United States Patent

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Continuation of application Ser. No. 585,796, Oct. 11, 1966, now abandoned.

[54] METHOD OF MAKING CONTACTING COLUMN

2 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **29/471.1,** 29/482, 29/483
[51] **Int. Cl.** **B23k 31/02**
[50] **Field of Search** 29/471.1, 472.1, 472.3, 475, 482, 483; 261/113, 114, 108; 202/158

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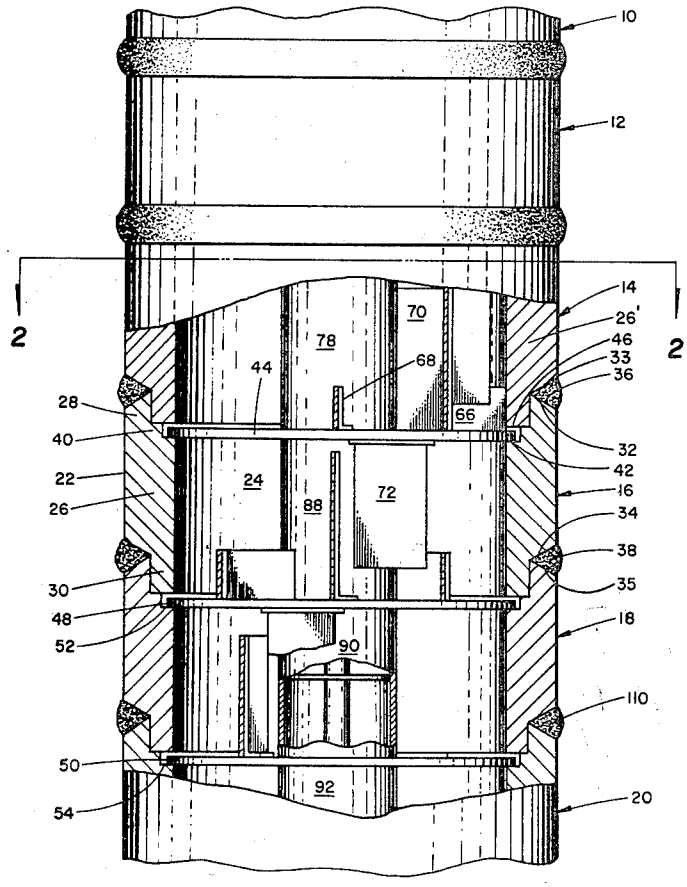
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ABSTRACT: Disclosed in a small diameter contact column having a vertical series of contact chambers separated by perforate plates. Fully erected columns of this type are substantially inaccessible for subsequent placement and attachment of internal parts. The column is achieved by superimposing a plurality of interengaging cylindrical sections adapted along their outermost engaging edges to be rigidly joined and along their innermost engaging edges to receive and support a perforate plate. The perforate plate support means permits free relative movement of the plate due to temperature change and at the same time prevents liquid from passing between the column wall and the peripheral edge of the perforate plate.



