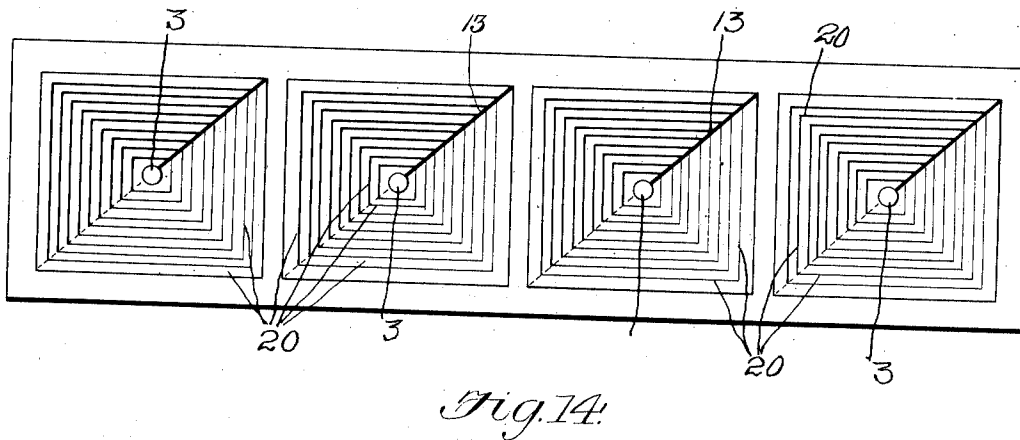
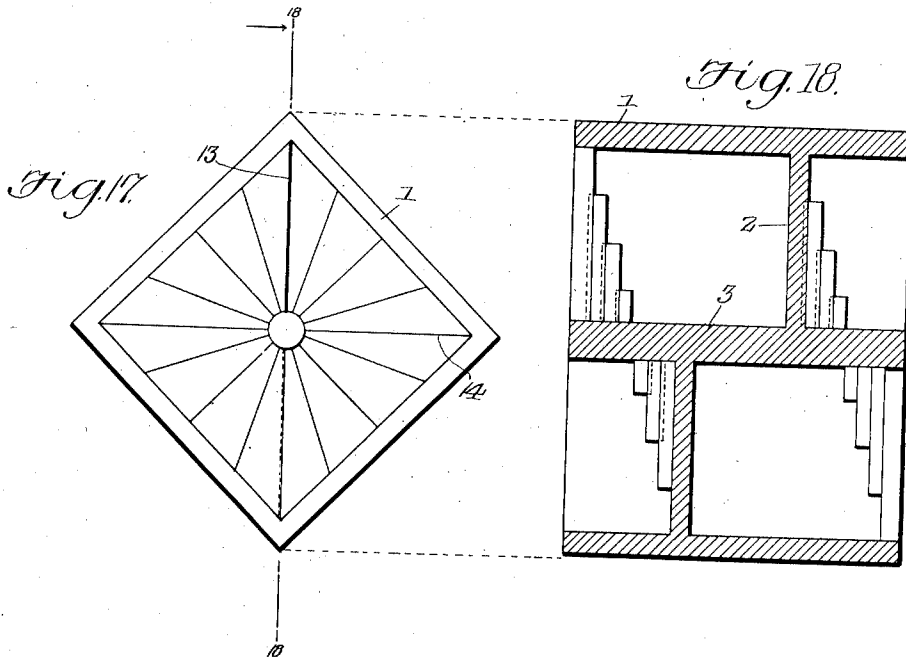


A. M. FAIRLIE.
FILLING MATERIAL FOR REACTION SPACES.
APPLICATION FILED MAR. 23, 1918.

1,365,671.

Patented Jan. 18, 1921.

3 SHEETS—SHEET 3.



WITNESSES:

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3 SHEETS—SHEET 2.

