

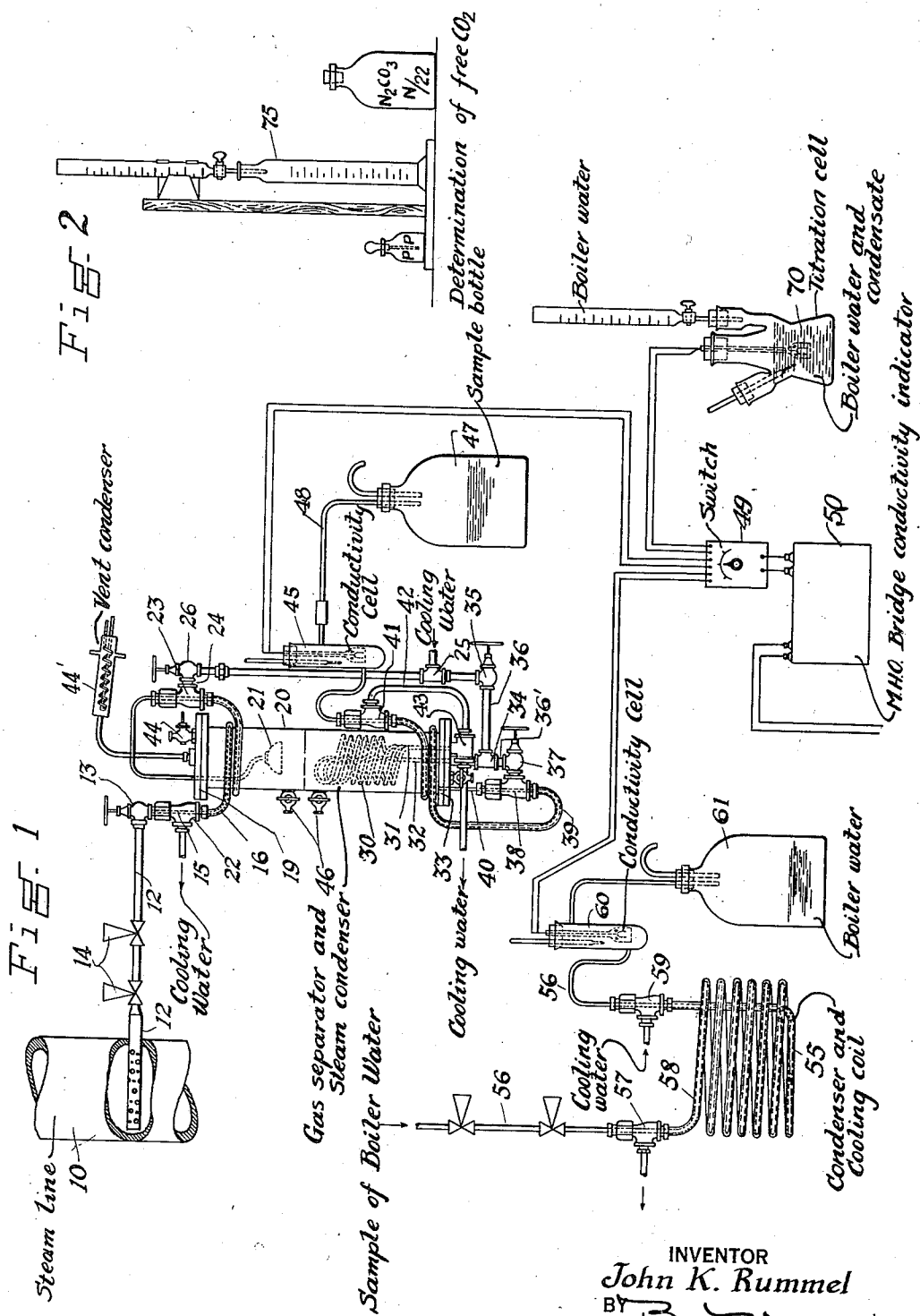
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FLUID TREATING DEVICE

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FLUID TREATING DEVICE

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This invention relates to a fluid treating device wherein a fluid mixture may be treated to remove gaseous matter therefrom, and has associated therewith a device for testing the treated fluid to determine certain characteristics.

