United States Patent

[11] 3,559,722

[72] Inventors James J. Schauls; Franklin D. Duncan, La Crosse, Wis.

[21] Appl. No. 858,373
[22] Filed Sept. 16, 1969
[45] Patented Feb. 2, 1971
[73] Assignee The Trane Company La Crosse, Wis. a corporation of Wisconsin.

[54] **METHOD AND APPARATUS FOR TWO-PHASE HEAT EXCHANGE FLUID DISTRIBUTION IN PLATE-TYPE HEAT EXCHANGERS**
32 Claims, 23 Drawing Figs.

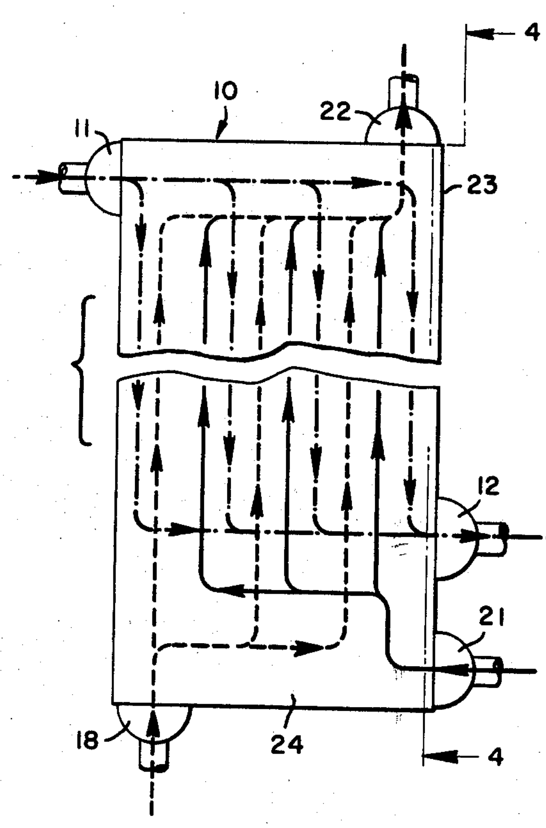
[52] **U.S. Cl.** **165/1,** 165/166; 159/16
[51] **Int. Cl.** **F28f 3/00**
[50] **Field of Search** 159/16; 165/166, 167, 1

[56] **References Cited**
UNITED STATES PATENTS

3,073,380	1/1963	Palmason	165/167X
3,282,334	11/1966	Stahlheber	165/166
3,488,686	1/1970	Dunwoody et al.	159/16

Primary Examiner—Martin P. Schwadron
Assistant Examiner—Theophil W. Streule
Attorneys—Lee E. Johnson, Arthur O. Andersen and Carl M. Lewis

ABSTRACT: Method and apparatus for heat exchanging a gaseous fluid and a liquid fluid with a third heat exchange fluid by a plate-type heat exchanger in a manner permitting variations of the gaseous mass flow rate relative to the liquid mass flow rate without relative maldistribution of the two fluid phases within the heat exchanger passages. Between the plates within the heat exchanger core, the gaseous and liquid fluids are separately distributed across the width of the heat exchanger. Only after the gaseous and liquid fluids have been thus uniformly distributed within the passages are they combined and passed in heat exchange relation with the third heat exchange fluid. The problems associated with relative maldistribution of the two fluid phases which normally accompany conventional arrangements for distributing a two-phase fluid across the width of a plate-type heat exchanger are thus avoided. Four embodiments of the invention are described and shown.



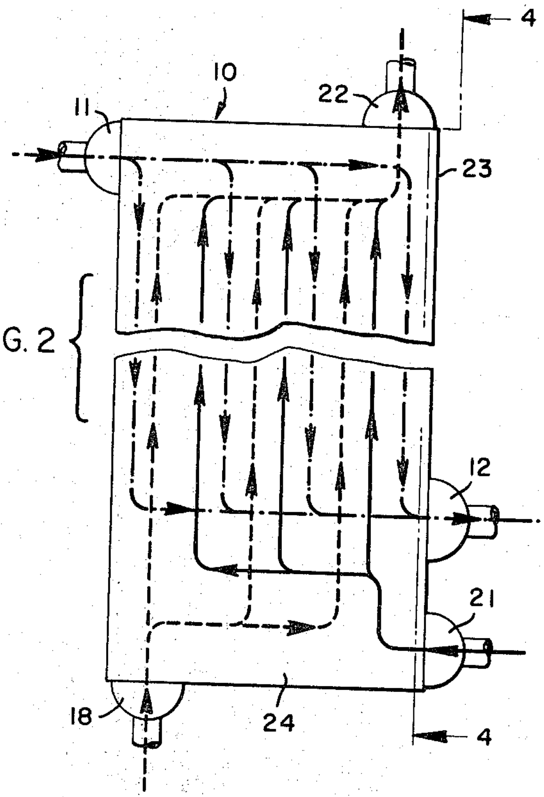


FIG. 2

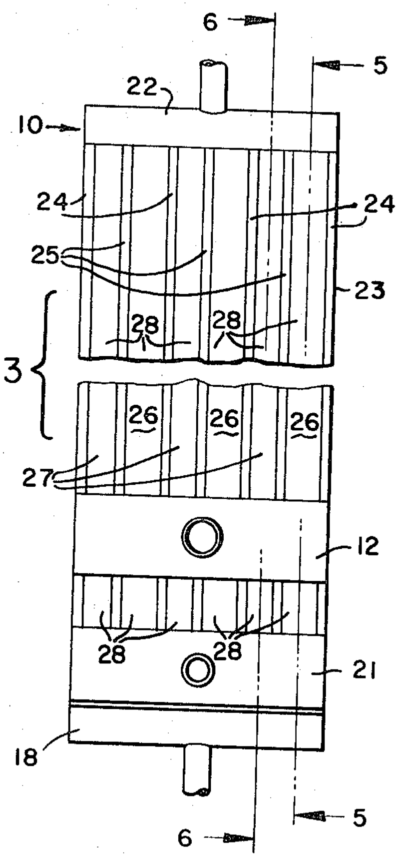


FIG. 3

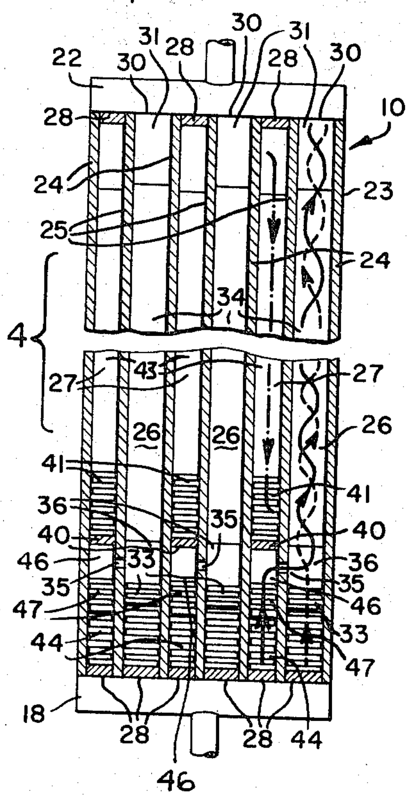
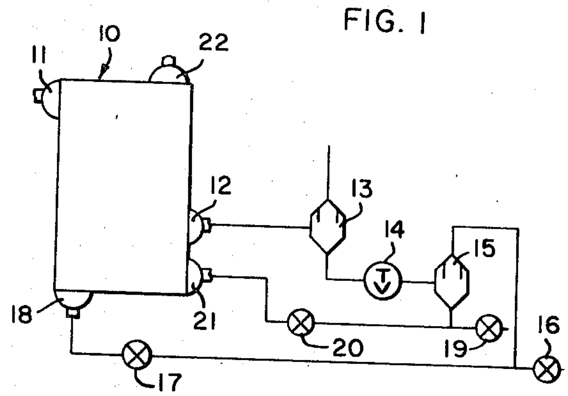