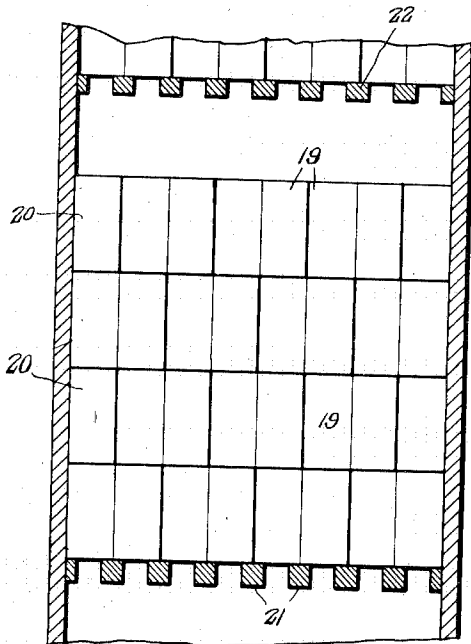


Fig. 12.

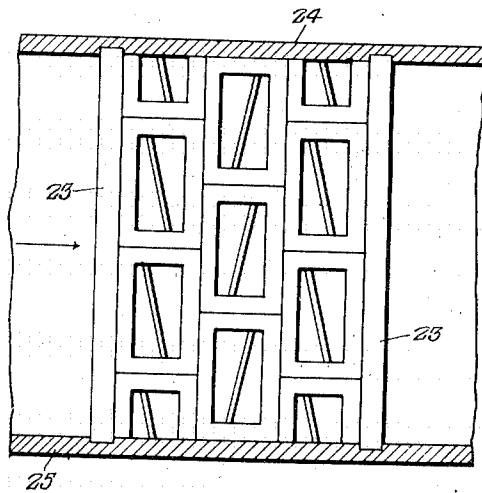


Fig. 13.

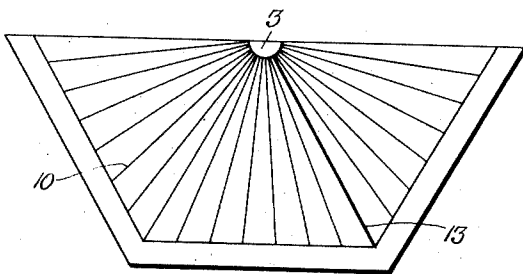


Fig. 15.

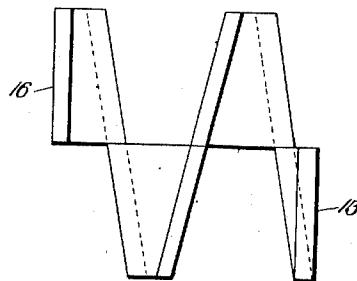


Fig. 16.

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3 SHEETS—SHEET 1.

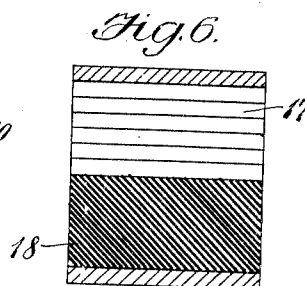
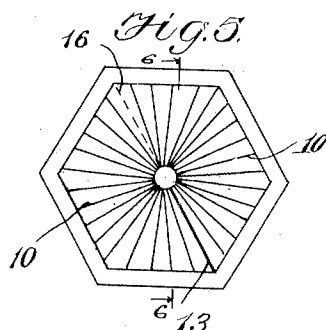
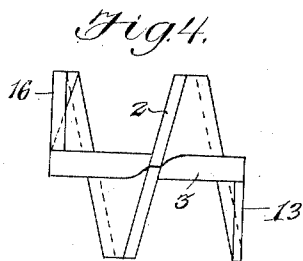
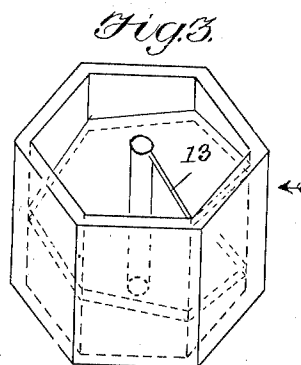
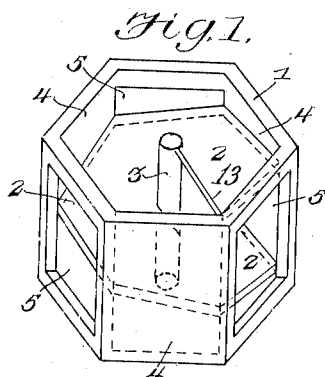
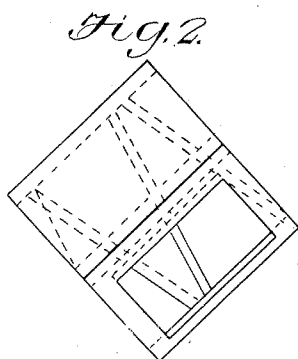