An object of the invention is to provide an apparatus for receiving a processed fluid, separating volatile matter therefrom, and may include a device associated therewith for testing the remaining treated fluid to determine at least one of its physical characteristics.

A specific object of the invention is to provide an apparatus to receive a vapor resulting from the evaporation of a liquid, to condense the vapor and separate gaseous matter therefrom, and also contemplates in certain instances the testing of the condensate to determine the quantity of non-gaseous impurities remaining therein.

These and other objects will be apparent to those skilled in this particular art from the claims and the description in the specification in connection with the drawing, in which—

Figure 1 is a diagrammatic view of a device illustrative of the invention.

Figure 2 is a diagrammatic view of an apparatus used in testing a sample obtained from the device illustrated in Figure 1.

The embodiment of the invention which has been chosen for purposes of illustration, shows a separator device in conjunction with testing apparatus especially adapted for determining impurities in steam.

Referring to Fig. 1 of the drawing, a main steam pipe 10 has a sampler tube 11 disposed within it which is connected through a connector 12 to a throttle valve 13. A double valve 14 is located in the connector intermediate of the sampler tube and the valve 13 and is adapted to regulate the pressure of the steam admitted to the throttle valve 13. A pipe 15 is connected to the outlet end of the valve 13, and has a cooling jacket 16 surrounding it for a portion of its length.

The end of the pipe 15 remote from the end connected to the outlet of the throttle valve 13 extends through a head 19 of a separator chamber 20. This end of the pipe 15 is connected to a distributing or spreader nozzle 21. The jacket 16 surrounding the pipe 15 for a portion of its length has an outlet fitting 22 at the end adjacent the valve 13 and an inlet fitting 23 at its other end. The fitting 23 is connected through a suitable fitting 24 and valve 26, which may be thermostatically controlled, to a supply pipe 25. The valve 26 controls the amount of cooling medium admitted to the jacket 16. When the device is in

operation the valve 26 is opened and water is passed through the space surrounding the pipe 15 in a direction counter to the flow of steam therein. By virtue of the cooling effect of the cooling medium, which may be water, a portion of the steam is condensed.

Within the chamber 20 is located a cooling coil 30 which has an inlet 32 and an outlet 31, the inlet end of this coil extends through the base 33 of the casing 20 and is connected by means of a T fitting 34 and through a suitable fitting 36 controlled by a valve 35, to the inlet of the water supply 25. Another branch 36' of the T fitting 34, in conjunction with a valve 37 and fitting 38, provides a supply of the cooling medium to a jacket 39. The jacket 39 surrounds an inner pipe 40 which is connected to the fluid within the separator 20. The cooling medium is passed through the jacket 39 in such amounts that the fluid within the pipe 40 is cooled to any temperature desired. The cooling medium then passes out the jacket 39 to an outlet fitting 41 which is joined through a connector 42 to a T fitting 43, one branch of which is connected to the outlet end 31 of the coil 30.

In testing steam to determine the amount of solids contained therein by the conductivity method, the steam must be condensed and any appreciable amount of CO₂ (carbon dioxide) or similar volatile associated with the steam will materially affect the conductivity of its condensate so that an accurate determination of the amount of solids is very difficult unless the condensate is substantially free from CO₂.

In view of the foregoing, it is obvious that the device just described is readily adapted to separate carbon dioxide from steam and its condensate which is to be delivered to a conductivity cell for obtaining data for the determination of the amount of solids or equivalent moisture as boiler water, contained therein by calculations to be described later. When the device is used for this purpose the operation is as follows:

The steam sample is obtained from the main line 10 by means of the sampler tube 11, and the pressure of this steam is controlled by the valve 14. This steam is passed through the tube 15 into the interior of the separator chamber 20, in amounts controlled by the needle throttle valve 13. In passing through the tube 15 it is subjected to the cooling effect of water admitted to the outer tube 16 by means of the valve 26. Because of this cooling, a portion of the steam is condensed so that it is a mixture of steam and water that is projected into the separator chamber 20 by means of the distributor nozzle 21 and

separation of dissolved gases in the mixture takes place.