FIG. 4

FIG. 1



INVENTOR.
JAMES J. SCHAULS
FRANKLIN D. DUNCAN
BY
Carl M. Lewis
ATTORNEY

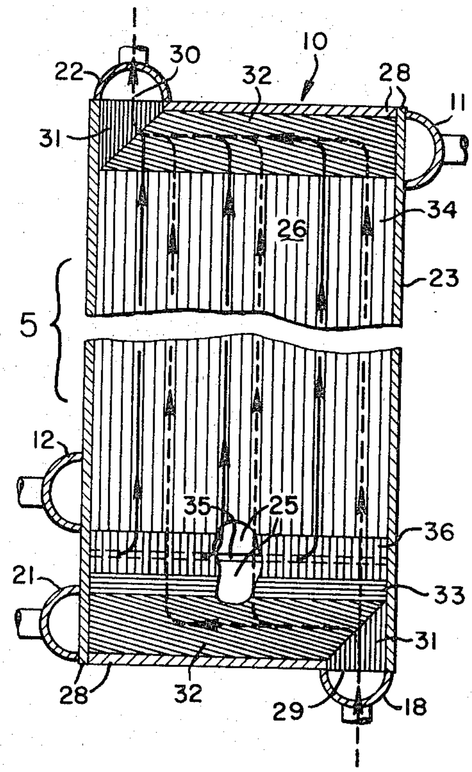


FIG. 5

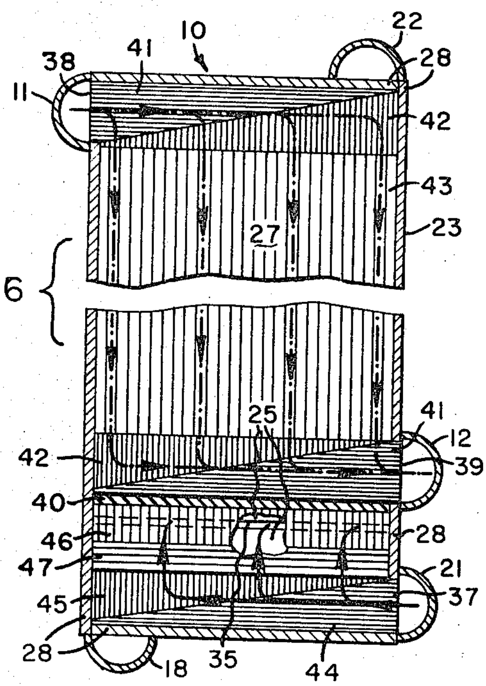


FIG. 6

INVENTOR.
JAMES J. SCHAULS
FRANKLIN D. DUNCAN

BY Carl M. Lewis

ATTORNEY

PATENTED FEB 2 1971

3,559,722

SHEET 3 OF 5

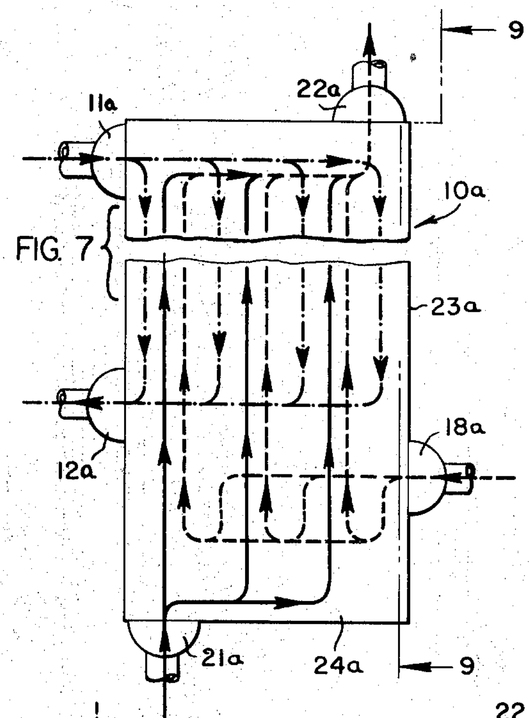


FIG. 7

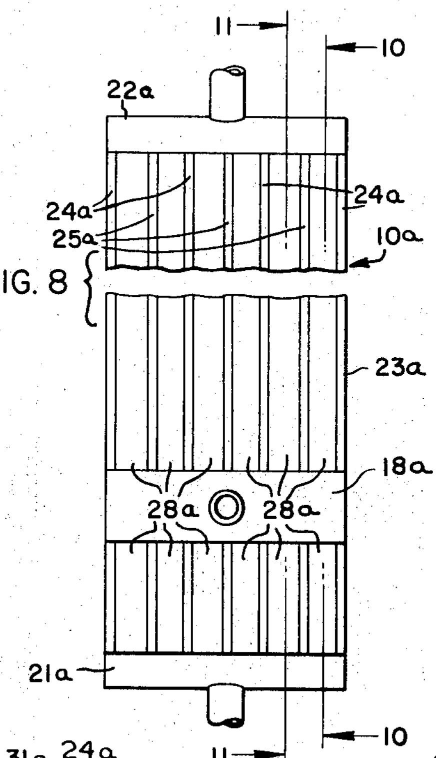


FIG. 8

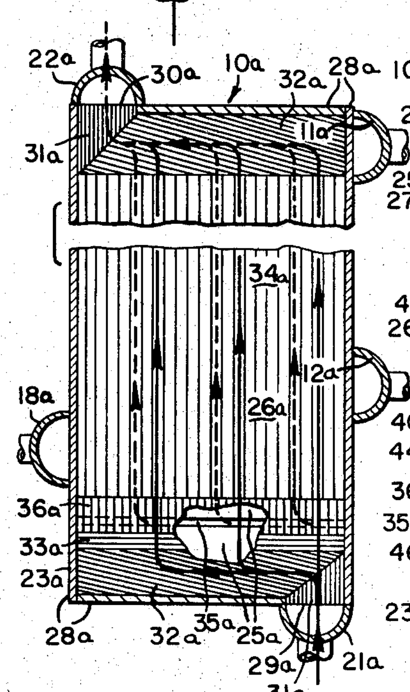


FIG. 10

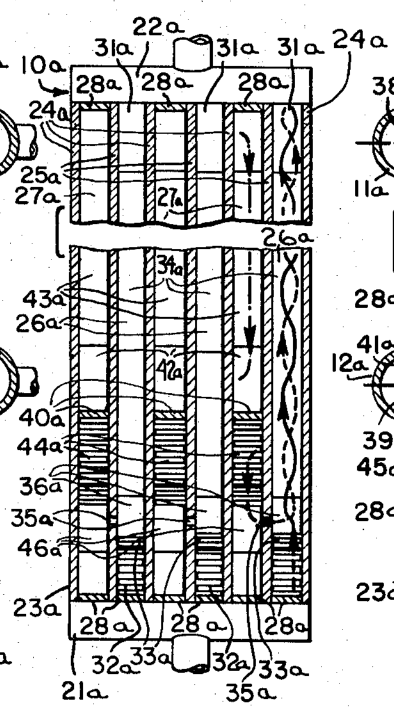


FIG. 9

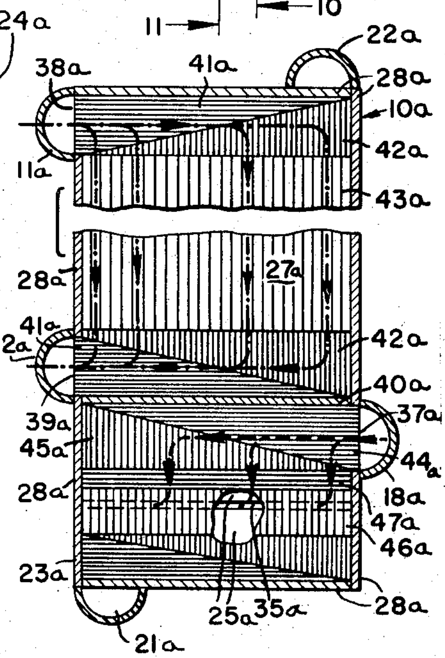


FIG. 11

INVENTOR.
JAMES J. SCHAULS
FRANKLIN D. DUNCAN

BY Carl M. Lewis
ATTORNEY

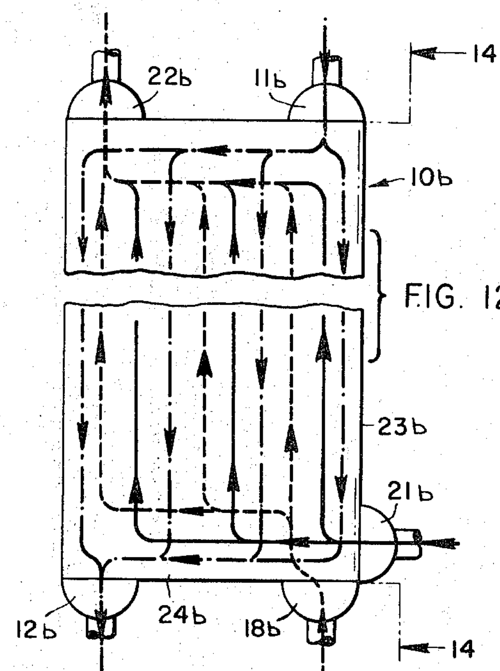


FIG. 12

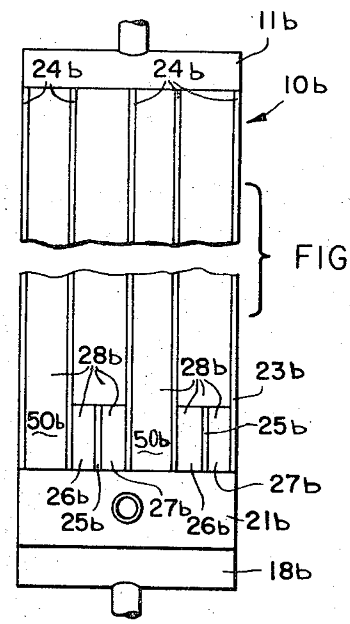


FIG. 13

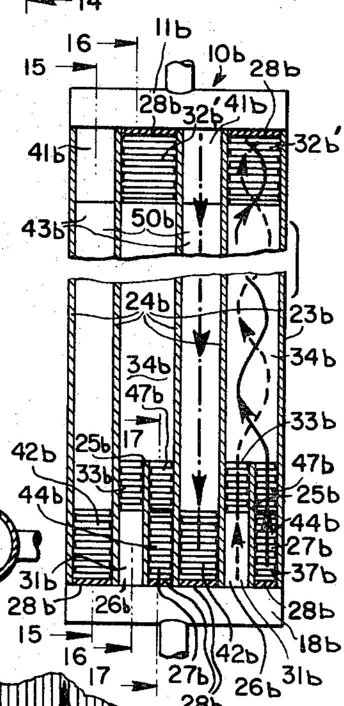


FIG. 14

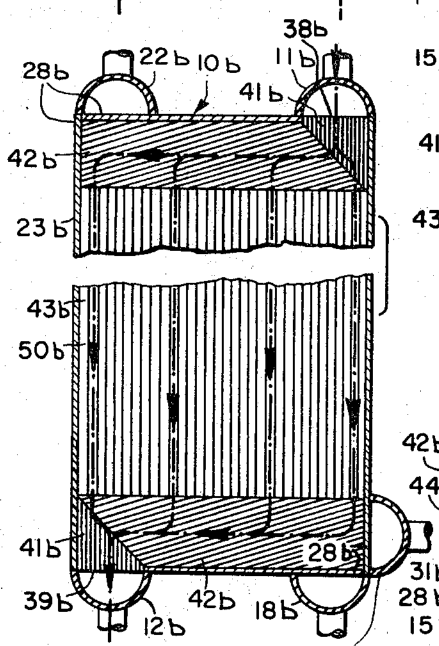


FIG. 15

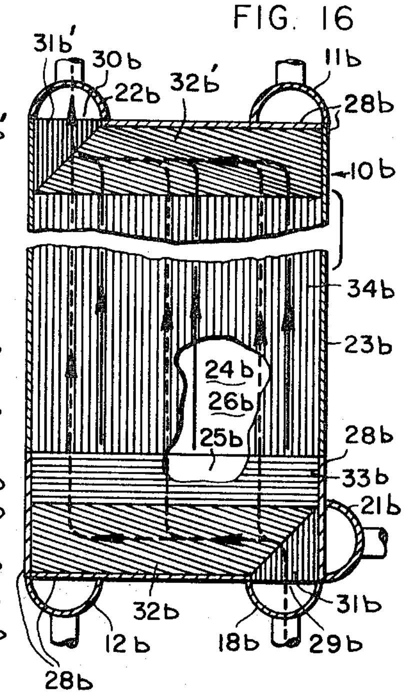


FIG. 16

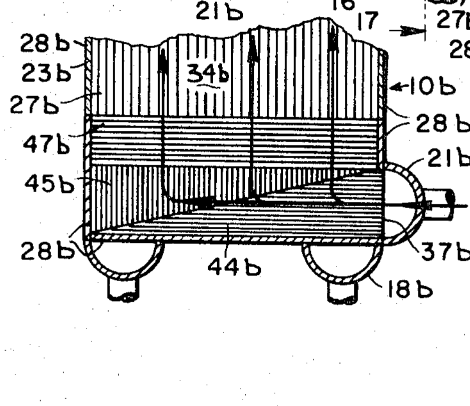


FIG. 17

INVENTOR.
JAMES J. SCHAULS
FRANKLIN D. DUNCAN

BY

Carl M. Lewis
ATTORNEY

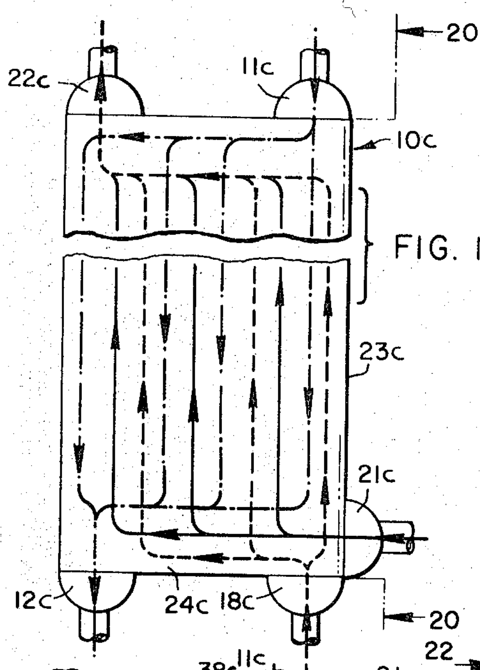


FIG. 18

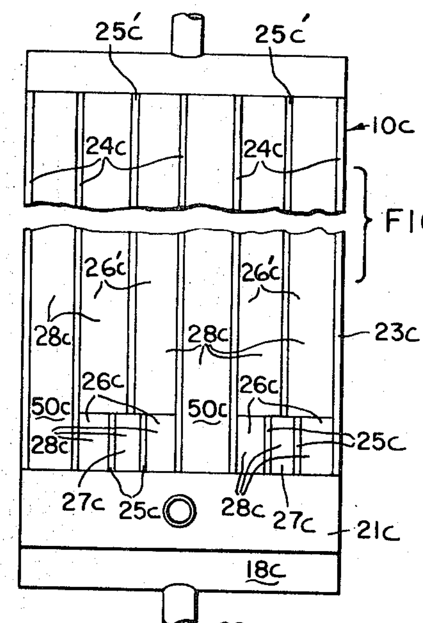


FIG. 19

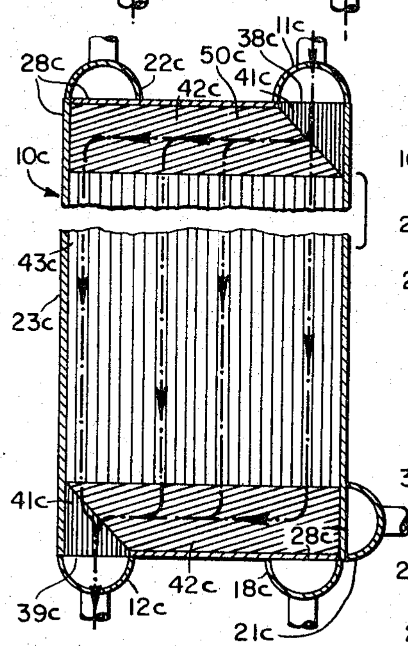


FIG. 21

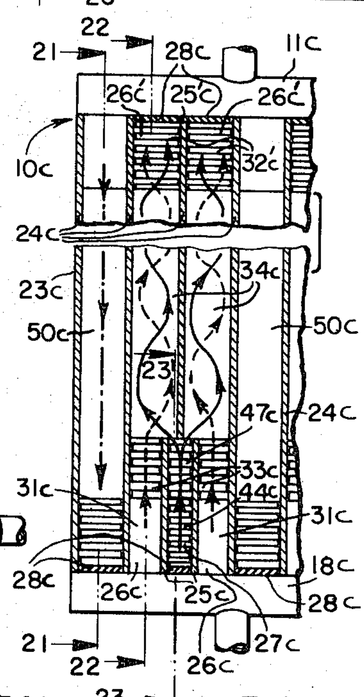


FIG. 20

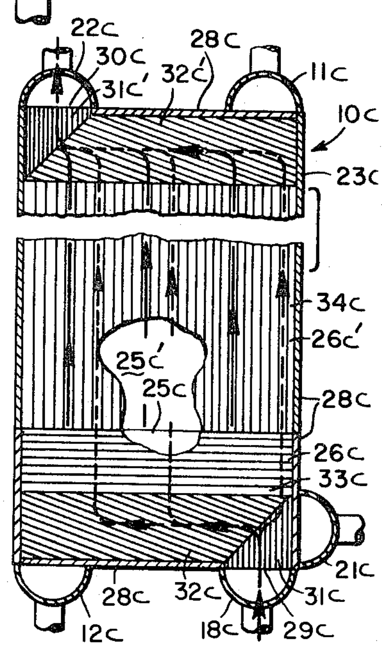


FIG. 22

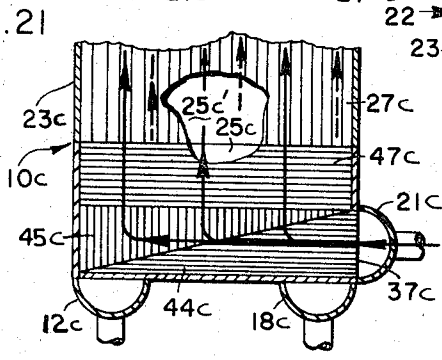


FIG. 23

INVENTOR.
JAMES J. SCHAULS
FRANKLIN D. DUNCAN

BY Carl M. Lewis

ATTORNEY

METHOD AND APPARATUS FOR TWO-PHASE HEAT EXCHANGE FLUID DISTRIBUTION IN PLATE-TYPE HEAT EXCHANGERS

BACKGROUND OF THE INVENTION

In modern processes such as the separation of natural gas or air into their components, it often becomes necessary to heat exchange a two-phase fluid with another fluid. However, many attempts to pass a fluid consisting of a liquid and a gas into a heat exchanger have failed because of the relative maldistribution of the two phases. Certain of the passages or certain portions of the passages would conduct excess liquid while other passages or portions of passages would conduct excess gas. Ideally, the liquid and the gas should be uniformly distributed to obtain maximum heat exchange with the third or other heat exchange fluids. These problems have been partially solved by first separating the two-phase fluid into its constituent phases. Various heat exchanger designs such as those shown in U.S. Pat. Nos. 3,282,334 and 3,310,105 both assigned to the assignee of this invention, have been directed to the problem of distributing the liquid phase uniformly among the vapor-liquid passages and distributing the gaseous phase uniformly among the vapor-liquid passages whereby each of the passages intended to conduct a vapor and liquid mixture receive the proper proportion of vapor and liquid. However, in those heat exchanger designs the vapor and the liquid are mixed at the inlet to the vapor-liquid passage. This mixture must then be distributed within the passages across the width of the heat exchanger. To accomplish this, those heat exchanger designs utilized a distributor structure comprising a corrugated metallic sheet fin material the convolutions of which form flow paths which extend from the inlet to the full width of the heat exchanger passage. To further enhance the distribution of gas