

April 26, 1960

J. J. VAN ROSSUM

2,934,166

GAS-DEMISTING APPARATUS WITH DRAINED MAT

Filed May 6, 1957

2 Sheets-Sheet 1

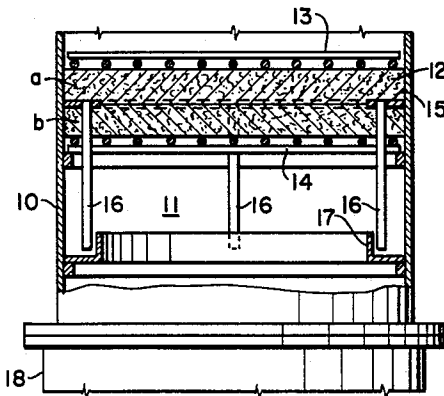


FIG. 1

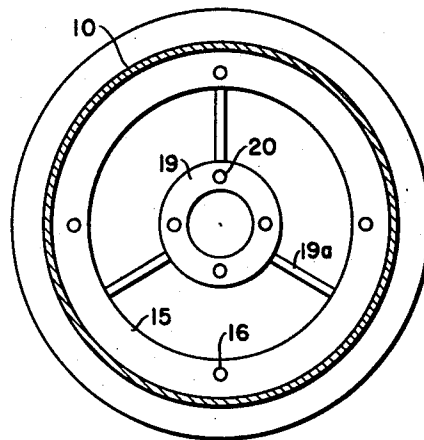


FIG. 3

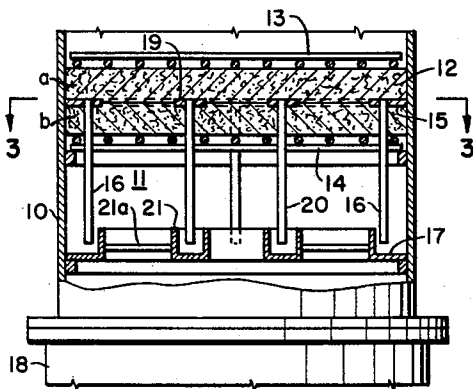


FIG. 2

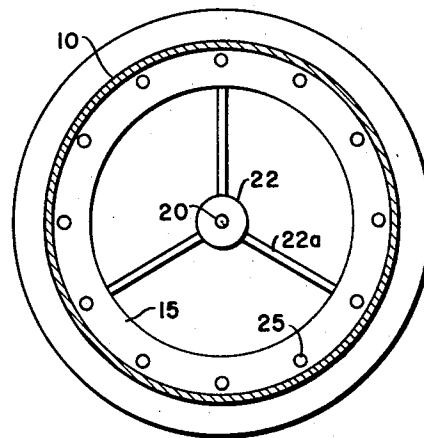


FIG. 5

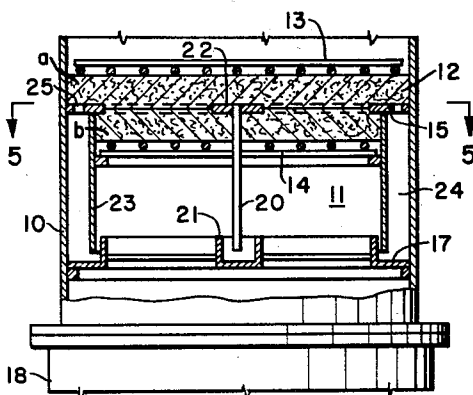


FIG. 4

INVENTOR:

JACOBUS J. VAN ROSSUM

BY: *Oswald H. Milmore*

HIS ATTORNEY

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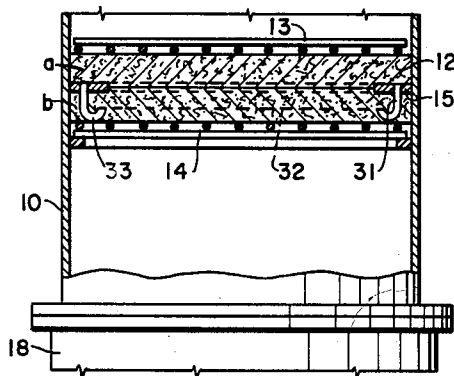