By means of the cooling coil 30, the mixture of steam and water within the separator is cooled further so that virtually all of the steam is condensed. A vent 44 is provided in the casing head 19 and the CO₂ separated from the steam is permitted to pass out this vent. If desired the CO₂ and any steam mixed therewith can be vented to a condenser 44' and collected. The water within the separator 20 is maintained at a desired level (preferably above coil 30) by regulating the vapor pressure (within the chamber) and by raising and lowering an electrical conductivity cell 45. Inspection of the water level may be made by means of pet cocks 46 or by the installation of a gauge glass, which may be connected at the bottom end, to the drainage cock 40 and at the top end to one of the openings in the top head; no top connection being required if the pressure inside the separator is essentially the same as the atmosphere.

A proper balance of steam and water inside the separator is maintained by regulating the steam valve 13 and the flow of cooling water through the coils 16 and 30 so that a small percentage of steam is vented with the separated CO₂ through the vent 44.

The steam condensate of which the solids content is to be determined, and which has been substantially freed of associated CO₂, is drawn from the separator 20 through the tube 38 which is surrounded by the jacket 39. This condensate passes by gravity through the conductivity cell 45. The liquid level in the conductivity cell is automatically regulated by the height (or the position) of the discharge connection on the side of the conductivity cell.

In passing through the tube 38 to the cell 45 the water is cooled to a desired degree, which may be 25 degrees centigrade or 77 degrees Fahrenheit. The exact temperature of the condensate is noted by a thermometer in the conductivity cell, and the conductivity is determined by means of a three-position switch 49 and an electrical conductivity indicator and/or recorder 50. A condensate overflow 48 conveys the condensate to a sample bottle 47.

A device 55 is provided for obtaining a sample of boiler water, and comprises a valve controlled pipe 56, connected to the water side of a boiler drum (not shown), and which passes through a suitable fitting 57 to a cooling coil 58 and fitting 59 to a second electrical conductivity cell 60 electrically connected to the conductivity measuring device 50. In connection with this device, the conductivity cell is optional, but as herein shown, one is provided, and an overflow therefrom delivers a cooled supply of boiler water to a sample bottle 61. A suitable CO₂ testing device 75, conventionally illustrated in Fig. 2, is provided to determine the amount of dissolved CO₂ remaining in the condensate. This amount should not exceed 1 part per million.

Having obtained a sample of boiler water and regulated its temperature to equal that of a measured quantity of steam condensate of which the conductivity and CO₂ content is known, one per cent of this sample of boiler water is added to the steam condensate in the titration cell 70 and after measuring the electrical conductivity of the mixture by means of the measuring device 50, the parts per million of solids or per cent moisture (boiler water) in the original sample of steam

condensate may be calculated by the following formulae:

P. p. m. of solids in steam=

$$\frac{L_s - W_c}{S \times 100} \times \text{P. p. m. solids in boiler water}$$

where

L_s=conductivity of steam condensate at standard temperature.

W_c=total conductivity correction due to carbon dioxide and pure water.

S=conductivity increase due to adding 1% boiler water to steam condensate, result corrected to standard temperature.

P. p. m.=parts per million

or

Per cent equivalent moisture=

$$\frac{L_s - W_c}{S} \text{ where symbols are the same}$$

as those given above.

In connection with these calculations it is to be noted that the p. p. m. of solids in the steam may be either the total solids or the soluble solids, depending on which is included in the boiler water sample which is taken for evaporation. The conductivity measurement includes only the soluble ionized solids in the sample.

The S value in the formula is preferred to one in which S equals 100% boiler water, the reason being that it is more desirable to have readings in the same dilution range and subject to the same variations as the steam condensate sample.

This apparatus may also be used to remove carbon dioxide from various water supplies, of which the conductivity or solids content is to be determined. In this case it may be necessary to heat the sample to the boiling point, such as by a coil similar to 16 which would be used as a heating unit, steam or other heating medium being passed through the jacket.

