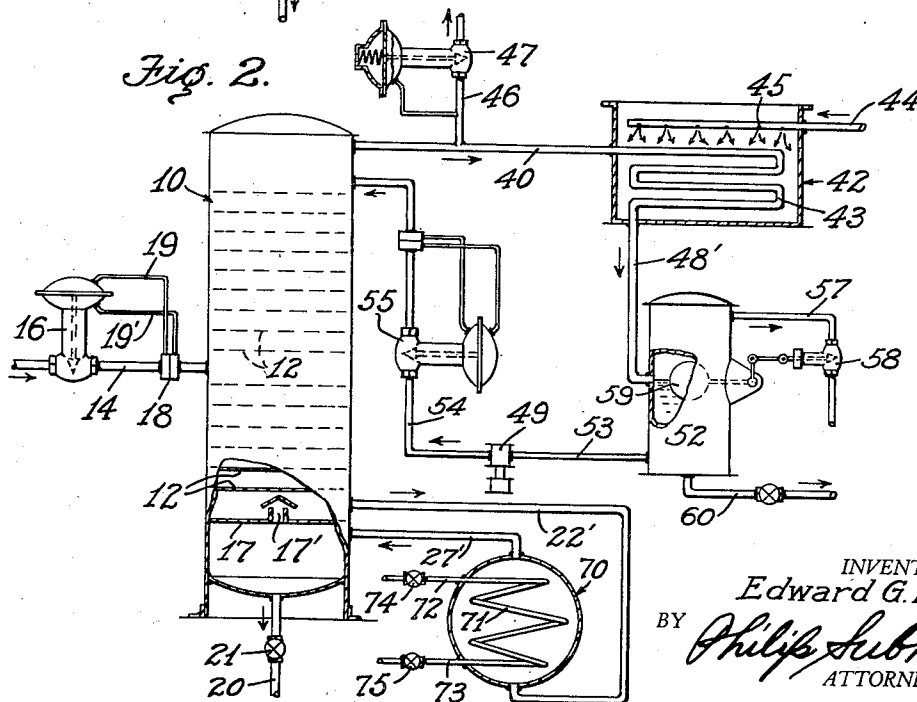


Fig. 2.



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UNITED STATES PATENT OFFICE

2,109,201

PROCESS AND APPARATUS FOR STABILIZ-
ING HYDROCARBONSEdward G. Ragatz, Los Angeles, Calif., assignor
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Application July 10, 1933, Serial No. 679,651

11 Claims. (Cl. 196—11)

This invention relates to methods and apparatus for stabilizing gasoline, such as natural gas gasoline. It is well known that during the recovery of gasoline from natural gas, a certain proportion of unstable or "wild" fractions are retained by the liquefied gasoline. Due to the dangers involved in the handling and use of such raw mixtures, as well as due to the greater utility if the lighter fractions are eliminated from such gasoline, it is necessary and desirable to stabilize the same, the stabilizing step consisting of reducing the volatility of the raw gasoline to bring it within a permissible limit for use.

Fundamentally, the stabilization of such a raw gasoline requires the introduction of said liquid into a rectifying or fractionating system, producing therein countercurrent contact between ascending vapor and descending liquid, supplying heat at the base of the tower and thus evaporating and returning to the column of said fractionating system, as vapor, a portion of the liquid arriving at the base thereof, and removing heat at the top of the column to thus condense and return to said column, as liquid, a portion of the vapor arriving at the top of said column.

To obtain a proper stabilization, it is highly essential to maintain the temperature conditions within the rectifying column as constant as possible, and it is therefore the main object of the invention to control the formation of liquid reflux in a fractionating or rectifying system automatically to provide the amount of liquid reflux necessary for a proper stabilization of the natural gas gasoline, and to obtain a very accurate and automatic control of the heating medium introduced into the lower portion of the column of such rectifying system.

As has been outlined above, one of the methods used for the rectification or reduction of volatility of a raw gasoline consists in passing the raw material through a plate tower which is provided with heating means at its lower end and into which a predetermined amount of liquid reflux is introduced substantially at the upper end of the tower to scrub the ascending gaseous fractions of the desired heavier vaporized fractions as well as of the liquid entrained therein. It is essential, for the production of a properly stabilized gasoline, to introduce a predetermined quantity of reflux sufficient to remove from the ascending gaseous fractions all of the desired liquid and high boiling fractions. For this purpose it has been customary to chill the overhead fractions, leaving the tower, thus liquefying said overhead fractions, and then introducing into

said tower only the desired portion of the thus liquefied fractions as reflux. Since frequently the balance of said liquefied overhead fractions is of no industrial value in the liquid form and because of the necessity of using them in a gaseous form, it has been customary to revaporize the same and to remove and use it as a gas. Such liquefaction and subsequent re-vaporization are, of course, uneconomical.

