

March 31, 1931.

S. G. STYRUD

1,798,563

GAS AND LIQUID CONTACT APPARATUS AND METHOD

Filed April 4, 1929

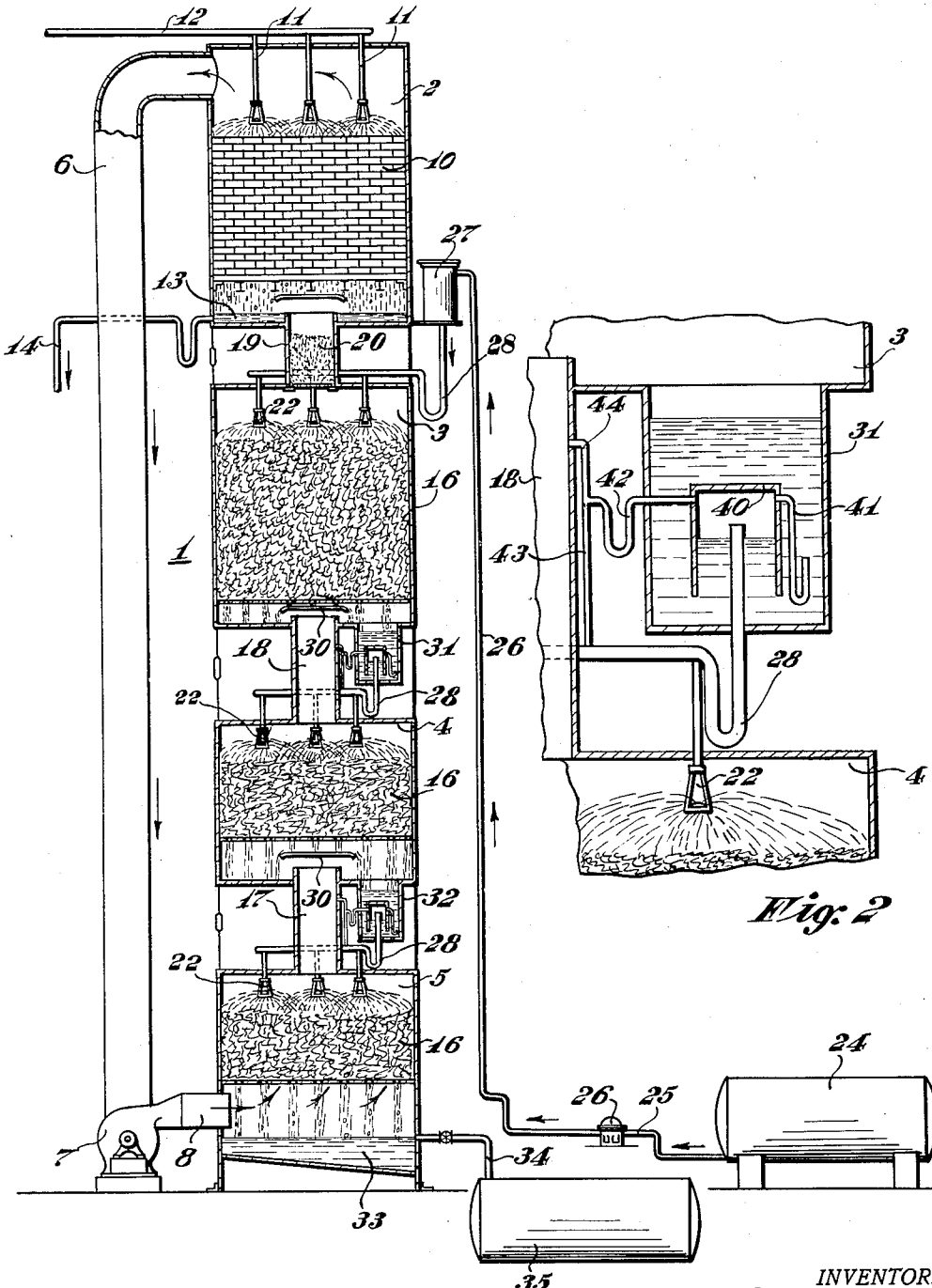


Fig. 1

Fig. 2

INVENTOR.
Sven G. Styru.
BY
Jesse R. Langley
ATTORNEY.

