Sept. 28, 1965 J. W. ANGSTADT ETAL 3,208,506

SPLASH GUARD-MIST EXTRACTOR

Filed March 5, 1962 2 Sheets-Sheet 1

Fig. 1.

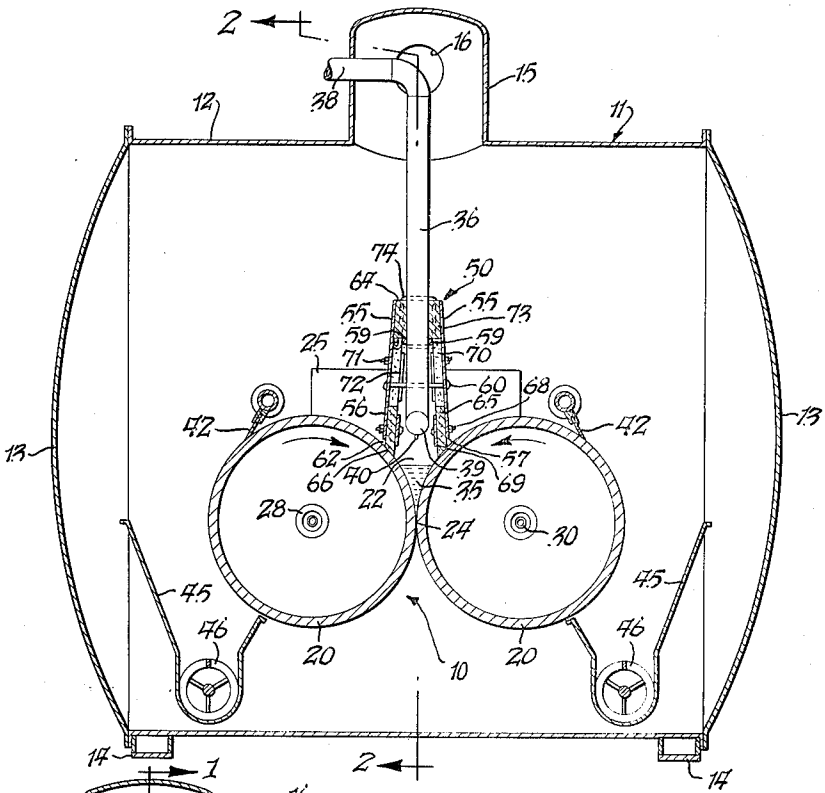
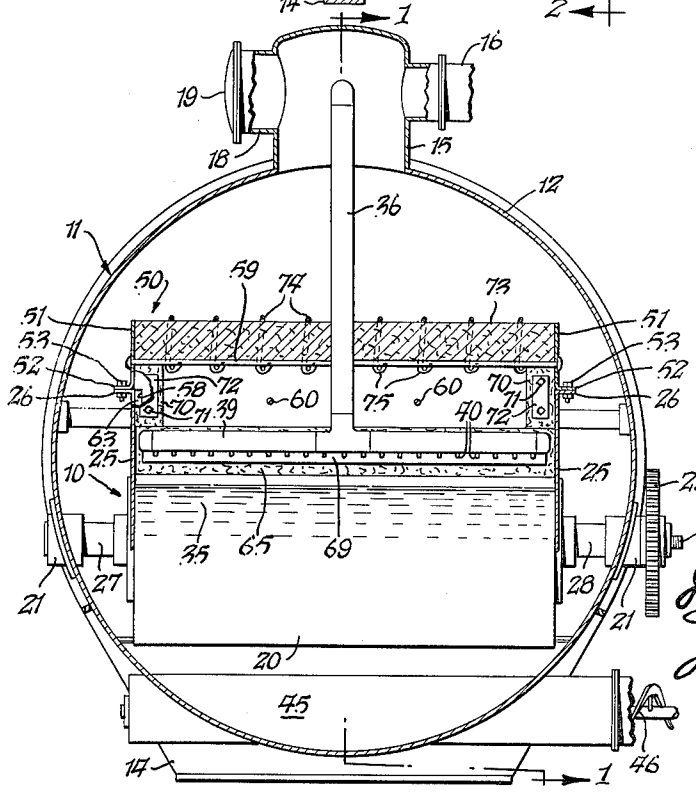


Fig. 2.



