

June 15, 1965

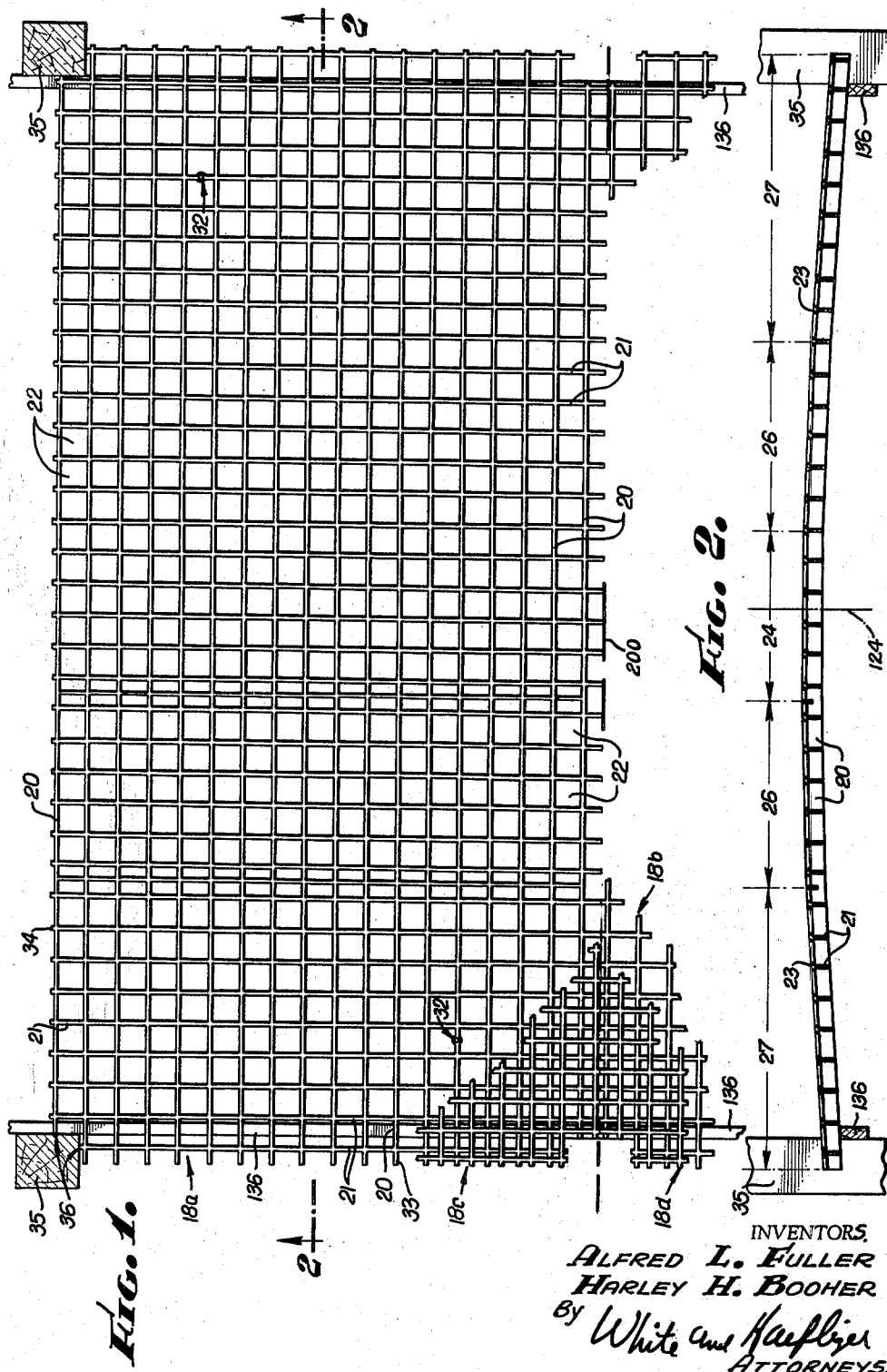
A. L. FULLER ETAL

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ARCHED PACKING FOR COOLING TOWERS

Filed May 28, 1962

4 Sheets-Sheet 1



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FIG. 3.