Attempts have also been made to obtain the required amount of liquid reflux by controlling the amount and/or temperature of the cooling medium, such as water, circulated in the reflux condenser. However, such attempts developed a plurality of operating difficulties which are primarily due to the time lag inherent in such indirect heat-exchange controlling arrangements, said time lag invariably resulting in a surging control of the equipment. Such a surging, it is obvious, will not produce accurate results, and the final product, i. e. the stabilized gasoline, will not have constant characteristics since the change in the quantity of reflux, assuming a constant feed and constant and uniform heating of the base of the column, will result in a final product having variable quantities of the heavier and lighter fractions.

It is, therefore, another object of the present invention to control the condensation of the overhead fractions automatically to yield only the required amount of reflux along with an accurate regulation of reflux feed and an automatic and accurate regulation of heat supply to the base of the rectifier. Another object of the invention is to supply the required amount of liquid reflux automatically and at the same time to discharge the balance of the overhead fractions in a gaseous form prior to condensation. Still another object of the invention is to condense only the required amount of reflux automatically without the necessity of any accurate automatic control of the amount and/or temperature of the cooling medium, such as water, at the reflux condensers.

As has been stated above, it is also essential, in conjunction with the above described rectifying operations, to control within very close limits the temperature of the heating medium circulated in the lower portion of the rectifying column so as to accurately control the temperature of the final product. Although such accurate control of the heating medium in the lower portion of the column or in the reboiler may be easily carried out when indirect heating is resorted to, such as passing steam through a heat exchanger, modern practice calls for the use

of a direct fired heater to heat all or a portion of the heavier fractions removed from the base of the column and cause the re-vaporization of the lighter fractions therefrom as well as from the liquids with which they come in contact upon being returned to the column. Heretofore, the equipment used for the control of such a system consisted of a valve in the line supplying fuel to the heater, said valve being controlled by the temperature of the liquid circulated through said heater. However, this equipment created a lag which prevented a close temperature control in the column without resorting to an "off-and-on" control on the fuel to the heater. As is well known, such a control causes many disadvantages, such as burned tubes, sprawled brick work, low fuel efficiencies, etc. It is therefore a still further object of the present invention to control the temperature of the heated bottoms returned to the column and at the same time to obviate the above difficulties.

The above and other objects are attained by the present invention which, broadly stated, comprises a method and apparatus for maintaining a predetermined and constant feed of raw gasoline to be stabilized, maintaining a predetermined and constant pressure in the line conducting the overhead gaseous vapors to the reflux condenser so that only the required amount of said vapors are condensed and utilized as reflux, while the remaining portion of said overhead vapors is released and removed from the stabilizing system in a gaseous state, and maintaining constant and within very close limits the temperature of the bottoms removed from and returned to the column for heating said latter.

More fully stated, the invention comprises a method and installation wherein the overhead vapors from a stabilizer are divided into two streams, so that only a predetermined quantity of such vapors is condensed and returned to the stabilizer as reflux, the surplus of the vapors being removed from the system in the form of a gas, and wherein all or a portion of the liquids accumulating in the lower portion of the column are withdrawn from said column, passed through a heater, the firing of which is controlled by the temperature of the liquid leaving the heater, said liquid being returned to the column, and providing a by-pass means automatically controlled by the temperature of the liquid leaving the base of the column, said by-passing permitting an accurate control of the temperatures at the base of the column without the creation of the difficulties enumerated above.

In its detailed form, the invention comprises a conventional stabilizing column into which the raw natural gas gasoline, or the like, containing the "wild" or highly volatile fractions, is introduced at a predetermined rate, heating means in or attached to the lower portion of the column to evaporate said wild fractions; and means connected with the upper portion of said column to remove the overhead fractions and to condense and return to the stabilizing column only a predetermined quantity of the liquid reflux.