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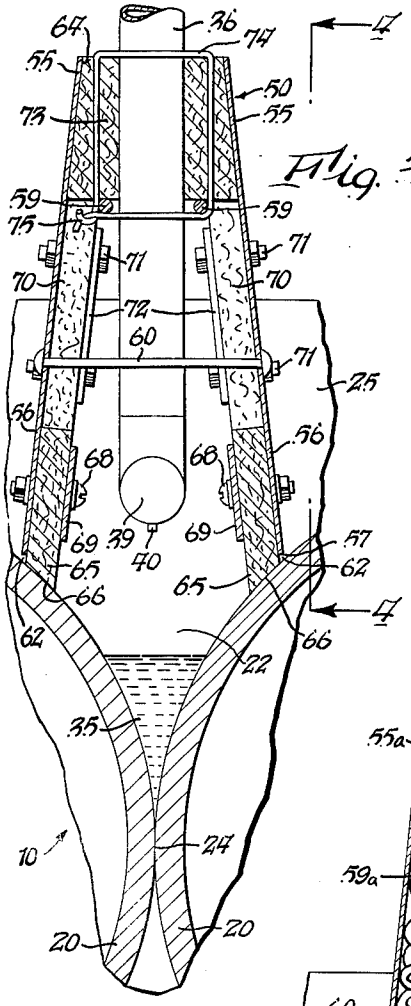


Fig. 3.

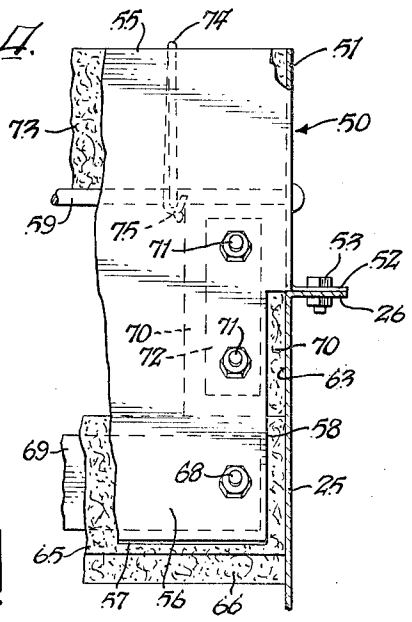


Fig. 4.

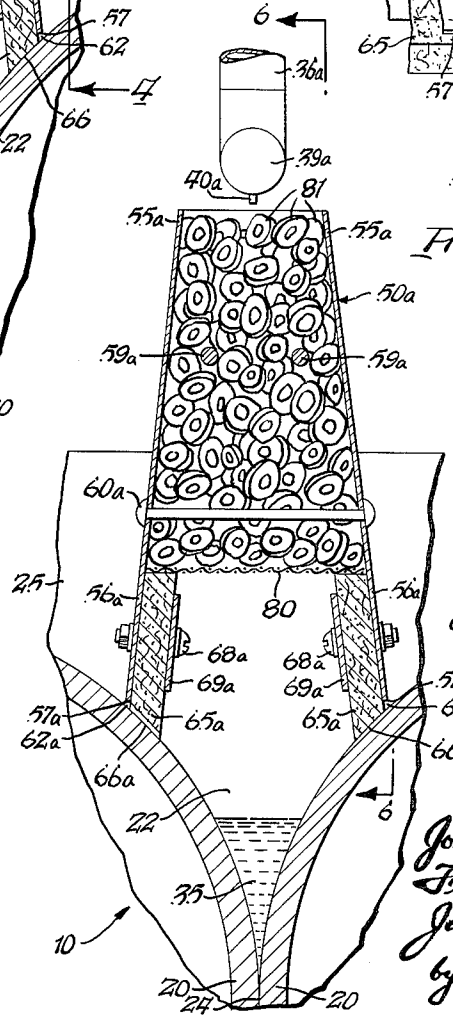


Fig. 5.

