PATENT SPECIFICATION (11) 1 570 692

1 570 692

(21) Application No. 49318/76 (22) Filed 25 Nov. 1976

(31) Convention Application Nos.
2 553 856 (32) Filed 29 Nov. 1975
2 624 187 29 May 1976 in

(33) Fed. Rep. of Germany (DE)

(44) Complete Specification published 9 July 1980

(51) INT. CL.[3] B01D 45/12

(52) Index at acceptance
B1T 1204 1301 1305 1307 1309 1705 BE

(54) APPARATUS FOR SEPARATING DROPLETS OF LIQUID FROM A GAS

(71) I HEINZ HOLTER, a German Citizen of Beisenstr. 39-41, 4390 Gladbeck, Germany, do hereby declare the invention for which I pray that a Patent may be gratend to me and the method by which it is to be peformed to be particularly described in and by the following statement:—

This invention concerns apparatus for separating droples of a liquid, for example a washing liquid, from a gas, and in particular the kind in which a stream of gas is conducted along a curvilinear path.

Apparatus of this kind is widely known, and includes cyclonic separators (also known at Drop or Trickle separators) which have contact edges upon which the stream of gas is impinged, and lamellar separators, or a combination of these two systems. Separators of this kind may be collectively grouped under the heading of Radial Drop or Trickle separators.

In such radial separators radial movement of the gas stream is invariably accompanied by movement in a longitudinal direction. In cyclonic separators and similar apparatus, the gas is conducted along a generally helical path, which frequently results in the formation of "Schlieren", or stratification of the gas stream into layers, which results in a considerably less efficient separation effect. Additionally, the droplets or mist particles entrained generally along the axis of gas stream tend not to be separated out, and remain entrained within the gas stream as it leaves the apparatus.

It is one of the various objects of this invention to provide apparatus, by the use of which one or more of the disadvantages of presently available drop or trickle separators may be overcome.

This invention provides apparatus for separating liquid droplets from a gas and comprising an elongate separation chamber which is part annular in cross section and which is defined by interior and exterior walls which are at least part cylindrical, the separation chamber being provided with spaced inlet and outlet openings which extend substantially the whole of the length of the chamber and parallel to the longitudinal axis thereof, an inlet chamber connected to the inlet opening, said inlet chamber providing an inlet passageway which decreases in cross sectional area as it extends towards the inlet opening, and an outlet chamber connected to the outlet opening, said outlet chamber providing an outlet passageway which increases in cross sectional area as it extends away from the outlet opening, wherein a plurality of inlet ducts are connected to the inlet chamber, through which gas containing liquid droplets may be fed into the inlet chamber generally radially with respect to the separation chamber, and the construction and arrangement are such that, in use, gas flows through the inlet ducts into the inlet chamber generally radially with respect to the separation chamber, and from the inlet chamber through the inlet opening into the separation chamber in a direction generally tangential to the interior wall thereof, the exterior wall being provided with slits extending lengthwise of the separation chamber through which liquid carried by the gas may pass therefrom as the gas flows around the separation chamber.

Thus, by the use of the apparatus, the stream of gas is positively guided in the form of a layer along a curvilinear path through the part-annular separation chamber with little or no movement in a direction longitudinally of the chamber, the gas flowing along paths which lie generally in planes extending at right angles to the longitudinal axis of the chamber, and being introduced into the chamber in a sub-

stantially smooth and shock-free flow.

This prevents the stratification of the gas stream into layers, and all the droplets of liquid carried by the stream of gas are subjected to similar forces in their passage through the chamber, so that substantially all said droplets can be trapped on the exterior wall and evacuated through the longitudinal slits. In this manner, the separation capacity of the apparatus is extremely good.

Desirably gas flowing through the outlet opening from the separation chamber into the outlet chamber is diverted into a generally radial direction.

The outlet chamber may be succeeded by a de-mister device through which, in use, gas flows from the outlet chamber, and which is designed to separate residual mist droplets from the gas stream.

