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(54) **COMPACT GAS-LIQUID SEPARATOR**

(57) The invention is intended for reliable and highly efficient separation within the wide range of gas consumption. The separator contains a vertical cylindrical body, a horizontal partition, inlet, outlet and drain pipes, a deflector installed in the direction of the flow spinning and a vertical separation unit with a flat bottom consisting of flat bent separation plates creating parallel plate ducts in the overlapping zone; the ends of these plates are distributed in various directions tangentially towards the external and internal diameters of the separation unit; the separator also contains a false bottom; in the center

of the flat and false bottoms there are the through holes with a hollow cylinder inserted into them; the cylinder base is seated on the false bottom; the upper cylinder edge is elevated above the false bottom surface; a cylindrical vertical diffuser with notches is installed at the external diameter of the lower false bottom surface; a disc is attached directly under the hollow cylinder; the separator comprises a deflector, the movable part of which can be displaced relative to the body wall using the running screw.

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Description

Field of the Invention

[0001] The invention relates to separation of gas and liquid phases and can be applied as a compact gas/liquid and liquid/gas unit in oil, gas, machine building, chemical and other industries.

Background of the Invention

[0002] A compact separator (RU 2244584, publ. 20.01.2005) is known [1]. The said separator comprises a vertical cylindrical body, horizontal partition, inlet/outlet and drain branch pipes, a deflector installed in the direction of the gas-liquid flow spinning and a vertical separation unit. The unit has vertical flat plates with bent ends. Parallel plate ducts are created by the plates in the overlapping zone. The plate ends are directed in various directions and are tangential to the external and internal diameters of the separation unit. The axial line of the inlet pipe is displaced horizontally relative to the axial line of the separator body by $\frac{1}{2}$ diameter of the inlet pipe; diameter of the inlet pipe does not exceed $\frac{1}{4}$ of the body diameter. The deflector has the max. permeable section and is installed in the inlet of the gas-liquid flow spinning.

[0003] The deflector section is narrowed horizontally in the direction of the gas-liquid flow spinning, but increased vertically. The cross section area is not changed anyhow. An arc-shaped plate is installed in the upper narrowed deflector part. The plate descends down the gas-liquid flow. The plate is guided under the angle of $15^\circ - 30^\circ$ to the horizontal line. A bent plate is also installed in the direction of the gas-liquid flow spinning, with a clearance towards the inner side of the body. The lower end of this plate overlaps the lower deflector cover.

[0004] Displacement of the inlet pipe axial line with respect to the axial line of the separator body by $\frac{1}{2}$ diameter of the inlet pipe creates a sliding impact onto the deflector surface. The deflector prevents gas from entering the axial area of the separation unit without pre-separation of gas suspension. Variable section of the deflector minimizes head losses in this part of the device. Thanks to the variable section of the deflector at the deflector outlet the gas-liquid flow is cleared of the separation unit ducts horizontally and the liquid phase load is distributed uniformly vertically. This increases the contact area of moisture drops with the body walls. At the same time with respect to the minimum deflector clearance at the outlet and surface tension the liquid phase is "pressed down" towards the separator body interior surface, which improves the process of separation.

[0005] However, hydrodynamic tests of this separator with optimal geometric dimensions - such as diameter/height ratio of the body, separation unit diameter and height, deflector width and other dimensions - show that the distance between the deflector surface and external surface of separation unit is a bottleneck. Therefore in

the process of gas-liquid phase separation a zone of reduced pressure is created in the central spinning flow area, drawing in a certain part of the separated air mass. It negatively affects the final separator output.

[0006] The compact gas-liquid separator (RU 2320395, publ. 27.03.2008) [2] is the prototype of the claimed invention. The separator contains a vertical cylindrical body, a horizontal partition, inlet, outlet and drain pipes, a deflector installed in the direction of the gas-liquid flow spinning and a vertical separation unit with flat bottom. The separation unit consists of flat vertical plates with bent ends. Parallel plate ducts are created by the plates in the overlapping zone.

[0007] The plate ends are distributed in various directions tangentially towards the external and internal diameters of the separation unit. The separator is also equipped by a false bottom. The through holes are provided in the center of the flat and false bottoms of the unit and a hollow cylinder is inserted into them. The cylinder base is installed on the false bottom and the top cylinder edge is elevated above the flat bottom. At the external diameter of the lower surface of the false bottom a cylindrical vertical diffuser with notches is installed. A disc is attached directly under the hollow cylinder.

[0008] The spinning motion of gas (air) flow inside the separation unit creates a low pressure zone in the central part of the spinning air mass. A hollow cylinder, through which the gas flow runs, creates no additional head losses in the separator. Transportation of additional flow through the hollow cylinder increases the separator output in the gas phase. Displacement of the axial inlet pipe line relative to the axial line of the device body allows effective operation of the separator in a wide range of gas-liquid and liquid-gas devices. As a result, the same design suits both types of separators.