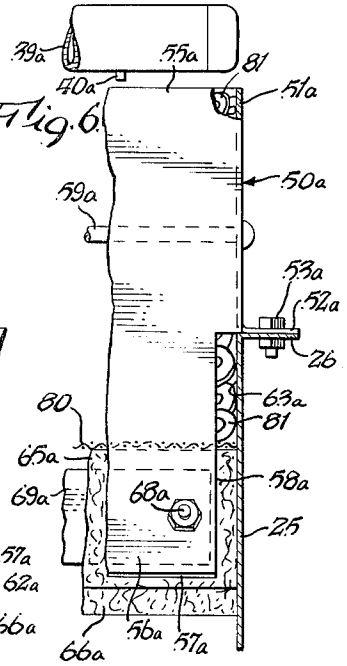


Fig. 6.

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SPLASH GUARD-MIST EXTRACTOR

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9 Claims. (Cl. 159—12)

This invention relates to a splash guard-mist extractor for use in conjunction with the ebullient pool of liquid contained between the drums of a double drum vacuum dryer and is particularly useful where the liquid is both violently ebullient and also heat sensitive to an extent that the product would be impaired if permitted to splash onto a heated surface, such as the approaching surfaces of the drying drums. Examples of materials with which the present invention is particularly effective in drying are antibiotics such as streptomycin sulfate, which is also costly, and tea.

It is the principal object of the present invention to provide such a splash guard which prevents the violently ebullient, splashing liquid from escaping from process or from being subjected to degradation.

Another important object is to provide an effective mist extractor or entrainment eliminator which serves to separate and return to process liquid in mist or entrained form which otherwise would be carried away with the vapor.

Another object is to confine the splashing of the ebullient liquid to a minimum space and at the same time permit the free escape of the vapors generated.

Another object is to provide such a splash guard and entrained liquid eliminator from which the arrested liquid quickly slumps back into processing thereby to minimize degradation due to excessive time in process or other related factors.

Another object is to provide such a splash guard and entrained liquid eliminator which is free from build-up and is self cleaning and in which the feed liquid can be used to augment such self cleaning.

Another object is to provide such a splash guard and entrained liquid eliminator which can be adapted to different conventional types of devices feeding the liquid to the pool between the drums.

Another object is to provide such a splash guard and entrained liquid eliminator which permits the drying operation to proceed an indefinite number of days without stopping the drying of costly, violently ebullient and highly heat sensitive materials such as streptomycin sulfate.

Another object is to provide such a splash guard and entrained liquid eliminator which is easily washed with water.

Other objects and advantages of the invention will be apparent from the following description and accompanying drawings wherein:

FIG. 1 is a vertical longitudinal section through the cylindrical shell of a vacuum double drum dryer equipped with a splash guard-mist extractor embodying the present invention, this section being taken on line 1—1, FIG. 2.

FIG. 2 is a vertical transverse section taken generally on line 2—2, FIG. 1.

FIG. 3 is an enlarged fragmentary view similar to FIG. 1 and showing the splash guard-mist exterior of the present invention in greater detail.

FIG. 4 is a fragmentary section taken generally on line 4—4, FIG. 3 and showing one end of the splash guard in elevation.

FIG. 5 is a similar view to FIG. 3 and showing a modified form of the invention.

FIG. 6 is a fragmentary vertical section taken generally on line 6—6, FIG. 5.

The splash guard-mist extractor of the present invention is shown as applied to a double drum dryer, indicated generally at 10, contained within a large cylindrical shell, indicated generally at 11, forming a chamber in which a vacuum is maintained.

The vacuum housing or shell 11 comprises a metal cylinder 12 arranged on a horizontal axis and having end heads 13 secured thereto. This shell is shown as supported at its opposite end on the floor by end stands or bases 14 which form cradles for the opposite ends of the shell. The shell is shown as having a cylindrical dome 15 at its top center through which the vapors generated by the double drum dryer 10 are withdrawn through a vapor outlet line or pipe 16. This dome is also shown as provided with an access neck 18 which can be provided with a cover 19.