and liquid within the passage, a section of "hardway" distributor fin consisting of a porous corrugated metallic sheet fin material having crests extending transversely to the direction of fluid flow, may be disposed within the passage. While this distributor structure has been partially successful, it should be appreciated that its affect upon a gaseous fluid will be somewhat different from its affect upon a liquid of substantially greater density and viscosity. This may result in a nonuniform distribution of liquid and gas across the width of the vapor-liquid passage. This is especially critical when the mass flow rate of either the liquid or the gas is varied. It is also critical when the attitude of the heat exchanger is such that the liquid does not flow downwardly through the heat exchange passage.

SUMMARY OF THE INVENTION

This invention solves the aforementioned problems by providing an entirely different method and apparatus for distributing gas and liquid in the passages of a plate-type heat exchanger intended to conduct a mixture of both fluid phases. More particularly this invention provides a means of uniformly distributing both the vapor and the liquid phases among the several passages of a heat exchanger and additionally provides a means of uniformly distributing the vapor and liquid phases across the width of each of the several passages. Because of superior distribution of the liquid and gaseous phases, it is possible to orient the heat exchanger for either upflow or downflow of liquid and to vary the mass flow rate of either the gas or the liquid fluid over a wide range without substantial reduction in heat exchanger efficiency.

Specifically this invention relates to a method of heat exchanging a first heat exchange fluid with a gaseous phase heat exchange fluid and a liquid phase heat exchange fluid including the steps of: providing a first supply of liquid phase heat exchange fluid; providing a second supply of gaseous phase heat exchange fluid; providing a third supply of a third heat exchange fluid; introducing the fluid of one of said phases into a first layer of a multilayer heat exchanger; distributing said introduced fluid of said one phase within said first layer substantially uniformly across the width of said heat exchanger; introducing the fluid of the other of said phases into a second layer adjacent said first layer; distributing said introduced fluid of said other phase within said second layer substantially uniformly substantially across the width of said heat exchanger; transferring the substantially uniformly distributed fluid of one of said phases from one of the first and second layers and diffusing it into the substantially uniformly distributed fluid of the other phase from the other of the first and second layers while substantially maintaining its uniform distribution substantially across the width of said heat exchanger whereby the gaseous and liquid phases are substantially uniformly combined substantially across the width of a heat exchanger independently of their relative mass flow rates; and passing the substantially uniformly distributed combined gaseous and liquid phase heat exchange fluids in heat exchange relation with said third heat exchange fluid.