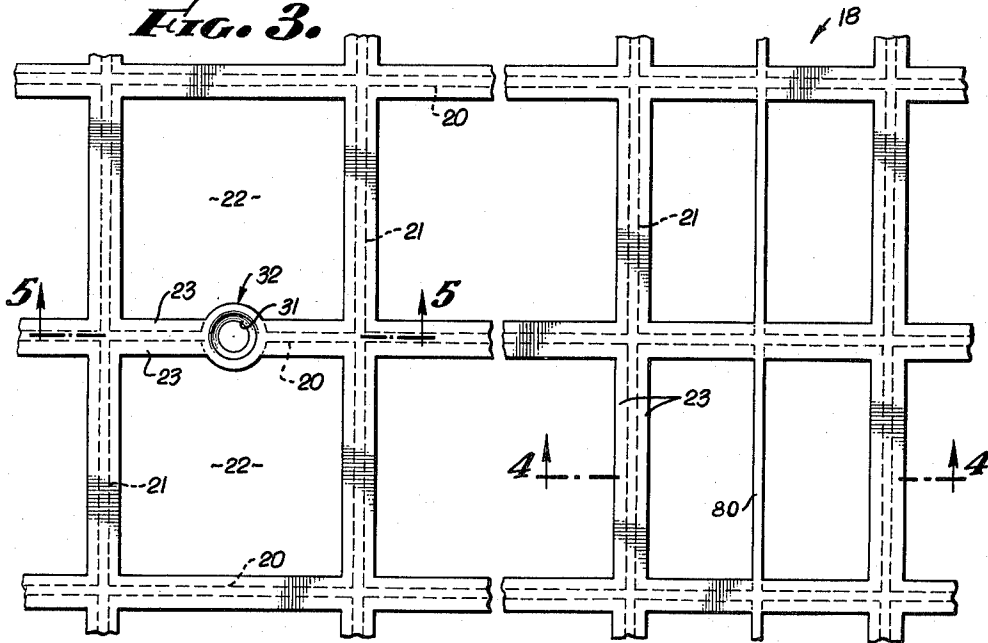


FIG. 4.

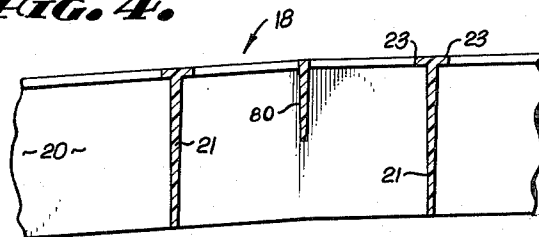
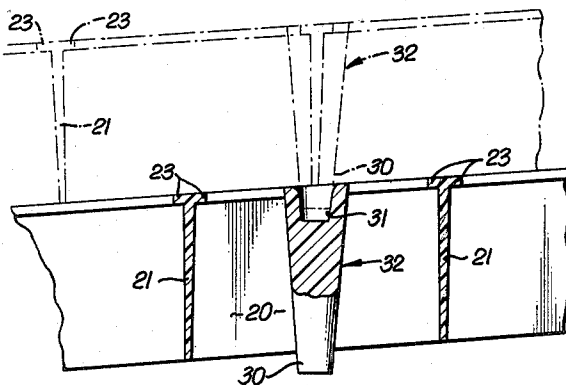


FIG. 5.



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FIG. 6.

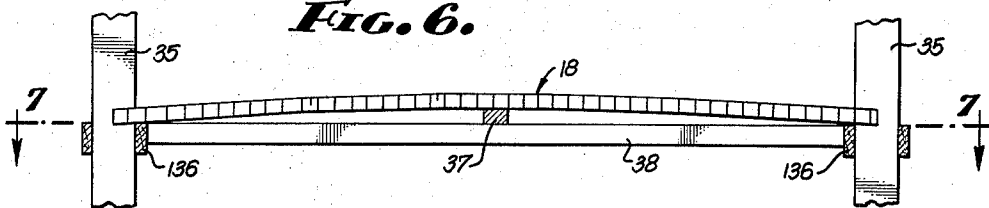


FIG. 7.