UNITED STATES PATENT OFFICE

SVEN G. STYRUD, OF BROOKLYN, NEW YORK, ASSIGNOR TO THE KOPPERS COMPANY,
A CORPORATION OF DELAWARE

GAS AND LIQUID CONTACT APPARATUS AND METHOD

Application filed April 4, 1929. Serial No. 352,364.

My invention relates to a method and apparatus for bringing gas and liquid into contact with each other whether for the purpose of interchanging a constituent or impurity from the one to the other or for the purpose of effecting heat exchange between them, or merely for the purpose of saturating the one or the other or any similar purpose, for the accomplishment of which the gas and liquid must be brought into intimate contact with each other.

An object of my invention is to provide a method and apparatus of bringing gas and liquid into intimate contact with each other that shall be advantageous with respect to the prior art, and effective to increase the efficiency of such contact under practical operating conditions.

My invention has for further objects such other operative advantages and results as may hereinafter be found to obtain.

As is well known, for most purposes gas and liquid contact is most effectively obtained by passing the gas and liquid through contact means of either static or motive type, generally in countercurrent. Especially when the amount of liquid is small in comparison with the amount of gas which is generally the case in the treatment of fuel gases and the like, it has been found particularly effective to employ, for the purpose of bringing the gas and liquid into contact with each, contact means of the static type. For example, a plurality of spaced hurdles or a bank of tile or metal turnings, wood shavings, and the like, all of which are to be considered primarily from the standpoint of the effective area wetted by the liquid and exposed to the gas.

In order that high efficiency may be attained, it is necessary that the flow of liquid over the contact means be uniform and so limited in amount that the liquid is exposed to the gas in the form of a very thin film. It has been found under actual operating conditions that very slight variations in distribution by failing to establish proper flow in some portions of the contact means and by establishing excessive flow in other portions have exerted an extremely deleterious effect

on the operating efficiency of the apparatus and since it is well known that in most devices of the prior art a certain inequality in distribution was inevitable this has necessitated the building of absorption apparatus of excessive size or provided with relatively costly and complicated moving parts.

It has been found advantageous and especially where small amounts of liquid are to be brought into contact with relatively large amounts of gas to accumulate the liquid to be supplied to the contact means and then to discharge it intermittently below or into said contact means. In this manner, as is well known, uniform distribution of liquid over wide areas can be attained, whereas if the same amount of liquid were distributed to the contact means at a uniform rate with respect to time such uniformity of distribution could not practically be attained.

It is also known that the contact means which are available for use and particularly those of the static type are necessarily somewhat limited in size. For example, when an absorption tower of even moderate dimensions is to be filled with static contact means for the distribution of gas and liquid, this contact means is not simply placed in the tower in one large mass or section, but is divided up into a plurality of separate sections. This is done not only for the purpose of supporting the contact means more readily, but also because in this manner better distribution of the gas and liquid is obtained and in some cases packing or compression of the lower portions of the contact material is avoided.

However, even under such conditions, a considerable amount of the liquid eventually finds its way to the sides of the apparatus and adhering thereto is thus prevented from traversing the contact medium and, moreover, it is practically impossible in practice to provide supporting trays for the contact material which are exactly level, and consequently the liquid tends to flow toward the lowest point and more liquid will fall from that point to the layer below than from any other point.

From these causes and from certain other causes, such as unavoidable inequalities in

the packing material itself, it is exceedingly difficult to obtain good distribution from one contact means or stage to the means or stage next to be traversed by the liquid and, consequently, inequality of distribution and poor efficiency result. This is sometimes exaggerated as the liquid passes through the series of contact means or stages and may eventually result in large portions of individual contact means receiving no liquid at all and others receiving more liquid than is proper for high efficiency.