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SHEET 1 OF 2

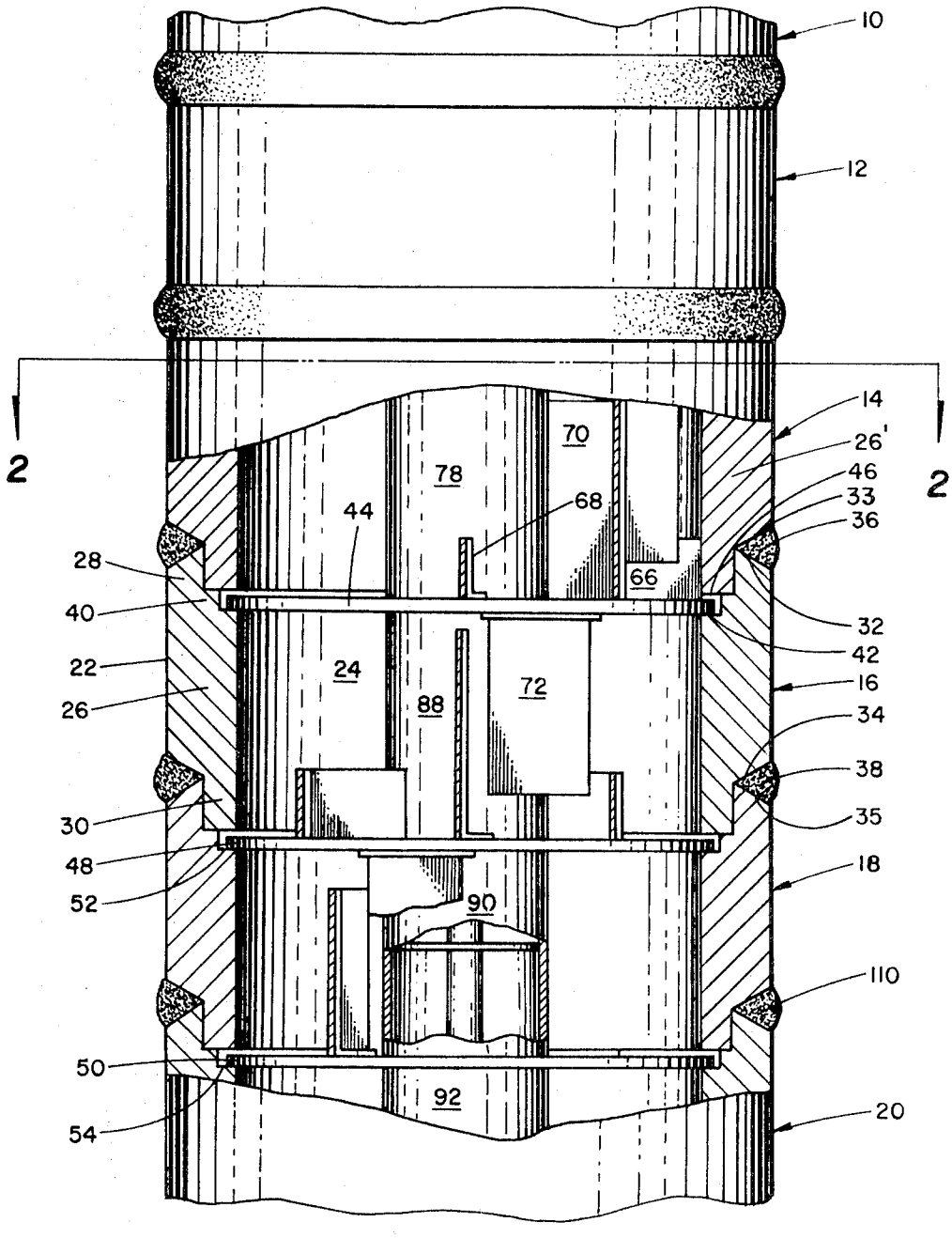


FIG. 1.

