March 16, 1937. S. S. SMITH 2,073,908

METHOD OF AND APPARATUS FOR CONTROLLING RECTIFICATION

Filed Dec. 29, 1930 2 Sheets-Sheet 1

Fig. 1.

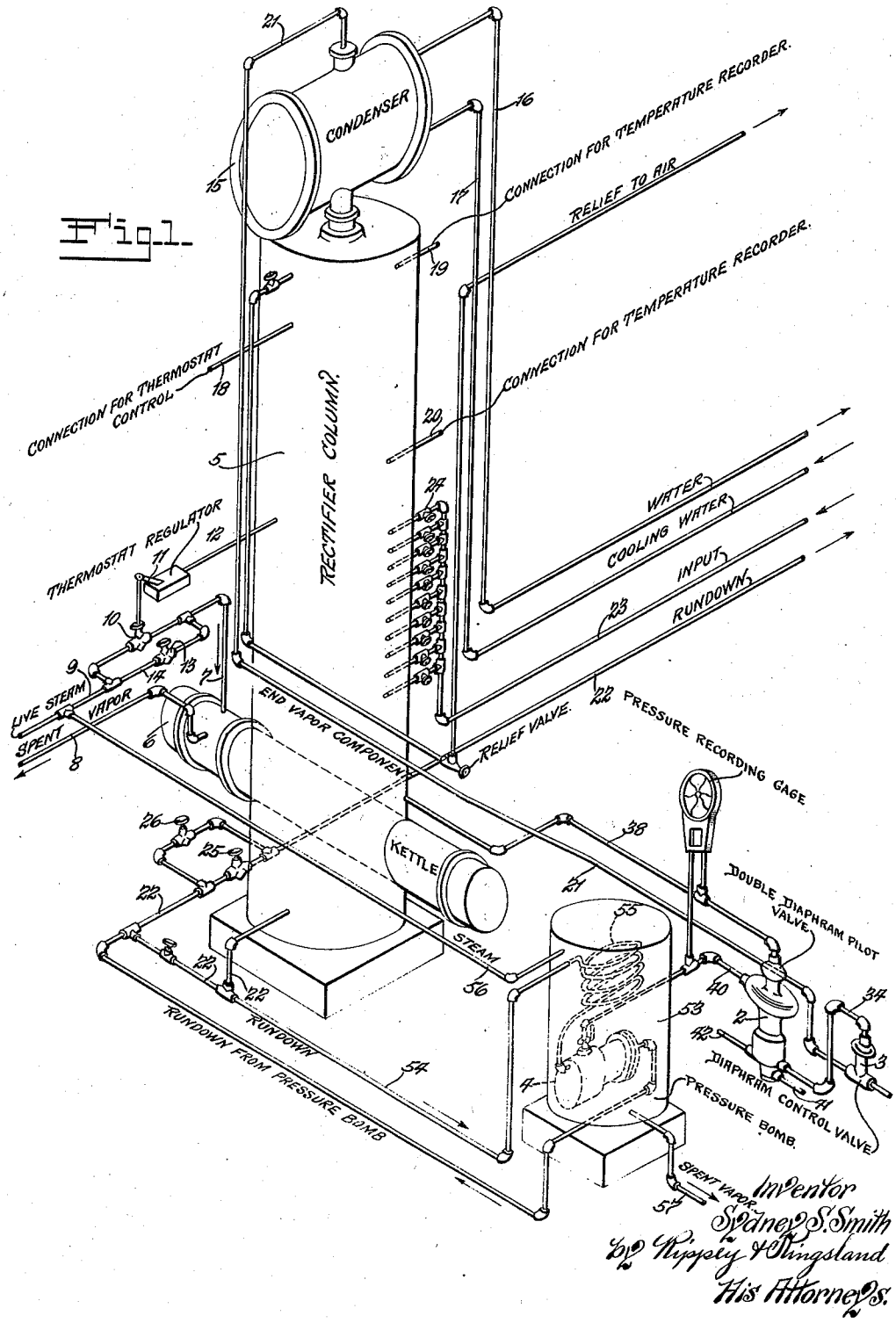

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Fig-2.

