Aug. 18, 1936. R. R. COLLINS 2,051,545

CONTACT APPARATUS

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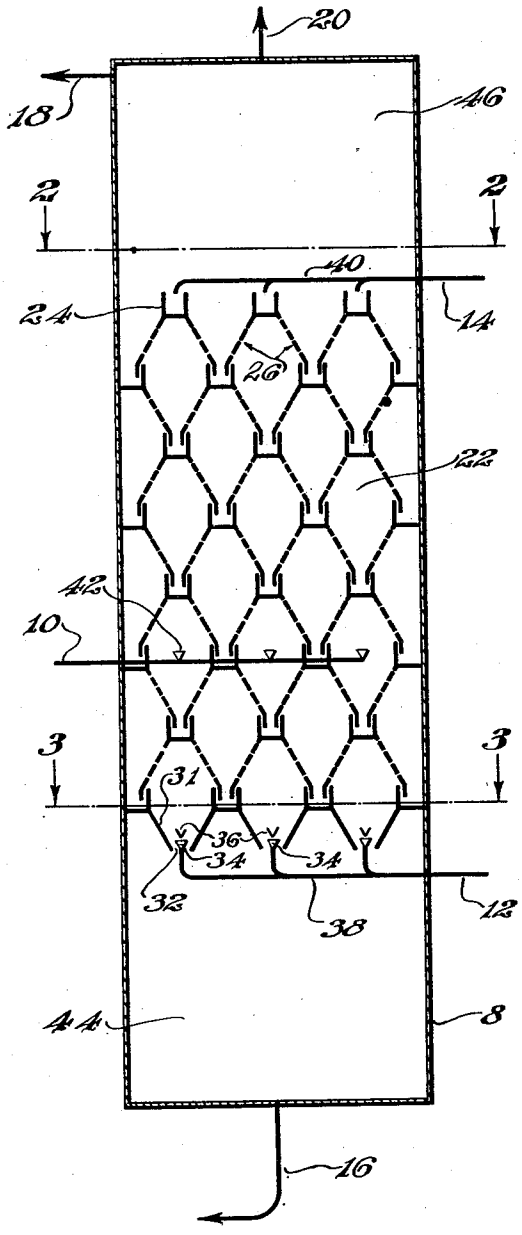
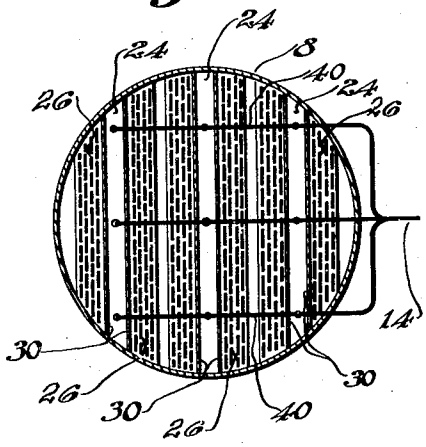