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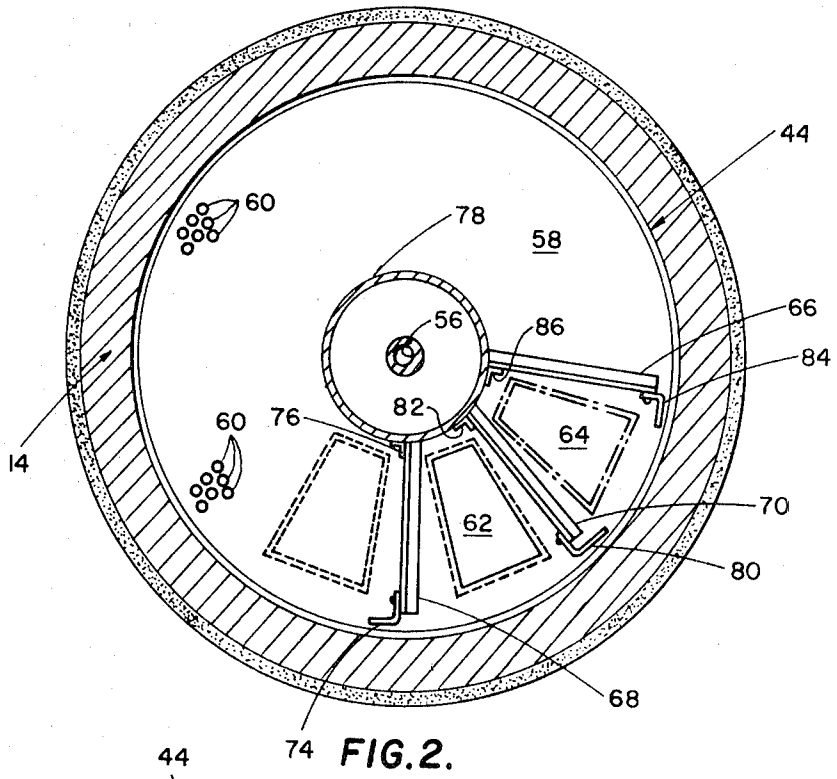


FIG.2.

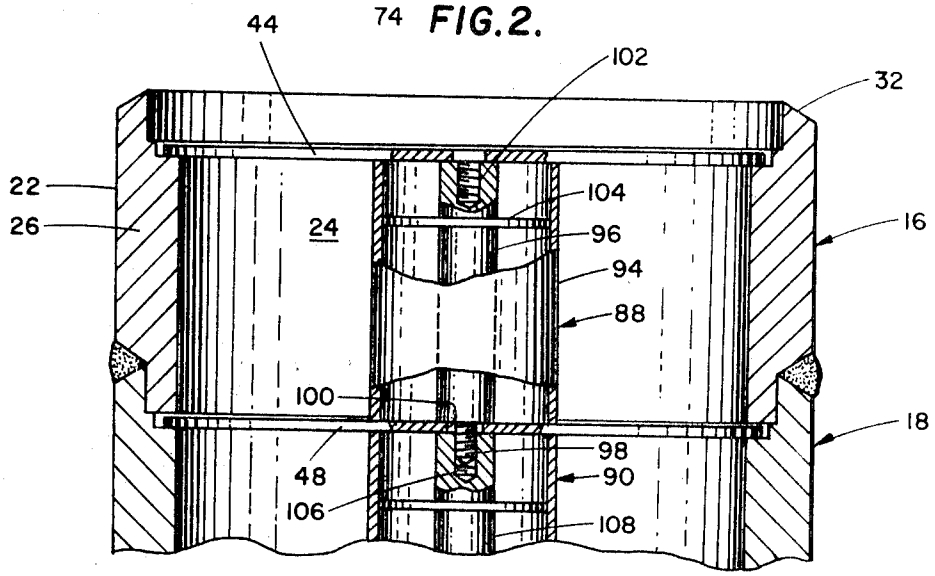


FIG.3.

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METHOD OF MAKING CONTACTING COLUMN

CROSS-REFERENCES TO RELATED APPLICATIONS

This application is a continuation of our copending application Ser. No. 585,796, filed Oct. 11, 1966, now abandoned.

BACKGROUND OF THE INVENTION

Contact columns having contact plates or trays can be used to separate the components of a liquid mixture to scrub gases or vapors with liquids and for fractionation of liquefied gases such as rectification of liquid air.