Specifically this invention further relates to a plate-type brazed heat exchanger comprising: first and second elongated metallic plates of generally similar peripheral configuration contraposed in face-to-face spaced relationship; first sealing means sealingly connecting said elongated metallic plates along the peripheral margins thereof thereby enclosing with said first and second elongated metallic plates a generally flat elongated plenum; a platelike partition interleaved with said first and second elongated metallic plates adjacent at least one end of said plenum and being coincidental with a plane spaced from said first and second elongated plates bisecting said plenum into first and second spacial layers; said partition extending transversely of the longitudinal axis of said elongated plenum to and in sealing connection with said first sealing means thereby defining within said first spacial layer a first passage intermediate said partition and said first elongated plate and within said second spacial layer a second passage intermediate said partition and said second elongated plate; said first sealing means defining a first inlet to said first passage adjacent said one end of said plenum for admitting one of a first gaseous phase and a second liquid phase heat exchange fluids; said first sealing means defining a second inlet to said second passage adjacent said one end of said plenum for admitting the other of said gaseous phase and liquid phase heat exchange fluids; said first sealing means further defining at the other end of said plenum a first outlet from said plenum; first distributor means in one of said first and second passages abutting one face of said partition for substantially uniformly distributing one of said first and second heat exchange fluids respectively from one of said first and second inlets within said one passage substantially across the width of said plenum; a transfer passage means within said plenum for combining said one uniformly distributed heat exchange fluid with the other of said first and second fluids; and means defining a third passage disposed in heat exchange relation with the combined first and second heat exchange fluids.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic of a gas separation system utilizing the heat exchange means of the instant invention.

FIG. 2 is a front elevation of a plate-type heat exchanger incorporating a first form of the invention.

FIG. 3 is a side elevation of the heat exchanger shown in FIG. 2.

FIG. 4 is a section taken at line 4—4 of FIG. 2.

FIG. 5 is a section taken at line 5—5 of FIG. 3.

FIG. 6 is a section taken at line 6—6 of FIG. 3.

FIG. 7 is a front elevation of a plate-type heat exchanger incorporating a second embodiment of the invention.

FIG. 8 is a side elevation of the heat exchanger shown in FIG. 7.

FIG. 9 is a section taken at line 9—9 of FIG. 7.

FIG. 10 is a section taken at line 10—10 of FIG. 8.

FIG. 11 is a section taken at line 11—11 of FIG. 8.

FIG. 12 is a front elevation of a heat exchanger incorporating a third embodiment of the invention.

FIG. 13 is a side elevation of the heat exchanger shown in FIG. 12.

FIG. 14 is a section taken at line 14–14 of FIG. 12.

FIG. 15 is a section taken at line 15–15 of FIG. 14.

FIG. 16 is a section taken at line 16–16 of FIG. 14.

FIG. 17 is a partial section of the heat exchanger taken at line 17–17 of FIG. 14.

FIG. 18 is a front elevation of a heat exchanger incorporating a fourth embodiment of the invention.

FIG. 19 is a side elevation of the heat exchanger shown in FIG. 18.

FIG. 20 is a vertical section of a portion of the heat exchanger taken along line 20–20 of FIG. 18.

FIG. 21 is a section taken along line 21–21 of FIG. 20.

FIG. 22 is a section taken along line 22–22 of FIG. 20.

FIG. 23 is a section of a portion of the heat exchanger taken along line 23–23 of FIG. 20.

DETAILED DESCRIPTION

A first 1 shows an exemplary system utilizing a heat exchanger **10** employing the instant invention. A gas feed such as air or natural gas under pressure is supplied to header **11**. The gas feed (See distributed by header **11** to certain passages within the heat exchanger **10**. The gas is cooled as it passes through these passages and a portion thereof is condensed. The liquid and gaseous portions are discharged from these passages to a header **12**. The gas and liquid mixture is then conducted to a separator **13**. The liquid portion from separator **13** may be throttled to a lower pressure by throttling means **14** with the resulting vapor liquid mixture being passed to separator **15**. The gas from separator **15** may be withdrawn from the system by way of a valve **16**, or may be returned to the heat exchanger **10** via valve **17** and gas header **18** to recover its cold content. Likewise, the liquid fluid from separator **15** may be withdrawn from the system by way of valve **19** or alternatively returned to heat exchanger **10** via valve **20** and liquid header **21**. The gas from header **18** and the liquid from header **21** are separately distributed uniformly within the passages across the width of head exchanger **10**. After being so distributed within the core of heat exchanger **10**, the gas and liquid phase fluids are combined to form a two-phase fluid which is passed in heat exchange relation with the feed gas, and is discharged from the heat exchanger core via discharge header **22**.

The gas from separator **13** may be further separated into various constituents which may be in part or total returned through various passages (not shown) of heat exchanger **10** to recover their cold content. The relative proportions of liquid and gas returned to heat exchanger **10** via headers **21** and **18** can be varied by adjustments of valves **16, 17, 19** and **20**. It will be appreciated that for purposes of practicing the invention herein disclosed, the liquid supplied to header **21** and the gas supplied to header **18** may be derived from sources other than the feed fluid. Furthermore, the feed fluid may enter the heat exchanger header **11** as a liquid, gas, or liquid and gas mixture.

Throughout the drawings of this disclosure heavy dashed vectors represent gas flow, heavy solid vectors represent liquid flow, and heavy dash-dot vectors represent the flow of a third heat exchange fluid which may be a liquid, gas, or liquid gas mixture.

Now referring to the embodiment of the invention shown in FIGS. 2—6 with particular attention to FIGS. 3 and 4, it will be seen that heat exchanger **10** has a core **23** comprised of a plurality of rectangular impervious metallic plates **24** of the same peripheral configuration contraposed in face-to-face parallel spaced relationship. Disposed within each of the plenums formed intermediate adjacent plates **24**, is a metallic platelike partition **25** interleaved with, parallel to, and spaced from metallic plates **24**. Each partition **25** has substantially the same peripheral configuration, although not shown, as plates **24**. Each partition **25** separates the plenum between adjacent plates **24** into first and second spacial layers **26** and **27** respectively.

A first sealing means in he form of a series of closing bars **28** bridging between each partition **25** and the adjacent plates **24** along the peripheral margins thereof (See FIGS. **5** and **6**) in each of the layers **26** and **27** bound the plenums between adjacent pairs of plates **24**. Bars **28** are sealingly bonded to the margins of plates **24** and partitions **25** by brazing. It should be appreciated that the sealing effect of bars **28** may be obtained by elements of other configuration such as s channel members, rods, tubes, etc.

Now referring specifically to FIG. **5** where the full width of one of layers **26** and the details therein can be viewed, it will be seen that a gap is provided at the lower end of layer **26** between the ends of bars **28** to thereby define a gas inlet **29** to a first passage, and that a second gap is provided at the upper portion of layer **26** between the ends of the bars **28** to form a fluid outlet **30** from the first passage.

Disposed adjacent inlet **29** and outlet **30** is a substantially triangular section **31** of corrugated metallic sheet fin material having crests extending vertically. A trapezoidal section **32** of corrugated metallic sheet fin material is disposed laterally of each fin section **31** and has crest extending diagonally as shown to provide a flow pattern between the inlet or outlet and the full width of the heat exchanger. A small rectangular section **33** of corrugated metallic sheet fin material having crests extending horizontally is arranged immediately above the lower trapezoidal section **32**. Section **33** must be porous as the gas passes the hard way therethrough and is accordingly termed a "hardway" fin section. Immediately below the upper fin section **32** is a large rectangular section **34** of corrugated metallic sheet fin material having crests extending vertically.

In the area intermediate fin section **34** and "hardway" section **33**, the partition **25** is provided with a slit **35** which extends horizontally across the width of the heat exchanger **10**. In FIG. **5**, a portion of the fin sections has been removed to expose partition **25** and slit **35**. As will be discussed hereinafter, slit **35** defines a transfer passage for the transfer of liquid fluid from a second passage within an adjoining layer **27** into the gas stream passing through the first passage in layer **26**. Slit **35** may be formed simply by spacing two separate plates to form the partition **25**. In the alternative slit **35** may be formed by cutting an elongated opening in a single piece partition. In either event, the ends of slit **35** may be formed adjacent the sides of heat exchanger **10** are closed to prevent external leakage. Since the plates within a plate-type heat exchanger constitute a structural element which is substantially weakened by an interruption such as slit **35**, a rectangular section **36** of corrugated metallic heavy guage fin material having crests extending vertically is disposed within layer **26** overlying partition **25** at both sides of slit **35**. Fin section **36** is brazed to partition **25** to provide the necessary structural continuity bridging slit **35**. We therefore refer to this type fin as a bridging fin.

Gas entering inlet **29** as illustrated by the heavy dashed vectors in FIGS. **4** and **5** is distributed across the width of the heat exchanger via lower fin sections **31, 32** and **33** in the lower portion of the heat exchanger. After having been uniformly distributed across the width of the heat exchanger, the gas is mixed with liquid entering the first passage via transfer passage slit **35** as illustrated by the heavy solid vectors in FIGS. **4** and **5**. The liquid and gaseous fluids respectively uniformly distributed across the width of the heat exchanger and subsequently combined in intimate contact with each other then flow upwardly through the main fin section **34** of the first passage. The fluid is then collected at the top of the heat exchanger and directed to the outlet **30** via upper fin sections **32** and **31** adjacent outlet **30** from whence it passes to header **22**. "Hardway" fin **33** in addition to serving as part of the gas distributing means also serves to reduce liquid flooding of the gas header **18**.