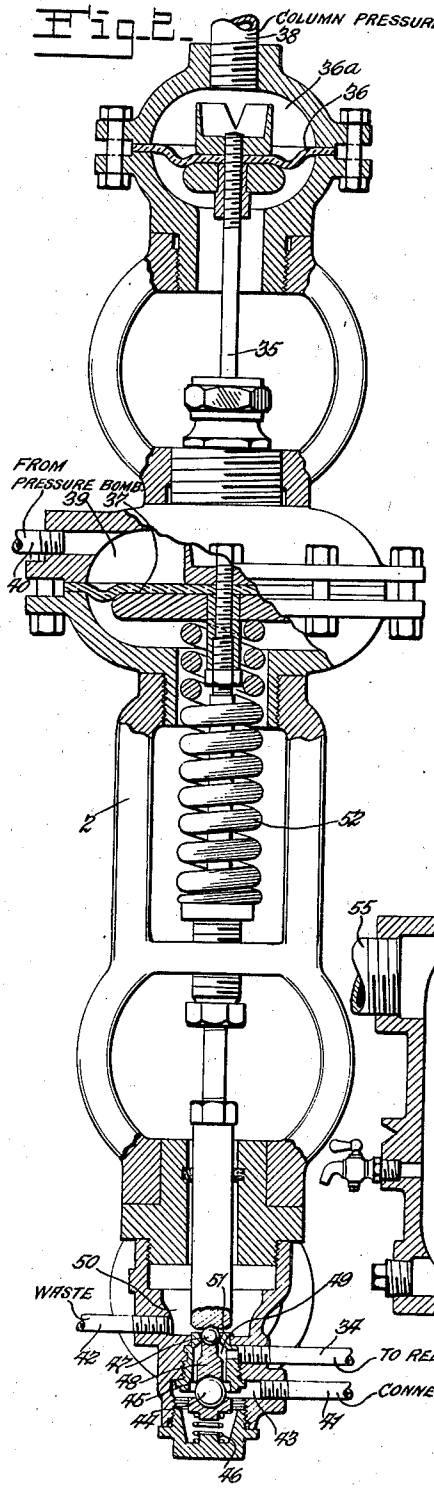


Fig-3.

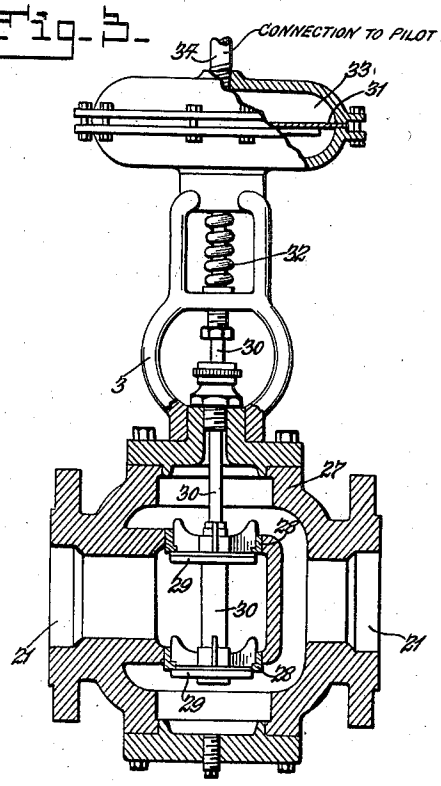
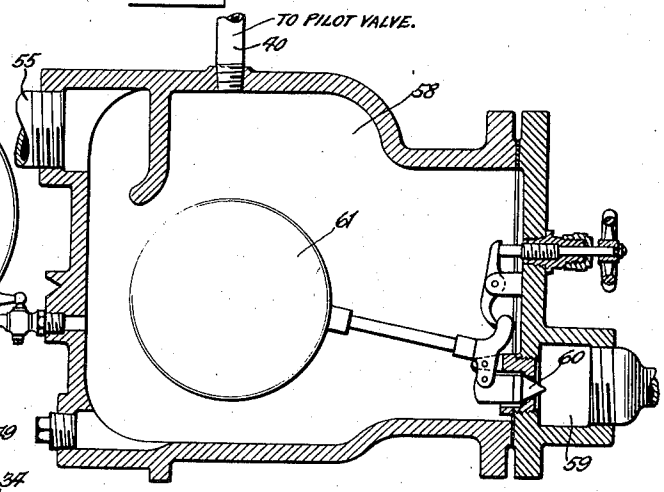


Fig-4.