Contact columns of narrow diameter, particularly those columns used in rectification of cryogenic fluids pose special design problems in obtaining operational efficiency. In wider columns of 36 or more inches having sufficient operating space for workmen inside thereof, a complete outer shell can be utilized and the inner parts, such as trays and the like, can be later fitted and sealed within the shell. These procedures cannot be utilized in connection with columns of smaller diameter, e.g., on the order of about 18 to 24 inches. In forming contact columns of small diameter, the conventional practice is to use thin copper trays of dish or bowllike shape which are stacked one above the other in nesting relation and sealed by soldering at the peripheral edges of the dishes. The assembled and united stack of trays is mounted within an enclosing shell and the assembled structure is then fitted and fixed into an outer enclosing secondary shell or pressure-proof vessel. Since the connecting conduit lines for introduction and removal of fluids into and from the column are generally made of metals other than copper, transition pieces and special flanges are required at the joints between the different metals. The soldered joints between trays and elsewhere also provide problems in maintaining firm fluid seals. Construction of this type, it will be appreciated, is comparatively costly. Substitution of aluminum for the copper dish trays in structures of this type is not feasible because of the inherent difficulties in soldering aluminum; whereas, welding presents added problems from the standpoint of buckling due to the high temperatures required.

SUMMARY OF THE INVENTION

It has been found that narrow contact columns can be constructed of a light metal such as aluminum or magnesium by providing a series of vertical interengaging chambers (rings) with perforate plates disposed between each chamber. The vertical chambers are so constructed that they can be circumferentially welded without distortion of the shell or the perforate plate. The plates are disposed in a recess provided by a shelf in the wall of one ring and closed by the mating of adjacent chambers (rings) in a manner so as to be able to freely expand and contract in service and at the same time maintain a fluid seal between the peripheral edge of the plate and the wall of the column.

The primary object of the present invention is to provide a small diameter column made of a light metal of high efficiency and good structural stability which can be economically produced.

A further object of the invention is to provide a method of assembly of such contact columns by welding of component parts without distortions ordinarily accompanying thermal stresses.

Another object of this invention is to provide a contact column wherein the trays are so supported that they can move laterally in response to thermal contraction and expansion and thus prevent buckling of the trays and column while, at the same time, maintaining a sufficiently small clearance between the trays and column walls so as to prevent liquid bypass when the column is in service.

It is another object of this invention to provide a contact column constructed entirely of aluminum, magnesium, or other light metals.

It is another object of this invention to provide contact columns of sufficient integral strength so as to eliminate the need for secondary shells.

It is still a further object of this invention to provide an assembly procedure wherein all assembly operations can be performed without the necessity of a workman entering the column.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an elevation view, partially in section of a fragmentary portion of a contact column embodying the preferred form of the nested ring construction.

FIG. 2 is a section taken along lines 2–2 of FIG. 1 showing the construction of a typical contact tray and illustrating the relative positions of its downcomer opening, weir and baffles.

FIG. 3 is an enlarged view partly fragmentary and partly in section of a full ring and a portion of an adjacent ring illustrating details of the method for fastening adjacent pillar sections.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1 there is shown a contact column of about 24 inches inside diameter comprising a plurality of chambers or rings **10**, **12**, **14**, **16**, **18**, and **20**. Each ring is identical in size and formed of a light metal such as aluminum or magnesium although other materials of construction may be employed. Each ring is preferably cylindrical in shape with an outer surface **22** and an inner surface **24** defining a wall **26** therebetween as shown in conjunction with ring **16** of FIG. **1**.

A portion of surface **24** is removed from the top and a portion of surface **22** is removed from the bottom of each ring to provide reduced wall sections **28** and **30** respectively. The reduced wall portions **28** and **30** are the same configuration for each ring so that a plurality of rings can be assembled in a stacked relationship with a resulting uniform inside and outside diameters for the assembled column. The type of joint resulting from the reduced wall portions of adjacent rings is commonly referred to as a lap joint. Reduced wall portions **28** and **30** are further provided with chamfered surfaces **32**, **34** to define a groove between adjacent rings (e.g. **14** and **18** respectively). Adjacent rings **14** and **18** are also provided with similar chamfered surfaces **33**, **35** respectively so that a V-groove is achieved between adjacent rings. The V-groove can then be used to circumferentially join adjacent rings as by placing therein welds **36**, **38** respectively. Other joining means can be employed depending upon the operating environment of the column; however, for a column constructed of aluminum for cryogenic fluids, conventional aluminum metal girth welds are preferred.