Now referring specifically the FIG. **6** showing one of layers **27**, it will be seen that the ends of bars **28** in layer **27** are spaced one from the other to thereby define a liquid inlet **37** in the lower portion of the heat exchanger, a fluid inlet **38** in the upper portion of the heat exchanger, and a fluid outlet **39** in the lower portion of the heat exchanger. Inlets **37** and **38** and outlet **39** communicate respectively with headers **21**, **11**, and **12**. The space within layer **27** is sealingly bisected into second and third passages by a second sealing means in the form of a horizontally extending bar **40** which bridges between partition **25** and plate **24** as best seen in FIGS. **4** and **6**. The space within layer **27** above bar **40**, i.e., the space of the third passage, is provided with first triangular sections **41** of corrugated metallic sheet fin material having crests extending horizontally, disposed adjacent inlet **38** and outlet **39**. Second triangular sections **42** of corrugated metallic sheet fin material having crests extending vertically are disposed intermediate each of fin sections **41** and a large rectangular section **43** of corrugated metallic sheet fin material also having crests extending vertically. Fluid passing from header **11** enters the third passage through inlet **38** and is distributed across the width of the heat exchanger via upper fin section **41** from whence it passes downwardly through upper triangular section **42**, rectangular a section **43**, and lower triangular section **42** where it is collected in lower fin section **41** and delivered from the third passage to header **12** via outlet **39**. This flow of fluid in the third passage is illustrated by the heavy dash-dot vectors in FIGS. **4** and **6**. The fluid is thus passed in counterflow heat exchange relation with the fluid passing through the first passage in layer **26**, the heat transfer taking place between layers **26** and **27** through metallic partition **25**.

Within layer **27** below bar **40** is a first triangular section **44** of corrugated metallic sheet fin material having crests extending horizontally to inlet **37**, and a second triangular section **45** of corrugated metallic sheet fin material having crests extending vertically. A rectangular section **46** of bridging fin similar to the bridging fin of section **36** is disposed immediately below bar **40** in layer **27** overlying and brazed to the area of partition **25** immediately adjacent slit **35**. Section **46** like section **36** is constructed from heavy guage corrugated metallic sheet fin material having crests extending vertically to thereby provide structural continuity in the area of slit **35**. Immediately below bridging fin **46** is a rectangular "hardway" fin section **47** of corrugated metallic sheet fin having crests extending horizontally. Like "hardway" section **33**, "hardway" section **47** is porous to permit passage of fluid therethrough transversely of the crests thereof. In FIG. **6** a portion of the fin sections has been removed to expose partition **25** and slit **35**. Liquid entering inlet **37** to the second passage from header **21** passes respectively through triangular section **44**, triangular section **45**, and "hardway" section **47** and is thus uniformly distributed across the width of the heat exchanger in the second passage. After having been thus distributed across the width of the heat exchanger, the liquid fluid passes along the bridging fin and is transferred from layer **27** to layer **26** through the slit **35** as herein before described. This flow of liquid in the second passage is illustrated by the heavy solid vectors.

Thus it will be seen that a two-phase mixture fluid passing through the major portion of layers **26** is heat exchanged with the third fluid passing through layers **27**. However, a portion of each layer **27** at the lower end thereof provides means for distributing liquid uniformly across the width of the heat exchanger prior to being transferred into the gaseous stream of layer **26**. Since the gas is uniformly distributed across the width of the heat exchanger in layer **26**, and the liquid is uniformly distributed across the width of the heat exchanger in layer **27** there is no necessity to further distribute these fluids across the width of the heat exchanger after they are combined even if the relative proportions of combined liquid and gas are varied as aforementioned. The flow vectors shown in FIG. **2** are a superimposed composite of the flow vectors of FIGS. **5** and **6** and illustrate the flow pattern for the aforedescribed heat exchange.

Now referring to the embodiment of the invention shown in FIGS. **7**—**11** with particular attention to FIGS. **8** and **9**, it will be seen that heat exchanger **10*a*** has a core **23 *a*** comprised of a plurality of rectangular impervious metallic plates **24*a*** of the same peripheral configuration contraposed in face-to-face parallel spaced relationship. Disposed within each of the plenums formed intermediate adjacent plates **24*a***, is a metallic platelike partition **25*a*** interleaved with, parallel to, and spaced from metallic plates **24*a***. Each partition **25*a*** has substantially the same peripheral configuration, although not shown, as plates **24*a***. Each partition **25*a*** separates the plenum between adjacent plates **24*a*** into first and second spacial layers **26*a*** and **27*a*** respectively.

A first sealing means in the form of a series of closing bars **28*a*** bridging between each partition **25*a*** and the adjacent plates **24*a*** along the peripheral margins thereof (See FIGS. **10** and **11**) in each of the layers **26*a*** and **27*a*** bound the plenums between adjacent pairs of plates **24*a***. Bars **28*a*** are sealingly bonded to the margins of plates **24*a*** and partitions **25*a*** by brazing. It should be appreciated that the sealing effect of bars **28*a*** may be obtained by elements of other configuration such as channel members, rods, tubes, etc.

Now referring specifically to FIG. **10** where the full width of one of layers **26*a*** and the details therein can be viewed, it will be seen that a gap is provided at the lower end of layer **26*a*** between the ends of bars **28*a*** to thereby define a liquid inlet **29*a*** to a first passage, and that a second gap is provided at the upper portion of layer **26*a*** between the ends of the bars **28*a*** to form a fluid outlet **30*a*** from the first passage.

Disposed adjacent inlet **29*a*** and outlet **30*a*** is a substantially triangular section **31*a*** of corrugated metallic sheet fin material having crests extending vertically. A trapezoidal section **32*a*** of corrugated metallic sheet fin material is disposed laterally of each fin section **31*a*** having crests extending diagonally as shown to provide a flow pattern between the inlet or outlet and the full width of the heat exchanger. A small rectangular section **33*a*** of corrugated metallic sheet fin material having crests extending horizontally is arranged immediately above the lower trapezoidal section **32*a***. Section **33*a*** must be porous as the liquid passes the hard way therethrough and is accordingly termed a "hardway" fin section. Immediately below the upper fin section **32*a*** is a large rectangular section **34*a*** of corrugated metallic sheet fin material having crests extending vertically.

In the area intermediate fin section **34*a*** and "hardway" section **33*a***, the partition **25*a*** is provided with a slit **35*a*** which extends horizontally across the width of the heat exchanger **10*a***. In FIG. **10** a portion of the fin sections has been removed to expose partition **25*a*** and slit **35*a***. As will be discussed hereinafter, slit **35*a*** defines a transfer passage for the transfer of gaseous fluid from a second passage within an adjoining layer **27*a*** into the liquid stream passing through the first passage in layer **26*a***. Slit **35*a*** may be formed simply by spacing two separate plates to form the partition **25*a***. In the alternative slit **35*a*** may be formed by cutting an elongated opening in a single piece partition. In either event, the ends of slit **35*a*** adjacent the sides of heat exchanger **10*a*** are closed to prevent external leakage. Since the plates within a plate-type heat exchanger constitute a structural element which is substantially weakened by an interruption such as slit **35*a***, a rectangular section **36*a*** of corrugated metallic heavy guage sheet fin material having crests extending vertically is disposed within layer **26*a*** overlying partition **25*a*** at both sides of slit **35*a***. Fin section **36*a*** is brazed to partition **25*a*** to provide the necessary structural continuity bridging slit **35*a***. We therefore refer to this type fin as a bridging fin.

Liquid entering inlet **29*a*** to the first passage from header **21*a*** as illustrated by the heavy solid vectors in FIGS. **9** and **10** is distributed across the width of the heat exchanger via lower fin sections **31*a*** and **32*a*** and **33*a*** in the lower portion of the heat exchanger. After having been uniformly distributed across the width of the heat exchanger, the liquid is mixed with gas entering the first passage via transfer passage slit **35*a*** as illustrated by the heavy dashed vectors in FIGS. **9** and **10**. The liquid and gaseous fluids respectively uniformly distributed across the width of the heat exchanger and subsequently combined in intimate contact with each other then flow upwardly through the main fin section **34***a* of the first passage. The fluid is then collected at the top of the heat exchanger and directed to the outlet **30***a* via upper fin sections **32***a* and **31***a* adjacent outlet **30***a* from whence it passes to header **22***a*.

Now referring specifically to FIG. **11** showing layer **27***a*, it will be seen that the ends of bars **28***a* in layer **27***a* are spaced one from the other to thereby define a gas inlet **37***a* at the lower portion of the heat exchanger, a fluid inlet **38***a* in the upper portion of the heat exchanger, and a fluid outlet **39***a* in the lower portion of the heat exchanger. Inlets **37***a* and **38***a* and outlet **39***a* communicate respectively with headers **18***a*, **11***a* and **12***a*. The space within layer **27***a* is sealingly bisected into second and third passages by a second sealing means in the form of a horizontally extending bar **40***a* which bridges between partition **25***a* and plate **24***a* as best seen in FIGS. **9** and **11**. The space within layer **27***a* above bar **40***a*, i.e., the space of the third passage, is provided with first triangular sections **41***a* of corrugated metallic sheet fin material having crests extending horizontally, disposed adjacent inlet **38***a* and outlet **39***a*. A second triangular section **42***a* of corrugated metallic sheet fin material having crests extending vertically is disposed intermediate each of fin sections **41***a* and a large rectangular section **43***a* of corrugated metallic sheet fin material also having crests extending vertically. Fluid passing from header **11***a* enters the third passage through inlet **38***a* and is distributed across the width of the heat exchanger via upper fin section **41***a*, from whence it passes downwardly through upper triangular section **42***a*, rectangular section **43***a*, and lower triangular section **42***a* where it is collected in lower fin section **41***a* and delivered from the third passage to header **12***a* via outlet **39***a*. This flow of fluid in the third passage is illustrated by the heavy dash-dot vectors in FIGS. **9** and **11**. The fluid is thus passed in head exchange relation with the fluid passing through the first passage in layer **26***a*, the heat transfer taking place between layers **26***a* and **27***a* through metallic partition **25***a*.