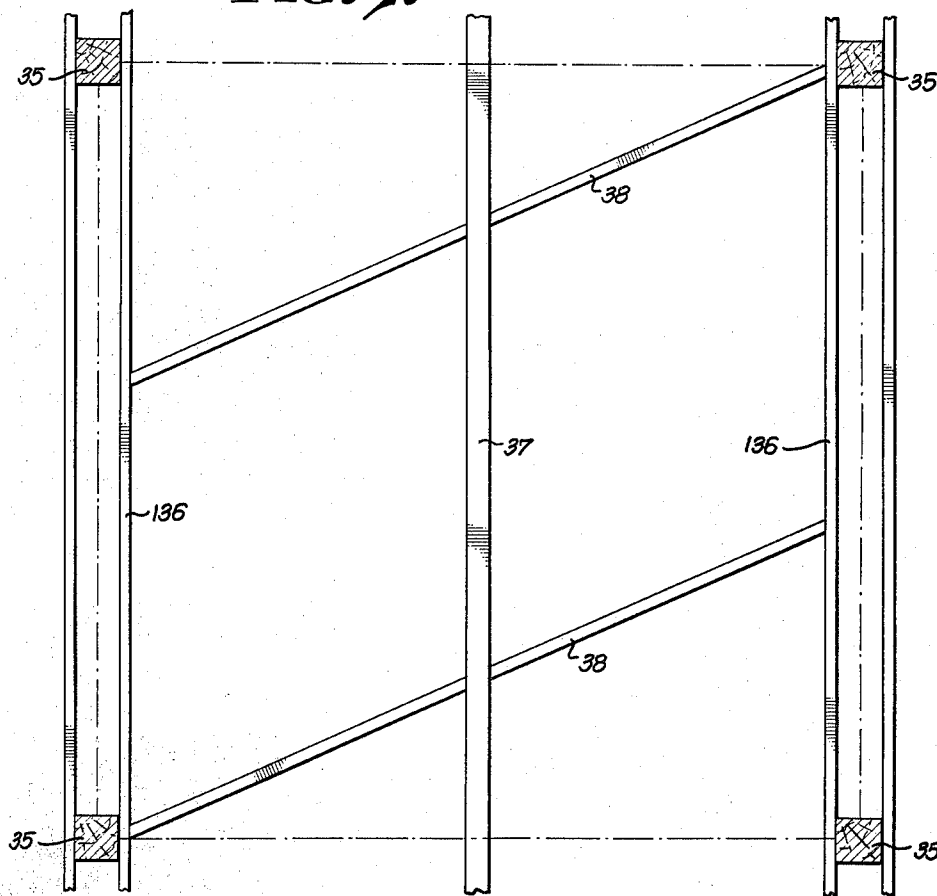
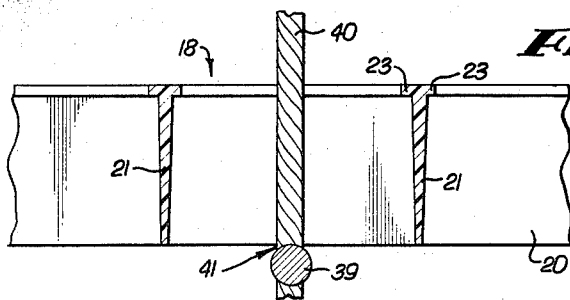


FIG. 8.



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FIG. 9a.