There is also formed on surface **24** a second portion of reduced wall thickness **40** which defines a shelf **42** for supporting tray **44** as will hereinafter be more fully described. The reduced wall section **40** is intermediate in thickness between reduced wall section **28** and wall **26**. Shelf **42** and the bottom surface **46** of wall **26'** of ring **14** thus form a peripheral recess for positioning of the tray **44** in the column. Reduced wall section **40** is formed with an axial length just sufficient to allow expansion of the tray from heat generated by circumferential weld **36** being put in place. It is also sized so that if the column is used with cryogenic fluids the space between the tray **44** and reduced wall section **40** will not be large enough to pass fluid to the chamber defined by surface **24** of ring **16**.

The rings are conveniently formed from aluminum plates cut to appropriate lengths which are rolled into cylindrical sections and welded along their length. The configurations of the reduced wall sections **28**, **30**, **40**, including the shelf **42**, may be formed during forming of the rings or may be conveniently machined into the formed and welded rings. The rings with reduced wall sections can also be formed by other conventional metalworking techniques such as casting, forgoing, extruding, etc., in conjunction with machining.

Perforate circular trays **44**, **48**, and **50** also preferably formed of aluminum, are adapted to be received and supported on shelves **42**, **52**, and **54** of rings **16**, **18**, and **20**

respectively, within annular recesses formed as described above between the respective adjacent rings. In the embodiment described, the radial dimension of each tray is about 0.12 inches less than the radial dimensions of reduced wall section **40** formed in wall **26** of ring **16**. This dimensional difference between a tray and its respective reduced wall section allows for different size changes in the column proper and trays during welding or in use, while at the same time preventing buckling of the trays. The vertical height of each recess after welding is about 0.01 inches greater than the thickness of the trays which is about one sixteenth of an inch. The gap formed between the top of the trays and the bottom of the wall of the adjacent ring is so small that liquid will not flow therethrough. The gap between the top of tray **44** and surface **46** can be accurately measured after the rings **14** and **16** have been joined by the weldment **36**.

Referring to FIGS. **1** and **2**, it can be seen that typical tray **44** includes a central opening **56**, a major surface **58** having perforations **60** therein, a downcomer opening **62** and a nonperforate annular sector **64**. The downcomer position thereabove is shown in phantom lines to the right of opening **62** of tray **44** (FIG. **2**) while the downcomer opening in the tray **48** therebelow is shown in dotted outlines to the left of opening **62**. The perforate region **58** occupies the major portion of tray **44** and extends from a low inlet weir **66** counterclockwise to an outlet weir **68** of the same height. The downcomer opening **62** is positioned angularly between outlet weir **68** and a substantially higher baffle **70**. The nonperforate sector **64** is located angularly between the high baffle **70** and the low inlet weir **66**. As can be seen in FIG. **1**, the outlet weir **68**, baffle **70** and the inlet weir **66** are all positioned on the upper surface of tray **44**. A downcomer conduit **72** is located on the underside of tray **44** and circumscribes the downcomer opening **62**. The elements **66**, **68**, **70**, and **72** are fixedly secured to and supported on the tray **44** in any convenient manner such as by riveting or welding.

Flexible tab **74** of substantially the same height as weir **68**, is secured along its outer edge to the weir **68**. The tab forms a fluidtight joint with the weir. The outer edge of tab **74** abuts the inner wall of ring **14** of the column in fluid sealing relationship therewith. If desired, the other edge of weir **68** may also be provided with a rigid or flexible tab **76** adjacent pillar **78**, which will be described in detail hereinafter. Tabs **80** and **82**, at least one of which is flexible, of the same length as the tall baffle **70** and one or more tabs **84** and **86**, at least one of which is flexible, of the same length as the low inlet weir **66** are also provided. Tab **80** forms a flexible fluidtight joint between baffle **70** and inner wall of ring **14** and tab **82** forms a fluidtight joint between baffle **70** and pillar **78**. Tab **84** forms a flexible fluidtight joint between weir **66** and the inner wall of ring **14** and tab **86** forms a fluidtight joint between weir **68** and pillar **78**. The tabs **74**, **80**, and **84** which form fluidtight joints between the respective baffle and weirs and the inner wall of ring **14** permit relative radial movement between tray **44** which supports baffle **70**, and weirs **66** and **68** and the column proper. The tabs can be formed of any material that will remain flexible under operating conditions. For cryogenic applications, thin metal (e.g. aluminum) tabs are satisfactory.