The heating means mentioned above includes a pipe leading all or a portion of the liquid from the lower portion of the column through a direct fired heater and returning said heated liquid back into the column, this line being provided with a by-pass with a valve thereon actuated by the temperature of the liquid leaving the column, the line conducting the fuel to the heater being also provided with a valve automatically

controlled by the temperature of the liquid leaving the heater. With such an arrangement it is possible to set the temperature controlled valve on the line conducting the fuel to the furnace so that it will control the temperature of the liquid leaving the heater within a fairly close temperature range, and to correct the fluctuations of the primary control by by-passing a portion of said liquid through the by-passing means, the valve on said means being actuated from the temperature of the liquid leaving the column to maintain said temperature within very close limits.

The refluxing means mentioned in the above statement of invention includes a pipe leading from the stabilizing column to a reflux condenser, said pipe being provided with a branch line carrying a back-pressure valve to maintain a predetermined and constant pressure in the pipe and condenser, and means connected with said condenser and adapted to conduct only a predetermined quantity of liquid reflux back into the column. The refluxing means may also include a reflux drum installed between the reflux condenser and the means regulating the amount of reflux returned to the stabilizing column, said reflux drum being provided with means to release all excess vapors which have not been liquefied in the reflux condenser.

Referring to the accompanying drawing which illustrates certain embodiments of the invention:

Fig. 1 discloses diagrammatically the preferred form of the invention; and

Fig. 2 is a diagrammatic elevation, partly in section of another form of the installation to be used preferably in conjunction with certain types of natural gasolines in which only a portion of the overhead fractions passing through the condenser is liquefied in the reflux condenser.

The drawing discloses an ordinary stabilizing or fractionating column 10 provided with a plurality of baffles or reflux plates 12 of any known type or form. A pipe 14 opening into said column 10 at some intermediate point is provided with an ordinary diaphragm valve 16 which, by means of an orifice plate or other constriction 18 installed in the pipe 14 downstream of said valve and by means of lines 19 and 19' leading from the opposite sides of said orifice plate to the opposite sides of the diaphragm of the valve 16, regulates and controls the rate of introduction into the column 10 of raw gasoline to be treated. It is, of course, obvious that any other type of feed-controlling means, such as a centrifugal pump, may be used instead of the above described valve 16.

Referring more particularly to Fig. 1, a pipe 20 leads from the bottom of the column 10, said pipe being provided with a valve 21 and a branch line 22. This line opens into the inlet of a pump 23, the discharge opening being in communication with another pipe 24, opening into a bank of tubes 25 located within a furnace or heater 26. The opposite end of said bank of tubes 25 is connected by means of a pipe 27 with the column 10 at some intermediate point thereof. A branch or by-pass line 28 connects pipes 24 and 27, said line being provided with a control valve 29 capable of being actuated in response to the temperature in pipe 20. Pipe 30 supplying fuel to heater 26 is also provided with a similar control valve 31 actuatable in response to the temperature in pipe 27. Preferably, valve 31 is of the type which is actuated only when the temperature in pipe 27 exceeds certain and comparatively wide limits, while valve 29 is of a much more sensitive

type so as to permit the by-passing of a certain portion of the liquids from pipe 24, through pipe 28 and directly into pipe 27, thus controlling within very narrow limits the temperature of the bottoms re-introduced into the column 10. Such an accurate control and regulation of the temperature permits the discharge of a very accurately stabilized gasoline through pipe 20.

Referring now to the refluxing means shown in Fig. 1, which means is considered to be another object of the invention, a pipe 40 leads from the upper part of the column 10 to one end of a reflux condenser 42, said condenser being of any known type, and in the drawing being represented as a coil 43 cooled by water or another cooling medium delivered from any source through a pipe 44 perforated as at 45 and positioned above the coil 43. A branch pipe 46 is connected to pipe 40, the former being provided with any type of a regulating valve 47 adapted to maintain a constant pressure in pipes 40 and 46. A pipe 48 leads from the other end of the reflux condenser 42 back to the upper portion of the column 10, said pipe being provided with a pump 49 and with a constant-feed controlling valve 50 similar to valve 16 on the inlet pipe 14.

In operation, regulating valve 16 maintains a constant rate of flow of the raw unstabilized gasoline through pipe 14 into the column 10, wherein said raw stock passes from plate to plate downwardly through the column, and the unvaporized portion is discharged through pipe 20. A part of this liquid is withdrawn through pipe 22, by pump 23, and introduced into the coil 25 in heater 26, wherein the liquid is heated and the lighter fractions in said liquid are volatilized by the heat supplied by the fuel introduced into the furnace pipe 30. The supply of fuel is regulated by valve 31 to maintain the temperature of the gasoline leaving coil 25 and entering into the column 10 through pipe 27 approximately constant. A more accurate control of the temperature of the heated material is obtained by by-passing a portion of the material through pipe 28 automatically controlled by valve 29. This results in a substantially constant temperature in the lower portion of the column 10 thus tending to maintain the temperature of the liquids leaving column 10 through pipe 20 constant. The vapors generated from the liquid fractions ascend countercurrently through the downwardly flowing raw stock. Due to the heated condition of the vapors, and since, as stated above, the temperature of the vapors is maintained substantially constant, the downwardly flowing liquid is heated and certain and definite lighter fractions thereof are vaporized therefrom. Thus, the gasoline removed from column 10 through pipe 20 is a well stabilized product having definite and predetermined characteristics.