The vacuum housing or shell as above described forms a support for the double drum dryer 10 contained therein and which is shown as comprising a pair of horizontal, parallel cylindrical drums or rolls 20 journalled in bearings 21 in the side walls of the cylinder 12 and forming between their upper parts a valley 22 above the bite 24 along which bite the opposing parts of the drums are arranged in closely spaced relation to each other. The opposite ends of the valley 22 between the upper parts of the drums are closed by vertical end boards 25 extending across the ends of the valley in contact with the ends of the drums and supported from the vacuum housing 11 in any suitable manner (not shown). The end boards 25 extend above the tops of the drums as best shown in FIG. 1, and each is provided along its upper edge with an outwardly projecting horizontal flange 26.

Each drum 20 has a stub shaft 27 at one end journalled in the corresponding supporting bearing 21 and has a tubular shaft 28 at its opposite end journalled in the other supporting bearings 21. Each of these tubular shafts 28 is shown as provided, externally of the vacuum shell 11, with intermeshing gears 29 which are driven to rotate the drums 20 in opposite directions so that the upper opposing surfaces of these drums move downwardly toward the bite 24 at the same rate of speed, this direction of rotation of the drums being indicated by the arrows in FIG. 1. Steam for heating the drums 20 can be introduced through steam pipes 30 extending through the tubular shafts or trunnions 28 for the drums and the condensate can be removed in any conventional manner (not shown).

The liquid to be dried is maintained in a body 35 in the valley 22 between the drums 20, this body being confined in the valley by the end boards 25 which contact the ends of the drums. The body 35 can be maintained at the required level by any suitable feeding means, the feed liquid being shown as being supplied through a vertical feed pipe 36 having a horizontal inlet part 38 extending through the side wall of the dome 15. Centrally along the valley 22 above the body 35 of liquid therein is arranged a horizontal distributing pipe 39 connected at its centers to the lower end of the vertical feed pipe 36 and extending substantially the full length of the valley 22 and closed at its opposite ends. At spaced intervals along its bottom this horizontal distributing pipe 39 is shown as having downwardly directed nozzles 40 which discharge the feed liquid downwardly into the center of the body of liquid 35 the full length thereof so as to provide uniformity in liquid feed the full length of the valley 22.

The liquid in the pool or body 35 maintained in the valley 22 formed by the upper inner opposing parts of the drum is carried in the form of films from the bite 24

between the drums downwardly around the undersides of the drums and upwardly in the outer sides of the same during which movement the films are dried on the drums. The drums are maintained at a temperature at which the liquid in the pool **35** between the drum boils and splashing occurs, it being one of the objects of this invention to prevent the splashed liquid from escaping from the drying process. During the last part of the upward movement of the films on the outer sides of the drums, the dried films of liquid are removed from the drums by doctor blades or scrapers **42** preparatory to depositing fresh coats of liquid on the cleared surface of the drums as a function of passing the body of liquid **35** maintained in the valley between the drums. The dried material removed by the doctor blades following downwardly along the rising outer surfaces of the drums **20** is caught in a trough **45** arranged lengthwise of each drum under the rising side thereof as best shown in FIG. 1. The dried material at the bottom of each trough can be removed by a screw conveyor **46** and conventional means (not shown) can be provided for removing the dried material conducted by the screw conveyors **46** from the vacuum housing or shell **11**.

The present invention is essentially concerned with drying liquids in the above apparatus which are violently ebullient in the body **35** contained between the drying drums **20**, and which are also heat sensitive and the essential purpose of the invention is to prevent this violently ebullient liquid from escaping from proper processing. To this end the splash guard-mist extractor of the present invention is shown as comprising a generally rectangular sheet metal splash hood **50** having vertical end walls **51** provided with outwardly projecting horizontal flanges **52** at their lower ends which rest on and are secured to the top flanges **26** of the end boards **25**, as by bolts **53**. These end walls are connected by spaced side walls **55** which are shown as being in downwardly diverging relation to each other and as having downward extensions **56**, the lower edges **57** of which are in closely spaced relation to the downwardly moving upper surfaces of the drums **20** as best illustrated in FIG. 3.