Fig. 7.

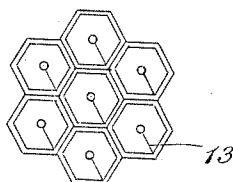


Fig. 8.

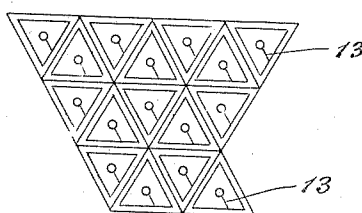


Fig. 9.

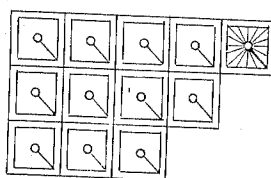
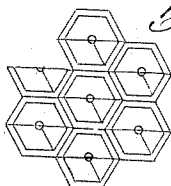


Fig. 11.

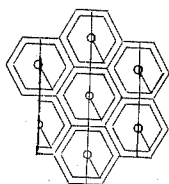


Fig. 10.

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UNITED STATES PATENT OFFICE.

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FILLING MATERIAL FOR REACTION-SPACES.

1,365,671.

Specification of Letters Patent.

Patented Jan. 18, 1921.

Application filed March 23, 1918. Serial No. 224,399.

To all whom it may concern:

Be it known that I, ANDREW M. FAIRLIE, a citizen of the United States, residing at Copperhill, in the county of Polk and State of Tennessee, have invented certain new and useful Improvements in Filling Material for Reaction-Spaces, of which the following is a specification.

The present invention relates to a novel filling material, suitable for use as the packing of Glover towers, Gay-Lussac towers and other reaction spaces, particularly those in which it is desired to bring a gas into intimate contact with flowing liquid in a spread-out condition.

In the accompanying drawings I have shown a number of types of material suitable for use in such towers or reaction spaces, the figures being illustrative of the invention.

In Figure 1 is shown a hollow block of hexagonal cross section, alternate sides of the block being left open. In Fig. 2 is shown a projection of the device shown in Fig. 1, looking from the right of Fig. 1. In Fig. 3 I have shown a similar hexagonal block with the sides all closed.

In Fig. 4 I have shown the helical flange or vane and central post or pillar, forming the vane of such a device as is shown in Figs. 1, 2, and 3, this vane being shown as removed from the walls of the block, and lying on its side.

Fig 5 is a top plan view of the device illustrated in Figs. 1, and 2 or 3. This figure also shows radial scoring 10 which may be employed if desired.

Fig. 6 is a section of the device shown in Fig. 5, taken on the line 6—6, with the helical vane removed from the block. The major portion of this figure accordingly shows the inner wall of the sides of a block without the vane therein.

In Fig. 7 I have shown the preferred method of assembling such blocks as are illustrated in Figs. 1, 2 and 3. In Fig. 8 I have shown a preferred method of assembling blocks of a triangular cross section, these blocks being illustrated as being equilateral triangles in cross section.

In Fig. 9 I have illustrated a method of assembling blocks somewhat similar to those shown in Fig. 7, these blocks, however, being made each in two pieces, these pieces being trapezoidal in cross section and two of these pieces forming a block of regular-hexagonal cross section. (This feature is more

clearly shown in Fig. 15.) In Fig. 10 I have shown another modification in which each hexagonal block is composed of two pieces, each piece being in the form of a pentagon. In Fig. 11 I have shown the preferred method of assembling blocks which are square in cross section.