Fig. 1

Fig. 2



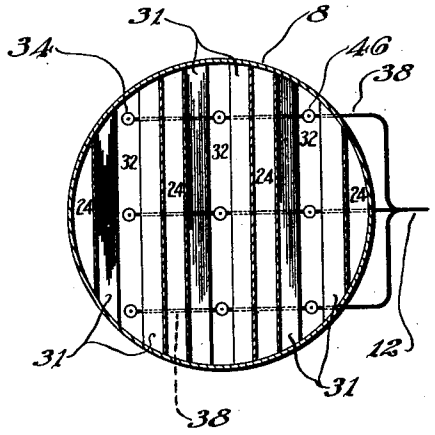




Fig. 3

Witness

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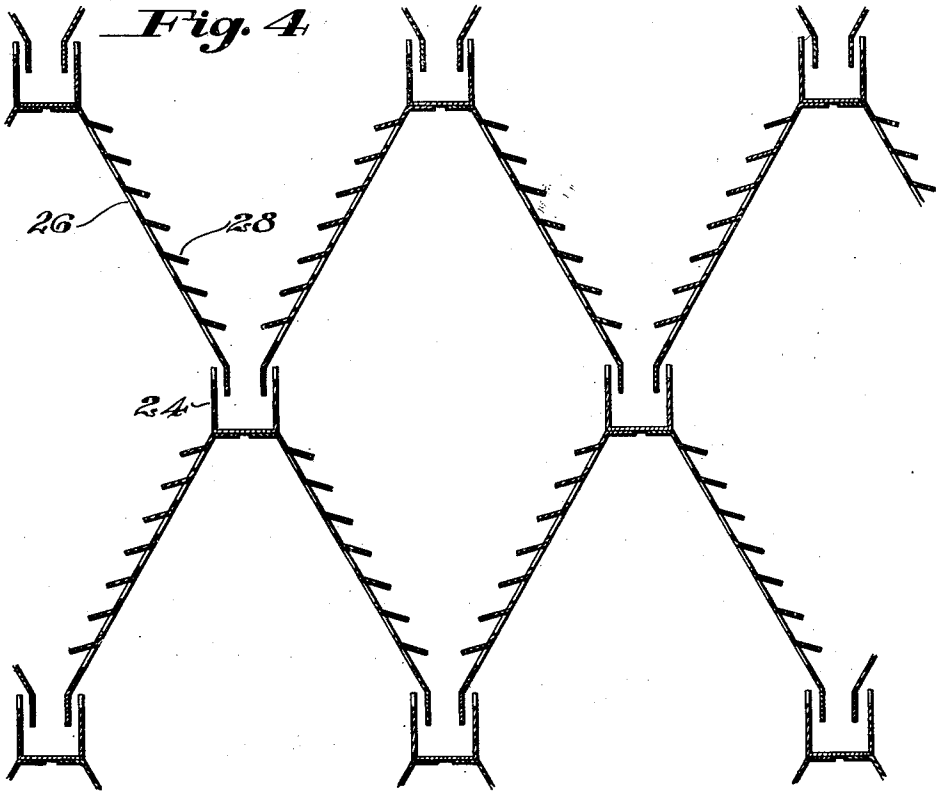
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CONTACT APPARATUS

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Fig. 4



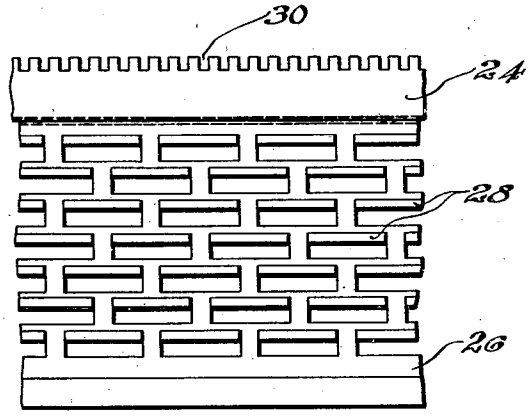




Fig. 5

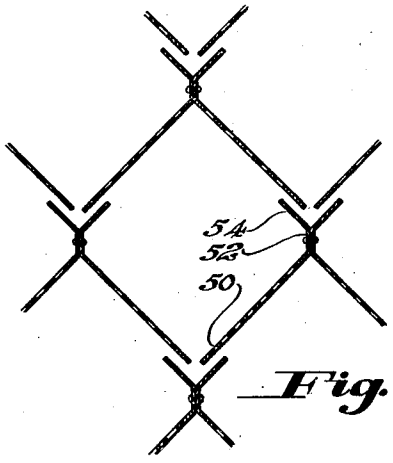



Fig. 6

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CONTACT APPARATUS

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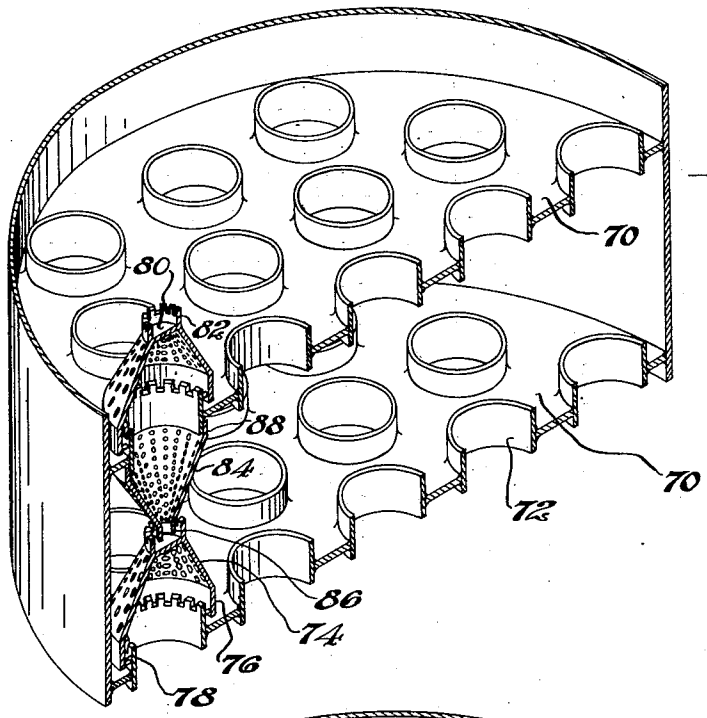