The side edges **58** of these downward extensions **56** of the side walls **55** of the sheet metal splash hood **50** are also preferably in spaced relation to the end boards **25**, as best shown in FIG. 3. A pair of transversely spaced horizontal tie rods **59** extend between the upper parts of the end walls **51**, these rods being in the same horizontal plane and flanking the vertical part **36** of the feed pipe and serving to support an intertwined wire mesh top pad as hereinafter described. A pair of horizontal transverse tie rods **60** connect the side walls **55** at spaced intervals and serve to prevent spreading apart of these side walls.

The sheet metal splash hood **50** as above described is lined with a plurality of substantially vertical horizontally extending removable pads, bats or bodies which are preferably made of fine intertwined stainless steel wire members and which serve to prevent the escape of the violently ebullient liquid in the body **35** from the space **62** between the lower edge **57** of each side wall and the adjacent drum surface; through the space **63** between the end edges **58** of the downward extensions **56** of these side walls and the end bars **25**; and through the space **64** between the upper edges of these side walls. These bats or bodies are of sufficient thickness and their wires sufficiently closely intertwined to intercept liquid splashed against the bats and to permit such liquid to slump downwardly through the bat or body.

The downwardly travelling upper surface of each drum **20** is contacted by a bottom body or bat **65** of intertwined stainless steel wire mesh which extends the full length of the adjacent drum and is shown as having its ends in abutting relation to the end boards **25**. The under surface **66** of each of these wire mesh bats **65** preferably contacts and conforms to the drum surface as best shown in FIG. 3, and each of these bats is removably secured to the inside face of the downward extension **56** of the corresponding side wall of the sheet metal splash hood **50** by bolts **68**, these bolts passing through these walls and bodies and also through a metal back-up or holding plate **69** extending along each of the bats **65**.

The upper part of each space **63** between each vertical end edge **58** of the downward extension **56** of each side wall **55** is closed by a relatively small intertwined stainless steel wire end bat **70**, the lower face of which abuts the top of the corresponding horizontal bottom intertwined wire mesh bat **65** and one vertical face of which abuts its end board **25**. Each of these small vertical end bats **70** is secured to the inside face of the side wall **55** of the sheet metal splash hood by a pair of bolts **71**, these bolts passing through these side walls and vertical end bats or bodies **70** and also through a back-up plate **72**.

The liquid escaping the space **64** between the top edges of the side walls **55** is passed through a horizontal top body **73** in the form of a mass of solid members which is shown as also made of intertwined stainless steel wire mesh and through which the vertical part **36** of the feed pipe extends as best shown in FIG. 3. This top body extends the full length of the drums and contacts the end walls **51** of the splash hood at its opposite ends as best shown in FIG. 4. This top body also contacts the opposing surfaces of the top parts of the side walls **55** of the splash hood as best shown in FIG. 3. This top intertwined wire body is shown as contacting the upper surfaces of the vertical end bats **70** and as resting on the longitudinal tie rods **59**. To secure this top body in position, a length of wire **74** can have its ends passed downwardly through this body at spaced intervals and around the undersides of the longitudinal tie bars **59** and have its end twisted together as indicated at **75**, FIG. 3.

With a vacuum of the required value maintained in the cylindrical vacuum shell **11** via the vacuum line **16**; with a feed of, say, streptomycin sulfate in liquid form through the feed line **38**, **36** and **39**; with the drums **20** rotating at the same speed in the direction of the arrows shown in FIG. 1 through the power applied to the intermeshing gears **29**; and with steam supplied to the interior of the drums **20** via the steam lines **30** to maintain them at the required temperature, the operation of the splash guard and entrainment separator in conjunction with the vacuum double drum dryer is as follows.