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METHOD OF AND APPARATUS FOR CONTROLLING RECTIFICATION

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12 Claims. (Cl. 196—132)

This invention relates to method of and apparatus for controlling rectification.

One of the objects of this invention is to provide means whereby a rectifier system may be automatically controlled to deliver the final end liquid product of substantially constant vapor pressure.

One of the uses of this invention is in the rectification of gasoline. Probably the most characteristic quality which gasoline has is its vapor pressures and is something which may be mechanically recognized and by which regulating equipment may be actuated.

The specific objects of the invention will be apparent from the following detailed description taken in connection with the accompanying drawings, in which—

Fig. 1 is a diagram of a rectifying system including this invention.

Fig. 2 is a side elevation partly in section of a double diaphragm pilot valve 2 shown diagrammatically with its connections in Fig. 1.

Fig. 3 is a side elevation partly in section of a diaphragm relief valve 3 shown diagrammatically with its connections in Fig. 1.

Fig. 4 is a detailed cross section of a trap 4 which constitutes a part of a pressure bomb and which is shown diagrammatically with its connections in Fig. 1.

It is to be understood that this invention relates to controlling rectification or the operation of a rectifier column and the particular construction and arrangement of the rectifier itself is of no importance. A typical rectifier system is illustrated and described but it is to be understood that this is merely an exemplification and that the method and apparatus constituting the subject matter of this invention may be used in connection with rectifier columns differing materially in construction from that which is illustrated and described.

A rectifier column 5 has a kettle 6 which is heated by steam introduced through a pipe 7, the spent vapor passing out through a pipe 8. Steam may be introduced into the pipe 7 from a pipe 9 by means of a valve 10, automatically controlled from a thermostat unit 11 having a pipe connection 12 with the interior of the column 5, or it may be controlled manually by a valve 13 in a by-pass 14. A condenser 15 is cooled by water passing into it from a pipe 16 and out through a pipe 17. A connection 18 with the interior of the column near its top provides means whereby cooling water flowing into the condenser may be automatically regulated through a thermostat valve and unit, not shown but well understood in the art. Connections 19 and 20 with the interior of the rectifier column provide means whereby pressure and temperature recorders may be connected for indicating or recording the pressures and temperatures in the column. The final end vapor product may be withdrawn through a pipe 21, and the final end liquid product may be withdrawn through a pipe 22. The raw product to be rectified, such as raw gasoline, may be introduced on various plates of the rectifier column through a pipe 23, the connections with the various points being regulated by valves 24.

The run down of the final end liquid product may be regulated by valves 25 and 26, one of which is usually regulated automatically by means not shown but which is well understood in the art. The operation of the rectifier is controlled by regulating the discharge of the final end vapor product through the pipe 21 for by so regulating this discharge it is obvious that the pressure in the column will be controlled.

A typical rectifier column has been described and now the novel method of and means for controlling the operation of such a rectifier column will be described. It consists, as forecast, of means for automatically regulating the discharge of the final end vapor product in accordance with the column pressure and the vapor pressure of the final end liquid product. It consists primarily of a valve 3 in the pipe 21. As illustrated this valve is of well known construction and is not of itself novel. It comprises a housing 27 in which are situated valve seats 28 for cooperation with valve disks 29 secured to and operated by the stem 30, which stem is secured to a diaphragm 31. A compressible spring 32 is positioned about the stem 30 in such a manner as to normally close the valve by bringing the disks 29 against their respective seats 28. The diaphragm 31 is situated in a chamber 33 having a connection 34 with a source of liquid pressure which, as will hereafter be described, is regulated in accordance with the column pressure and the vapor pressure of the final end liquid product.

The fluid pressure introduced through the connection or pipe 34 is regulated by the pilot valve 2. The valve 2 includes a stem 35 to which is secured diaphragms 36 and 37. The diaphragm 36 is situated in a chamber 36a which has a pipe connection 38 leading to and communicating with the interior of the rectifying column, and, therefore, the diaphragm 36 is responsive to the column pressure. The dia-

phragm 37 is situated in a chamber 39 having a pipe connection 40 connected with means for securing a constant vapor pressure of the final end liquid product by means which will be disclosed later in detail. A pipe 41 communicates with a source of constant pressure, not shown, and the reciprocation of the valve stem 35 permits a fluid under such constant pressure from the pipe 41 to be impressed through the pipe 34 on the diaphragm 33 of the control relief valve. A pipe 42 permits the relief of such pressure from the diaphragm 33 in a manner which will presently be described.