Fig. 7

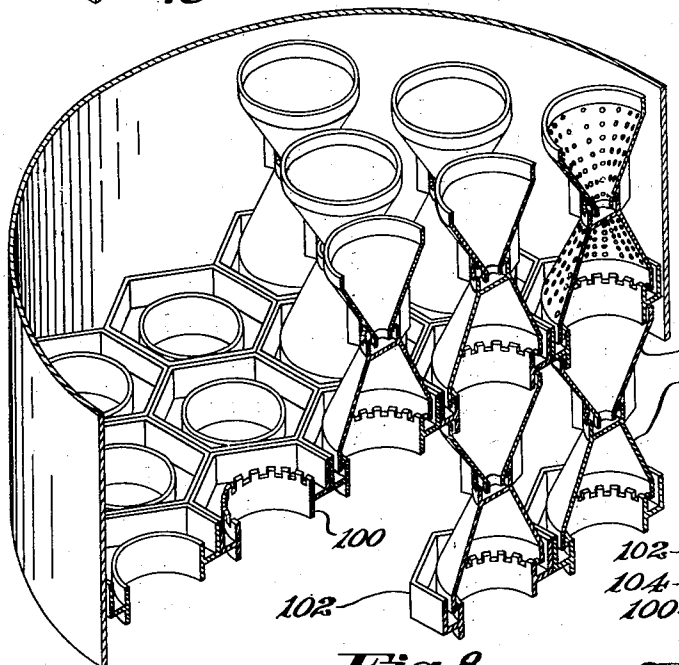



Fig. 8

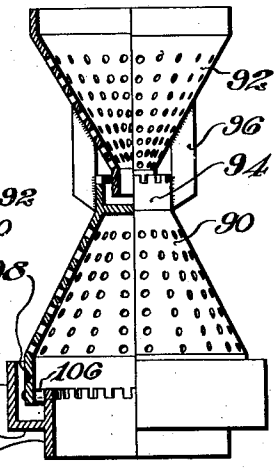



Fig. 9

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Patented Aug. 18, 1936 2,051,545

# UNITED STATES PATENT OFFICE

2,051,545

## CONTACT APPARATUS

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Application April 14, 1933, Serial No. 666,144

11 Claims. (Cl. 261—113)

The present invention relates to contact apparatus and more particularly to apparatus for promoting liquid-to-liquid contact, as in liquid extraction process, or liquid-to-gas contact, as in scrubbing and rectifying processes.

In the usual forms of liquid extraction apparatus, the degree of extraction is limited by the efficiency of contact which is frequently low because of the formation of channels and the poor distribution of the liquid across the column. Even with the usual expedients for promoting contact, such as Raschig rings, channeling is not completely prevented and uncontacted streams may form throughout the length of the tower.

The object of the present invention is to provide an apparatus particularly useful in liquid extraction processes and also suitable for gas-to-liquid contact, in which effective distribution of the fluids across the column is maintained, and in which undesirable channeling is practically avoided. To this end, the present invention comprises the apparatus hereinafter described and particularly defined in the claims.

In the accompanying drawings, Fig. 1 is a diagrammatic sectional elevation of the preferred form of the invention; Fig. 2 is a section on line 2—2 of Fig. 1; Fig. 3 is a section on line 3—3 of Fig. 1; Fig. 4 is an enlarged sectional view of a number of units; Fig. 5 is a side view of a portion of one of the units; Fig. 6 is a vertical sectional view of a modified unit; Fig. 7 is a perspective view of still another modified form of the invention; Fig. 8 is perspective view of a modification embodying a unitary arrangement; and Fig. 9 is a view, partly in section, of one of the units of Fig. 8.

