July 14, 1970 R. R. GOOD 3,520,116

VAPOR-LIQUID SEPARATOR HAVING IMPROVED VANE SPACER MEANS

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Fig. 2.

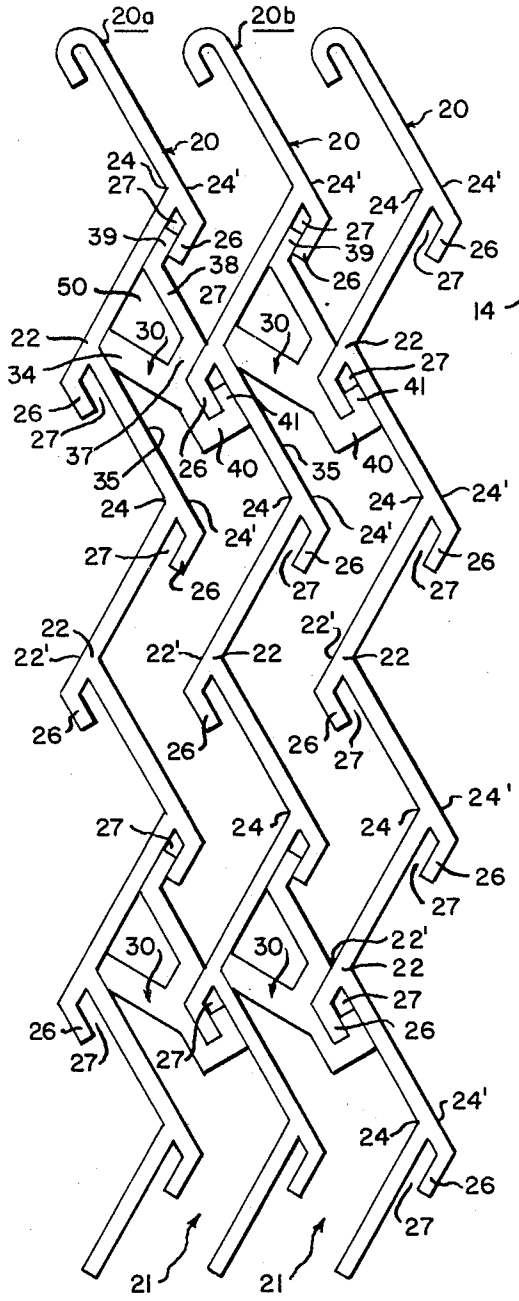


Fig. 1.

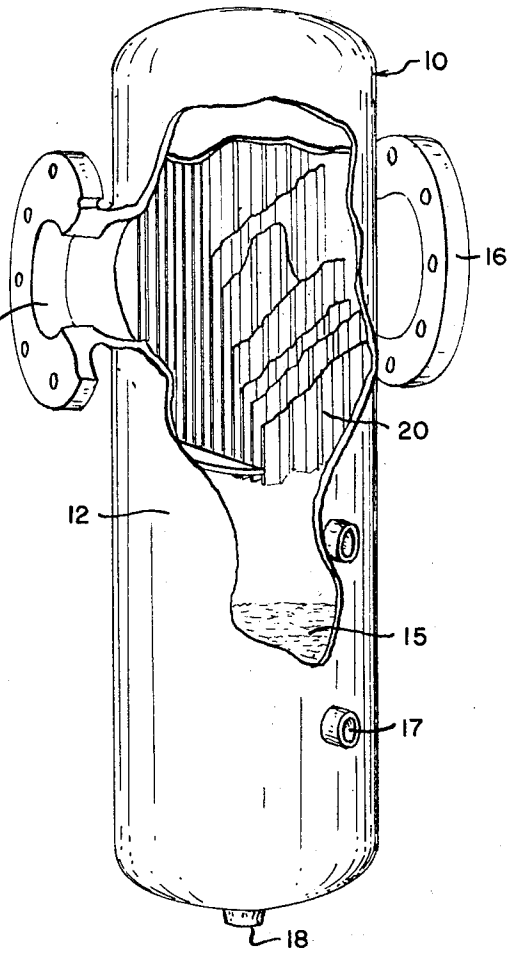
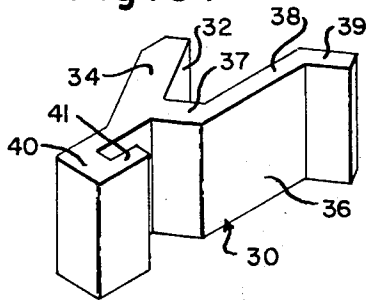