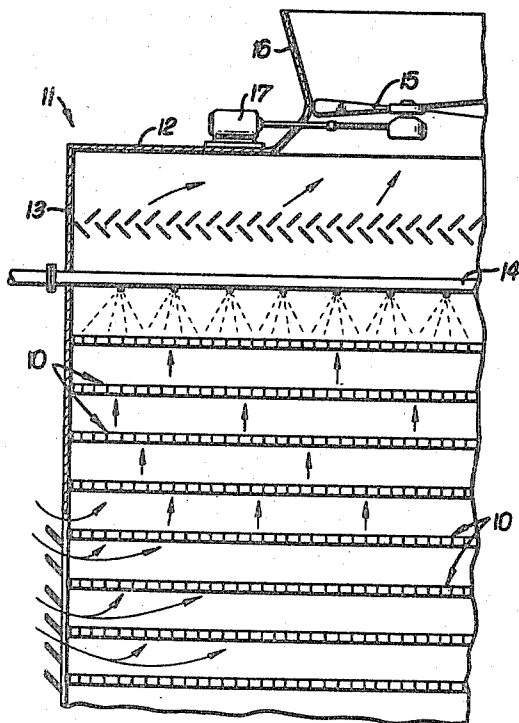
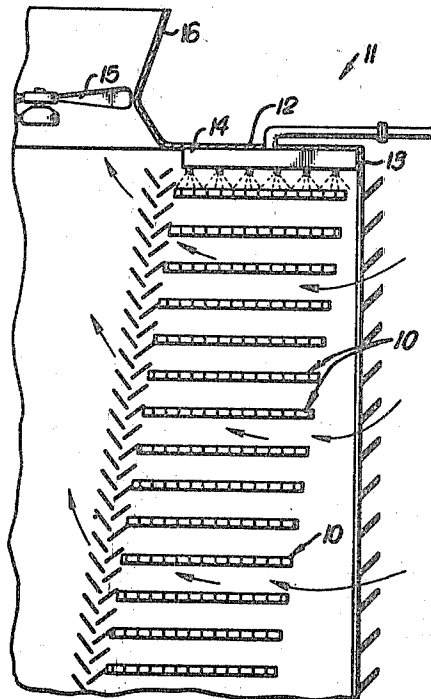


FIG. 9b.



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ARCHED PACKING FOR COOLING TOWERS
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Los Angeles, Calif., a corporation of California
Filed May 28, 1962, Ser. No. 198,224
1 Claim. (Cl. 261-112)

This invention relates generally to improvements in gas-liquid contacting structure usable for any of various purposes served by effecting extended surface exposure of the liquid to gas or vapors, such purposes including liquid cooling, evaporation, gas absorption, biological oxidation, scrubbing and the like. Having particularly advantageous adaptability to the cooling of water, the invention will be described in a typical application for that illustrative purpose.

More particularly, the invention is concerned in certain of its aspects with improvements in grid-type packing for installation in water cooling tower chambers within which the water to be cooled is passed downwardly splashing and filming on the surfaces of the packing and with correspondingly extended exposure to cooling air flowing up through or horizontally across the packing. The particular form of packing with which this invention is concerned may be characterized as a cellular grid-type, being cellular by reason of each grid deck or unit being composed of intersecting strips disposed in essentially vertical planes and defining cells or voids shaped and dimensioned in accordance with the strip arrangement and dimensions.

Water cooling tower packing as thus generally characterized, heretofore has been proposed or used in the form of grids made of strips in cellular arrangement. Such grids have been made of wood or other material which together with the particular forms and relative arrangements of the grids, have limited their effectiveness and practicability in various respects including lack of capacity for most effective repeated splash break-up and filming of the water, inadequate distribution of the air and water during their passage through the packing, excessive weight and tendencies of the grid materials toward warpage or other deterioration, and limitations in their adaptability for pre-fabrication in conveniently usable and transportable forms.

The present invention has for its major object the provision of novel packing adapted to be used as generally horizontally disposed grid decking in gas-liquid contacting equipment. The packing comprises interconnecting sheet-like strips extending in planes generally normal to the packing and forming vertically open cells and the packing includes projections extending from the strips for splash intercepting liquid to be filmed on the strip sides.

In accordance with the invention the tops of the projections define a plane having upward camber along the major extent of the packing span. As will be brought out, the packing may be further characterized as comprising molded plastic material such as polystyrene or alternately polyethylene or polypropylene, and each cambered or arched unit has substantially uniform vertical thickness. It has been found that upward camber, as hereinafter will be more fully described, enhances the even distribution of water or other liquid splashing and filming on the packing projections and strips, and furthermore that when the entire packing unit is given upward camber the disadvantages of plastic creep and normal deflection resulting in downward deflection of the packing at operating temperatures may be overcome.