Within layer **27***a* below bar **40***a* is a first triangular section **44***a* of corrugated metallic sheet fin material having crests extending horizontally to inlet **37***a*, and a second triangular section **45***a* of corrugated metallic sheet fin material having crests extending vertically. Immediately below triangular section **45***a* is a rectangular "hardway" fin section **47***a* of corrugated metallic sheet fin having crests extending horizontally. Like "-hardway" **33***a*, "hardway" section **47***a* is porous to permit passage of gas therethrough transversely of the crests thereof. A rectangular section **46***a* of bridging fin similar to bridging fin **36***a* is disposed immediately below "hardway" section **47***a* in layer **27***a* overlying and brazed to the area of separator **25***a* immediately adjacent slit **35***a*. Section **46***a* like section **36***a* is constructed from a heavy sheet of corrugated sheet fin material having crests extending vertically to thereby provide structural continuity in the area of slit **35***a*. In FIG. **11** a portion of the fin sections has been removed to expose partition **25***a* and slit **35***a*.

Gas entering inlet **37***a* to the second passage from header **18***a* passes respectively through triangular section **44***a*, downwardly through triangular section **45***a*, and "hardway" section **47***a* and is thus uniformly distributed across the width of the heat exchanger in the second passage. After having been thus distributed across the width of the heat exchanger, the gas passes along the bridging fin **46***a* and is transferred from layer **27***a* to layer **26***a* through the slit **35***a* as herein before described. This flow of gas in the second passage is illustrated by the heavy dashed vectors.

Thus it will be seen that a two-phase mixture fluid passing through the major portion of layers **26***a* is heat exchanged with the third fluid passing through the layers **27***a*. However, a portion of each layer **27***a* at the lower end thereof provides means for distributing gas across the width of the heat exchanger prior to being transferred into the liquid stream of layer **26***a*. Since the liquid is uniformly distributed across the width of the heat exchanger in layer **26***a*, and the gas is uniformly distributed across the width of the heat exchanger in layer **27***a*, there is no necessity to further distribute these fluids across the width of the heat exchanger after they are combined even if the relative proportions of combined liquid and gas are varied as aforementioned. The flow Vectors shown in FIG. **7** are a superimposed composite of the flow vectors of FIGS. **10** and **11** and illustrate the flow pattern for the aforedescribed heat exchange. It should be noted that in the embodiment of FIGS. **7** through **11**, it is the gas stream that passes through the transfer passage slit **35***a* in the partition **25***a*. Since the gas inlet **37***a* is disposed vertically intermediate bar **40***a* and slit **35***a*, the gas is first caused to pass downwardly in layer **27***a* before passing upwardly in layer **26***a*. The downward course of the gas flow in layer **27***a* provides an effective means of preventing liquid under low flow conditions from backing up into the gas supply.

Now referring to the embodiment of the invention shown in FIGS. **12—17** with particular attention to FIGS. **13** and **14**, it will be seen that heat exchanger **10***b* has a core **23***b* comprised of a plurality of rectangular impervious metallic plates **24***b* of the same peripheral configuration contraposed in face-to-face parallel spaced relationship. Disposed within the lower portion of each of the plenums formed intermediate certain pairs of adjacent plates **24***b*, is a rectangular metallic platelike partition **25***b* interleaved with, parallel to, and spaced from metallic plates **24***b*. Partitions **24***b* have a vertical extent as shown in FIG. **14** and a horizontal extent equal to plates **24***b*. A portion of the fin material has been removed in FIG. **16** to directly expose a portion of the face of one of partitions **25***b*. Each partition **25***b* separates the lower portion of its respective plenum into first and second spacial layers **26***b* and **27***b* respectively.

A series of closing bars **28***b* sealingly bridging between each partition **25***b* and the adjacent plates **24***b* along the margins thereof at the lower portion of plates **24***b* in each of the layers **26***b* and **27***b* and between adjacent plates **24***b* along the margins thereof at the upper portion of plates **24***b* bound the plenums between said certain pairs of adjacent plates **24***b*. Bars **28***b* are sealingly bonded to the margins of plates **24***b* and partitions **25***b* by brazing. It should be appreciated that the sealing effect of bars **28***b* may be obtained by elements of other configurations such as channel members, rods, tubes, and etc.

Now referring specifically to FIG. **16** where the full width of one of layers **26***b* and the details herein can be viewed, it will be seen that a gap is provided at the lower end of layer **26***b* between the ends of bars **28***b* to thereby define a gas inlet **29***b* to a first passage, and that a second gap is provided at the upper portion of said plenum between the ends of bars **28***b* to form a fluid outlet **30***b* from the first passage.

Disposed adjacent inlet **29***b* and outlet **30***b* is a substantially triangular section **31***b* of corrugated metallic sheet fin material having crests extending vertically. Disposed adjacent outlet **30***b* is a substantially triangular section of corrugated sheet fin **31***b'* having its crests extending vertically. A trapezoidal section **32***b* of corrugated metallic sheet fin material is disposed laterally of fin section **31***b* having crests extending diagonally as shown to provide a flow pattern from inlet **29***b* to the full width of the heat exchanger. A trapezoidal section **32***b'* of corrugated metallic sheet fin material is disposed laterally of fin section **31***b'* having crests extending diagonally as shown to provide a flow pattern from the full width of the heat exchanger to outlet **30***b*. A small rectangular section **33***b* of corrugated metallic sheet fin material having its crests extending horizontally is arranged immediately above trapezoidal section **32***b*. Section **33***b* must be porous as the fluid passes the "hardway" therethrough and is accordingly termed a "hardway" fin section. Intermediate "hardway" fin section **33***b* and trapezoidal fin section **32***b'* is a large rectangular section **34***b* of corrugated metallic sheet fin material having its crests extending vertically. It should be noted that fin sections **31***b'*, **32***b'* and **34***b* are sufficiently thick as to bridge between spaced plates 24*b* whereas fin sections 33*b*, 31*b* and 32*b* are sufficiently thick as to bridge only between a plate 24*b* and a partition 25*b*.

Gas entering inlet 29*b* from header 18*b* as illustrated by the heavy dashed vectors in FIGS. 14 and 16 is distributed across the width of the heat exchanger via lower fin sections 31*b*, 32*b*, and 33*b*. After the gas has been completely distributed across the width of the heat exchanger by passing through fin sections 31*b*, 32*b*, and 33*b*, it passes beyond the upper edge of partition 25*b* into fin section 34*b* where it is combined with liquid, as illustrated by the heavy solid vectors in FIGS. 14, 16, and 17, entering the fin section 34*b* in a manner hereinafter described in connection with layer 26*b*. The liquid and gaseous fluids respectively uniformly distributed across the width of the heat exchanger and subsequently combined in intimate contact with each other then flow upwardly through the main fin section 34*b* of the first passage. The fluid is then collected at the top of the heat exchanger and directed to the outlet 30*b* via upper fin sections 32*b*′ and 31*b*′ adjacent outlet 30*b* from whence it passes to header 22*b*.

Now referring specifically to FIG. 17 showing one of layers 27*b*, it will be seen that the ends of bars 28*b* in layer 27*b* are spaced one from the other to thereby define a liquid inlet 37*b*, to a second passage which communicates with header 21*b* of heat exchanger 10*b*. Disposed within each layer 27*b* adjacent an inlet 37*b* is a first triangular section 44*b* of corrugated metallic sheet fin material having crests extending horizontally. A second triangular section 45*b* of corrugated metallic sheet fin material is disposed immediately above section 44*b* also having crests extending vertically. Immediately above fin section 45*b* is a rectangular "hardway" section 47*b* of corrugated metallic sheet fin material having crests extending horizontally. Like "hardway" section 33*b*, "hardway" section 47*b* is porous to permit passage of fluid therethrough transversely of the crests thereof. Liquid entering inlet 37*b* from header 21*b* passes respectively through triangular section 44 *b*, triangular section 45*b*, and "hardway" section 47*b* and is thus uniformly distributed across the width of the heat exchanger in the second passage. After thus being distributed across the width of the heat exchanger, the liquid fluid passes vertically beyond the upper edge of partition 25*b* where it intimately mixes with the gas within fin section 34*b* of the first passage. In this particular embodiment of the invention it will be noted that no discrete slit or gap is provided within partition 25*b*. However, a transfer passage is formed as both layers 26*b* and 27*b* become a common layer above the upper edge of partition 25*b*.

It will be seen that the gas flowing within the first passage of layer 26*b* and the liquid flowing within the second passage of layer 27*b* are separately substantially uniformly distributed across the width of the heat exchanger prior to their combination, and that there is no necessity for further distribution of these fluids across the width of the heat exchanger after being so combined. The combined fluids flowing in section 34*b*, i.e., the upper portion of the first passage, are heat exchanged with a third heat exchange fluid flowing in a third passage of an adjacent layer 50*b* as illustrated by the heavy dot-dash vectors of FIG. 15.

Referring now specifically to FIG. 15, the third passage is formed by certain other adjacent metallic plates 24*b* and closing bars 28*b* bridging therebetween along the margins thereof. It will be seen that the ends of bars 28*b* within layer 50*b* are spaced to define a fluid inlet 38*b* at the upper portion of the heat exchanger and a fluid outlet 39*b* at the lower portion of the heat exchanger arranged to communicate respectively with headers 11*b* and 12*b*. Disposed within the space of layer 50*b* adjacent each inlet 38*b* and outlet 39*b* is a substantially triangular section 41*b* of corrugated metallic sheet fin material having crests extending vertically. A trapezoidal section 42*b* of corrugated metallic sheet fin material is disposed laterally of each of fin sections 41*b* and has crests extending diagonally as shown to provide a flow pattern between the inlet or outlet and the full width of the heat exchanger. Intermediate trapezoidal sections 42*b* is a large rectangular section 43*b* of corrugated metallic sheet fin material which forms the main packing for the third passage within layer 50*b*. The fluid to be heat exchanged with the aforementioned gaseous and liquid fluids enters the third passage via header 11*b*, inlet 38*b* and is distributed across the width of the heat exchanger by upper triangular section 41*b* and upper trapezoidal section 42*b* whereupon it moves downwardly through rectangular section 43*b* from which it is directed via lower trapezoidal section 42*b* and lower triangular section 41*b* to outlet 39*b* into header 12*b*.