Fig. 3.



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3,520,116

VAPOR-LIQUID SEPARATOR HAVING IMPROVED VANE SPACER MEANS

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U.S. Cl. 55—440 5 Claims

ABSTRACT OF THE DISCLOSURE

A vapor-liquid separator, including spaced zig-zag shaped vanes separated by removable spacers formed to abut the surface of one vane in the vicinity of a crest thereof and the surface of a fin or pocket element of an oppositely disposed vane, and further having tabs diagonally opposed which, respectively, fit snugly and partly in a pocket of the one vane and in a diagonally opposite pocket in the opposite vane.

This invention relates to a vapor-liquid separator and more particularly to a vane type vapor-liquid separator having improved vane spacer means.

Well-known vane type vapor-liquid separators use vanes formed in a zig-zag pattern and horizontally spaced from each other to form parallel tortuous flow passages. Vapor or gas and entrained liquid entering the separator tank are divided into vertical ribbons which flow through the tortuous passages. Each ribbon of vapor or gas is subjected to multiple changes of direction while flowing through the flow passages. The entrained liquid droplets contact the surface of the vanes where they impinge and adhere to the vane surface. The vanes are often provided with pockets open to the flow-stream. These pockets serve to trap the liquid and to provide vertical channels or passageways for the liquid to accumulate and flow vertically downwardly of the separator into a collection and storage section. A common way of separating the vanes is to remove pockets from the inlet and outlet sides of the vanes, drill holes through the vanes, insert tubular spacers between the vanes, pass a bolt through the holes and spacers, secure the bolt with a nut, and, finally, lock the nut to the bolt. This manner of spacing is very time consuming and, accordingly, expensive. In addition, removal of the pockets and placing of the spacers in their place interferes with liquid drainage. Other spacer arrangements are used, such as formed metal spacers which are tack welded to sequentially spaced vanes, but these spacer arrangements also require expensive time for installation. I overcome the problems inherent in the commonly used vane spacers by providing a spacer which does not require removing of pocket elements from the vanes, or drilling of the vanes, or welding operations, while providing accurate spacing of vanes without interference of liquid drainage. More specifically, my present invention provides a vapor-liquid separator which, in preferred form, comprises: a housing having an inlet, an outlet, and a liquid collection and storage bottom section; a plurality of transversely spaced vanes arranged in pairs of sequentially spaced first and second vanes; the vanes being formed at least in part in a zig-zag pattern to define a plurality of tortuous passages for the vapor or gas stream, with the zig-zag pattern having a plurality of crests and troughs substantially horizonally aligned among the vanes, each of the vanes having fins adjacent the apexes of the crests and troughs and open to face upstream of the flowstream; a plurality of spacer means removably secured to each of the first and second vanes for positioning the vanes in thier

transversely spaced relationship, each of the spacer means having: an elongated main body section with its longitudinal centerline extending generally transversely to a flow passage and shaped at one end to abut at least a part of the inner surface of a first vane from one angle forming one crest of the first vane to adjacent the apex of the next downstream trough thereof, the main body section being provided with a passageway for liquid to flow freely downwardly therethrough; a first tab extending downstream from the one end of the main body section and shaped to fit snugly and part way in the pocket at the trough of the vane next downstream the one crest: and a second tab extending generally upstream from the other end of the main body section and shaped to fit snugly and part way in the pocket on the second vane defined by the fin opposite to the one crest.