The liquid discharged downwardly from the nozzles **40** along the horizontal feed pipe **39** joins the violently ebullient and splashing body **35** of liquid held in the valley **22** between the two drums **20** by the end boards **25**. This very violent boiling and splashing action often occurs in vacuum double drum drying due to feed flash and deaeration of the feed liquid discharging downwardly from the nozzles **40** and is more pronounced with such materials as streptomycin sulfate and tea as the liquid to be dried. All arrangements of baffles were found inadequate to prevent this splashing from depositing liquid on the crests of the heated drums **20** and overshooting these drums and the end boards **25** and also to prevent the vapors carrying away entrained liquid out through the vacuum line **16**. The splashing of heat sensitive materials onto the crests of the heated drums **20** can result in overheating and degradation of the product. The splashing of materials to surfaces from which they are not immediately returned to the body or pool **35** can result in deterioration through being held out of process. The splashing of materials beyond the doctor blades **42** and against the inside of the vacuum shell **11** not only can result in direct loss of costly material and contamination of the dried product with undried liquid, but also creates a serious cleaning problem.

With the splash guard-mist extractor of the present invention, any splashing in the direction across the crests of the drum **20** is positively blocked principally by the horizontal intertwined stainless steel wire bottom pads or

bats, any such splashing overshooting these pads or bats being positively intercepted by the top parts of the side walls **55** of the sheet metal splash hood **50**. These bottom wire mesh pads or bats **65** are spaced as closely together as is practicable to accommodate the unencumbered boiling of the liquid pool **35** and the free escape of vapor and the liquid material so splashing against these parts is positively intercepted and slumps down through the mesh of the intertwined wires of the pads or bats **65** and rapidly rejoins the pool **35**. By virtue of the contact of these wire mesh pads or bats **65** with the downwardly moving drum surfaces not only is escape of splashing liquid prevented through the spaces **62** between the drums and the side walls **55** of the sheet metal splash hood **50** positively prevented, but the liquid material slumping down out of these pads or bats is caught by the downwardly moving drum surfaces and rapidly returned to process.

Splashing at the extreme ends of the drums in a horizontal direction is positively blocked by the end boards **25** and by the vertical intertwined stainless steel wire end bats or pads **70** which block the spaces **63** between these end boards and the side walls **55** of the splash hood **50**. From the end boards the splashed material returns immediately to the pool **35** and from the end bats or pads **70** the caught liquid slumps down into the ends of the horizontal bottom pads or bats **65** and thence to the descending drum surfaces to also be returned to the pool **35**.

Material splashing upwardly is positively blocked by the intertwined stainless steel wire top body or pad **73** from which it slumps downwardly and drips back into the pool **35**.

This top bat or pad **73** is also fully effective as entrained liquid eliminator or mist extractor. Thus this bat or body is of substantial depth and in passing through it the path of the vapor is constantly being changed by the interlaced wires to collect the mist in the vapor as a liquid on the surfaces of the stainless steel wires to slump to the bottom of the body and drip back into the pool **35**.

As is usual with vacuum double drum dryers, the material passing through the bite **24** between the drums **20** forms layers on the undersurfaces of these drums which dry and are scraped off by the doctor blades **42** into the troughs **45** in which they are broken up and along which they are moved by the screw conveyors **46** for discharge from the vacuum shell **11**.

In FIGS. 5 and 6, a modified form of splash guard-mist extractor is shown in conjunction with the same double drum dryer **10** illustrated in FIGS. 1 through 4 and to which double drum dryer the same reference numerals have been applied. As with the form of the invention shown in FIGS. 1 through 4, the modified form of splash guard and mist extractor shown in FIGS. 5 and 6 comprises a generally rectangular sheet metal hood **50***a* having vertical end walls **51***a* provided with outwardly projecting horizontal flanges **52***a* at their lower ends which rest on and are secured to the top flanges **26** of the end boards **25** as by bolts **53***a*. These end walls are connected by side walls **55***a*, which are shown as being in downwardly diverging relation to each other and as having downward extensions **56***a*, the lower edges **57***a* of which are in closely spaced relation to the downwardly moving upper surfaces of the drums **20**. The side edges **58***a* of these downward extensions **56***a* of the side walls **55***a* of the sheet metal splash hood are also shown as being in spaced relation to the end boards **25**. A pair of transversely spaced horizontal tie rods **59***a* extend between the upper parts of the end walls **51***a*, and a pair of horizontal transverse tie rods **60***a* connect the side walls **55***a* at spaced intervals and serve to prevent spreading apart of these side walls.