Separation efficiency of the apparatus may be further improved by the provision of baffle elements connected to the exterior and/or interior walls of the chamber, and which extend into the part-annular chamber, conveniently being provided by plates which are adjustably hinged to one or both side walls and extending longitudinally of the chamber. By the use of such adjustable elements, it is possible to reduce the cross section of the separation chamber and thus obtain higher contact energy, which improves the degree of separation. The adjustable elements may also be used to deflect the gas stream towards the longitudinal slits in order to improve droplet separation.

In the washing or scrubbing of, for example, heavily sulphur-polluted waste gases, it is necessary to work with very high water contents. In this event it is preferable to separate a major proportion of the water contained in the gas stream before this is admitted to the separation chamber. This can successfully be achieved by connecting to the inlet chamber a lamellar water stripper which extends across, preferably at right angles to, the direction of flow of the gas stream into the inlet chamber. Preferably the water stripper comprises a grating of parallel members of angular cross-section and a drainage conduit, preferably in the form of a pouch, fitted beneath said grating to catch the water which has been separated thereby from the gas stream. Thus, gas togethetr with the washing liquid carried thereby, will first impinge on the grating, and pass therethrough, and will collect in the region of the drainage conduit and be deflected with the consequence that most of the washing liquid will separate. The re-directed gas stream passes again through the stripper grating, whereby a further quantity of water will be extracted, and is then directed into the separation chamber. In this way, as much as 90% of the water content may be extracted from the gas stream before it is actually fed into the separation chamber.

Conveniently, to reduce energy loss suffered by the gas stream in its passage through the water stripper, the grating may be designed, at least in part, as a deflector to change the direction of the stream of gas from a generally radial inward direction into a generally tangential direction into the separation chamber.

There will now be given detailed descriptions, to be read with reference to the accompanying drawings, of two preferred embodiments of this invention which have been selected to illustrate the invention by way of example.

In the accompanying drawings:—

FIGURE 1 is a perspective view, part shown in section of the apparatus which is the first embodiment of this invention; and

FIGURE 2 is a view similar to that shown in Figure 1 of the apparatus which is the second embodiment of this invention.

The apparatus illustrated in Figure 1 of the drawings is designed to separate droplets of a washing liquid from a stream of gas, and comprises a part-annular separation chamber 5 which is defined by an interior wall 6, provided by a cylindrical pipe, and an exterior wall 7 which is arranged concentrically with the interior wall. The chamber 5 is provided with an inlet opening which extends substantially the whole of the axial length of the chamber 5, and parallel to the longitudinal axis thereof, and connected to said inlet opening is an inlet chamber 3, said chamber 3 providing an inlet passageway which decreases in cross-sectional area as it extends towards the inlet opening. A plurality of inlet ducts 1 open into the inlet chamber 3, said inlet ducts having axes extending generally radially of the separation chamber and each housing spray jet means 2, whereby washing liquid may be introduced into the streams of gas flowing through the inlet ducts. In the use of the apparatus, the gas flow through the inlet ducts 1 is in a direction generally radially of the separation chamber, and the construction and arrangement of the inlet chamber is such as to change the direction of flow of such gas from this radial direction to a direction generally tangential to the interior wall as the gas flows through the inlet opening into the separation chamber 5.

Spaced from the inlet chamber 3 is an outlet chamber 10. In a similar manner, the outlet chamber 10 is connected to an

outlet opening of the chamber 5 and provides an outlet passageway which increases in cross-sectional area as it extends away from the outlet opening, said outlet opening also extending substantially the whole of the length of the separation chamber and parallel to the longitudinal axis thereof.

In use of the apparatus gas flows from the separation chamber through the outlet opening into the outlet chamber 10, which is provided with baffle plates 11 to cause the gas flowing from the separation chamber through the outlet opening into the outlet chamber to be diverted into a generally radial direction. The enlargement of the outlet chamber 10 from the point of exit from the separation chamber is preferably sufficient to provide for diffusion of the gas as it leaves the chamber.

The exterior wall 7 is provided with a plurality of circumferentially spaced scaling or skimmer slits 8 extending lengthwise of the chamber 5, viz, in the axial direction.