Thus it will be seen that two-phase mixture fluid passing through the first passages is heat exchanged via plates 24*b* with the third fluid passing through the third passage within layer 50*b*. However, means is provided intermediate plates 24*b* for independent distribution of both the liquid and gaseous phases uniformly across the full width of the heat exchanger prior to their mixture. Since the gas is uniformly distributed across the width of the heat exchanger in layer 26*b*, and the liquid is uniformly distributed across the width of the heat exchanger in layer 27*b* there is no necessity to further distribute these fluids across the width of the heat exchanger after they are combined even if the relative proportions of combined liquid and gas varied as aforementioned. The flow vectors shown in FIG. 12 are a superimposed composite of the flow vectors of FIGS. 15, 16, and 17 and illustrate the flow pattern for the aforedescribed heat exchange.

Now referring to the embodiment of the invention shown in FIGS. 18—23 with particular attention to FIGS. 19 and 20, it will be seen that heat exchanger 10*c* has a core 23*c* comprised of a plurality of rectangular impervious metallic plates 24*c* of the same peripheral configuration contraposed in face-to-face parallel spaced relationship. Disposed within each of the plenums formed intermediate certain adjacent plates 24*c*, is a pair of rectangular metallic platelike partitions 25*c* interleaved with, parallel to, and spaced from the lower portions of metallic plates 24*c*. Intermediate the planes of adjacent partitions 25*c* immediately above partitions 25*c* is a third rectangular metallic platelike partition 25*c*′ interleaved with, parallel to, and spaced from the upper portions of said certain plates 24*c*. Partition 25*c*′ has a vertical extent as shown in FIG. 20 and a horizontal extent equal to that of plates 24*c*. Portions of the fin material have been removed in FIGS. 22 and 23 to directly expose portions of the faces of partitions 25*c* and 25*c*′. Each pair of partitions 25*c* separates the lower portion of the plenum between said certain adjacent plates 24*c* into a pair of spaced spacial layers 26*c* and an intermediate spacial layer 27*c* shown in FIGS. 22 and 23 respectively. Each partition 25*c*′ separates the upper portion of the plenum between said certain adjacent plates 24*c* into two identical spacial layers 26*c*′ shown in FIGS. 20 and 22. Each layer 26*c* is somewhat narrower than but coextensive and in fluid communication with a layer 26*c*′. Layer 26*c*′ may be considered as a thickened extension of layer 26*c*. Layer 27*c* is coextensive and in communication with two adjacent layers 26*c*′. A series of closing bars 28*c* sealingly bridging between each partition 25*c* and the lower portion of adjacent plates 24*c* along the margins thereof in each of layers 26*c*, between partitions 25*c*′ along the lower and side margins thereof in layer 27*c*, bound each plenum between said certain adjacent pairs of plates 24*c*. Bars 27*c* are sealingly bonded to the margins of plates 24*c* and partitions 25*c* and 25*c*′ by brazing. It should be appreciated that the sealing effect of bars 28*c* may be obtained by elements of other configurations such as channel members, rods, tubes, etc.

Now referring specifically to FIG. 22 where the details of layers 26*c* and 26*c*′ are shown, it will be seen that a gap is provided between the ends of bars 28*c* at the lower end of the layer 26*c* to thereby define a gaseous fluid inlet 29*c* to a first passage, and that a second gap is provided between the ends of bars 28*c* at the upper portion of the first passage in layer 26*c*′ to form a fluid outlet 30*c* from said first passage. Disposed adjacent inlet 29*c* is a substantially triangular section 31*c* of corrugated metallic sheet fin material having crests extending vertically. Disposed adjacent outlet **30***c* is a substantially triangular section **31***c'* of corrugated metallic sheet fin material having crests extending vertically. A trapezoidal section **32***c* of corrugated metallic sheet fin material is disposed laterally of fin section **31***c* having crests extending diagonally as shown to provide a flow pattern from inlet **29***c* to the full width of the heat exchanger. A trapezoidal section **32***c* ' of corrugated metallic sheet fin material is disposed laterally of fin section **31***c'* having the crests extending diagonally as shown to provide a flow pattern from the full width of the heat exchanger to outlet **30***c*. A small rectangular section **33***c* of corrugated metallic sheet fin material having crests extending horizontally is arranged immediately about trapezoidal section **32***c*. Section **33***c* must be porous as the gas passes the hard way therethrough and is accordingly termed a "hardway" fin section. Intermediate "hardway" fin section **33***c* and the trapezoidal fin section **32***c'* is a large rectangular section **34***c* of corrugated metallic sheet fin material having crests extending vertically. It should be noted that the fin sections **31***c'*, **32***c'* and **34***c* are sufficiently thick as to bridge between a partition **25***c'* and the adjacent plate **24***c* and that fin sections **31***c*, **32***c*, and **33***c* are sufficiently thick as to bridge between partition **25***c* and adjacent plate **24***c*.

Gas entering inlet **29***c* from header **18***c* as illustrated by the heavy dashed vectors in FIGS. **20**, **22** and **23**, is distributed uniformly across the width of the heat exchanger via lower fin sections **31***c*, **32***c* and **33***c* in the lower portion of the heat exchanger core **23***c*. After the gas has been completely distributed across the width of the heat exchanger by passing through fin sections **31***c*, **32***c* and **33***c*, it passes beyond the upper edge of partition **25***c* into fin section **34***c*where it is combined with liquid as illustrated by the heavy solid vectors in FIGS. **20**, **22** and **23** entering the fin section **34***c* in a manner hereinafter described in connection with layer **27***c*. The liquid and gaseous fluids respectively uniformly distributed across the width of the heat exchanger and subsequently combined in intimate contact with each other then flow upwardly through the main fin section **34***c*. The fluid is then collected at the top of the heat exchanger and directed to the outlet **30***c* via upper fin sections **32***c'* and **31***c'* adjacent outlet **30***c* from whence it passes to header **22***c*.

Now referring specifically to FIG. **23** showing layer **27***c*, it will be seen that the ends of bars **28***c* of layer **27***c* are spaced one from the other to thereby define a liquid inlet **37***c* to a second passage which communicates with header **21***c* of heat exchanger **10***c*. Disposed within each layer **27***c* adjacent inlet **37***c* is a first triangular section **44***c* of corrugated metallic sheet fin material having crests extending horizontally. A second triangular section **45***c* of corrugated metallic sheet fin material is disposed immediately above section **44***c* having crests extending vertically. Immediately above fin section **45***c* is a rectangular "hardway" section **47***c* of corrugated metallic sheet fin material having crests extending horizontally. Like "-hardway" section **33***c*, "hardway" section **47***c* is porous to permit passage of liquid therethrough transversely of the crests thereof. Liquid entering inlet **37***c* to the second passage from header **21***c* passes respectively through triangular section **44***c*, triangular section **45***c*, and "hardway" section **47***c* and is thus uniformly distributed across the width of the heat exchanger. After thus being distributed across the width of the heat exchanger in the second passage, the liquid fluid passes vertically beyond the upper edge of partition **25***c* where the liquid intimately mixes with the gaseous fluid in the first passage at fin sections **34***c* aforedescribed. In this particular embodiment of the invention it will be noted that no discrete slit or gap is provided within partition **25***c*. However, a transfer passage is formed as both layers **26***c* and **27***c* become a common layer **26***c'* above the upper edge of partition **25***c*. It will be seen that the gas flowing within layer **26***c* and the liquid flowing within layer **27***c* are separately substantially uniformly distributed across the width of the heat exchanger prior to their combination, and that there is no necessity for further distribution of these fluids across the width of the heat exchanger after being so combined. The combined fluids flowing in section **34***c*, i.e., the upper portion of the first passage, are heat exchanged with a third heat exchange fluid flowing in a third passage of an adjacent layer **50***c* via plates **24***c* as illustrated by the heavy dot-dash vectors of FIG. **21**.

Referring now specifically to FIG. **21**, the third passage is formed by certain other adjacent metallic plates **24***c* and closing bars **28***c* bridging therebetween along the margins thereof. It will be seen that the ends of bars **28***c* within layer **50***c* are spaced to define a fluid inlet **38***c* at the upper portion of the heat exchanger and a fluid outlet **39***c* at the lower portion of the heat exchanger arranged to communicate respectively with headers **11***c* and **12***c*. Disposed within the space of layer **50***c* adjacent inlet **38***c* and outlet **39***c* is a substantially triangular section **41***c* of corrugated metallic sheet fin material having crests extending vertically. A trapezoidal section **42***c* of corrugated metallic sheet fin material is disposed laterally of each of fin sections **41***c* and has crests extending diagonally as shown to provide a flow pattern between the inlet or outlet and the full width of the heat exchanger. Intermediate trapezoidal sections **42***c* is a large rectangular section **43***c* of corrugated metallic sheet fin material which forms the main packing for layer **50***c*. The third fluid to be heat exchanged with the aforementioned gaseous and liquid fluids enters the third passage in layer **50***c* via the header **11***c*, inlet **38***c* and is distributed as illustrated by the dot-dash vectors in FIG. **21** across the width of the heat exchanger by upper triangular section **41***c* and upper trapezoidal section **42***c* whereupon it moves downwardly through rectangular section **43***c* from which it is directed via lower trapezoidal section **42***c* and lower triangular section **41***c* to outlet **39***c* from the third passage into header **12***c*.

Thus it will be seen that two-phase mixture fluid passing through the first passage is heat exchanged with the third fluid passing through the third passage within layer **50***c* via plates **24***c*. However, means is provided between plates **24***c* for independent distribution of both the liquid and gaseous phases uniformly across the full width of the heat exchanger prior to their mixture.

Since the gas is uniformly distributed across the width of the heat exchanger in layer **26***c*, and the liquid is uniformly distributed across the width of the heat exchanger in layer **27***c*, there is no necessity to further distribute these fluids across the width of the heat exchanger after they are combined even if the relative proportions of the combined liquid and gas varied as aforementioned. The flow vectors shown in FIG. **18** are a superimposed composite of the flow vectors of FIGS. **21**, **22** and **23** and illustrate the flow pattern for the aforedescribed heat exchange.

Reference may be made to FIGS. **9**, **10** and **11** of U.S. Pat. No. 3,282,334 for a more comprehensive illustration of the types of material utilized in the corrugated metallic sheet fin sections for the heat exchanger embodiments disclosed herein.