Coil 43 is preferably provided with a capacity sufficient to prevent any flooding of the reflux system. However, this is not absolutely necessary. Thus, if for any reason the rate of inflow of overhead fractions into the coil 43 suddenly increases, or if the return of the reflux into column 10 suddenly decreases, as for example due to the closing of valve 50 or the slowing down of pump 49, there will be a tendency of a flooding of coil 43 with the liquid condensed therein. This will naturally tend to prevent any further inflow of vapors into the reflux system. However, such a condition will merely tend to increase the vapor pressure in pipes 40 and 46, thus causing more vapors to be discharged through valve 47 auto-

matically kept wide open by such a pressure increase. This condition will continue until a proper balance is obtained, when valve 47 will close down, partially or completely, to maintain a constant pressure in line 40 so as to permit only a predetermined rate of flow of vapors into condenser 42.

The above described installation presupposes that all of the overhead fractions entering the reflux condenser 42 are sufficiently heavy so as to be liquefied substantially completely therein. However, certain types of unstabilized gasolines contain considerable quantities of extremely light fractions which are not condensable under ordinary conditions. In such cases, the installation described hereinabove must be modified, and Fig. 2 discloses such a modified installation. In this case, the mixture of gaseous and liquefied fractions leaving reflux condenser 42 enters through pipe 48' into a reflux drum 52 wherein a separation of the liquefied portions from the gaseous fractions occurs. The thus separated liquid fractions are removed by pump 49 from the lower portion of the reflux drum 52 through pipe 53, and are forced through pipe 54 back into the upper part of the column 10, as reflux, the control valve 55 installed in said pipe 54 maintaining the rate of inflow of said reflux into column 10 constant.

Drum 52 is provided with a gas discharge line 57 carrying a valve 58. This valve 58 is controlled by a float 59 within the drum 52. Thus, if the liquid level in drum 52 begins to drop due to an accumulation of an excess quantity of uncondensed vapors in the upper portion of the drum, float 59 starts to fall thus opening valve 58 to discharge the vapor excess. The drop in pressure permits the flow of more vapors through pipe 40 thus generating more condensate. Such a condition will continue until the liquid level in drum 52 again reaches the desired height, at which time float 59 again closes valve 58. On the other hand, if the liquid level rises, float 59 rises and thus closes valve 58. This causes a rise in vapor pressure in drum 52, which increases the pressure in the reflux system, thus opening valve 47 and permitting the condensation of a smaller amount of vapors in coil 43. It is thus seen that this arrangement tends to maintain a constant liquid level in drum 52, and therefore aids in the maintenance of a constant and predetermined regulation of the amount of reflux introduced into the column 10. Pipe 60 leading from the lower end of drum 52 may be used to discharge any water accumulating in said drum periodically.

Fig. 2 also discloses a modification wherein the heating of the bottoms is carried out by indirect heat exchange. In this case the lower portion of the column 10 is separated by a plate 17 provided with vapor passage 17'. The liquid fractions accumulating on plate 17 are led through pipe 22' into the bottom of a reboiler 70 from where they are returned through pipe 27' into the column 10 below plate 17. Heat is furnished to the reboiler 70 by passing steam or the like through coil 71 connected respectively to inlet pipe 72 and outlet pipe 73. These pipes are provided with valves 74 and 75 respectively, said valves being either manually or automatically controlled to maintain a predetermined temperature of the liquid being heated.

The above disclosure is merely illustrative of preferred embodiments of the present invention and is not to be taken as limiting, since many

variations thereof may be made within the scope of the following claims without departing from the spirit of the invention.

I claim:

1. In a method for stabilizing gasoline, the steps of withdrawing a portion of the gasoline to be treated from a stabilizing zone, heating said withdrawn portion, and returning said heated portion to the stabilizing zone, the temperature of the thus re-cycled portion being maintained uniform by regulating the heating in proportion to the temperature of the withdrawn portion and by returning a portion of said withdrawn gasoline directly to said stabilizing zone without heating the same.