Other details and advantages of the invention will become apparent as the following description of a present preferred embodiment thereof proceeds.

In the accompanying drawings I have shown a present preferred embodiment of the invention in which:

FIG. 1 is a perspective sectional view, with some parts broken away, showing a vapor-liquid separator embodying the present invention;

FIG. 2 is a top plan view of a portion of the vane elements of the separator of FIG. 1 showing details of construction; and

FIG. 3 is a perspective view of a spacer means for separating the vanes of the present invention.

Referring now to the drawings wherein like reference numerals are used to designate like parts throughout the various views, **10** refers generally to a vapor-liquid separator including a generally cylindrical closed ended vertical tank **12** having a flanged inlet **14**, a flanged outlet **16**, and a liquid collection and storage bottom section **15** provided with suitable liquid tap and drain openings **17** and **18**, respectively. A plurality of identical horizontally spaced vane elements **20** are suitably disposed within tank **12** between the inlet **14** and outlet **16** thereof. Three representative vane elements **20** are shown in plan view in FIG. 2. The vane elements **20** shown are extruded in a well-known zig-zag pattern throughout the vertical length thereof, with the pattern being of uniform pitch in the direction of inlet and outlet vapor or gas flow entering and leaving tank **12** through intet **14** and outlet **16**, respectively. By virtue of the horizontal spacing and zig-zag shape of the vane elements **20** a plurality of parallel tortuous passages **21** for the vapor or gas flow is defined. For sake of ease of description the gas or vapor entering separator **10** will be referred to in the remainder of this specification as the gasous stream with the understanding that this expression is not limited technically to gas. The pitch of the vane elements **20** referred to is the distance between successive crests **22** and troughs **24** forming the zig-zag pattern illustrated in the drawings. The crests **22** and trougs **24** have respective apexes **22'** and **24'**, formed by alternating angles extending in opposite directions relative to a vertical plane passing through either a crest or a trough. The apexes of the similarly positioned crests **22** and troughs **24**, of each of the spaced vane elements **20** are substantially aligned with each other in vertical planes.

The vane elements **20** have fins **26** suitably formed thereon, adjacent the apexes of the crests **22** and troughs **24** thereof. Each fin **26** traverses the entire vertical length of the vane elements **20** and is disposed on the vane elements **20** to extend in an upstream direction relative to flow passages **21**. The fins **26** thus define upstream open pockets **27** for entrapping liquid and providing channels

or passageways for the liquid to accumulate and flow vertically downwardly of tank **12** into the collection and storage section **15**.