With respect to the separator just described in connection with the above testing apparatus, it is to be understood that its use is not limited to association with a testing device, for example, instead of a steam line such as is shown at 10, the separator might be connected with an evaporator for the purpose of separating carbon dioxide gas and oxygen from the steam generated therein. When used in this connection, the testing apparatus would of course be eliminated and several separators might be used in series.

In addition, such a separator as described would be extremely useful in the purification of petroleum or other liquids and in the fractional distillation thereof. When used in connection with such a device the temperature control by means of cooling coils 16 and 30 could be regulated so that products of high volatile characteristics would be vented from the casing, in this case through the condenser 44'.

A specific apparatus has been described in some detail as illustrative of this invention, but it is to be understood that changes, additions, substitutions and omissions may be made therein within the spirit of the invention as defined by the appended claims.

I claim:

1. The method of measuring the solid content of steam mixed with carbon dioxide which comprises condensing a representative sample of the steam and separating substantially all of the carbon dioxide therefrom and subsequently measuring the electrical conductivity of the condensate at a known temperature.

2. The method of measuring the solid content of steam mixed with an undesirable amount of carbon dioxide which comprises condensing a representative sample of the steam and separating substantially all of the carbon dioxide therefrom, measuring the electrical conductivity of the condensate at a known temperature, and comparing the conductivity measurement with the electrical conductivity of the condensate with the addition of a relatively small percentage of unevaporated water at a known temperature.

3. The method of measuring the solid content of steam mixed with an undesirable amount of carbon dioxide which comprises condensing a representative sample of the steam and separating substantially all of the carbon dioxide therefrom, measuring the electrical conductivity of the condensate at a known temperature, and comparing the conductivity measurement less a correction for the amount of dissolved carbon dioxide in the condensate with the electrical conductivity of the condensate with the addition of a relatively small percentage of unevaporated water at a known temperature.

4. The method of measuring the solid content of steam mixed with an undesirable amount of carbon dioxide which comprises condensing a representative sample of the steam and separating substantially all of the carbon dioxide therefrom, separately measuring the electrical conductivity of the condensate and the unevaporated boiler water, and calculating the solid content of the steam by the formula:

P. p. m. of solids in steam =

$$\left(\frac{L_s - Wc}{S} \right) \times \text{P. p. m. solids in boiler water}$$

where L_s is the electrical conductivity of the steam condensate at a known temperature; Wc is total conductivity correction value for the remaining carbon dioxide present and pure water; S is the conductivity of the boiler water at the known temperature; and p. p. m. is parts per million.

5. The method of measuring the solid content of steam mixed with an undesirable amount of carbon dioxide which comprises condensing

a representative sample of the steam and separating substantially all of the carbon dioxide therefrom, separately measuring the electrical conductivity of the condensate per se and with the addition of 1% of boiler water, and calculating the solid content of the steam by the formula:

P. p. m. of solids in steam =

$$\frac{(L_s - Wc)}{S \times 100} \times \text{P. p. m. solids in boiler water}$$

where L_s is the electrical conductivity of the steam condensate at a known temperature; Wc is a conductivity correction value for the remaining carbon dioxide present and pure water; S is the conductivity increase after adding 1% of boiler water to the steam condensate and corrected for the known temperature; and p. p. m. is parts per million.

6. The method of determining the solids in steam mixed with objectionable gases which comprises condensing a portion of a steam sample, separating the uncondensed steam and objectionable gases from the condensate, cooling the condensate to a predetermined temperature, and measuring the electrical conductivity of the cooled condensate.

7. The method of determining the solids in steam mixed with carbon dioxide which comprises condensing a portion of a steam sample, withdrawing the uncondensed steam and carbon dioxide from the sample while the condensate temperature is near the boiling point, then cooling a condensate sample to a predetermined temperature, and measuring the electrical conductivity of the cooled condensate.

8. Apparatus for measuring the solids in steam mixed with a gas comprising in combination, a condenser for separating the gas and condensing steam having an inlet for the steam and gas, a gas outlet from said condenser, a cooling coil associated with said condenser, a condensate discharge pipe from said condenser, an electrolytic cell to which said discharge pipe leads, and means for continuously determining the electrical conductivity of the condensate in the cell.

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