In addition to the rings and trays, the contact column includes central cylindrical pillar sections **78**, **88**, **90**, and **92**. Referring now to FIG. **3** it can be seen that each pillar section is formed with a collar **94** and an inner shaft **96** having a threaded extension **98** at one end adapted to extend through the opening **100** of tray **48**. A complementary threaded recess **102** is provided at the other end of shaft **96**. Each shaft is connected to its respective collar by an annular plate **104**. The dimensions of the collars and shafts are so related to the dimensions of the rings and trays that the adjacent shafts, when interthreaded, will cause their respective collars to tightly clamp the trays with which they are assembled. For example, tray **48** is tightly clamped by collars **88** and **90** when the threaded extension **98** of shaft **96** is inserted in the threaded aperture **106** of shaft **108** of pillar **90**.

While the liquid vapor contact trays of the type illustrated in FIGS. **1** and **2** are preferred, it will be understood that the essential features of the invention can be utilized with columns having vapor-liquid contact trays other than of the sieve or perforated bottom type, such as trays provided with bubble caps, valved openings, or other types known in the art. Moreover, with any type of tray employed, the central pillar can be omitted and the whole surface of the tray utilized for vapor-liquid contact, with or without localized liquid downcomer or withdrawal openings.

In addition to the ring, tray, and pillar units described above, the contact column includes a conventional top closure and bottom closure (not shown) fitted with the usual conduits for entry and removal of fluid.

The operation of the contact column when employed for example, in the rectification of liquid air is as follows: Vapors from above the liquid on a first liquid-vapor contact tray move upwardly through the perforations of the tray above and bubble into the liquid contained thereon. The liquid on the first tray received from the downcomer of the tray above travels (counterclockwise in the illustrated embodiment) along an annular passageway on the tray around the pillar. In its travel, the liquid receives vapors from below through the perforations of the first tray and loses vapors to the space thereabove. The liquid on the first tray flows over the weir through the downcomer opening of the first and onto the imperforate sector of the tray below. Each lower tray is oriented with respect to the tray above so that the nonperforate annular region thereof is directly beneath the downcomer of the tray immediately thereabove. The liquid seal between the trays and recesses in the column proper provided by their relative dimensions eliminates, for all practical purposes, leakage of liquid down the inner wall of the column. Such seal is effected by reason of the surface tension of the liquid and the pressure differential across the narrow gap between the top of the tray at its peripheral edge and the recess in which it rests.

A preferred method for assembly of the column will now be described with reference to the specific embodiment illustrated in the drawings. This type of column can be readily assembled employing a lathe-type setup utilizing a welding positioner and retractable support rollers movable along the lathe bed between the lathe head and tailstock.

A first ring, for example ring **20** shown in FIG. **1**, having a pillar section **92** arranged concentrically therein is positioned in a chuck on the lathe head with its lower end (as seen in FIG. **1**) held by the chuck. The first tray **50** is then placed on shelf **54** and over the top of pillar section **92**, care being taken to assure proper orientation of the tray. The threaded extension (not shown) of pillar section **90** is then inserted through the central opening of tray **50** and is screwed into the female threaded recess of the shaft (not shown) within pillar section **92** thus tightly clamping tray **50** between the opposed edges of the collars of pillar sections **90** and **92**. Pillar sections **90** and **92** now hold tray **50** with its downcomer in correctly oriented position. The second ring **18** is now inserted into the exposed end of ring **20** with the reduced wall section at the bottom of ring **18** nested within the reduced wall section at the top of ring **20** forming a lap or rabetted joint.