[0009] A common drawback of the centrifugal separators described above is as follows: a narrow gas consumption range, where separator operates effectively, i.e. under the conditions of relative low pressure losses. Within a narrow gas consumption range increase of the rate results in rising hydraulic resistance, and decrease - in decreasing separation output. One possible solution for this problem consists of installation of multiple separators, each of them with different capacity. For instance, one separator is of 33% output, and the other one of 67%. This increases costs for body wiring and therefore is not advantageous economically.

Brief Description of the Invention

[0010] To solve the described problem, maintaining of the effective operation range of the separator is offered. This is a gas consumption range where the separator operates adequately effectively with small pressure losses. If this range is exceeded, pressure losses increase rapidly and if the preset range is not reached - efficiency of separation is decreased as small drops are taken away by the flow, because the velocity is not sufficient to push

them to the wall. It is proposed to maintain the effective range of separator operation by applying deflector with adjustable outlet section. The movable part of deflector can be displaced relative to the body wall. Displacement of the movable deflector part is made using a running screw. If, during operation, the gas-liquid flow section can bring the separator back to the effective range of gas consumption. Adjustment of the outlet section enables to maintain a constant high velocity of the gas-liquid flow, which, in turn, shall provide constant and high effective operation within a wider range of gas consumption.

Brief Description of the Drawings

[0011] Fig. 1 shows the section of the proposed separator; Fig.2 - Section A-A; Fig. 3-Section B-B; Fig. 4 - section b-b.

Detailed Description of the Invention

[0012] The separator has a vertical cylindrical body 1 with the axis 0, horizontal cover 2 with cylindrical opening 3 with outlet pipe 4 arranged above it. The separator is also equipped by an inlet pipe 5 connected with the body 1 in its upper part, and the deflector 6. The deflector 6 is installed in the direction of the gas-liquid flow spinning and forms the spinning motion of gas-liquid flow inside the separator. The separator has a separation unit 7. Axis O_1 of the unit 7 is displaced with respect to the axis 0 of the body 1 so that the clearance between the deflector 6 and the external surface of the unit 7 conforms to the clearance between the external surface of the separation unit and the internal surface of the separator body 1. The separation unit 7 comprises flat plates 8 with bent ends. Bent ends of the plates 8 are distributed in various directions tangentially towards the external and internal diameters of the separation unit 1. The plates 8 are fixed along the internal perimeter of the horizontal cover 2. They assist to maintain constant size of the ducts 9 in the overlapping area.

[0013] In the upper part of the separation unit 7 between the lower external surface of the outlet pipe 10 and the internal surface of the upper part of the plate 8 an annular clearance (not shown) is created. This clearance is intended for compensation of uneven linear extension of the body 1 and the unit 7. This clearance creates, together with the internal surface of the horizontal cover 2, a trap pocket 11.

[0014] Inside the lower part of the plates 8 a flat bottom 12 is arranged. The flat bottom 12 is elevated relative to the lower edge of the plates 8. The bottom 12 has a radial clearance 13 relative to the internal surface of the lower part of the plates 8. The bottom 12 is connected with the false bottom 15 by radial plates 14 at the distance of 0.1-0.15 of the separation unit 7 diameter. The annular clearance 16 is created between the separator body 1 and the false bottom 15.

[0015] The bent plate 17 is installed in the direction of

the gas-liquid flow spinning directly upstream the inlet pipe with a clearance towards the internal side of the device body 1, exceeding the deflector height. Right end of the bent plate 17 protrudes under the lower deflector cover 2.

[0016] In the center of the flat bottom 12 of the separation unit 7 and the false bottom 15 there are the central openings with a hollow cylinder 18 inserted inside them. The cylinder base 18 is installed on the false bottom 15 and the upper edge of the cylinder 18 is elevated relative to surface of the bottom 12.

[0017] Brackets 19 and ring 20 attached to the plates 8 fix the cylinder 18, the flat bottom 12 and the false bottom 15. The cylindrical vertical diffuser 21 with notches is installed on the outer diameter of the lower surface of the false bottom 15.

[0018] Directly under the hollow cylinder 18 the disc 22 is fixed. The separated liquid phase flows down the body walls 1 into the separator storage vessel 23, from where it is transported on the separator bottom 24 into the drain opening 25. The connecting pipe 26, intended for periodic draining of collected suspended particles, if any, is installed to the bottom 24.