The pipe 41 communicates with a chamber 43 in which is situated the ball 44 having a seat 45 and normally pressed outwardly against its seat by a spring 46. The ball 44 is pressed downwardly by action of the stem 35 against a ball 47 and a floating member 48. The pipe 34 communicates with a chamber 49 which is in communication with the chamber 43 through a passage between the ball 44 and its seat 45. Thus the passage between the pipe 41 communicating with the source of constant pressure and the pipe 34 leading to the diaphragm 33 is controlled by the reciprocation of the ball 44, which reciprocation is caused by operation of the valve stem 35. The pipe 42 communicates with a chamber 50 which has a passage to the chamber 49 controlled by the ball 47 and its seat 51. As the valve stem 35 rises the ball 47 is lifted from its seat at the same time the ball 44 is positioned on its seat, thereby closing the communication between the pipe 41 and the pipe 34, and opening communication between the pipe 34 and the pipe 42. It is to be understood, of course, that the pipe 42 is open to atmosphere.

A compressible spring 52 is positioned to move the stem 35 upwardly in a direction contrary to the movement of the stem when influenced by pressures on the diaphragms 36 and 37.

It is to be understood, therefore, that excessive pressures on the diaphragms 36 and 37 cause the valve stem 35 to be moved downwardly opening communication between the pipe 41 and the pipe 34, thus causing a pressure to be exercised on the diaphragm 31 of the relief valve sufficient to open the valve 3 relieving the pressure on the rectifier column. When the pressure has been sufficiently relieved the spring 52 will cause the stem 35 to move upwardly closing communication between the pipe 41 and the pipe 34 and opening communication between the pipe 34 and the pipe 42, thus venting the chamber 33 to atmosphere and causing the spring 32 to close the valve 3. It will be seen, of course, that so far as principle is concerned the apparatus might work just as well if the valve stems 35 and 30 were integral, thus operating the valve 3 directly by the operation of the diaphragms 36 and 37, but the pilot type of valve is preferred since much finer control may thereby be obtained.

I prefer to make the diaphragm 36, which is responsive to the column pressure, smaller in area than the diaphragm 37, which is responsive to the vapor pressure of the end liquid product. I prefer to make the area of the diaphragm 37 about two and one half times that of the area of the diaphragm 36. In rectifying gasoline typical pressures may be 125 pounds column pressure on the diaphragm 36 and a vapor pressure of 200 to 250 pounds per square inch on the diaphragm 37.

The vapor pressure of the final end liquid product is obtained in a pressure bomb 53 including the trap 4 to which is connected the pipe 40. A pipe 54 connects with the pipe 22 containing the run down and with a coil 55 within the bomb 53. The bomb is heated by steam from a pipe 56 and discharged through a pipe 57. The trap 4 is connected to the coil 55 and is of a form which is common as a continuous flow steam trap. It includes a chamber 58 having an outlet 59 controlled by a valve 60 operated by a float 61. The run down product is introduced into the coil 55 from the pipe 54, is heated by steam, and thus caused to impress its vapor pressure through the pipe 40 in the diaphragm 37.

From the foregoing description it will be obvious that the objects of the invention have been obtained. Means have been provided whereby a rectifier column may be controlled in its operation from vapor pressure of the final end liquid product in conjunction with the column pressure.

Parts of the invention may be used without the whole and various changes may be made in the details of construction, within the scope of the appended claims, without departing from the spirit of this invention.

I claim:

1. In apparatus for controlling the operation of a rectifier column, means for securing a continuous vapor pressure of a condensed middle fraction including a coil in communication with a source of said fraction, means for applying heat to the coil, a trap connected to the coil, and a connection from the trap above the level of liquid therein, in combination with regulating means responsive to pressure communicated through said connection.