2. In a method for stabilizing gasoline the steps of withdrawing gasoline being stabilized from a stabilizer, heating a portion of said withdrawn gasoline and returning said heated portion to the stabilizer, the temperature of the thus re-cycled portion being maintained uniform by regulating the heating thereof in response to the temperature of the said returned portion, and by returning another portion of said withdrawn gasoline directly to the stabilizer without heating.

3. In a method according to claim 2, wherein the quantity of the unheated gasoline returned is regulated by the temperature of the withdrawn portion of the gasoline.

4. In a method for stabilizing light hydrocarbon oil such as gasoline, the steps of withdrawing oil being stabilized from a stabilizer, heating a portion of said withdrawn oil and returning said heated oil to the stabilizer, and returning another portion of said withdrawn oil to the stabilizer without heating, passing the resultant vapors through the stabilizer in countercurrent contact with descending reflux condensate, condensing a regulated portion of the overhead vapors by passing only a regulated portion of the said vapors through a condenser to produce a proper quantity of reflux, and returning all of said reflux condensate as said first mentioned reflux condensate.

5. In a method according to claim 4 wherein the heating of a portion of the withdrawn oil is regulated in proportion to the temperature of said withdrawn oil.

6. In a method according to claim 4 wherein the heating of a portion of the withdrawn oil is regulated in proportion to the temperature of said heated oil and wherein the quantity of the unheated oil returned is regulated by the temperature of the oil being withdrawn from said stabilizer.

7. In a stabilizing apparatus, a stabilizer adapted to treat crude stock introduced therinto, a pipe communicating with said stabilizer and adapted to withdraw a portion of said stock, a heating coil connected to said pipe, a pipe connecting the other end of said coil with the stabilizer and adapted to return the heated stock to said stabilizer, means co-operating with said last-mentioned pipe and tending to maintain a constant and regulable temperature of the thus returned stock, and by-passing means communi-

cating with the pipes leading to and from the stabilizer and adapted to automatically correct for any temperature variations of the thus re-cycled stock.

8. In a stabilizing apparatus, a stabilizer adapted to treat crude stock introduced therinto, a pipe communicating with said stabilizer and adapted to withdraw a portion of said stock, a heating coil connected to said pipe, a pipe connecting the other end of said coil with the stabilizer and adapted to return the heated stock to said stabilizer, means cooperating with said last mentioned pipe adapted to regulate the heating of the heating coil, by-passing means communicating with the pipes leading to and from the stabilizer, and means on said by-passing means adapted to be actuated by the temperature in the aforementioned stock-withdrawing pipe.

9. An apparatus for stabilizing a light hydrocarbon oil such as gasoline which comprises a stabilizer, a vapor withdrawing pipe leading from the upper portion of said stabilizer, means on said pipe adapted to maintain a predetermined and regulatable pressure therein, vapor condensing means communicating with said pipe, means in communication with said condensing means and the stabilizer and adapted to conduct the condensate to the stabilizer at a predetermined rate, a pipe leading from the lower portion of the stabilizer, a heating coil connected to said pipe, a pipe connecting the other end of said coil with said stabilizer, means cooperating with said last mentioned pipe and adapted to regulate the temperature within said pipe, a by-pass between the pipes leading to and from the coil, and means on said by-pass adapted to correct for any minor temperature variations by by-passing a portion of the fluid flowing through said pipes.

10. In a structure according to claim 9 wherein the last mentioned means on the by-pass is regulated by the temperature in the pipe leading from the lower portion of the stabilizer.

11. An apparatus for stabilizing gasoline comprising a stabilizer, a vapor withdrawing pipe leading from the upper portion of said stabilizer, means on said pipe adapted to maintain a predetermined and regulable pressure therein, vapor condensing means communicating with said pipe, means in communication with said condensing means and the stabilizer and adapted to conduct the condensate to the stabilizer at a predetermined rate, a pipe leading from the lower portion of the stabilizer, a heating coil connected to said pipe, a pipe connecting the other end of said coil with said stabilizer, a heater adapted to heat the coil, means in communication with said heater and pipe leading from the coil to the stabilizer and adapted to regulate the heating to maintain substantially constant the temperature within said pipe, a by-pass between the pipes leading to and from the coil, and means on said by-pass adapted to correct for any minor temperature variations by by-passing a portion of the fluid flowing through said pipes.

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