[0019] Location of the deflector 6 relative to the wall of the body 1 is characterized by the outlet section 27. Adjustment of this section is performed by the movable part 28 of the deflector 6 created by the clearance 29. For compensation of the mutual displacement of structure. Displacement of the movable part 28 is ensured by the running screw 32 located in the lug 33 welded into the body 1. Tight connection is provided with the bushing 34, which also has a protective function.

Principle of separator operation.

[0020] Gas-liquid mixture is fed into the device through the inlet pipe 5. Displacement of the inlet pipe 5 horizontally relative to the central line of the body 1 creates the sliding impact of the flow onto the surface of the deflector 6. The deflector 6 prevents gas from penetrating into the axial area of the separation unit 7 without pre-separation of gas suspension. Prior to start, the separator, the movable part 28 of the deflector 6 is adjusted against the wall 30 by rotating the running screw 32. It sets the separator to a lower gas consumption, while keeping efficiency of the separation.

[0021] The main volume of liquid is released from the gas flow in the zone, created by the wall of the body 1 and by the plates 8. Liquid drops are thrown by centrifugal force onto the separator walls of the body 1 and are transported by gravity in the direction of the gas flow spinning as a downward spiral through the annular clearance 16 towards the drain pipe 25.

[0022] The finely dispersed dropping liquid not settled on the body 1 reaches external surface of the vertical plates 8 and is taken by the gas flow through the inlet tangential ducts reaching their internal surface.

[0023] Thanks to design of the plates 8 the liquid film

is transported in the direction of the gas flow from the end of one plate 8 towards the beginning of the other one. When leaving the plates 8, the said film keeps tangential trajectory of movement relative to the internal diameter of separation unit 7.

[0024] By rotational motion of the gas flow inside the separation unit 7, creating a low-transported through the cylinder 18 towards the outlet opening. Most of the gas mass (air) goes down as the descending spiral into the separation unit, some gas goes through the annular clearance 16 towards the storage vessel 23. Passing through the diffuser 21 notches, the flow loses its centrifugal force and is sucked in the calm state by the hollow cylinder 18. Going down the internal plate surface 8 the liquid particles approaching the lower edge slip off and reach the surface of the false bottom 15, from where they are transported towards the drain pipe 25 through the annular clearance 16.

[0025] Application of the claimed separator shall provide high and stable efficiency of separation within a wider range of gas consumption.

Claims

1. The compact separator for separation of the gas and liquid phases comprising a vertical cylindrical body 1, a horizontal partition, inlet, outlet pipe, drain pipes 25, a deflector 6 installed in the direction of the gas-liquid flow spinning, a vertical separation unit 7 with a false bottom 15 made of flat bent separation plates 8 creating the parallel plate ducts in the overlapping zone; the plate 8 ends are distributed in various directions tangentially towards the external and internal diameters of the separation unit 7 and the false bottom 15; wherein in the center of the flat bottom and false bottom 15 of the separation unit 7 the through holes are provided with a hollow cylinder 18 inserted into them; the base of the cylinder 18 is arranged on the false bottom 15, the upper edge of the cylinder 18 is elevated relative to the surface of the false bottom 15; a cylindrical vertical diffuser 21 with notches is installed at the outer diameter of the lower part of the false bottom 15; under the hollow cylinder 18 a punched disc with the following feature is arranged, **characterized in that** the separator contains a deflector 6, the movable part of which enables displacement relative to the wall of the body 1 thanks to the running screw 23.