In applying the second, third and fourth embodiments of the invention to the system of FIG. **1**, numerals **11**, **12**, **18**, **21**, and **22** will become respectively: **11***a*, **12***a*, **18***a*, **21***a*, and **22***a*; **11***b*, **12***b*, **18***b*, **21***b*, and **22***b*, and **11***c*, **12***c*, **18***c*, **21***c*, and **22***c*. Their operation within the system of FIG. **1** is similar to that of the first embodiment.

We claim:

1. A plate-type heat exchanger apparatus comprising: first and second elongated metallic plates of generally similar peripheral configuration contraposed in face-to-face spaced relationship; first sealing means sealingly connecting said elongated metallic plates along the peripheral margins thereof thereby enclosing with said first and second elongated metallic plates a generally flat elongated plenum; a platelike partition interleaved with said first and second elongated metallic plates adjacent at least one end of said plenum and being generally coincident with a plane spaced from said first and second elongated metallic plates bisecting said plenum at said one end

into first and second spacial layers; said partition extending transversely of the longitudinal axis of said elongated plenum substantially to said first sealing means thereby defining within one of said spacial layers a first passage intermediate said partition and said first elongated metallic plate and within the other of said spacial layer a second a passage intermediate said partition and said second elongated plate; said first sealing means defining a first inlet to said first passage adjacent said one end of said plenum for admitting one of a first gaseous phase and a second liquid phase heat exchange fluids; said first sealing means defining a second inlet to said second passage adjacent said one end of said plenum for admitting the other of said gaseous phase and liquid phase heat exchange fluids; said first sealing means further defining at the other end of said plenum a first outlet from said plenum; first distributor means in one of said first and second passages abutting one face of said partition for substantially uniformly distributing one of said first and second heat exchange fluids respectively from one of said first and second inlets within said one passage substantially across the width of said plenum; a transfer passage means within said plenum for combining said one uniformly distributed heat exchange fluid with the other of said first and second fluids, and means defining a third passage disposed in heat exchange relation with the combined first and second heat exchange fluids.

2. The apparatus as defined by claim **1** including a second distributor means in the other of said first and second passages abutting the other face of said partition for substantially uniformly distributing the other of said first and second heat exchange fluids respectively from the other of said first and second inlets within said other passage substantially across the width of said plenum.

3. The apparatus as defined by claim **2** wherein the sum of the thicknesses of said first distributor means, said second distributor means, and said partition substantially equal the thickness of said plenum.

4. The apparatus as defined by claim **1** wherein said distributor means includes a corrugated metallic sheet.

5. The apparatus as defined by claim **4** wherein the crest of said corrugated metallic sheet extended transversely of the longitudinal axis of said plenum and wherein said metallic sheet is perforated.

6. The apparatus as defined by claim **1** wherein said third passage is disposed within said second spacial layer and wherein said partition has approximately the same length as said first and second elongated metallic plates whereby said third passage is separated from said first spacial layer; and second sealing means disposed within said second spacial layer extending transversely of the longitudinal axis of said plenum for sealing separating said second passage from said third passage.

7. The apparatus as defined by claim **6** wherein said transfer passage is disposed intermediate said second inlet and said second sealing means with respect to said longitudinal axis.

8. The apparatus as defined by claim **6** wherein said second inlet is disposed intermediate said transfer passage and said second sealing means with respect to said longitudinal axis.

9. The apparatus as defined by claim **1** wherein said transfer passage extends through said partition.

10. The apparatus as defined by claim **9** wherein said transfer passage is substantially the full width of said plenum.

11. The apparatus as defined by claim **10** wherein said partition is comprised of two metallic plates disposed in end-to-end spaced relationship wherein the space therebetween defined defines said transfer passage.

12 The apparatus as defined by claim **9** wherein the longitudinal axis of said plenum is vertical; and wherein said transfer passage is disposed in the lower portion of said partition.

13. The apparatus as defined by claim **12** wherein said second inlet to said second passage is s disposed below said transfer passage.

14. The apparatus as defined by claim **12** wherein said inlet to said second passage is disposed above said transfer passage.

15. The apparatus as defined by claim **1** including a third elongated metallic plate of generally similar peripheral configuration to said first and second elongated metallic plates contraposed in face-to-face spaced relationship with said second elongated metallic plate externally of said plenum; said first sealing means further sealingly connecting said second and third elongated metallic plates along the peripheral margins thereof whereby said third passage is defined therebetween; said first sealing means defining an inlet and an outlet respectively to and from said third passage.

16. The apparatus as defined by claim **15** including a second partition within said plenum interleaved with said first partition and second elongated metallic plate whereby the opposing faces of said second passage are defined by said first and second partitions.

17. A method of heat exchange including the steps of: providing a supply of gaseous phase heat exchange fluid; providing a supply of liquid phase heat exchange fluid; introducing the fluid of one of said phases into a first layer of a multilayer heat exchanger; distributing said introduced fluid of said one phase within said first layer substantially uniformly substantially across the width of said heat exchanger; passing the substantially uniformly distributed fluid of said one phase through the remainder of said first layer; simultaneously introducing the fluid of the other of said phases into a second layer adjacent said first layer; distributing said introduced fluid of said other phase within said second layer substantially uniformly substantially across the width of said heat exchanger; and transferring the substantially uniformly distributed fluid of said other phase from said second layer to said first layer while substantially maintaining its uniform distribution substantially across the width of said heat exchanger whereby the gaseous and liquid phases are substantially uniformly combined substantially across the width of a heat exchanger independently of their relative mass flows.

18. A method of heat exchanging a first heat exchange fluid with a gaseous phase heat exchange fluid and liquid phase heat exchange fluid including the steps of: providing a first supply of liquid phase heat exchange fluid; providing a second supply of gaseous phase heat exchange fluid; providing a third supply of a third heat exchange fluid; introducing the fluid of one of said phases into a first layer of a multilayer heat exchanger; distributing said introduced fluid of said one phase within said first layer substantially uniformly substantially across the width of said heat exchanger; introducing the fluid of the other of said phases into a second layer adjacent said first layer; distributing said introduced fluid of said other phase within said second layer substantially uniformly substantially across the width of said heat exchanger; transferring the substantially uniformly distributed fluid of one of said phases from one of the first and second layers and diffusing it into the substantially uniformly distributed fluid of the other phase from the other of the first and second layers while substantially maintaining its uniform distribution substantially across the width of said heat exchanger whereby the gaseous and liquid phases are substantially uniformly combined substantially across the width of a heat exchanger independently of their relative mass flow rates; and passing the substantially uniformly distributed combined gaseous and liquid phase heat exchange fluids in heat exchange relation with said third heat exchange fluid.

19. A method as defined by claim **18** wherein said one phase is the gaseous phase and said other phase is the liquid phase.

20. A method as defined by claim **18** wherein said one phase is the liquid phase and said other phase is the gaseous phase.

21. A method as defined by claim **18** wherein the combined gaseous and liquid phase fluids are passed generally upwardly through said other of said first and second layers.

22. A method of operating a plate-type heat exchanger having a plurality of substantially parallel spaced plates defining therebetween a plurality of relatively thin but wide passages including the steps of: passing a gas into a first of said relatively thin but wide passages formed by said plates; spreading said gas out in said first passage over substantially the full width of said plates forming said first passage; passing a liquid into a second of said relatively thin but wide passages formed by said plates; spreading said liquid out in said second passage over substantially the full width of said plates forming said second passage; passing the thus spread gaseous and liquid fluids in substantially a common direction within their respective passages and passing one of said gaseous and liquid fluids beyond an edge of one of said plates forming one of a said first and second passages into the other of said gaseous and liquid fluids in the other of said passages for uniform intimate mixing of the gaseous and liquid fluids across the full width of said other passage; and passing the resulting mixture of gas and liquid in heat exchange relation via one of said plates with a third heat exchange fluid.

23. A method of operating a plate-type heat exchanger having a plurality of substantially parallel spaced plates defining therebetween a plurality of relatively thin but wide passages including the steps of: passing a gas into a first of said relatively thin but wide passages formed by said plates; spreading said gas out in said first passage over substantially the full width of said plates forming said first passage; passing a liquid into a second of said relatively thin but wide passages formed by said plates; spreading a said liquid out in said second passage over substantially the full width of said plates forming said second passage; passing the thus spread gaseous and liquid fluids in substantially opposite directions within their respective passages and passing one of said gaseous and liquid fluids beyond an edge of one of said plates forming one of said first and second passages into the other of said gaseous and liquid fluids in the other of said passages for uniform intimate mixing of the gaseous and liquid fluids across the full width of said other passage; and passing the resulting mixture of gas and liquid in heat exchange relation via one of said plates with a third heat exchange fluid.

24. A plate-type heat exchanger comprising: a plurality of substantially parallel closely spaced plates defining therebetween a plurality of relatively thin but wide passages; one of said plates being common to a first and second passage adjacent to each other; said one plate having an edge in fluid communication with each of said first and second passages; said first passage having a gas inlet; means within said first passage downstream of said edge for distributing gas entering said gas inlet uniformly across the width of said first passage; said second passage having a liquid inlet; means within said second passage downstream of said edge for distributing liquid entering said liquid inlet uniformly across the width of said second passage whereby said gaseous and liquid fluids are uniformly mixed as they pass beyond said edge of said one plate; and a third passage for conducting a third heat exchange fluid in heat exchange relation with the mixture of gas and liquid fluids.

25 The apparatus as defined by claim **24** wherein said edge extends transversely to said first passage.

26. The apparatus as defined by claim **24** wherein said edge extends substantially across the full width of said first and second passages.

27. The apparatus as defined by claim **24** wherein said edge is lower than said gas inlet to a said first passage.

28. The apparatus as defined by claim **24** wherein said gas distributing means and said liquid distributing means abut opposite faces of said one plate.

29. The apparatus as defined by claim **24** wherein said edge is the peripheral edge of said plate.

30. The apparatus as defined by claim **29** including a second plate having a peripheral edge parallel to and spaced from said first edge, the space between said edges conducting one of said gaseous and liquid fluids into the other of said gaseous and liquid fluids.

31. The apparatus ad as defined by claim **30** wherein said one plate and said second plate are coplanar.

32. The apparatus as defined by claim **29** wherein said one plate and said second plate are noncoplanar.