A demister device 12, which may be a filter, is connected to the outlet chamber 10 and below said demister device 12 there is a channel 13 to catch and evacuate the water collected in the demister device 12.

The apparatus illustrated in Figure 1 includes a housing 14 whereof the lower portion 15 is of funnel configuration to collect the water separated from the gas during its passage through the separation chamber, and which comprises a suitable pipeline 16 for evacuating the collected water, and operates in the following way:—

The gas stream laden with washing liquid passes, radially of the separation chamber into the inlet chamber 3, and is diverted to pass tangentially through the inlet opening into the part-annular separation chamber 5. The water droplets which are conveyed by the gas stream are pushed by the centrifugal forces in the direction towards the exterior wall 7 and escape through the slits 8, possibly with part of the gas stream. The water collects in the lower portion 15 of the housing 14 and is evacuated through the pipeline 16. Residual mist droplets which have not been separated out in this way will be trapped in the demister device 12.

In the apparatus illustrated in Figure 1 the interior wall 6 is provided on the side which faces the chamber 5 with a plurality of circumferentially-spaced axially extending baffle elements provided by adjustable plates 17 hingedly mounted on the wall, whereby to improve contact energy and to direct the gas stream towards the slits 8 with the result of improved droplet separation.

The apparatus, which may be considered to be a cylinder-type design of a radial trickle separator, conducts the gas stream in a comparatively thin layer substantially exclusively in the circumferential direction of the chamber 5 and substantially no flow in the axial direction takes place. Consequently, the risk of stratification of the gas formation is eliminated.

In the apparatus illustrated in Figure 2, like references have been used for like parts. Basically the apparatus according to Figure 2 is designed in the same way as the apparatus according to Figure 1. However, the apparatus shown in Figure 2 additionally comprises a lamellar water stripper comprising a grating arranged orthogonally in relation with the direction of flow of the admitted gas stream, said grating 18 in the illustrated example consisting of a plurality of relatively parallel members of angular cross section. Beneath the grating 18 there is provided a drainage conduit 19 in the form of a pouch or bag for evacuation of the water which has been striped from the gas stream. It will be noted from Figure 2 that the stripper grating 18 is at least partly designed to change the gas flow from a radial direction into a direction which is tangential relative to the chamber 5 by virtue of the fact that one of the angles of the grating 18 is arranged in the immediate vicinity of the point at which the gas stream enters into the chamber 5.

The apparatus illustrated in Figure 2 works in the following way:

The gas which has been enriched with large quantities of washing liquid, flows initially in the radial direction (arrow 20) into the inlet chamber 3 and there impinges against the water stripper grating 18 which is arranged orthogonally relative to the direction of gas flow, and passes through this grating, where some of the water is retained in the region of the drainage conduit 19, and the gas redirected in the direction of the arrows 21. This reversal of flow causes the major part of the washing liquid to fall out of the gas stream. A further portion of the washing liquid still carried along by the gas stream is separated out in the course of the second passage through lamellar grating 18 after said reversal of flow. In the final result up to 90% of washing liquid is extracted from the gas stream before the latter enters into the chamber 5 wherein it is cleaned of the remaining water droplets.

WHAT WE CLAIM IS:

1. Apparatus for separating liquid droplets from a gas and comprising an elongate separation chamber which is part annular in cross section and which is defined by interior and exterior walls which are at least part cylindrical, the separation

chamber being provided with spaced inlet and outlet openings which extend substantially the whole of the length of the chamber and parallel to the longitudinal axis thereof, an inlet chamber connected to the inlet opening, said inlet chamber providing an inlet passageway which decreases in cross sectional area as it extends towards the inlet opening, and an outlet chamber connected to the outlet opening, said outlet chamber providing an outlet passageway which increases in cross sectional area as it extends away from the outlet opening, wherein a plurality of inlet ducts are connected to the inlet chamber, through which gas containing liquid droplets may be fed into the inlet chamber generally radially with respect to the separation chamber, and the construction and arrangement are such that, in use, gas flows through the inlet ducts into the inlet chamber generally radially with respect to the separation chamber, and from the inlet chamber through the inlet opening into the separation chamber in a direction generally tangential to the interior wall thereof, the exterior wall being provided with slits extending lengthwise of the separation chamber through which liquid carried by the gas may pass therefrom as the gas flows around the separation chamber.