In Fig. 12, I have shown a portion of a vertical tower. Fig. 13 shows a vertical section of a horizontal flue or chamber through which the gases pass in a horizontal direction, as indicated by the arrow. In Fig. 14 I have shown a plan view of a unit consisting of a single piece or structure which constitutes the equivalent of four square blocks, with four helical vanes therein with longitudinal scoring 20 thereupon, this device being molded in one piece. Fig. 15 shows a half-hexagonal block, with the vane molded integral therewith, this being a plan view corresponding to the lowermost half-hexagonal block shown in Fig. 9. Fig. 16 is a view similar to Fig. 4, of a helical vane for a hexagonal block, having no central post or pillar. The vane is in this case preferably of a sufficient width to come to or even to pass the center line of the block, so as not to leave any straight-flow passage extending through the length of the block.

Fig. 17 is a plan view of a block illustrating another modification, and Fig. 18 is a central section thereof taken on the line 18—18 of Fig. 17.

It will be noted that in Figs. 7, 8, 9, 10 and 11, in which assembled blocks are shown, these blocks fit against each other without leaving any voids or open spaces of appreciable size. This is a decided advantage, since with the use of blocks fitting together in this manner, the entire space in the reaction tower is utilized for the reaction of the gases and liquids upon each other, and there are no open spaces left, by which the gases can travel in a straight course between the blocks of any given tier. It will be understood that a number of tiers of blocks can be placed upon each other, thus filling or substantially filling the entire reaction space.

In the present invention, each complete block comprises a hollow body 1, for example in the shape of a hexagon, triangle or square, preferably of regular shape, so that the blocks can be readily fitted together without leaving voids therebetween, and within this hollow body is located a helical vane or flange 2, carried by a central post or pillar 3,

whereby all of the gases traveling upwardly through the reaction space must pursue a tortuous passage in their course through each hollow block, and by reason of the fact that the blocks fit closely together, all of the gases must necessarily pass through the interior of a hollow block in each tier or layer of blocks.

As stated above, it is preferable that the blocks be constructed with some open sides and some closed sides. As illustrated in Fig. 1, the sides 4 are closed, and the sides 5 are open, and each open side of one block is fitted against a closed side of another block, so that one closed side wall serves as the side wall for each of two blocks, the blocks accordingly being of lighter weight than would be the case if all of the sides were closed, and there is a certain amount of additional reaction space provided in the tower filled with these blocks, and the space is more irregular in shape.

As illustrated in Fig. 4, the helical vane may be removable from the hollow block, these being made as separate pieces, although it is in many cases desirable to make the hollow block, helical vane and supporting post or pillar in one piece. Fig. 6, shows the interior of the hexagonal block of Fig. 3 (solid walls, which block is also shown in plan view in Fig. 5) and Fig. 6 also shows, on the interior face of the wall, vertical scoring or roughening indicated at 17, or helical scoring shown at 18. In Fig. 5 the heavy line 13 represents the top edge of the vane, and the dotted line 16 represents the lower edge of the vane. The device shown in Figs. 1 to 5, inclusive, comprises a vane having one complete turn and a half. Fig. 5 also shows radial scoring 10 on the vane.

In Figs. 9 and 10, I have shown each hexagonal block being made in two pieces capable of being fitted together on the horizontal division lines in Fig. 9 and the vertical division lines in Fig. 10. For some kinds of apparatus it is advisable to make the blocks in two or more pieces in this manner, which fit together, forming complete hexagonal blocks, or blocks of other shape, while in other cases it is more advisable to build the entire block, helical vane and post in one piece.