My invention contemplates the avoidance of such operating disadvantages and difficulties by providing adequate distribution between the individual contact means or stages. I accomplish this object by accumulating the liquid leaving a given contact means and distributing it intermittently and at relatively high rate over the contact means next to be traversed by the liquid and in this manner obtain the same uniformity of conditions and the same high efficiency throughout a series of individual contact means.

In order that my invention may be clearly set forth and understood, I now describe with reference to the accompanying drawing a preferred manner in which it is accomplished and embodied.

In the drawing, Figure 1 is a vertical view partly in elevation and partly in section of apparatus for effecting contact between gas and liquid in accordance with the present invention; and

Fig. 2 is a similar enlarged view of a portion of the apparatus shown in Fig. 1.

Similar numerals designate similar parts in each of the views of the drawing.

It will readily be understood that my invention may be applied to various processes and operations in which intimate contact is to be secured between a gas and a liquid and that my invention is not limited to any specific use thereof in a particular process, but my invention is particularly useful when it is desired to extract a constituent or impurity from a gas by means of a liquid and for purposes of explanation my invention is herein described with respect to a particular process, namely, the removal of tar acid from liquid containing the same.

According to this process, the gas liquor or other material from which tar acid is to be removed is treated with a gas for the removal of the tar acid, and the tar acid laden gas is then passed through a suitable absorbent, for example, a solution of caustic soda, for recovery of the tar acid in the form of sodium phenolate and the like. In order that the removal of material from the liquid may be limited to the tar acids and in order to prevent large thermal losses which would otherwise occur, the process is preferably carried out by recirculating the gas through a cycle comprising a stripping stage wherein the tar

acid is removed from the liquor and a scrubbing stage wherein the tar acid is removed from the gas by the caustic soda solution, the whole being carried out at uniform temperature sufficiently high to prevent condensation of steam.

The apparatus shown in Fig. 1 is particularly designed for the accomplishment of this process and embodies the present invention in the scrubbing stage as will appear hereinbelow.

The transfer of the tar acid from the gas liquor to the caustic soda solution is carried out in apparatus consisting primarily of a transfer tower 1 that is divided into a stripping section 2 and a plurality of scrubbing sections, 3, 4 and 5. The carrier gas is caused to traverse the tower in an upward direction, passing through the scrubbing sections 5, 4, 3 in series and through the stripping section 2 and is then returned through a conduit 6 to a blower 7, which returns it through a conduit 8 to the tower 1 for further recirculation.

The stripping section 2 is provided with a suitable contact material 10, such as the so-called spiral tile well known in the art, and is supplied with the liquor to be treated from a plurality of sprays 11 and a conduit 12. After traversing the contact material 10, the liquor collects in a well 13 in the bottom of the stripping section 2 and then passes out through a seal overflow pipe 14 for whatever use is desired of it.

During the passage of the liquor through the stripping section 2, it is brought into contact with the rising current of gas and is stripped of its content of tar acid which passes out with the carrier gas into the conduit 6 and then enters the first scrubbing section 5 through the conduit 8. The gas passes upwardly through a suitable contact material 16, such as metal turnings, and then passes through a vertical conduit 17 into the interior of the scrubbing section 4 which is likewise filled with contact material 16 and through a vertical conduit 18 into the scrubbing section 3, also filled with contact material 16, the gas which during its passage through the scrubbing sections 5, 4 and 3 has been stripped of its tar acid content then passes through a vertical conduit 19 into the stripping section 2. The vertical conduit 19 may be filled with a suitable contact material 20 for the purpose of removing any liquid entrained from the scrubbing sections, 5, 4 or 3.