Further objects of the invention include the provision of a particular form of upward camber characterized in that spanwise successive sections of the plane defined by the tops of the projections are substantially flat and ex-

tend at different angles from horizontal, one planar section being uppermost and extending at spanwise opposite sides of a vertical plane bisecting the packing in widthwise sense, with a pair or pairs of planar sections extending at opposite sides of the said one section, the sections of each pair having equal angularity with respect to horizontal. Advantages of this construction include relative ease of molding the plastic grid, without diminishing the desired enhancement of water distribution evenness resulting from the cambered configuration, or the advantages of the cambered construction overcoming plastic creep and deflection problems.

The invention is also concerned with the vertical stacking of molded plastic units as described, particularly in a gas-liquid contacting environment wherein streams of liquid particles and gas travel countercurrently in heat exchange relation. As will be described, the units are vertically stacked in series to arch upwardly and are supported to resist downward deflection thereof tending to reduce said upward arching. Typically the vertically successive units have interfitted relationship acting to hold the units with the projections thereon vertically staggered, such holding also resisting downward deflection which tends to occur under water loading against the projections together with plastic creep resulting from heating of the grid units by contact with the hot water.

These and other objects and advantages of the invention, as well as the details of an illustrative embodiment, will be more fully understood from the following detailed description of the drawings, in which:

FIG. 1 is a plan view of a typical arched packing unit mounted or supported in a cooling tower, together with a fragmentary showing of superimposed units;

FIG. 2 is a section taken on line 2-2 of FIG. 1;

FIG. 3 is an enlarged plan view of a fragmentary section of a typical packing unit;

FIG. 4 is a section taken on line 4-4 of FIG. 3;

FIG. 5 is a section taken on line 5-5 of FIG. 3;

FIG. 6 shows a modified supporting arrangement for a typical packing unit illustrated in elevation;

FIG. 7 is a plan view taken on line 7-7 of FIG. 6;

FIG. 8 is an enlarged elevation showing a fragmentary portion of a typical packing unit with modified supporting means combined therewith; and

FIGS. 9a and 9b are typical showings of counter flow and cross flow cooling towers within which the packing may be incorporated.

Referring first to FIGS. 9a and 9b, vertically spaced packing decks are generally indicated at 10 contained within water cooling towers 11 having vertical and top walls 12 and 13 respectively defining a cooling chamber within which water is sprayed or otherwise supplied to pass downwardly from headers or distribution pans 14. The falling water droplets splash on the packing and are filmed thereon, to promote highly efficient heat transfer with air flowing up through or across the chamber. The cooling towers may be of an induced draft type in which air displacement upwardly in the chamber is effected by a fan 15 contained within the usual ring 16 and driven by a suitable motor 17.

One form of packing 10 comprises horizontally extending and superimposing packing units or grids generally indicated in FIG. 1, depending upon the size of the cooling chamber in any given instance. As illustrated, the grids 18a and 18c are vertically spaced to induce high impact splashing of falling water drops, whereas the grids 18b and 18d are likewise vertically spaced apart and located adjacent respective units 18a and 18c. A vertical plane 200 marks the adjacent edges of side by side lower units 18a and 18b. The upper grids 18c and 18d are rotated 180 degrees with respect to the lower grids 18a

and 18b in order to vertically stagger the drop intercepting surfaces thereof. It is also possible to rotate the upper grids only 90 degrees, and still interfit the corner posts 35, since the units are each twice as long as they are wide.

Each of the grids comprises a unit molded integrally of durable, water resistant and lightweight material such as to achieve not only the functional advantages of efficient water distribution, i.e. splashing and filming, but also structural advantages flowing from reduced weight which permits reduced size and cost of the cooling tower structure accommodating the packing. Each grid unit may be molded of a suitable organic plastic material such as the known polystyrene, polyethylene, polypropylene, polyester, ABS (acrylonitrile butadiene styrene), polyvinyl chloride or phenolformaldehyde, polystyrene being preferred by virtue of affording the least deflection with a temperature increase. Polypropylene may be considered the performance equal of polystyrene if the strip cross sectional dimensions are increased to increase the flexural strength of a polypropylene grid.