FIG. 8

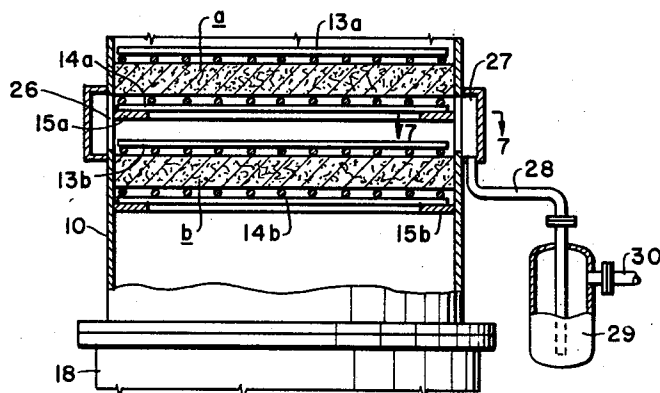


FIG. 6

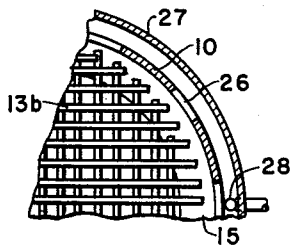


FIG. 7

INVENTOR:
JACOBUS J VAN ROSSUM

BY: *Oswald H. Milmore*
HIS ATTORNEY

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2,934,166

GAS-DEMISTING APPARATUS WITH DRAINED MAT

Jacobus J. Van Rossum, Delft, Netherlands, assignor to
Shell Oil Company, a corporation of Delaware

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Claims priority, application Netherlands May 8, 1956

9 Claims. (Cl. 183—48)

This invention relates to apparatus for removing liquid particles, such as oil or water, from a gas stream in which they are entrained, and is particularly related to apparatus of the type which comprises an enclosure defining a chimney or substantially upright flow passage through which the gas to be treated ascends, an impingement filter mat for collecting liquid positioned across the flow passage, and one or more ducts having intakes situated to draw off liquid from the mat at a region of the flow passage whereat the gas velocity is relatively low. An apparatus of this general type is known from the U.S. Patent No. 2,230,453.

In this known apparatus the drawoff duct is a liquid-downcomer having the upper, intake end thereof positioned immediately beneath the lower surface of the collecting mat. The intake end is fashioned as an annular trough near the outer wall of the passage, and the trough constitutes a deflecting plate extending generally at right angles to the vertical gas-stream which creates within the mat an annular, peripheral region wherein the gas velocity is low in relation to that prevailing in the central region. The intake of the drain is, therefore, situated to receive liquid from the region of the mat wherein the gas velocity is relatively low; this region may be regarded as a shadow zone above the deflecting plate.

The above-described apparatus permits the use of higher gas velocities without the risk of flooding than in devices not having such drains. (By "flooding" is meant the state in which the open spaces within the mat are at least locally filled with liquid to the upper surface of the mat, thereby causing liquid which was already separated to be again entrained by the gas.) Since such liquid-collecting mats are essentially impingement collectors, their collecting efficiency generally increases with increasing gas velocity, up to a limiting velocity at which accumulation of liquid in the mat reaches the flood point. Such drained mats also permit the effective demisting treatment of gas bearing a higher liquid load than that possible at the flood point with undrained mats operated at the same gas velocity. By "liquid load" is meant the quantity of liquid carried in a unit volume of the gas.

Leading up to the making of the present invention, it was found that the degree of interception of liquid by the mat falls off when the quantity of liquid accumulated within the mat is below a certain value. The known filter mat devices, having liquid-downcomers with intakes positioned at the lower surface of the mat, often tend to remove more liquid from the mat than is desirable for achieving a high degree of interception.

It is the general object of this invention to improve further the operation of demisting devices of the type indicated, by improving the effectiveness of the inception of liquid and/or to increase the maximum permissible gas velocity before the flood point.