2. In the process of operating a rectifying column at a predetermined pressure, the steps of withdrawing a product from the column, accumulating at least a portion of the withdrawn product in a confined space, heating the accumulated product while in said space to a predetermined temperature to produce a saturated vapor, thereby creating a vapor pressure within the confined space and automatically regulating the pressure within the column in accordance with the vapor pressure within the said confined space.

3. In the process of operating a rectifying column at a predetermined pressure, the steps of withdrawing a liquid product from the column, accumulating at least a portion of the withdrawn product in a confined space, heating the accumulated product while in said space to a predetermined temperature to produce a saturated vapor, thereby creating a vapor pressure within the confined space and automatically regulating the pressure within the column in accordance with the vapor pressure within the said confined space.

4. In the process of operating a rectifying column at a predetermined pressure, the steps of withdrawing a product from the column, accumulating at least a portion of the withdrawn product in a confined space, heating the accumulated product while in said space to a predetermined temperature to produce a saturated vapor, thereby creating a vapor pressure within the confined space, adding the column pressure to the vapor pressure of the withdrawn product within said confined space, said pressures acting in the same direction, and automatically regulating the column pressure in accordance with said combined pressures.

5. In the process of operating a rectifying column at a predetermined pressure, the steps of continuously withdrawing from the column a top product and a relatively high boiling product, accumulating at least a portion of the relatively high boiling product in a liquid form in a confined space, heating the accumulated product while in such space to maintain a constant temperature therein, thereby producing within the said confined space a saturated vapor under a pressure corresponding to the composition of the product and said constant temperature, and automatically regulating the rate of withdrawing the top product in accordance with the pressure within the confined space.

6. The process of claim 5, wherein the column pressure is added to the vapor pressure of the product within the confined space, said pressures acting in the same direction, and the rate of withdrawing the top product is regulated in accordance with said combined pressures.

7. The process of claim 5, wherein the relatively high boiling product is the bottom product produced by the column.

8. In the apparatus for rectifying a fluid mixture, a rectifying column, a column pressure-regulating means, a conduit for withdrawing a product from the column, a chamber in said conduit, means for heating the withdrawn product while in said chamber to maintain the same at a predetermined temperature below the dew point of the product, a first pressure responsive means for automatically controlling the column pressure-regulating means, a closed vapor conduit between the said chamber and first pressure responsive means for communicating the vapor pressure of the product within the chamber to the first pressure responsive means and means responsive to the pressure in said column and cooperatively connected with the first pressure responsive means for adding the column pressure to the vapor pressure of the product in said chamber.

9. In the apparatus for rectifying a fluid mixture, a rectifying column, a column pressure-regulating means, a conduit for withdrawing a product from the column, a chamber in said conduit, means for heating the withdrawn product while in said chamber to maintain the same at a predetermined temperature below the dew point of the product, a diaphragm-actuated pilot valve for automatically operating the column pressure-regulating means, a closed vapor conduit between the said chamber and the diaphragm for communicating the vapor pressure of the product within the chamber to the diaphragm, a second diaphragm in pressure communication with the column, and a connecting means between the two diaphragms.

10. The apparatus of claim 9, wherein the areas of the first and second diaphragms are in a ratio, which is reverse to the ratio of the column pressure to the chamber pressure.

11. In the apparatus for rectifying a fluid mixture, a rectifying column, a column pressure-regulating means, a conduit for withdrawing a product from the column, a chamber in said conduit, a heating means for heating the withdrawn product while in the chamber to maintain its temperature at a predetermined value below the dew point of the product, a pressure responsive means comprising a diaphragm exposed to the vapor pressure of the withdrawn product within the chamber and a pilot valve operated by the diaphragm for automatically controlling the column pressure-regulating means, and a closed vapor conduit between the said chamber and the pressure responsive means for communicating the vapor pressure of the product within the chamber to the pressure responsive means.

12. In continuously operating apparatus for fractionating a fluid mixture and having different means adjustable to regulate the operative factors of temperature and pressure therein to continuously produce a discharged sampled liquid product of substantially constant volatility, the method of control which comprises directing a continuous sample of the product through an evaporation cup, maintaining the temperature condition in said cup at a constant value whereby pressure condition in said cup is variable in accordance with the volatility of the sample, and actuating a said adjustable regulating means by means controlled by the said variable condition in the cup whereby the sampled said product may have a constant volatility, the setting of the other adjustable said regulating means remaining constant.

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