The invention is herein illustrated and described as embodied in a liquid extraction apparatus particularly constructed for a solvent method of separating naphthenic and paraffinic oil components from a lubricating stock. In some forms of the extraction process, the lubricating stock is passed in countercurrent to a single solvent which has selective dissolving powers for either the naphthenic or the paraffinic oil groups, while another process contemplates passing in countercurrent two solvents which have selective dissolving actions on the two oil groups, the oil feed being then introduced into a mediate point of the countercurrent path. The apparatus shown in Fig. 1 is particularly constructed for the practice of the extraction operation of the second type involving the use of two solvents.

The apparatus comprises a column 8 having at a mediate point a feed inlet 10 for introduction of the oil to be subjected to the extraction process. Near the bottom of the column is an inlet pipe 12 for introducing the lighter solvent which has selective dissolving power for the paraffinic oils and near the top is an inlet pipe 14 for introducing a heavier solvent having selective dissolving power for the naphthenic components. At the bottom is a draw-off 16 from which is withdrawn the extracted naphthenic components in mixture with some of both solvents and at the top is a withdrawal pipe 18 for removal of the extracted paraffinic components which are also associated with some of both solvents. A vent pipe 20 is provided at the top. In operation of the process, the heavy solvent introduced at 14 descends, and the lighter solvent, introduced at 12, ascends through the column. In a single solvent process, the pipe 10 would be omitted, the oil feed would be introduced through one of the pipes 12 or 14, and the solvent would be introduced through the other pipe.

Between the inlets 10 and 12 there are arranged a plurality of contact units, indicated generally at 22. The units comprise a plurality of liquid collecting troughs 24 arranged in rows across the column, the rows being staggered or offset, as shown in Fig. 1. Connected to the bottom of each trough are two inclined perforated plates 26, the ends of which are immersed in troughs of the row next below, the construction forming a diamond-shaped arrangement of the plates. The plates are perforated, as shown in Fig. 4. The material of the perforations may be struck out to form louvers 28. Each trough is provided with a serrated overflow edge 30, as shown in Fig. 5, to permit substantially uniform overflow of liquid, regardless of any slight failure to level the column exactly. The plates 31 of the bottom row are imperforate, and adjacent plates converge to form narrow transverse openings 32 in each of which is disposed a plurality of nozzles 34. Above each nozzle is a deflector 36 for dispersing liquid flowing through the nozzles. The nozzles are all connected together by pipes 38 which are connected to the inlet pipe 12. At the top of the column, the pipe 14 connects with a series of pipes 40 which distribute the heavy solvent into the troughs 24 of the uppermost row. The feed pipe 10 is similarly connected with nozzles 42 disposed internally of the units at a mediate section of the column.

In operation, the light and heavy solvents are continuously introduced by the pipes 12 and 14

and the feed oil is introduced by the pipe 10. The entire column is filled with liquid. The heavy solvent flowing into the uppermost troughs 24 overflows and runs down the inclined plates 16. At the same time, lighter liquid passing upwardly through the column goes through the perforations of the plates and contacts intimately with the descending heavy solvent. In this operation, the heavy solvent is denuded of its paraffinic constituents and is enriched by naphthenic constituents extracted from the ascending stream. The heavy liquid finds its way to the troughs of the row next below, from which it overflows into the succeeding rows of troughs. The action of contact at the surfaces of the plates is enhanced by the fact that the ascending lighter solvent carries some particles of the heavier material upwardly into the diamond-shaped areas, after which these heavier particles separate from the descending stream and descend directly into the troughs. A fairly turbulent condition arises by which complete and effective contact between all particles of the several liquids is assured. It will be observed that since the liquid collecting in the troughs is always heavier than that rising through the diamond-shaped areas, there is no opportunity for the lighter liquid to pass into troughs but, on the contrary, it is obliged to ascend and pass through the perforations, thereby promoting the turbulent contact of the liquids. In the lowermost row, the descending liquid is caused to converge toward the nozzles 34, thereby promoting a final intimate contact which assures substantially complete removal of the remnant of paraffinic constituents. The bottom of the column is provided with an enlarged settling chamber 44 in which opportunity is afforded for segregation of the material into layers, the lower layer being withdrawn at 16. Similarly, the upper section of the column is provided with an enlarged separating chamber 46 to permit segregation of the extracted paraffinic oils from any heavier components which may tend to rise toward the top of the column.