A specific object is to provide an improved construction of a gas-demisting apparatus employing a drained impingement filter mat which combines the advantage of the

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drain duct with those of a wetted mat arrangement, wherein the mat always contains a certain minimal quantity of liquid.

In summary, according to the invention the objects are achieved in that the intake to the liquid-drawoff duct is situated within the mat between the upper and lower surfaces of the mat. Such a mat may be vertically continuous between the said upper and lower surfaces (interrupted only locally by the said duct intake and, in the preferred design, by a deflecting plate) or may be constructed in vertically spaced layers; in the latter case, the duct intake may be positioned within one of the spaces between layers. By positioning the duct intake between the upper and lower mat surfaces liquid is withdrawn from the upper portion of the mat, but a certain quantity of liquid will always remain within the lower portion; this improves the degree of interception.

Thus, on the one hand this construction reduces the tendency toward flooding by drawing off liquid from the upper portion of the mat and, on the other hand, utilizes the favorable effect on the degree of interception of a large quantity of liquid retained in the lower portion of the mat.

Normally the liquid-drawoff ducts are downcomers, through which the liquid flows by gravity, either to a lower part of the main gas-flow passage below the mat or to the outside of the apparatus, but the invention is not limited to such an arrangement. In a specific variant, applicable to demisting gas wherein the liquid load is low, the drawoff ducts, or at least some of these ducts, have discharge openings situated within the mat, above the lower surface thereof but below the duct intakes. In any arrangement, whenever there is danger of the upflow of gas through the ducts, these are arranged to prevent such flow, e.g., by locating the discharge openings in a liquid seal or providing a U-shaped trap which is always filled with liquid.

It should be understood that whenever reference is herein made to a "mat," it includes any known or suitable structure providing extended surface and a high void volume (in excess of 70% and, usually, above 94%) for the upward flow of gas with but little resistance and having an appreciable thickness (in excess of one inch and, usually, from two to eight inches). The invention is, therefore, applicable not only to the preferred filamentous mats, e.g., those made of woven or knitted sheets made from fine metal wire, but also layers of packing bodies, such as Raschig rings, balls, spirals, or similar elements held between perforated supports and providing a multitude of points or edges on which liquid can be collected. A number of thin mats can be stacked to form a contiguous or non-contiguous series which collectively form a mat as the term is used herein.

The invention will be described in detail with reference to the accompanying drawings forming a part of this specification and showing certain preferred embodiments by way of example, wherein:

Figure 1 is a vertical sectional view through a demisting apparatus according to the invention;

Figure 2 is a vertical sectional view of a modified demister;

Figure 3 is a transverse sectional view taken on the line 3—3 of Figure 2;

Figure 4 is a vertical sectional view through a demister embodying a second modification;

Figure 5 is a transverse sectional view taken on the line 5—5 of Figure 4;

Figure 6 is a vertical sectional view through a demister embodying a third modification;

Figure 7 is a fragmentary, transverse sectional view taken on the line 7—7 of Figure 6; and

Figure 8 is a vertical sectional view through a demister embodying a fourth modification.

Referring to Figure 1 in detail, the apparatus includes a column the wall 10 of which defines a vertical flow passage 11 containing a transverse impingement filter mat 12 mounted between retaining elements 13 and 14, such as heavy large-mesh retaining screens, at the upper and lower surfaces, respectively, of the mat. The mat may, for example, be formed by rolling up about a vertical axis a band of knitted, fine steel wire or other filamentous web so fine that when gas charged with small liquid drops or mist is passed through the mat the said liquid is retained on the mat. The mat may, of course, include other loose packing material, as previously indicated, held between the retaining elements 13 and 14. The passage 11 is so shaped that ascending gas passes through different, horizontally contiguous regions of the mat at different velocities. This effect is preferably achieved by mounting a deflecting plate 15, shaped in this embodiment as an annulus adjoining the wall 10, at a level between the upper and lower surfaces of the mat, so as to create a shadow region within the mat above the plate; in this region the gas velocity will be low in relation to that which prevails in the central region of the mat. It is convenient to form the mat as separate upper and lower sections *a*, *b*, respectively, which are contiguous at the level of the deflecting plate. The positioning of the deflecting plate within the vertical space occupied by the mat, although preferred, is not in every case essential, and the plate may be placed beneath the mat, as shown for the plate 15*b* in Figure 6.