2. Apparatus according to claim 1 wherein, in use, gas flowing through the outlet opening into the outer chamber is diverted into a direction generally radially of the separation chamber.

3. Apparatus acording to one of claims 1 and 2 wherein the outlet passageway increases in cross-sectional area to an extent sufficient to provide for diffusion of the gas as it leaves the separation chamber.

4. Apparatus according to any one of the preceding Claims comprising a demister device connected to the outlet chamber and through which, in use, gas flows from the outlet chamber.

5. Apparatus according to any one of the preceding Claims comprising baffle elements connected to the interior and/or exterior walls, and which extend into the separation chamber.

6. Apparatus according to Claim 5 wherein the baffle elements are provided by plates hingedly connected to the interior wall and which are adjustable to vary the degree of deflection of gas flowing in the separation chamber towards the exterior wall.

7. Apparatus according to any one of the preceding Claims wherein the inlet chamber is in communication with a lamellar water stripper extending substantially at right angles to the direction of gas flow into the inlet chamber, ducting means being provided below the water stripper for draining the water removed thereby.

8. Apparatus according to Claim 7 wherein the water stripper comprises a grating of parallel members of angular cross-section, one side of each member constituting means to change the direction of flow of gas from a direction which is generally radial with respect to the separation chamber to a direction generally tangential to the interior wall.

9. Apparatus for separating liquid droplets from a gas, constructed and arranged substantially as hereinbefore described with reference (a) to Figure 1, or (b) to Figure 2 of the accompanying drawings.

FORRESTER KETLEY & CO.
Chartered Patent Agents
Rutland House,
148 Edmund Street,
Birmingham B3 2LD
— also at —
52 Bounds Green Road,
London. N11 2EY
and
Scottish Provident Building,
29 St Vincent Place,
Glasgow G1 2DT

Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1980.
Published at the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