It will be observed that neither the descending nor the ascending liquid is permitted to pass in any well-defined inactive channels through the column. The descending liquid divides at each trough into two streams and accordingly, there is a definite transverse motion of the liquid across the column. Similarly, the ascending liquid is divided into two streams within each diamond-shaped area. Thorough distribution throughout the cross-section of the column is thereby assured. The distribution and contact are attained, however, while keeping a definite classification of the streams at any level. Descending heavy liquid passes from trough to trough over the upper surfaces of the plates without being permitted to pass through the perforations, while the ascending lighter liquid moves upwardly through the plates without mixing with the collected liquids in the troughs. Accordingly, the proper differences in density are maintained to assure progressive countercurrent action whereby the descending heavy solvent picks up increasing quantities of naphthenic components, and the ascending lighter solvent picks up increasing quantities of paraffinic components.

A modified and somewhat simpler form of the invention is shown in Fig. 6. Each plate 50 is formed at its upper end with a vertically extending portion 52 and an inturned portion 54. The portions 52 of adjacent plates are riveted or welded together and a triangular-shaped trough is thereby formed. The plate 50, as shown in Fig. 6, is perforated according to any desired pattern. Louvers, similar to those indicated at 28 in Fig. 4 may be used, and these contribute to completeness of contact by promoting turbulence in the cascading stream of heavy solvent. However, plain perforated plates are entirely satisfactory since the ascending liquid is forced to contact intimately with the descending stream.

In either form of the invention, the column is highly efficient since the only portion of the cross-section not available for contact is that taken up by the troughs themselves, which are of comparatively small area. The area available for contact may be as high as 85% of the total cross-section of the column, as compared with about 65% for Raschig ring columns or other towers of the filled type.

In the construction shown in Fig. 7, the inclined plates are arranged in the form of conical surfaces co-operating with collecting decks which take the place of the troughs of the modification first described. As shown in the drawings, a plurality of decks 70 are arranged at successive levels within the shell, each deck being provided with regularly spaced openings within which cylindrical overflow sleeves 72 are welded. The upper edge of each sleeve may be serrated. Co-operating with each sleeve 72 is a cone-shaped contact device 74 provided with perforations for promoting contact between the countercurrent fluid. At the bottom, each cone is provided with a ring 76 surrounding the overflow sleeve and suitably attached thereto by bolts or other securing means 78. At the top, each cone has a small collecting pan 80 surrounded by an upstanding serrated overflow sleeve or weir 82. A second cone 84 has a ring-shaped bottom portion 86 fitting within the sleeve 82, and an upper ring section 88 secured to the cylindrical overflow sleeve 72 of the deck next above. The apparatus operates in exactly the same fashion as that shown in Fig. 4, the decks 70 and the collecting pans 80 serving the same function as the troughs 24. The conical contact devices serve the same purpose as the inclined plates. It will be observed that the liquid collecting on each deck 70 is caused to distribute and divide so that all opportunity for channeling is prevented. The lighter liquid rising from below passes internally of the lower cone 74 of each unit and out through the perforations, and thence inwardly through the perforations of the upper cone 84, this process being repeated from deck to deck. The introduction of liquids is accomplished in the same manner as in the arrangement previously described.

A simple unitary arrangement is shown in Figs. 8 and 9. The entire column is made up of a plurality of individual units, all of the type shown in Fig. 9. Each unit comprises two opposed perforated cones 90 and 92, the lower cone 90 having at the top a collecting pan surrounded by a sleeve 94, as in the arrangement shown in Fig. 8. The two cones are held together by a series of braces 96, each welded to the upper cone and the sleeve 94. Except for the braces 96, the cones are identical with those shown in Fig. 7.

The bottom ring 98 of the lower cone is immersed in an overflow section which comprises an overflow sleeve 100 preferably having an up-

per serrated edge and a surrounding hexagonal sleeve 102, the hexagonal sleeve being connected with the clindrical sleeve by a horizontal tray portion 104. The bottom ring of the cone is secured to and spaced from the sleeve, as indicated at 106. The units are nested together, as indicated in Fig. 7, the hexagonal sleeves joining together to form in effect a continuous deck. The uppermost units are supported by the units below. It is unnecessary to attach the hexagonal sleeve portions of adjacent units together, since the column is almost completely filled by the joining hexagonal surfaces. It will be observed that the side portions of the hexagonal sleeve 102 are appreciably higher than the overflow edges of the cylindrical sleeves 100, in order to prevent overflow through the joints between adjacent units. For this reason, little distribution of descending liquid takes place, each column of individual units acting more or less independently of the others, but adequate contact and classification are nevertheless obtained, and the construction has the advantages of simplicity and economy of manufacture.