The tailstock of the lathe is advanced to initially engage the distal end of the second ring **18**, after making sure that the bottom of ring **18** is properly mated with the top of ring **20**. The tailstock is then advanced further to exert firm pressure between the seated rings. Now the rings are welded in their nested relation by applying a girth weld as shown at **110** within the V-groove formed by chamfering the adjacent outermost surfaces of adjacent rings. Such welding can be accomplished in a conventional manner using a torch mounted in fixed position on a translatable carriage, while rotating the sections held between the lathe stocks.

After welding together the first two cylindrical sections having the first tray therebetween, the assembled portion of the column is laterally supported by retractable rolls and the tailstock backed off to provide access within the second ring and

permit installation of the weir and baffle end tabs. These are riveted, bolted, or otherwise fixed in place similarly as shown in FIG. 2 for tabs 74, 80, 84, 76, 82, and 86. Thereafter tray 48, with weirs, baffle, and downrun conduit attached thereto, is positioned on the exposed surface of shelf 52. Pillar 88 is next threadily connected to pillar 90 as described for the connection of pillar sections 90 and 92. The downcomer opening in tray 48 is aligned with the nonperforate annular region of tray 54 as tray 48 is clamped and held in position by pillar 88. Ring 16 is then fitted into ring 18. The tailstock is advanced to press ring 16 against ring 18 and the weld 38 is made. Thereafter the tailstock is backed off and the tabs are installed and secured by bolts or rivets.

Other trays, pillars, and rings are added to the assembly as were ring 16, tray 48, and pillar 88. Thereafter the assembled rings may be removed from the lathe and the top closure and bottom closure welded or otherwise attached to the ends thereof.

During initial assembly, the height of the reduced wall section (e.g. 40 of FIG. 1) defining the tray supporting recess of the column is somewhat greater than that required, so that the gap between the top of a tray and the overhanging bottom of the next adjoining ring is larger than the desired tolerance. During welding of the ring sections, the rings are drawn together more tightly, thus shrinking the distance between ring and tray thereby providing the desired tolerance permitting lateral movement of the edge of the tray while maintaining the desired liquid seal between the periphery of the tray and its supporting recess.

Having thus described our invention by what is considered to be the preferred embodiment, we wish it understood that it is to be limited only by the scope of the appended claims.

We claim:

1. A method of fabricating a welded contact column having vapor-liquid contact trays supported therein, the assembly being arranged to permit relative movement between column and tray structure sufficient only to prevent distortion and buckling of the latter resulting from expansion or contraction of the column and tray during fabrication or in service without sacrificing the fluid seal between the contact tray and column, said method comprising the steps of:

providing a plurality of rings having complementary end portions adapted for end-to-end interengagement, the inner perimeter at the upper end of each ring having a tray-supporting shelf and the outer perimeters at the top and bottom of the ring being chamfered;

seating on the shelf of a first ring a circular tray whose diameter and thickness are such as to provide top and side clearance on the shelf;

nesting a second ring on top of the first ring, in interlocking engagement therewith, whereby the bottom end surface of the second ring overhangs the shelf of the first ring to lock the tray loosely in a recess, and the opposed chamfered surfaces form a circumferential groove;

applying endwise pressure to the assembled rings;

depositing weld metal in the circumferential groove to unite adjacent rings, the clearance provided between the edge of the tray and the confining surfaces of the recess being sufficient to accommodate the differential expansion resulting from the high temperatures obtained by welding, without buckling the tray;

and repeating said steps until the desired number of column sections are assembled.

2. A method as in claim 1, including the steps of inserting cylindrical spacers between trays before seating a tray on its shelf, said spacers having complementary threaded elements at their opposite ends, the male element of which projects through a central opening provided in the tray, and screwing the spacers together to clamp the trays into a unitary tray assembly.