Each of the grids 18 is better shown in FIGS. 3-5 to be formed of integrally molded, thin, sheet-like strips 20 and 21 extending lengthwise and widthwise of the packing grid in intersecting vertical planes to define between the strips vertically open cells 22 which are shown as square in FIG. 3 although not restricted to this configuration. The side surfaces of the strips 20 and 21 present in the aggregate a large area for filming of water passing downwardly through the grids in intimate contact with the upwardly or horizontally displaced air. Structural ribs 30 form no part of the invention.

As will be described in detail, the cell strips or webs are formed with lateral projections or flanges, an understanding of the reasons for which may be benefited by brief mention at this point of the conditions of water flow and filming downwardly through the packing. Upon being sprayed from the headers 14, the water is dispersed in droplets falling onto the packing with high velocity so that some of the water splashes intensely and some of the water films over the surfaces of the cell walls, most of the splash formed droplets tend to pass laterally and downwardly through the cell voids and between the grid decks in high efficiency heat transfer contact with rising air. Also the water films tend to collect and redistribute as droplets falling from the bottom edges of the strips, with some of the droplets impinging against the sides of the cells below, and others tending to fall straight through.

It is important that provisions be made in association with the strips in cell formation, to provide for breaking up and distribution of water from its droplet form, all in a manner maintaining desirable lower resistance and air flow pressure drop through the entire packing.

For this purpose we form the strips 20 and 21 with integrally molded projections extending from the strips for intercepting liquid to be splash redistributed and filmed on the strip sides, such projections typically having the form of thin webs or flanges 23 projecting generally laterally at the upper edges of the strips thereby presenting essentially T-sections as viewed in FIGS. 4 and 5. In these same views we show the strips 20 and 21 having slight downward taper. Thus as regarding FIGS. 4 and 5, the flanges 23 centrally and symmetrically overlie the downwardly continuing strips 20 and 21 and present upwardly exposed surface areas for aid to conversion into splash and filmed condition of a larger percentage of the water than could be so effected in the absence of the projections, it being understood that the approaching water droplets splash against the tops of the flanges or projections.

It is an important feature of the invention that the tops of the projections 23 define a plane, best seen in FIG. 2, having upward camber along the major extent of the packing span considered lengthwise of the packing, i.e. left and right in FIG. 2. Also, the lowermost face or surface of the packing defines a plane having upward

camber along the major extent of the packing span. Such upward camber is relatively slight, but nevertheless sufficient to maintain some camber during normal operating conditions of the tower, in order to enhance the even distribution of water being splashed and filmed on and by the packing. As an example, a typical plastic packing unit will be subjected to plastic creep in use, and will deflect downwardly under water loading and heating of the plastic material, to an extent determined by the particular design of the grid including overall length, width and height dimensions, and the dimensions of the strips and projections making up the grid. Such deflection under the most adverse conditions should not result in elimination of slight upward camber, whereby the advantages of such camber may be maintained at all times. In this regard, polystyrene is found to be preferable as a grid forming material in view of its tendency to deflect to considerably lesser extent than polyethylene and polypropylene for the same increases in temperature, a typical temperature condition in a water-air cooling tower being in the range 100° to 120° F.

FIG. 2 shows a particular configuration of grid camber characterized in that spanwise successive sections of the packing and of the plane defined by the tops of the projections 23 are substantially flat and extend at different angles from horizontal. Thus, one planar section within the spanwise interval 24 is uppermost and extends at spanwise opposite sides of a vertical plane 124 which itself extends widthwise to bisect the entire packing span. Two symmetrical planar sections 26 of the packing extend at opposite sides of the one section 24, these having a like degree of angularity with the horizontal, and finally two additional planar sections 27 extend from the sections 26 with symmetry, these having a slightly greater angularity with respect to horizontal. As previously mentioned, this configuration maintains the desired upward camber of the plane defined by the tops of the projections 23 while at the same time simplifying the injection molding of the grid, particularly as compared with the problems presented by the injection molding of a grid having continuously curved camber or arched extent spanwise thereof.