In the device shown in Fig. 12, hexagonal blocks are represented. These are indicated at 19, and half-hexagonal blocks 20 are represented, to complete certain tiers or layers of the blocks. It is understood that the blocks of the bottom layer rest upon a grating or support 21, and any suitable number of layers may be placed thereupon, for instance four layers as shown. Above the uppermost layer, another grating or grid work 22 may be provided for supporting additional layers of filling blocks. It is assumed in Fig. 12 that blocks without open sides are used, and that these blocks are viewed

from the right as shown in Fig. 3, that is to say, looking in the direction of the arrow shown in Fig. 3. The heavy vertical lines in Fig. 12 represent the places where two blocks are fitted together, while the light vertical lines therein represent the edge of the blocks, that is to say, the place where two faces of the same block meet. In laying the blocks in a tower, instead of staggering the adjacent courses or layers, each block of a higher course may be superposed exactly on a block of similar shape and size in the course next below, this practice being continued indefinitely, from the bottom course as high up as desired, thus forming, when all courses are laid, many columns, each adjacent and contiguous to other similar columns on every side, each column equipped with an internal helical flange throughout its entire height. In these the direction of the vanes may alternate at intervals.

In Fig. 13, I have shown a horizontal gas flue through which the gases pass in the direction of the arrow. This is provided with vertical layers or tiers of square blocks, lying on their sides, with the gases flowing in a horizontal direction therethrough. In this figure, vertical slats 23 are provided for acting as supports. These are secured to the top 24 and bottom 25 of the horizontal flue, in any suitable manner, and spaces of course are left between the slats, for the entry of gases into the blocks. The blocks are shown as being provided with open sides, and as represented, the blocks of the first tier have their vanes turning toward the right, those of the second tier have their vanes turning toward the left and those of the third tier have their vanes turning toward the right. The blocks are also shown as being in staggered relation, half-blocks being shown at the top and bottom of the first and third tiers. It is understood that the blocks next behind, and the blocks next in front of, those shown in Fig. 13 will have their open sides up and down, so that closed sides thereof will close the spaces appearing in the sides of the blocks in Fig. 13.

While I have referred particularly to the blocks being employed as packing material for Gay-Lussac or Glover towers, the invention is not restricted thereto, but the blocks, or the filling material produced by constructing layers of these blocks may be conveniently employed in other tower structures, or other spaces in which liquids and gases come into contact with each other, for the purpose of cooling, condensing, drying, moistening or absorbing all or a portion of the gases, or in a general way for bringing gases and liquids into contact with each other for effecting any desired treatment of the gases or liquids or both.

These blocks may also be used for filling reaction spaces in which no liquid is intro-

duced as such, for example, the reaction spaces or chambers of sulfuric acid plants, either contact, chamber or tower systems, which, together with the filling material therein, may be used for mixing or condensing gases, without the aid of liquids added thereto.

In most of the existing forms of tower packing material, the gases and liquids passing through the towers are caused to take a more or less zig-zag or devious course through the interstices of the packing material, but in most of the devices heretofore employed, the units or blocks were placed in the tower more or less at random, so that the gases and liquids are not obliged to take any definite course through the tower, and the contact of the gases and liquids, in the devices employed in the prior art, is essentially more or less haphazard, whereby some portion of the total possible efficiency of the tower space is wasted or lost. In the present invention, on the contrary, by packing the blocks in the manner above specified, in regular tiers or layers, filling substantially the entire reaction space, a very much more complete contact of the gases and liquids is produced.

In building up a number of superposed layers or tiers of these blocks, it is sometimes advisable to alternate the direction of the helical vanes in the successive layers or tiers, whereby a whirling motion in one direction is produced in one tier, and a whirling motion in the opposite direction is produced in the following tier.

When filling a tower with the blocks, as shown in Fig. 12, ordinarily a sufficient number of blocks are fitted together to form a layer or tier, resting on a suitable horizontal grid or grating, another layer or tier is then formed resting on top of this bottom layer, and a third layer rests on the second, and so on until a sufficient number of layers or tiers have been put in to fill the entire height of the tower, or so much thereof as may be necessary. Each of these layers or tiers would in that case be horizontal or substantially so. However, grids may be inserted at intervals, to support the weight of the blocks, and more or less space may be left just below each grid. I call attention, however, to the fact that in some forms of apparatus other than towers, the successive tiers or layers may be vertical instead of horizontal, or in other forms of apparatus the successive tiers may be inclined, this depending of course upon the particular structure of apparatus or reaction space in which the blocks are to be employed.