A plurality of liquid-drawoff ducts 16 is secured to the plate 15. Each duct has the upper, intake end thereof in communication through an opening in the plate with the said region of relatively low gas velocity above the plate at a level between the upper and lower surfaces of the mat. The said level may be half-way between the upper and lower surfaces of the mat, as shown, and is usually situated at a distance above the lower surface equal to one-fifth to three-fifths the thickness of the mat. While this range of levels is not in all cases restrictive, it is essential that the distance from the bottom of the mat to the duct intake be chosen sufficiently high so that a reasonable quantity of liquid remains within the lower portion of the mat, but not so high that flooding occurs. The ducts 16 are distributed circumferentially to draw off liquid all around the peripheral, low-velocity region and advantageously are provided with liquid seals. Thus, the ducts 16 may be immersed in liquid contained within an annular sealing trough 17 from which liquid overflows. Liquid within this trough prevents gas from flowing up through the ducts 16 into the mat 12. The apparatus is provided with means 18 for flowing a gas burdened with entrained liquid droplets upwardly through the passage 11 and mat 12; thus, the means 18 may represent variously the top of a distillation column, flashing unit, gas scrubber, or some other unit of a plant from which such a gaseous stream is discharged and which may include a fan or a blower.

In operation, the gas ascending the passage 11 is deflected by the annular plate 15 to traverse the mat 12 mainly through the central region, and flows at a relatively low velocity in the annular shadow region above this plate. The entrained liquid impinges upon the surfaces within the mat and flows from the central region into the shadow region and drains down through the ducts 16 and sealing trough 17. Removal of the liquid from the upper portion *a* of the mat reduces the risk of flooding; in other words, this permits the gas to be flowed at a higher velocity before the open spaces within the mat are filled with liquid to the upper mat surface. However, because the intakes of the ducts 16 are situated above the bottom surface of the mat, the lower portion *b* of the mat retains a layer of liquid which is beneficial

in enhancing the ability of the mat to intercept liquid droplets from the gas and to retain such liquid.

Figs. 2 and 3 show a modification which is of particular advantage when the column 10 has a larger diameter. In this embodiment an extra, annular deflecting plate 19 is mounted by means of spokes 19*a* at the level of the plate 15 in radially spaced relation thereto and creates an additional, annular shadow region of low gas velocity. A plurality of liquid-drawoff ducts 20 extends from this low-velocity shadow region into a liquid-filled sealing trough 21 carried by spokes 21*a*. Other reference numbers denote parts previously described for Fig. 1 and the operation is similar.

The embodiment of Figs. 4 and 5 includes two changes: the inner deflecting plate 19 is replaced by a disc 22 supported by spokes 22*a* and provided with a single duct 20; and the duct from the peripheral low-velocity zone is a cylindrical wall 23 spaced inwardly from and concentric to the wall 10 so as to define an annular duct 24 communicating with the peripheral shadow region through a circle of intake openings 25 formed in the plate 15. Other reference characters denote parts previously described and the operation is similar.

Referring to Figs. 6 and 7, there is shown an embodiment wherein the liquid-drawoff duct extends to the outside of the column and wherein the mat comprises vertically spaced portions *a* and *b*, having retaining elements 13*a*—14*a* and 13*b*—14*b*, respectively. Annular deflecting plates 15*a* and 15*b* are situated immediately beneath the upper and lower sections *a* and *b*, respectively. At the level of the upper deflecting plate 15*a* the column 10 is provided with a plurality of openings 26 leading to an annular collecting chamber 27 which is fitted with a drain duct 28. The latter extends into a sealing pot 29 having an overflow outlet 30. It is evident that the openings 26 and the chamber 27 constitute the intake to the drawoff duct. Gas, burdened with entrained liquid emerging from the supply means 18, is demisted by the mat as described for Fig. 1.