It is a further feature of the invention that the packing units 18 have locating means proximate upper and lower sides thereof for locating like packings in stacked relationship with upper packing reversed spanwise, i.e. rotated 180 degrees, relative to the next lower packing in a manner similar to the reversed relationship of units 18a and 18c in FIG. 1. Such a close stacked configuration is particularly useful and desirable in a so called "trickling filter" application wherein the water is primarily filmed. One form of locating means is better shown in FIG. 5 to comprise a vertically interfitting extension 30 and recess 31, the extension projecting below the general level of the strips 20 and 21 of the planar sections 27. The recess 31 is formed downwardly in the upper portion of the enlarged rib 32 which is integral with the strip 20 as better seen in FIGS. 3 and 5. Only two such ribs 32 are necessary, as is clear from FIG. 1, and these are so located that the projections 23 on vertically successive and rotated packing units are vertically staggered. As a result, it can be seen in FIG. 5 that water droplets falling on the projections 23 will in general be filmed on the strips of that packing and will drain downwardly, the majority of such drainage then passing downwardly through the vertical openings in the lower unit to impinge upon a still lower unit.

In this connection, such vertical staggering of the projections on vertical successive units is accommodated to the requirement that horizontally successive units form a continuous grid pattern, by spacing the terminals 33 of the lengthwise running strips from the nearest widthwise running strip 21, and also by spacing the terminals 34 of the widthwise running strips from the nearest lengthwise running strip 20.

The invention is also directed to the supporting of verti-

cally stacked packing units in arched relationship so as to resist downward deflection thereof tending to reduce upward arching. One means of so supporting the units is to effect a relatively close interfit between the extensions 30 and recesses 31 as viewed in FIG. 5, whereby no single unit can deflect downwardly to appreciable extent without simultaneous deflection of the unit interconnected therewith as described. Accordingly, an interfitting stack of such packing units is strengthened to a degree considerably greater than is afforded by the resistance to deflection characteristic of a single unit. Such a close stacked configuration is, as previously mentioned, desirable in so called "trickling filter" applications.

A further means of supporting the units to resist downward deflection thereof is shown in FIG. 1 to comprise relatively close interfitting relation between the vertical columns or posts 35 of the tower and the recessed corner portions of the packing unit as designated at 36, such recessing shortening the strips 20 and 21 at such corners. It is clear that downward deflection of the packing tending to reduce its upward arching is resisted by the vertical posts or columns 35. Horizontal supports 136 run between and are connected with the columns or posts 35 in undersupporting relation to the spanwise opposite end portions of the packing unit seen at FIG. 2. FIGS. 6 and 7 show a slight modification wherein further support is given the packing unit 18 by means of a framing strip 37 extending in undersupporting relation to the mid-portion of the packing for blocking downward deflection thereof. This framing strip may in turn be supported by strips 38 running diagonally with respect to and connected with the framing strips 136 which are suitably connected to the post 35.

A final modification is shown in FIG. 8 wherein hanger suspended means such as a horizontal rod 39 integral with a vertical cord 40 extends in undersupporting relation to a unit 18 at the general location 41. Here again the hanger suspended means blocks downward deflection of the unit tending to reduce the desired upward arching.

We claim:

Packing adapted to be used as generally horizontally disposed grid decking in gas-liquid contacting equipment having means supplying liquid particles to fall on said decking, the packing comprising interconnected sheet-like strips extending in generally vertical planes and forming vertically open cells the sides of which present water film-forming surfaces, and projections extending from the strips and facing upwardly for intercepting falling liquid causing

the liquid to splash against the projections and then film on said surfaces, the packing having opposite ends and a span therebetween, the packing having uppermost and lowermost faces each with a predetermined amount of upward camber along a major extent of the packing span when said packing is in said generally horizontal disposition, said packing consisting of molded plastic and being subject to increasing tendency to sag with temperature increase, the plastic packing being generally rectangular in outline with an overall length dimension between said ends which is substantially greater than the packing overall width dimension, the predetermined amount of said camber at each of said uppermost and lowermost faces being slight yet sufficient that some camber is retained when the plastic packing is solely supported at said opposite ends thereof and when said plastic packing is continuously subjected to an environmental temperature of between 100° and 120° F. while at the same time the liquid splashed and filmed by the packing is evenly distributed, the packing being free of supporting structure at its underside and between said opposite ends and the packing everywhere having substantially the same vertical thickness between said uppermost and lowermost faces, the overall length of the packing between said opposite ends being greatly in excess of said vertical thickness.

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