The blocks may be made of any suitable material, it of course being obvious that the blocks will be made of a material which is resistant to chemical action of the gases and liquids to be contacted with each other in

the presence of such blocks. For Gay-Lussac and Glover towers, it is often advisable to make the blocks, by molding in one piece, from suitable clay mixture or chamotte, which are subsequently baked or fired, during which heat treatment, suitable glazing operations may be effected. The interior surface of the blocks and the exterior surface also if desired, and the upper and lower surface of the helical vane, or any one or more of these surfaces may be, at the time of molding or subsequently, roughened or scored, instead of being smooth, for the purpose of causing eddy currents and producing a more effective mixing of the gases and liquids under treatment. The inside and outside of the side walls of the blocks may have vertical or preferably spiral grooves or corrugations upon their surfaces, to induce the flow of liquids down the side walls as well as down the surface of the vanes. In some instances it is advisable to construct the vanes with radial scores, thereby producing a structure somewhat similar to a winding stairway, this being illustrated in the right-hand block in Fig. 11.

In Fig. 17, I have shown a plan view of a block illustrating this "winding stairway" effect, and in Fig. 18 I have shown a central section thereof taken on the line 18-18 of Fig. 17. In this figure, the heavy radial line 13 is the top edge of the vane, and the radial lines 14 represent the edges of the several steps, over the upper surface of which the liquid flows in a downward direction and against both surfaces (upper and lower) of which the gases come into contact to be thoroughly mixed during their upward passage through the block. In Fig. 18, the gases can flow horizontally through the blocks, or the blocks can be turned 90° for vertical flow.

I call attention to the fact that in all modifications, the vane is so constructed as not to leave any straight-flow passages through the block, and hence there will be no straight-flow passages through the tier composed of such blocks.

The helical vane inside the triangular, square or hexagonal blocks shown in the illustration may be replaced (although not preferably) by diaphragms or partitions or partial partitions of various shapes, and such substitutions would not depart from the spirit of this invention, so long as the shape of the block used was such that there were no voids or spaces between units. It is obvious that the blocks herein described may be molded or made in clusters of two or more units to a cluster, without departing from the spirit of this invention. The posts 3 may sometimes be omitted.

Likewise the length of the blocks may be either greater or less than, or the same as, the width or diameter, the proportion of

length to width being a non-essential feature of this invention.

Among the advantages of the tower filling material of the preferred form of the present invention, the following are particularly to be noted.

a. The entire interior of the tower is built into a mass of uniform cells, like a honeycomb, systematically, and there is no hazardous arrangement of the packing units.

b. There are no voids between the units, and hence the gases and liquids can pursue the desired course and no other.

c. There are no spaces in the center of the units, through which gases or liquids can proceed vertically, thus taking a short cut and escaping contact with the solid surfaces present in the interior of the units.

d. By constantly and positively causing the gases and liquids to change their course and meet new solid surfaces the efficiency of the tower for the designed purposes is greatly enhanced.

e. By causing the gases and liquids to pursue positively a helical course around the interior of the units, the desired result may be obtained with a much shorter tower constructed at much less expense for initial capital, or a tower of usual height will yield much better results, *i. e.* a much more thorough treatment of the gases and liquids with each other, the actual improvement in efficiency depending on the number of complete helices in the interior of each unit or hexagonal block.

f. By omitting three alternate sides of each hexagonal block, a large percentage of the material required for each block can be saved, and greater efficiency can be obtained from the surfaces of each block, both the interior and exterior surfaces being utilized.

g. By having the horizontal layers of hexagonal blocks alternately composed of blocks which contain in their interior helical vanes or spirals, which are, in one layer or course, right-handed, and in the next layer or course, left-handed, and so on, the direction of rotation of the gases and liquids can be frequently changed, to advantage.

h. These hexagonal blocks present a maximum of free space and of condensation surface.

i. By positively and constantly causing the gases to pursue a spiral or sinuous course and to meet new solid surfaces, the component parts of a gas mixture are much more thoroughly mixed, while passing through a tower or other reaction space.

j. When the block is so molded that the shape of the block inside is triangular, square, or hexagonal, as illustrated, the gases passing through such block and following the internal helical flange are thoroughly mixed, this being materially aided by being

forced to make angular turns, and by striking against the inside walls of the block.