Escape of the splashing ebullient liquid in the body **35** from the space **62***a* between the lower edge **57***a* of each side wall and the adjacent surface of the corresponding drum **20** is prevented by a body or bat **65***a* of intertwined stainless steel wire mesh which extends the full length of the adjacent drum and is shown as having its ends in abutting relation to the end boards **25**. The under surface of each of these wire mesh bodies or bats **65***a* preferably contacts and conforms to the drum surface as shown in FIG. 5, and each of these bodies or bats is removably secured to the inside face of the downward extension **56***a* of the corresponding side wall of the sheet metal splash hood **50***a* by bolts **68***a*, these bolts passing through these walls and bodies and also through a metal back-up plate **69***a* extending along each of the bats **65***a*.

With the form of the invention shown in FIGS. 5 and 6, a rectangular piece **80** of metal screening has its opposite edges supported on the bats or bodies **65***a* with its ends in abutting relation to the end boards **25** as shown in FIG. 6. This screen supports a mass of solid members shown as being a mass of ceramic shapes **81** which can be in the form of raschig rings, beryl saddles or any other out-of-round shape to act in removing entrained liquid from the vapor rising therethrough.

In the form of the invention shown in FIGS. 5 and 6, these ceramic shapes completely fill the space in the sheet splash hood **50***a* above the screen **80** and are washed by the feed liquid. To this end, the vertical section **36***a* of the feed pip at the center of the valley **22** between the drums terminates above the splash hood **50***a* and is provided with horizontal discharged arms **39***a* which extend substantially the full length of the sheet metal splash hood **50***a* above the ceramic shapes **81** therein. These horizontal arms are provided with a series of downwardly direct nozzles **40***a* extending longitudinally thereof and which directs streams of feed liquid downwardly upon the shapes **81** the full length of the splash hood shell so as to wash these shapes with the feed liquid.

It will be seen that the operation of the modified form of splash guard-mist extractor shown in FIGS. 5 and 6 is identical with that shown in FIGS. 1–4 except that the upward splashings from the boiling pool **35** are positively blocked by the mass of ceramic shapes **81** as are the horizontal splashings at the extreme ends of the drums. This splashed material, as well as the liquid collected from the mist or entrained liquid in the vapor rising through this body of ceramic shapes, slumps downwardly to return to the pool **35**. This downward or return movement of this liquid is, however, accelerated by the feed liquid from the nozzles **40***a* which flows down the ceramic shapes and hence acts to wash them.

It will be seen that both the upper bat **73** of interwined wire and the mass of ceramic shapes **81** on the screen **80** constitute a mass of solid members above the valley **22** bridging the entire horizontal space between the bottom horizontal bars **65** or **65***a* and the end boards **25** and are in partial contact with each other to form voids providing circuitous passages through which substantially all the vapor from the valley **22** escapes upwardly, the mass of solid members intercepting both the liquid splashing upwardly from the pool **35** and also intercepting mist carried upwardly from the valley **22** by the vapor generated therein.

From the foregoing it will be seen that the present invention provides a highly effective splash guard-mist extractor which is fully effective with violently ebullient liquids in vacuum double drum dryers in confining the liquid material to prcessing and in returning liquid entrained in the vapor to processing.

What is claimed is:

1. In a double drum vacuum dryer having a pair of parallel horizontal drying drums which have their opposing sides in closely spaced relation to each other to form a bite and a valley therebetween, and boards at the opposite ends of said drums to confine a pool of the liquid to be dried in said valley, means rotating said drums to move their upper surfaces forming said valley downwardly through said pool to form layers of liquid

on said drums on passing said bite, doctor blades arranged to remove said layers from rising surfaces of said drums, and a vacuum shall arranged to form a vacuum chamber around and to maintain said drums and valley in a vacuum; the combination therewith of a splash guard-mist extractor for returning to said pool liquid splashing from said pool or being carried away with the vapor therefrom, comprising substantially vertical horizontally extending bats of intertwined wire arranged in said vacuum chamber above the level of and along opposite sides of said pool and each extending substantially the full length of the corresponding drum along the downwardly moving upper surface thereof, the liquid splashed onto said bats slumping downwardly therethrough onto said downwardly moving upper surfaces of said drums to be returned thereby to said pool, a mass of solid members, and means supporting said mass of solid members above said valley to bridge the entire horizontal space between said bats and between said end boards, said solid members being in partial contact with one another to form voids providing circuitous passages through which substantially all the vapor from said valley escapes upwardly into said vacuum shell, said mass of solid members intercepting both liquid splashing upwardly from said pool and also intercepting mist carried from said valley with the vapor generated therein.

