April 14, 1936. M. R. FENSKE 2,037,317

PACKING MATERIAL

Filed June 26, 1933

FIG. 1.

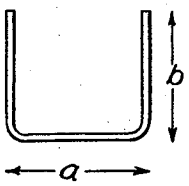


FIG. 2.



FIG. 3.

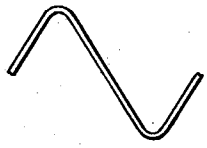


FIG. 4.



FIG. 5.

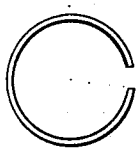


FIG. 6.



FIG. 7.

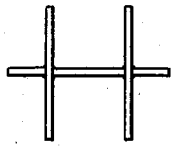


FIG. 8.



FIG. 9.

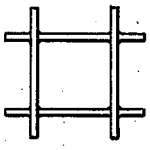
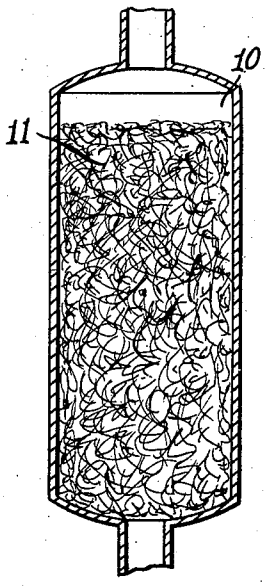


FIG. 10.



FIG. 11.



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UNITED STATES PATENT OFFICE

2,037,317

PACKING MATERIAL

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Application June 26, 1933, Serial No. 677,755

7 Claims. (Cl. 261—95)

This invention relates to packing material, and with regard to certain more specific features, to packing material for bringing about interaction between vapors and liquids in confined spaces.

Among the several objects of the invention may be noted the provision of packing material of the class described which has a greatly improved overall efficiency as compared with prior types of packing material, the improved features comprising the extent of intimacy of contact produced between the liquid and the vapors, the throughput capacity of the packing material, and the like; and the provision of packing material of the class described which is relatively simple to manufacture and use. Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly comprises the elements and combinations of elements, features of construction, and arrangements of parts which will be exemplified in the structures hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawing, in which are illustrated several of various possible embodiments of the invention,

Figures 1 and 2 are, respectively, front and side elevations of a packing element made in accordance with the present invention;

Figures 3 through 10, in groups of two, are, respectively, front and side elevations of additional embodiments of the invention; and

Fig. 11 is a diagrammatic view of a packed tower.

In commercial operations, packing materials are used to bring about a variety of types of reactions between phases, such as liquids and vapors. Packing materials, for example, are used in the so-called packed fractionating towers, of the type shown in my copending application, Serial No. 677,754, filed June 26, 1933, wherein the vapors are saturated and the liquids are at their boiling point. In another case, the packing material carries a liquid which merely absorbs the gas or vapor, such as in a scrubber or an absorber. Again, the liquid may be stripped of a volatile component by the gas or vapor, the tower then being a stripper. Still again, a gas or vapor may be humidified or dried. In all of these cases, however, the function of the packing material is to secure an interaction between the phases comprising the gas or vapor and the liquid.

There are two factors which are of primary importance in the consideration of the value of a packing material in any of these cases of use. First, there is the capacity factor, which determines how much vapor or gas and liquid can be passed through the packing material per unit area of the column enclosing the material, without flooding or backing up the liquid, in a given time. Second, there is the efficiency factor, which is an expression of the degree to which the vapor or gas and liquid are contacted by the packing material. This factor is a function of the intimacy of contact secured between the vapor or gas and the liquid by the packing material. The calibration of the first factor is usually stated as vapor velocity in feet per second in a distillation column operating under total reflux (that is, with as much liquid descending the column as possible). The calibration of the second factor may desirably be made by consideration of a value known as the "height equivalent to a theoretical plate" (hereinafter termed H. E. T. P.) for the material. The H. E. T. P. value is the number of vertical inches of packing material of given cross-sectional area required to effect a fractionation equivalent to that of a theoretically perfect bubble plate in a bubble-plate type fractionating column. That is, a perfect plate achieves a perfect intermingling of vapor and liquid, the vapor stripping the liquid of all of the desired component of the liquid, and the liquid scrubbing the vapor of all of the desired component of the vapor, under perfect adiabatic conditions. This subject of the H. E. T. P. value is treated more at length in my said copending application. Suffice it for the present to say that the H. E. T. P. value for a packing material is an expression of the intimacy of contact achieved by the material, and hence of the efficiency of the material as a contacting medium.