What I claim is:

1. A filling material for reaction spaces, towers and the like, such filling material comprising units capable of being fitted against each other without leaving voids of substantial size therebetween, such units being hollow and being provided interiorly with helical vanes substantially filling the entire cross section thereof.

2. A filling for reaction spaces, towers and the like, such filling comprising units capable of being fitted against each other without leaving voids of substantial size therebetween, such units being hollow and being provided interiorly with helical vanes having central pillars, such vanes and pillars filling the entire cross section of the hollow interiors of such units, and such helical vanes each embracing at least one complete turn.

3. A hollow block open at both ends, suitable for filling reaction spaces, such block having in its interior a hollow space, a post carrying a helical vane completely filling the cross section of the hollow interior thereof, the said vane embracing at least one complete turn.

4. A regular-polygonal hollow body, alternate sides being left open whereby a side wall to one body can serve to stop the open side of an adjacent body, said body being further provided interiorly with a helical vane which completely fills the cross sectional area of said hollow body.

5. A tier of hollow blocks, each of polygonal cross section exteriorly, and each carrying a helical vane interiorly, such helical vane substantially filling the entire cross section of the hollow interiors of such blocks, such blocks being open at both ends and fitting against each other without voids of substantial size therebetween, providing no straight-line passages but many tortuous-flow passages through such tier.

6. A tier of hollow blocks of polygonal cross section exteriorly, and each carrying a helical vane interiorly, such vanes substantially filling the entire cross section of the hollow interiors of such blocks, such blocks being open at both ends and fitting against each other without voids of substantial size therebetween, providing no straight-line passages but many tortuous-flow passages through such tier, a portion of the sides of the blocks being open, and a portion thereof being closed, whereby a side wall to one block can serve to stop up an open side of some other block.

7. A filling block for gas and liquid contact spaces, comprising a block having a helical flange projecting from the inner wall thereof, said flange being of such a width as to join a central pillar around which such

flange is located, and whereby no straight line passage is left in the interior of said block.

5 8. A filling block for the purpose set forth, comprising a prismatic hollow block of acid-proof material, having an internal continuous helicoid flange, whose inner edge is attached to a central pillar.

10 9. A hollow block suitable for filling reaction spaces, towers and the like, such block being open at both its ends, and being provided with a helical vane or flange of a sufficient width to substantially fill the interior cross section of said block, so that no
15 straight-line passage is left through said block.

20 10. A hollow body of acid-resistant material, suitable for use as filling for reaction towers, such body being regular-polygonal in cross section, and having a portion of its sides left open, such body being capable of fitting against other bodies of similar size and shape without leaving voids or passages of substantial size therebetween, and the
25 open sides of a particular body being capable of fitting against the closed sides of such other bodies, whereby one side wall serves to fill the space between the open hollow interiors of two such adjacent hollow bodies.

30 11. A structure for the treatment of gases

and vapors comprising an elongated passage through which the gases and vapors flow, a plurality of tiers of blocks, such tiers being arranged substantially perpendicular to the direction of flow of the gases and vapors 35 through such passage, the blocks of each tier being staggered with respect to the blocks in the next preceding and succeeding tiers, such blocks being polygonal in cross section and each of such blocks fitting against others 40 without leaving spaces of substantial size therebetween, each of such blocks having a portion of its sides left open.

12. A block flat-sided exteriorly freely open at both its ends, suitable for filling reaction spaces, towers and the like, such block 45 having a hollow interior, a helical vane projecting inwardly from the inner face of the side wall of said block and a central post, which with said vane is capable of completely filling the cross section of the said hollow interior of said block, said helical vane embracing more than a complete turn, whereby there is provided in said block, no
50 straight line passage for the flow of gases and liquids, but leaving a tortuous-flow passage therethrough, between said open ends.

In testimony whereof I affix my signature.

ANDREW M. FAIRLIE.