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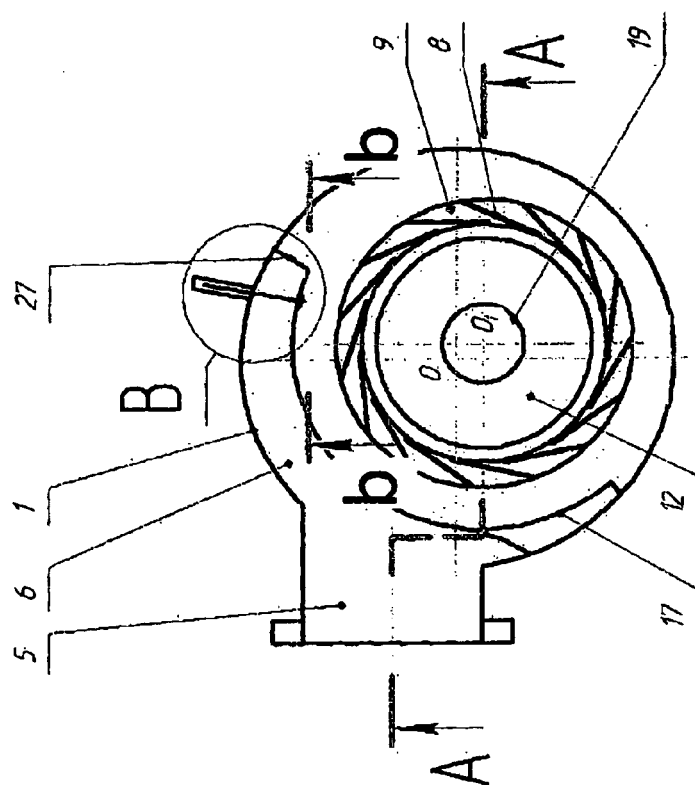
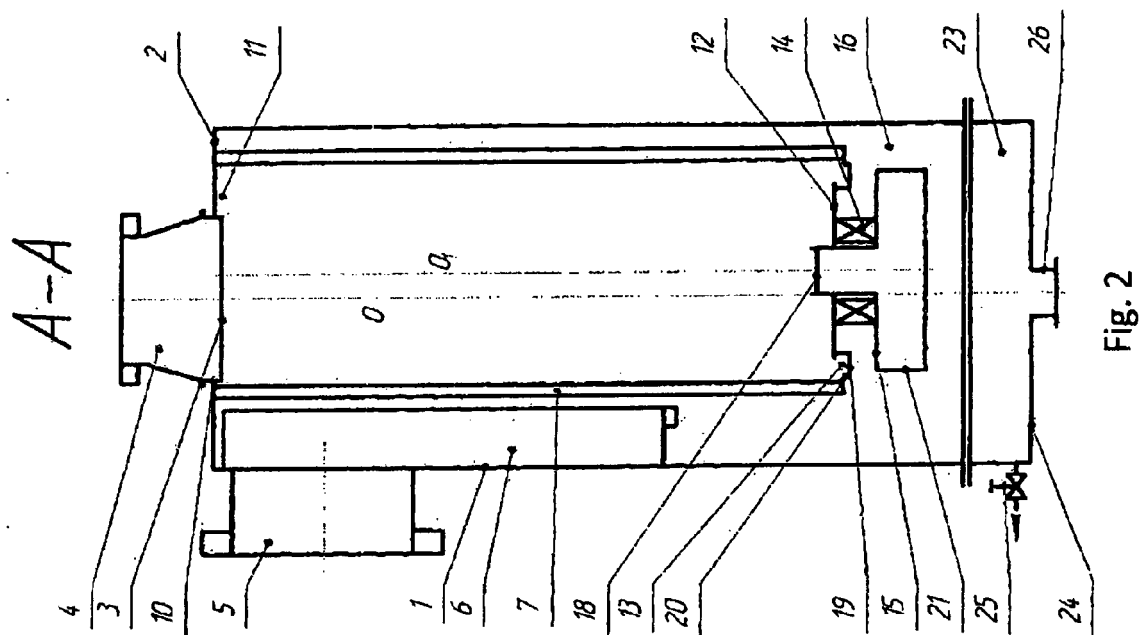
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B-B

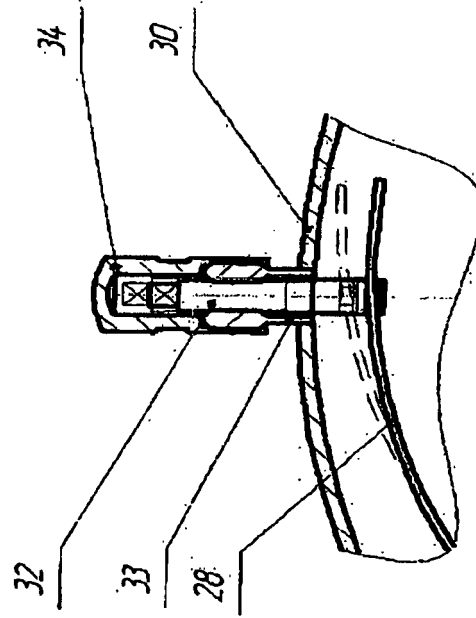


Fig. 3

b-b

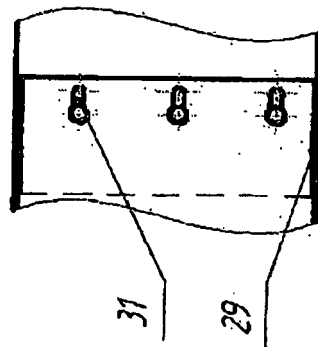


Fig. 4



EUROPEAN SEARCH REPORT

Application Number
EP 15 00 0977

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A	US 3 865 242 A (MUSTO RICHARD LEOPOLD) 11 February 1975 (1975-02-11) * column 4, line 24 - column 5, line 64; figure 1 *	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			B04C
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 12 May 2016	Examiner Tiercet, Marc
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12-05-2016

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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