Fig. 8 shows an embodiment in which the drawoff ducts 31, which have their intakes positioned at the upper surface of the annular plate 15, are so curved as to discharge upwardly to a plane 32 which is situated between the lower surface of the mat and the plane of the intakes. These ducts extend beneath the plane 32 to form liquid traps 33, so as to prevent the upflow of gas through the ducts. Other reference numbers denote parts previously described. In this embodiment the ducts 31 lead liquid from the upper portion of the mat to the lower portion, so that the risk of flooding is reduced, while maintaining a layer of liquid within the lower portion of the mat to improve the degree of interception.

Although flat, horizontal mats were shown, these characteristics of the mats are not in every case essential, it being necessary only that the mats be arranged to provide an upper section which contains relatively less liquid than a section below it.

The apparatus described may be used in all cases wherein a liquid, such as oil or water, occurring as droplets must be removed from a gas stream, e.g., in the effluent from distillation columns, separators, flashers, evaporators, air-treating installations and the like.

Example

A column 20" in diameter was fitted as shown in Figures 6 and 7 with a mat consisting of two sections, each 4" high with a 3/4" interval and an annular deflecting plate 2" wide beneath each mat section, and had a lateral liquid-drawoff including openings and an external collecting chamber, as also shown in these views. The mat was made of fine wire, 0.27 mm. in diameter, and had 97% free volume. Air was passed upwards at various flow rates and the velocities were determined by averaging the rate over the free area within the deflector rings. Spindle oil was charged into the air

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stream at a constant rate of 2 kg. per hour in the form of a fine mist with a maximum droplet size of about 40 microns.

The separating efficiency increased up to a maximum of over 97% at an air velocity of 5.5 meters per sec.; at this velocity the lower mat section just started flooding and the pressure loss across the total mat was only 67 mm. of water column while the total oil hold-up was 1.5 kg.

For comparison, another run was made in which the lower mat section was omitted, whereby the apparatus corresponded to the known arrangement with the liquid-drawoff intake beneath the mat. In this run the maximum efficiency at an air velocity of 5.5 meters per sec. was only 92.5%, and reached a value of 92.8% at about 6.8 meters per sec. In a second comparative run wherein the lower mat section was also omitted and the liquid-drawoff duct was shut off the maximum efficiency was 91%, attained at an air velocity of about 5 meters per sec.; the efficiency dropped off to below 85% at 5.8 meters per sec.

I claim as my invention:

1. Apparatus for removing liquid particles from a gas stream which comprises a confining wall defining a flow passage which is substantially upright and of substantially constant cross sectional area, an impingement filter mat positioned entirely across said passage, gas-deflecting means at said mat obstructing a portion of the flow passage and situated a sufficient distance below the top thereof to define within the mat immediately above the deflecting means a shielded region of relatively low gas velocity and, laterally contiguous to said shielded region, a region of higher high gas velocity, and at least one liquid-draw-off duct having an intake situated between the upper and lower surfaces of the mat within said shielded region, whereby the part of the mat beneath the level of said intake can be substantially filled with liquid while the part above said level is only partly filled with liquid.

2. Apparatus according to claim 1 wherein said gas-deflecting means is a plate situated intermediate the upper and lower surfaces of the mat.

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3. Apparatus according to claim 2 wherein said plate is annular and a plurality of said ducts is provided, said ducts being downcomers extending through said plate at circumferentially spaced locations.

4. Apparatus according to claim 1 wherein at least one of said liquid-drawoff ducts is a downcomer spaced inwardly from said confining wall.

5. Apparatus according to claim 1 wherein at least one of said liquid-drawoff ducts is a downcomer pipe having a discharge opening situated within the mat below the intake of the downcomer and above the lower surface of the mat.

6. Apparatus according to claim 1 wherein said liquid-drawoff duct is a downcomer having a discharge situated below the said mat within a liquid seal formed by a seal pot, said seal pot having a discharge.

7. Apparatus according to claim 1 wherein said liquid-drawoff duct extends outside of said confining wall.

8. Apparatus according to claim 1 wherein said mat is vertically continuous between said upper and lower surfaces thereof.

9. Apparatus according to claim 1 wherein said mat includes two layers which are vertically spaced and situated respectively above and below the said intake of the liquid-drawoff duct.

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