2. The combination set forth in claim **1** wherein said mass of solid members comprises a body of interwined wire.

3. The combination set forth in claim **1** wherein said mass of solid members comprises a mass of ceramic shapes among which the vapors pass in a circuitous path in passing upwardly through said mass.

4. The combination set forth is claim **1** wherein means feeding said liquid to said pool discharges on top of said mass of solid members to wash the same and accelerate the return movement to said pool of the liquid intercepted thereby.

5. In a double drum vacuum dryer having a pair of parallel horizontal drying drums which have their opposing sides in closely spaced relation to each other to form a bite and a valley therebetween, end boards at the opposite ends of said drums to confine a pool of the liquid to be dried in said valley, means rotating said drums to move their upper surfaces forming said valley downwardly through said pool to form layers of liquid on said drums on passing said bite, doctor blades arranged to remove said layers from rising surfaces of said drums, and a vacuum shell arranged to form a vacuum chamber around and to maintain said drums and valley in a vacuum; the combination therewith of a splash guard-mist extractor for returning to said pool liquid splashing from said pool, comprising a sheet metal hood arranged in said vacuum chamber having end walls supported on said end boards and connected by spaced side walls having their lower edges in closely spaced relation to the downwardly moving upper surfaces of said drums, said sheet metal hood being open at its top and bottom, and substantially vertical horizontally extending bats of intertwined wire secured to the lower parts of said side walls and extending substantially the full length of said drums and in contact with said downwardly moving upper surfaces thereof, the liquid splashing onto said bats slumping downwardly therethrough onto said downwardly moving upper surfaces of said drums to be returned thereby to said pool.

6. In a double drum vacuum dryer having a pair of parallel horizontal drying drums which have their opposing sides in closely spaced relation to each other to form a bite and a valley therebetween, end boards at the opposite ends of said drums to confine a pool of the liquid to be dried in said valley, means rotating said drums to move their upper surfaces forming said valley downwardly through said pool to form layers of liquid on said drums on passing said bite, doctor blades arranged to remove said layers from rising surfaces of said drums, and a vacuum shell arranged to form a vacuum chamber around and to maintain said drums and valley in a vacuum; the combination therewith of a splash guard-mist extractor for returning to said pool liquid splashing from said pool or being carried away with the vapor therefrom, comprising a sheet metal hood arranged in said vacuum chamber having end wall removably supported on said end boards and connected by spaced side walls having their lower edges in close proximity to the downwardly moving upper surfaces of said drums, said sheet metal hood being open at its top and bottom substantially vertical horizontally extending bats of intertwined wire secured to the lower parts of said side walls and extending substantially the full length of said drums and in contact with said downwardly moving surfaces thereof, the liquid splashing onto said bats slumping downwardly therethrough onto said downwardly moving surfaces of said drums to be returned thereby to said pool, a mass of solid members, and means supporting said mass of solid members above said valley to bridge the entire horizontal space between the upper parts of said side walls and between said end boards, said solid members being in partial contact with one another to form voids providing circuitous passages through which substantially all the vapor from said valley escapes upwardly into said vacuum shell, said mass of solid members intercepting both liquid splashing upwardly from said pool and also intercepting mist carried from said valley with the vapor generated therein.

7. The combination set forth in claim **6** wherein said mass of solid members comprises a body of intertwined wire.

8. The combination set forth in claim **6** wherein said mass of solid members comprises a mass of ceramic shapes among which the vapors pass in a circuitous path in passing upwardly through said mass.

9. The combination set forth in claim **6** wherein means feeding said liquid to said pool discharges on top of said mass of solid members to wash the same and accelerate the return movement to said pool of the liquid intercepted thereby.

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