Each of the scrubbing sections 3, 4 and 5 is provided with a plurality of sprays 22 so situated as to distribute liquid uniformly over the contact material 16. In the case of the upper scrubbing section 3, the sprays 22 are supplied with caustic soda solution or other liquid from a supply tank 24 by means of a line 25, pump 26 and a device 27 which

is effective to accumulate the relatively small supply of liquid coming from the pump 26 and to discharge the cumulative liquid at intervals and at high velocity through a line 28 through the sprays 22.

In this manner the contact material 16 within the scrubbing section 3 is caused to be periodically wetted with absorbent liquid at intervals frequent enough to maintain a sufficient amount of fresh liquid in the tower 16 at all times.

During its passage downward through the contact material 16 and the scrubbing section 3, the liquid tends to run together so that the liquid leaving the contact material 16 does so at a more or less uniform rate as applied to the intermittent supply of liquid through the sprays 22. This liquid as it leaves the contact material 16 is prevented from dropping through the vertical conduit 18 by a suitable baffle 30 and passes into a well 31 which is provided with suitable means for accumulating the liquid therein and discharging it at intervals through the sprays 22 to the scrubbing section 4 below it.

A similar well 32 is provided at the bottom of the scrubbing section 4 and it serves to redistribute the liquid flowing from the contact material 16 to the scrubbing section 4 at intervals over the contact material 16 and the scrubbing section 5.

The liquid falling from the contact material 16 within the scrubbing section 5 drops into a well 33 and from which it drains through a line 34 into a suitable reservoir or storage tank 35.

Various devices well known in the art may be employed for the purpose of accumulating the liquid and discharging it intermittently over the contact means 16 in the various scrubbing sections, but a preferred device is illustrated in the figures and particularly in Fig. 2. It will be noted that the line 28, which is provided with a suitable seal, projects upward into the interior of the well 31 or 32 or the tank 27, as the case may be. This portion of the line 28 in each case is covered with a seal pot 40 that is provided with a seal 41 and a trap 42. The trap 42 is also connected to the line 28 through a line 43.

Assuming that the well 31 is substantially empty and that a certain portion of liquid is present in the trap 42, the operation is as follows. Liquid from the pump 26 or from the scrubbing section immediately above the device, as the case may be, enters the well 31. The liquid rises inside the seal pot 40 and also outside thereof, pressure conditions under the seal pot being maintained equal to the pressure conditions in well 31 by reason of the free communication afforded through the seal 41 which is then empty.

This condition continues until the liquid level reaches the open end of the seal 41, at

which time the seal becomes partly filled with liquid and therefore since liquid is also present in the trap 42 and also in the sealed conduit 28, the air under the seal pot is trapped and becomes compressed as the liquid level continues to rise in the well 31. This trapped air prevents the flow of liquid from the interior of the well 31 into the line 28.

This condition continues until there is a sufficient pressure under the seal pot 40 to "blow" the trap 42, at which time the air under the seal pot 40 passes off through a vent 44. The liquid rises rapidly in the seal pot 40 and a siphon action is set up whereby liquid is supplied with extreme rapidity to the line 28 and thence to the sprays 22. This principle of operation is shown in patent to Chase No. 1,078,995.

The siphon action continues until the liquid level falls to a point below the free end of the seal 41, at which time the seal 41 is empty of liquid and air enters the seal pot 40 breaking the siphon. Of course, during the siphon operation the trap 42 has again become filled with liquid so that the apparatus is again in condition for operation upon liquid being supplied in suitable quantity to the reservoir 21, the tank 27 or the reservoir 22, as the case may be.

By properly dimensioning the well 31 and by adjustment of the seal 41 the amount of liquid accumulated between operations of the siphon may be regulated to any desired figure, but in each case should be so regulated that the rate of supply of liquid is adequate to cause good distribution through the plurality of sprays 22 in the contact material 16.