Spacers **30** are arranged between each pair of sequentially opposed vane elements **20**. For convenience of description, the vane element **20** on the left of FIG. 2 will be referred to as the first vane element **20***a* and the middle vane element of FIG. 2 will be referred to as second vane elements with the understanding that second vane and **20***b* will be considered as a pair of sequentially spaced vane elements with the understanding that second vane element **20***b* and the right vane element of FIG. 2 also form a pair of sequentially spaced vane elements, as do any two sequentially spaced vane elements. As shown in FIG. 2 a pair of spacers **30** is disposed horizontally with respect to the vane elements. Other pairs of spacers **30** may be disposed at various other horizontal locations between the vane elements. A single spacer **30** is shown in perspective in FIG. 3. Each spacer **30** includes an elongated main body section **32** having its centerline extending generally transversely to the flow passage **21** when such spacer is arranged between a pair of sequentially spaced vane elements. The detailed description of spacer **30** will be made as it is arranged between first and second vane elements **20***a* and **20***b*, with the understanding that the description is applicable to spacers **30** used between any pair of vane elements **20** used with separator **10**. Main body section **32** has an elongated first leg **34** extending generally transversely to and upstream of flow passage **21** and has one of its ends shaped to snugly abut the inner surface **35** of first vane elements **20***a* adjacent both sides of the apex of a crest **22** of first vane element **20***a*. That is, the end of first leg **34** fits snugly, as shown, in the crotch of a crest portion of the first vane element **20***a*. An elongated generally Z-shaped second leg **36** forms the remainder of the main body section **32** and includes a first portion **37** fixed to an intermediate region of the first leg **34** and extending downstream of and parallel to flow passage **21**. Leg **36** also has a second portion **38** extending at an acute angle from first portion **37** in a downstream direction and generally transversely to flow passage **21**. A vertical passageway **50** is defined by first leg **34** and second leg **36**, which passageway serves to permit liquid to flow downwardly with virtually no obstruction by the spacers **30**. Second portion **38** extends to adjacent the inner surface of first vane element **20***a* where a tab **39**, generally parallel to the first portion **37**, extends downstream of flow passage **21** to fit snugly in the pocket **27** at the trough **24** of the first vane element **20***a* next downstream of the crest **22** where leg **34** is in abutment. The tab **39** is suitably sized to extend only partially into the pocket **27** such that a good hold is insured between the tab **39** and fin **26** while at the same time leaving enough open space in the pocket **27** to allow vertical flow of accumulated liquid through the pocket. The first portion **37** of leg **36** abuts a part of the downstream facing outer surface of the fin **26** of the second vane element **20***b* which fin **26** is on a crest of the second vane element **20***b* located directly opposite to the crest of the first vane element **20***a* in which the first leg **34** abuts. A generally U-shaped hook portion **40** forms the remainder of spacer **30** and extends from the first leg **34** to abut a part of the upstream facing outer surface of the fin **26** of second vane element **20***b* with the remainder of the upstream facing outer surface of the fin **26** being in abutment with a suitably shaped section of first leg **34**. A tab **41** is formed on hook portion **40** and is shaped and sized to fit snugly and part way into the pocket **27** defined by the fin **26** on the crest of second vane element **20***b* directly opposite the crest of the first vane element **20***a* in which first leg **34** abuts. Tab **41** is suitably sized to extend into the pocket **27** a distance such that a good hold is insured between the tab **41** and fin **26** while at the same time leaving enough open space in the pocket to allow vertical flow of accumulated liquid through the pocket.

The vertical dimensions of the various segments forming the spacer **30** are all the same. As shown in FIG. 1 the vertical dimension of each spacers **30** is considerably smaller than the vertical dimension of each vane element **20**. A suitable vertical dimension of a spacer **30** would be between ½ to 2 inches. The relative vertical dimensions of the spacers **30** and vanes **20** can be readily varied to meet specific requirements so long as the spacers result in maintaining the vane elements in an accurate and stable transversely spaced relationship. Transverse spacing of the vane elements **20** is used herein by considering the longitudinal axis of the vane elements **20** as extending in the direction of gaseous flow through the separator **10**.

The spacers **30** of the invention can be readily made by extruding any suitable metallic or non-metallic material.

It should be understood that the overall shape of the spacers **30** can vary so long as a good hold is maintained between the spacers **30** and any pair of sequentially spaced vane elements to provide accurate and stable spacing of the vane elements, while at the same time leaving enough of the pockets **27** unobstructed to avoid blocking vertical downward flow of accumulated liquid and providing a suitable vertical liquid flow passage through the body thereof.

While I have shown and described a present preferred embodiment of the invention it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied within the scope of the following claims.