It has been determined that the surface area of packing per unit volume of packing (say per 100 cc.) and the percentage of free space in the packing are closely associated with the performance of the packing with respect to both the capacity and efficiency factors above described. The surface area may be expressed as the total surface area of the packing in square centimeters per 100 cc. of packing material. The percent of free space is the total volume occupied by the packing less the volume of the packing itself divided by the volume occupied by the packing, times 100. That is,

$$\%\text{ free space}=\frac{\text{total volume}-\text{volume of packing}}{\text{total volume}}\times 100$$

The present invention provides new packing material which has both improved capacity factor and improved efficiency factor. The invention in its simplest, and most valuable aspect, provides packing material which constitutes substantially uniplanar, small-dimensioned wire shapes of no great complexity. For example, Figures 1 and 2 show a carding tooth, which is made, for example, of light wire such that dimension *a* is ⅛ inch while dimension *b* is $\frac{5}{32}$ inch. Figures 3 and 4 show a simple crimped copper wire shape (uniplanar) drawn to the same scale. Figures 5 and 6 show an open wire ring, which is likewise uniplanar. Figures 7 and 8 show a H-shape crossed

wires piece, also uniplanar. Figures 9 and 10 show a doubly-crossed or "#" shaped unit, also uniplanar. All of these forms are much smaller and of greatly simplified shape over packing materials heretofore used.

A particular advantage of these uniplanar wire shapes is that when they are bunched together in a mass, they interlock to an extent sufficient to make the mass as a whole hang together with only a relatively few units separating. This feature, it will readily be seen, facilitates handling the packing material in loading and unloading fractionating towers in which it is used.

Such a tower, for example, is indicated diagrammatically at numeral 10 in Fig. 11, and the interlocked mass of packing material is indicated by numeral 11.

Other shapes might be provided without limit.

The table below shows the factors as above derived for these various types of packing material:

Figure remarks	I	II	III	IV	V
1. $a=\frac{1}{8}''$, $b=\frac{5}{32}''$	1890	84.9	1.6	$\frac{3}{4}''\times30''$	1.3—1.5
1. $a=\frac{1}{8}''$, $b=\frac{15}{64}''$	1721	81.6	1.5	$\frac{3}{4}''\times30''$	1.3—1.5
3	1755	64.0			
5	1505	82.0	2.0	$\frac{3}{4}''\times52''$	1.3—1.5
7	1338	71.9	1.9	$\frac{3}{4}''\times26''$	1.0
9	1070	79.6	4.9	$\frac{3}{4}''\times55''$	

In the above table, column I shows the value yielded for the expression

$$\frac{\text{Area}\times\%\text{ free space}}{100}$$

column II shows the % free space, column III shows the H. E. T. P. value in inches, column IV shows the dimensions of the test column, and column V shows the flooding velocity in feet per second.

The table below is given for comparative purposes, showing the values as above given for several prior art type of packing materials (the columns meaning the same as in the table above):

Description	I	II	III	IV	V
#20 single link jack chain	980	69.5	5.2	$2''\times75''$	1.1
#18 single link jack chain	785	69.4	6.5	$2''\times75''$	1.2
#16 single link jack chain	595	72.3	5.9	$\frac{3}{4}''\times55''$	1.2
Six turn wire helix	831	91.2	5.4	$\frac{3}{4}''\times52''$	1.6
Lessing rings, $0.255''\times0.3''$	747	84.7			
Glass rings, $0.271''\times0.38''$	600	69.7	5.4	$\frac{3}{4}''\times55''$	1.0
Cholet Vanderhoef rings, $0.40''\times0.46''$	495	90.0			
U. S. Stoneware rings, $\frac{1}{2}''\times\frac{1}{2}''$ (plain Raschig)	191	57.0			
U. S. Stoneware rings, (hexahelix, single spiral)	59	43.0			

From the above, it is seen that the packing material of the present invention is considerably advantageous over prior art forms. It will be noted that the expressions of the first two columns, namely, the

$$\frac{\text{Area}\times\%\text{ free space}}{100}$$

value and the % free space value, are expressions of the size and shape of the units, while the remaining columns express results achieved with such units. Thus, the invention may be characterized as wire shapes such that the

$$\frac{\text{Area}\times\%\text{ free space}}{100}$$

value is 1000 or more, while the % free space value is 70.0 or more.

The area, it will be understood, in the above expressions represents the surface area of the packing material in square centimeters per 100 cc. of packing material (space occupied, not absolute volume of packing material).

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As many changes could be made in carrying out the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. Packing material comprising small units of wires arranged substantially in H conformation, said units being substantially uniplanar.

2. Packing material comprising relatively small, substantially uniplanar wire-like forms, said forms comprising such figures that they readily interlock to form a mass which hangs together.

3. A packing material comprising small units of wires, each unit comprising at least two parallel straight wires and at least one wire joining said first two wires at an angle thereto.

4. Packing material comprising small units of wires arranged substantially in # conformation, said units being uniplanar.

5. In combination, a device adapted to contact phases, such as liquids and vapors or gases, and packing material therein, said packing material comprising an interlocked mass of wire-like forms, each of said wire-like forms being individually relatively small and being of substantially uniplanar conformation, whereby there is obtained in said packing material a relatively high surface area and a relatively high percentage of free space.

6. Packing material comprising relatively small substantially uniplanar wire carding teeth.

7. Packing material comprising relatively small substantially uniplanar wire rings.

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