Although the invention has been described above as embodied in an apparatus for practicing a liquid extraction process, it is equally suitable for liquid-to-gas or liquid-to-vapor contact, as in scrubbing, washing or rectifying systems. For example, the column, in substantialy identical form to that shown in Fig. 1, may be used for steam distillation. The oil to be distilled is first heated and then charged into the column through the feed pipe 10, steam is introduced by the pipe 12, and reflux liquid is introduced at 14. Vapors and residual product are withdrawn from the column at 18 and 16, respectively. The vapors ascending the column pass through the plates and contact with descending liquid which passes from trough to trough over the upper surfaces of the plates. This type of column is especially suitable for vacuum distillation, since excellent contact may be promoted without introducing excessive back pressure.

Having thus described the invention, what is claimed is:

1. Contact apparatus comprising a column, a plurality of staggered rows of troughs, and a plurality of rows of inclined perforated plates, each attached at its upper end to a trough and immersed at its lower end in a trough of the row next below certain of said troughs receiving the lower ends of a plurality of said plates and having a plurality of downwardly extending diverging plates attached thereto.

2. Contact apparatus comprising a column, a plurality of staggered rows of troughs, and a plurality of inclined perforated plates, each attached at its upper end to a trough and immersed at its lower end in a trough of the row next below, each plate having fins extending outwardly from the plate.

3. Liquid extraction apparatus comprising a column, a plurality of staggered rows of troughs, a plurality of inclined perforated plates, each attached at its upper end to a trough and immersed at its lower end in a trough of the row next below, a bottom row of unperforated plates, adjacent plates converging to a narrow opening, means for introducing a liquid into the openings, and means for introducing a liquid into the uppermost troughs.

4. Liquid extraction apparatus comprising a column, a plurality of staggered rows of troughs, a plurality of inclined perforated plates, each attached at its upper end to a trough and immersed at its lower end in a trough of the row next below, a bottom row of unperforated plates, adjacent plates converging to a narrow opening, means for introducing a liquid into the openings, and means for introducing a liquid into the uppermost troughs, and means for introducing a third liquid into a mediate point of the column.

5. Contact apparatus comprising a column, a plurality of inclined perforated plates in the column, means for passing a liquid downwardly over the upper surfaces of the plates, and means for passing a lighter fluid upwardly through the perforations in the plates, the plates being provided with louvers over which the descending liquid cascades.

6. Contact apparatus comprising a column, a plurality of contact units in the column, each including an integral plate having an inclined perforated portion and an upper portion oppositely inclined, two of such units being attached together, whereby said upper portions form a trough.

7. Contact apparatus comprising a column having a plurality of decks, overflow sleeves in each deck, an upper perforated conical contact member depending from each overflow sleeve, a lower conical contact member surrounding a sleeve of the deck below, and having a collecting pan at the top, and an overflow weir at the edge of the collecting pan.

8. Contact apparatus comprising a column, a plurality of contact units, each consisting of an overflow sleeve and a surrounding polygonal sleeve, a horizontal tray between the sleeves, a perforated cone upstanding from the overflow sleeve and having a collecting pan at the top, and a second perforated cone above the first cone and arranged to receive liquid overflowing from the unit above.

9. Contact apparatus comprising a column, a plurality of contact units, each consisting of an overflow sleeve and a surrounding polygonal sleeve, a horizontal tray between the sleeves, said units being arranged at different levels in the column, and inclined perforated plates to direct the flow of liquid from one overflow sleeve to the tray next below.

10. Contact apparatus comprising a column, a plurality of upwardly facing liquid collectors arranged at each of a number of different levels in the column, perforated contact members connected at their upper ends to said collectors and having inclined surfaces extending downwardly toward the collectors at the level next below, said surfaces converging toward said last-named collectors, means for passing a fluid downwardly over the surfaces and through the collectors successively, and means for passing a fluid of less density upwardly through the perforations.

11. Contact apparatus comprising a column, a plurality of upwardly facing liquid collectors at a number of different levels in the column, perforated conical contact members connected at their upper ends with certain of said collectors and converging toward collectors of the level next below, and means for flowing a liquid downwardly over the conical surfaces while passing a fluid through the perforations in countercurrent to said liquid.

RAYMOND R. COLLINS.