I claim:

1. A separator for separating liquid entrained in a gaseous stream, comprising:

a housing having an inlet, an outlet, and a liquid collection and storage bottom section;

a plurality of elongated transversely spaced vane elements disposed in said housing between the inlet and outlet thereof, with said vane elements being arranged in pairs of sequentially spaced first and second vane elements;

said vane elements being formed at least in part in a zig-zag pattern to define a plurality of tortuous passages for the gaseous stream, with the zig-zag pattern having a plurality of crests and troughs having apexes formed by alternating angles extending in opposite directions with the apexes of a first vane element being substantially aligned with similarly positioned apexes of a second vane element;

each of said vane elements having fins adjacent the apexes of each crest and trough to define pockets open to face upstream of the flow of the gaseous stream;

a plurality of spacer means removably secured to each first and second vane elements for positioning the vane elements in their transversely spaced relationship;

each of said spacer means having: an elongated main body section with its longitudinal centerline extending generally transversely to a flow passage and shaped at one end to abut at least a part of the inner surface of a first vane element from one angle forming one crest of the first vane element to adjacent the apex of the next downstream trough thereof; a first tab extending downstream from said one end of the main body section and shaped to fit snugly and extending part way in the pocket at the trough of the first vane element next downstream of said one crest; a second tab extending generally upstream from the other end of said main body section and shaped to fit snugly and extending part way in the pocket on the second vane element defined by a first fin positioned opposite to said one crest; and said main body section further having a passageway for liquid to flow freely downwardly therethrough.

2. A separator as set forth in claim 1 wherein said second tab is further shaped to abut a part of the outer surface of said first fin on the second vane element.

3. A separator as set forth in claim 2 wherein the other end of said main body section is shaped to abut substantially the remainder of the surface of said first fin.

4. A separator as set forth in claim 1 wherein said main body section includes an elongated first leg extending transversely to a flow passage and contoured at one end to abut the inner surface of the first element adjacent the apex formed by said one angle; an elongated second leg fixed at one end thereof to an intermediate region of said first leg and extending at an acute angle to said first leg in a downstream direction to adjacent the first vane element; and wherein said first tab extends downstream from the other end of said second leg.

5. A separator for separting liquid entrained in a gaseous stream, comprising:

a housing having an inlet, an outlet, and a liquid collection and storage bottom section;

a plurality of elongated transversely spaced vane elements disposed in said housing between the inlet and outlet thereof, with said vane elements being arranged in pairs of sequentially spaced first and second vane elements;

said vane elements being formed at least in part in a zig-zag pattern to define a plurality of tortuous passages for the gaseous stream, with the zig-zag having a plurality of crests and troughs having apexes formed by alternating angles extending in opposite directions with the apexes of a first vane element being substantially aligned with similarly positioned apexes of a second vane element;

each of said vane elements having fins adjacent the apexes of each crest and trough to define pockets open to face upstream of the flow of the gaseous stream;

a plurality of spacer means removably secured to each first and second vane elements for positioning the vane elements in their transversely spaced relationship;

each of said spacer means having: an elongated first leg extending generally transversely to a flow passage and contoured at one end to abut the inner surface of a first vane element adjacent the apex formed by a first angle of one crest of the first vane element; an elongated second leg fixed at one end thereof to an intermediate region of said first leg and extending at an acute angle to said first leg in a downstream direction to adjacent the first vane element and having a foot at the other end thereof shaped to fit snugly and extending part way in the pocket at the trough of the first vane element next downstream to said first angle of the first element; an arm fixed at one end thereof to the other end of the first leg extending in a generally upstream direction and formed to snugly abut at least a portion of the surface a first fin on a second vane element facing the first vane element and having a finger at the other end thereof shaped to fit snugly and extending part way in the pocket defined by said first fin.

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FRANK W. LUTTER, Primary Examiner

B. NOZICK, Assistant Examiner

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,520,116 July 14, 1970

Robert Raphael Good

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 72, "thier" should read -- their --. Column 2, line 13, "crest:" should read -- crest; --; line 47, "intet" should read -- inlet --; line 53, "gasous" should read -- gaseous --; line 59, "trougs" should read -- troughs --. Column 3, line 9, "elements" should read -- element --, and insert -- 20b; and first and second vane elements 20a and 20b will be considered as a pair of sequentially spaced vane elements --; line 30, "elements" should read -- element --. Column 5, line 29, after "zig-zag" insert -- pattern --.

Signed and sealed this 23rd day of February 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

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Commissioner of Patents