My invention is not limited to the specific example set forth hereinabove, but may be variously employed and embodied for different purposes and with such modifications as will be obvious to those skilled in the art. For example, in the instance above described by way of illustration, the same principle may be applied to both the scrubbing and the stripping sections, although as hereinabove pointed out, the advantages of my invention are most evident when a small amount of liquid is employed for the removal of a constituent or impurity from a relatively large amount of gas.

Nor is my invention limited to any particular form of apparatus shown hereinabove by way of example, but it is to be construed as of the scope of the claims.

I claim as my invention:

1. Gas and liquid contact apparatus which comprises a pair of contact means serially disposed in the path of the gas, means for supplying liquid to one of said contact means, means for accumulating said liquid after it traverses said contact means, and means for supplying it at regular intervals to the other contact means.

2. The method of bringing a gas and a liquid into contact which comprises passing the gas through a pair of contact means in series, supplying liquid to one of said contact means, accumulating said liquid after it traverses said contact means, and supplying it at regular intervals to the other contact means.

3. Apparatus for treating a gas with a liquid which comprises, a combination, a plurality of contact means serially disposed in the path of the gas; means for supplying each with liquid at regular intervals, the contact means last traversed by the gas being supplied with fresh liquid, and the other contact means being supplied with liquid leaving the contact means next to be traversed by the gas.

4. The method of bringing a gas and liquid into contact which comprises passing the gas through a plurality of contact means in series, supplying liquid to each contact means at regular intervals, the liquid supplied to the last contact means traversed by the gas being fresh, and the liquid supplied to the other contact means being that leaving the contact means next to be traversed by the gas.

5. Gas and liquid contact apparatus which comprises, in combination, a plurality of contact means in the path of the gas and traversed by the liquid in a series countercurrent to the passage of the gas therethrough, means for accumulating the liquid leaving each of said means and means for supplying it at regular intervals to the next contact means.

6. The method of treating a gas with a liquid interchange of a constituent which comprises passing the gas through a plurality of contact means in series, introducing the liquid to the last of said contact means traversed by said gas and allowing it to traverse said means, accumulating the liquid leaving said means and supplying it at regular intervals to the adjacent contact means.

7. In the method of treating a gas with a liquid comprising passing the gas and liquid through a plurality of contact means in series, the step which comprises allowing the liquid leaving one of said contact means to accumulate and supplying it at regular intervals to the adjacent contact means.

8. In the method of treating a gas with a liquid comprising passing the gas and liquid through a plurality of contact means in countercurrent series, the step which comprises allowing the liquid leaving one of said contact means to accumulate, and supplying it at regular intervals to a contact means traversed by said gas prior to the contact means from which said liquid is taken.

9. In the method of treating a gas with a liquid comprising passing the gas and liquid through a plurality of contact means in countercurrent series, the step which comprises allowing the liquid leaving one of said contact means to accumulate, and supplying

it at regular intervals to the contact means traversed by said gas just prior to its passage through the contact means from which said liquid is taken.

10. Gas and liquid contact apparatus comprising a tower, means for passing the gas upwardly therethrough, a plurality of spaced contact sections vertically disposed throughout said tower, a liquid well below each contact section and means for supplying liquid at regular intervals from each well to the section immediately below it.

11. Gas and liquid contact apparatus which comprises a pair of contact means serially disposed in the path of the gas, means for supplying liquid to one of said contact means, means for accumulating said liquid after it traverses said contact means, and means for supplying it at intervals to the other contact means, said supplying means being responsive to a predetermined volume of said accumulated liquid.

12. Gas and liquid contact apparatus which comprises a pair of contact means serially disposed in the path of the gas, means for supplying liquid to one of said contact means, means for accumulating said liquid after it traverses said contact means, and means for supplying it at intervals to the other contact means, said supplying means being responsive to a predetermined volume of said accumulated liquid and effective to supply the liquid at a higher rate than the rate at which said liquid is accumulated.

In testimony whereof, I have hereunto subscribed my name this 30th day of March, 1929.
SVEN G. STYRUD.