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Sheet 1

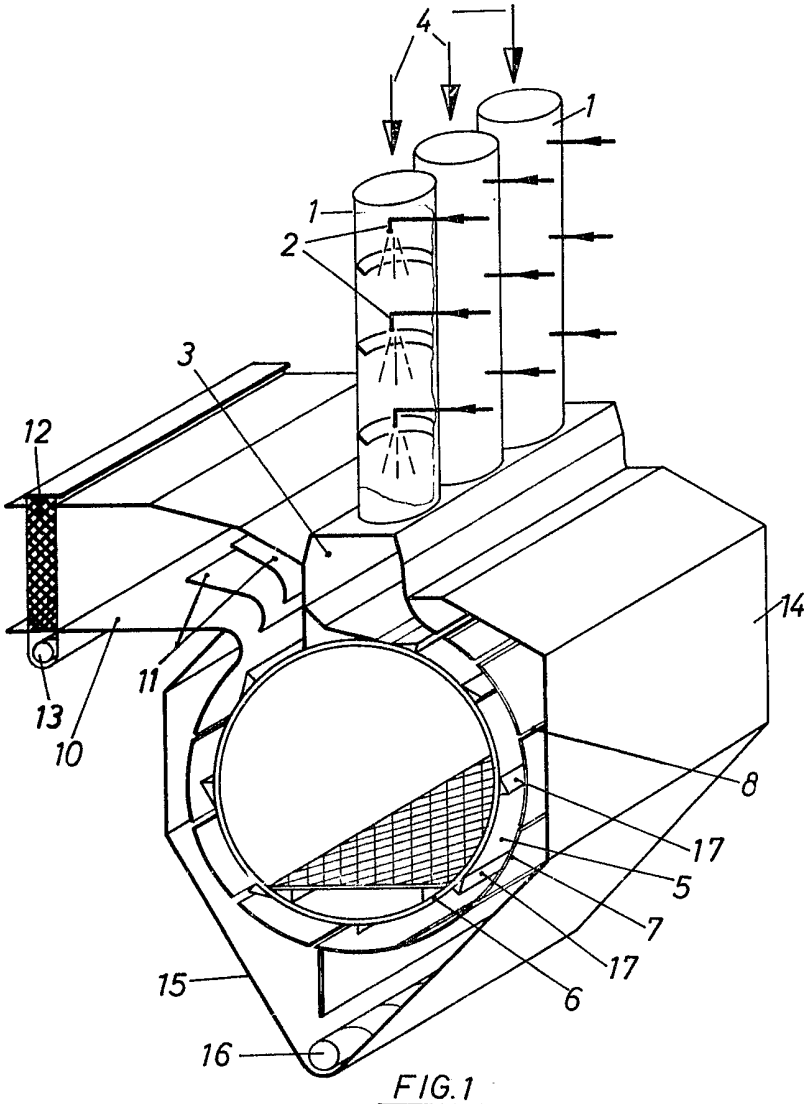

FIG.1

1570692 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

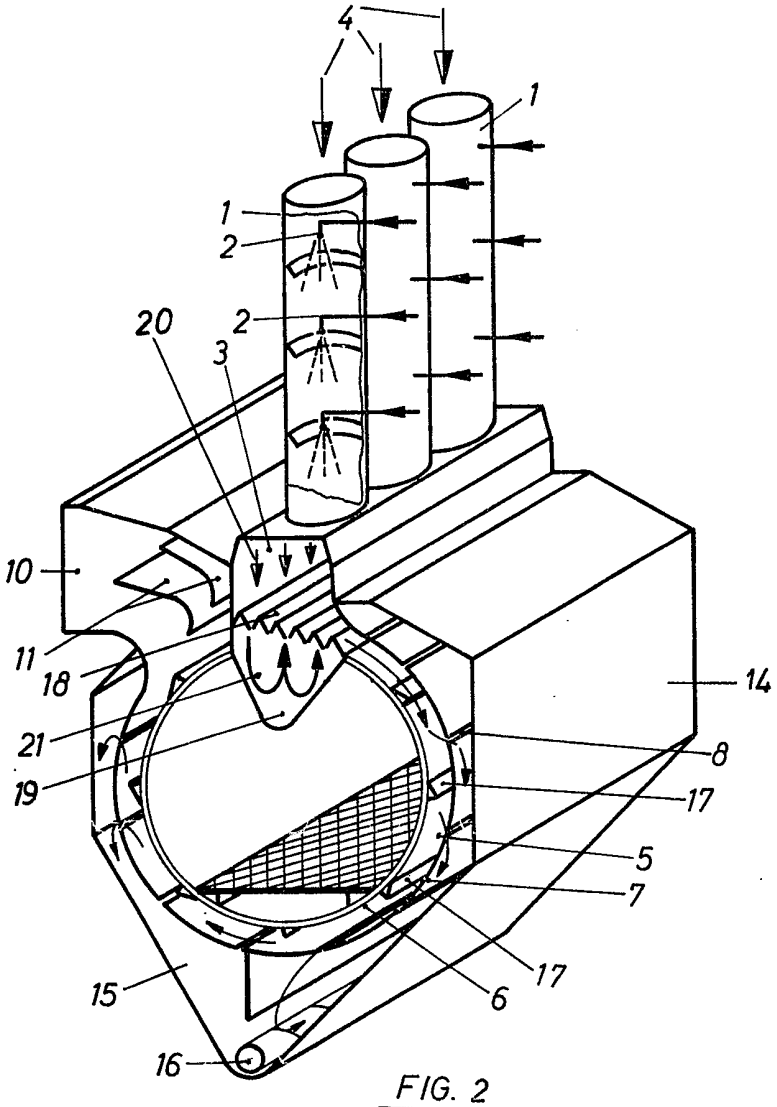

FIG. 2