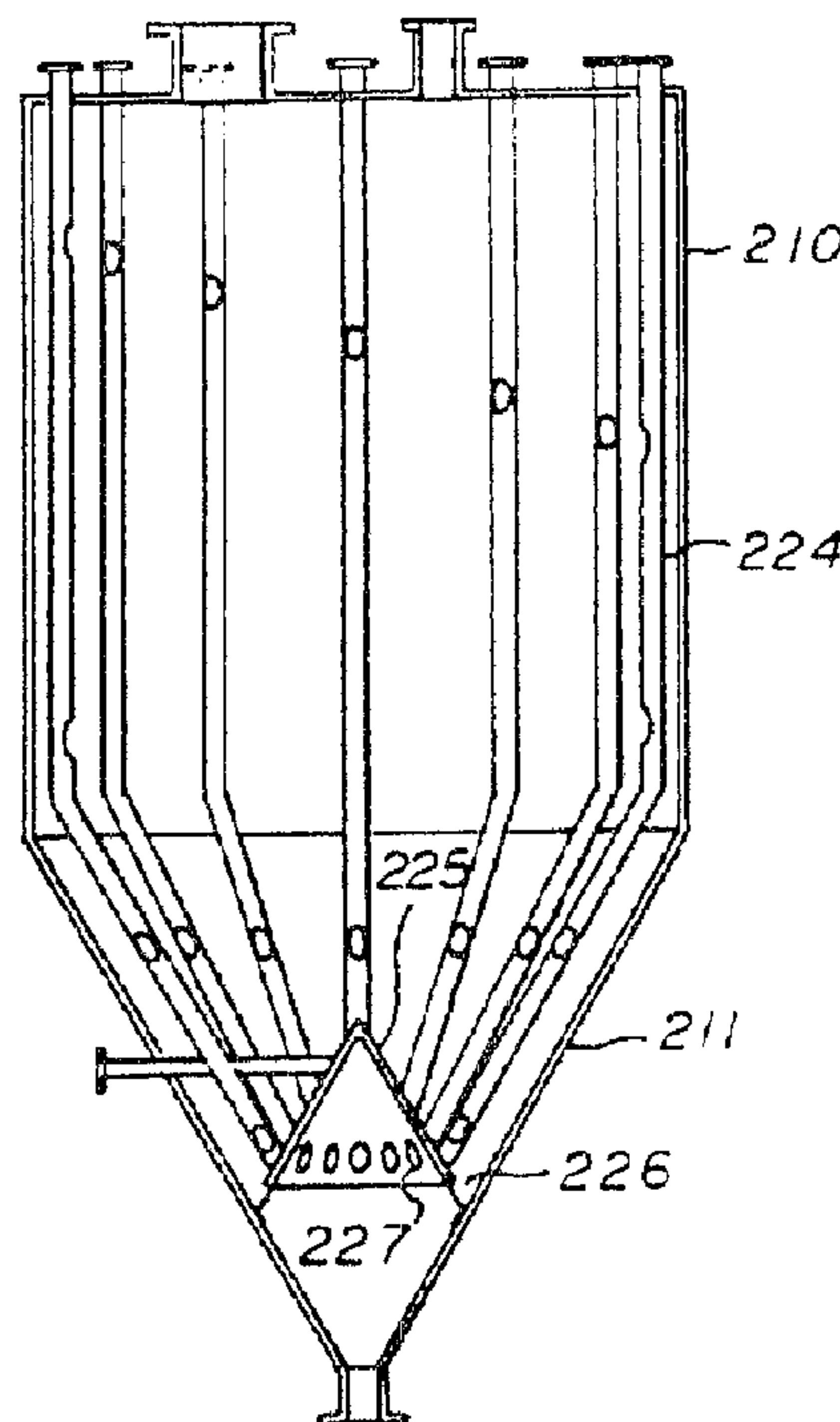




(86) Date de dépôt PCT/PCT Filing Date: 1992/04/09
(87) Date publication PCT/PCT Publication Date: 1992/10/29
(45) Date de délivrance/Issue Date: 2004/06/08
(85) Entrée phase nationale/National Entry: 1993/01/12
(86) N° demande PCT/PCT Application No.: US 1992/002890
(87) N° publication PCT/PCT Publication No.: 1992/018229
(30) Priorités/Priorities: 1991/04/10 (683,320) US;
1992/01/17 (822,082) US; 1992/03/27 (858,704) US

(51) Cl.Int.⁵/Int.Cl.⁵ B01F 5/24
(72) Inventeur/Inventor:
AVERY, HUGH E., JR., US
(73) Propriétaire/Owner:
JANSENS & DIEPERINK, B.V., NL
(74) Agent: BERESKIN & PARR

(54) Titre : MELANGEUR AVEC CHICANE VIRTUELLE POUR SUBSTANCES PARTICULAIRES
(54) Title: BLENDER WITH VIRTUAL BAFFLE OF PARTICULATE MATERIAL



(57) Abrégé/Abstract:

A blending apparatus, inexpensive in construction and requiring a minimum of recirculation, is today essential for economical and thorough blending of particulate material, for example, plastic pellets of virgin material and of pellets that have been reconstituted from recycled material. Construction of the blender is low in cost not only because the customary receiver, and its piping, conventionally installed below the blender are eliminated, but because the rigid baffle of the prior blender has been replaced by a virtual baffle (626) of particulate material, which forms a toroidal block within: the conically walls (610) of the blender; the converging blended conduits (602) adjacent thereto; and the structural supporting matrix. The baffle of particulate material (626) serves: 1) as a termination surface for the conventional perforated blending conduits; and 2) retains a toroidal annular volume of particulate material in position between the upper outer surface of the baffle and the inside wall of the blender.





INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification⁵ :

B01F 5/24

A1

(11) International Publication Number:

WO 92/18229

(43) International Publication Date:

29 October 1992 (29.10.92)

2087178

(21) International Application Number: PCT/US92/02890

(22) International Filing Date: 9 April 1992 (09.04.92)

(30) Priority data:

683,320	10 April 1991 (10.04.91)	US
822,082	17 January 1992 (17.01.92)	US
858,704	27 March 1992 (27.03.92)	US

(60) Parent Application or Grant

(63) Related by Continuation

US

Filed on

683,320 (CIP)
10 April 1991 (10.04.91)

(71)(72) Applicant and Inventor: AVERY, Hugh, E., Jr. [US/US]; 3764 Lake Drive, Houston, TX 77098 (US).

(74) Agent: SCHACHT, Ezra, L.; 1620 West Main Street, Houston, TX 77006 (US).

(81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CA, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CI (OAPI patent), CM (OAPI patent), DE, DE (European patent), DK, DK (European patent), ES, ES (European patent), FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), GN (OAPI patent), GR (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC (European patent), MG, ML (OAPI patent), MR (OAPI patent), MW, NL, NL (European patent), NO, PL, RO, RU, SD, SE, SE (European patent), SN (OAPI patent), TD (OAPI patent), TG (OAPI patent), US.

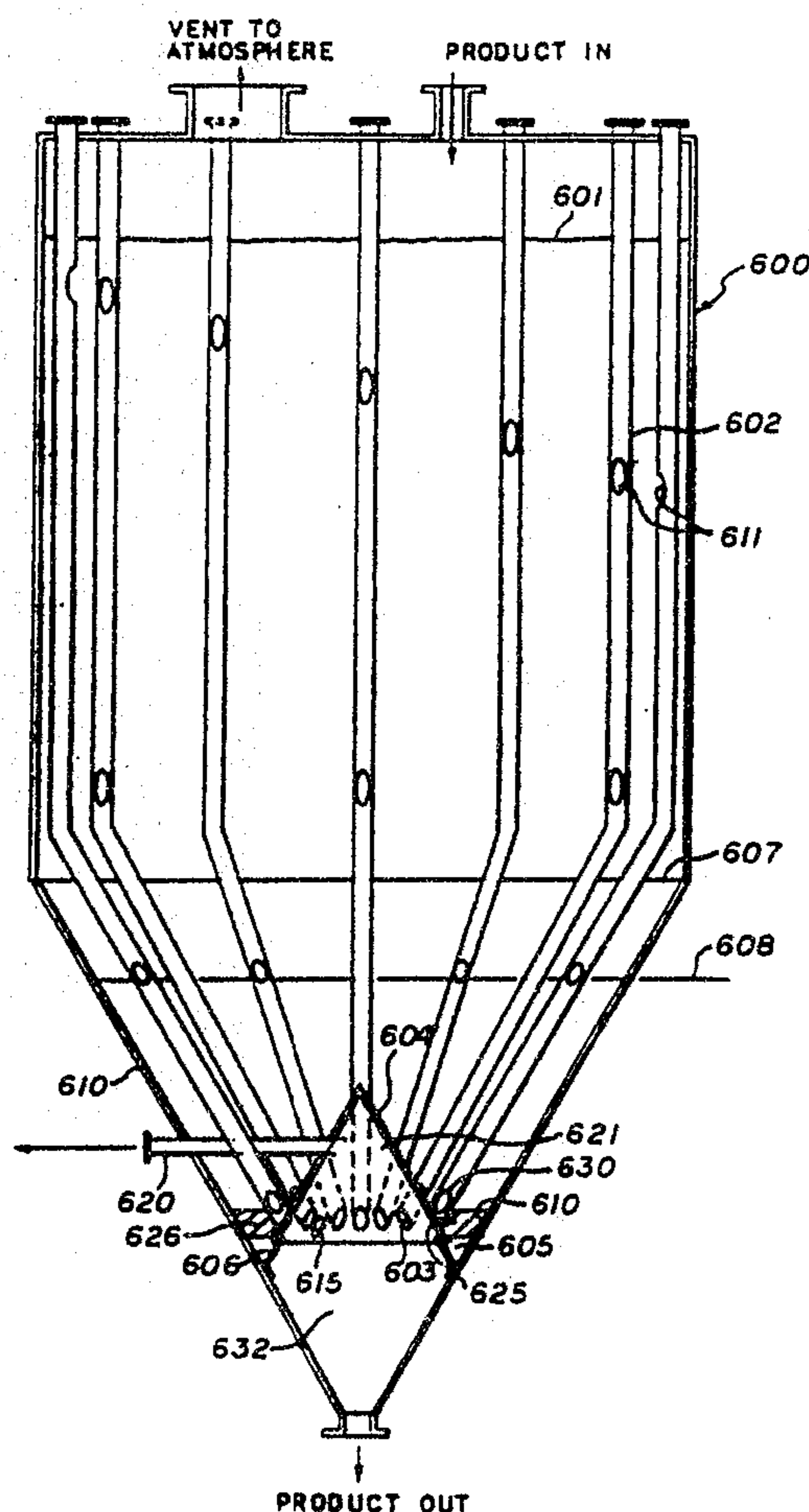
Published

With international search report.

(54) Title: BLENDER WITH VIRTUAL BAFFLE OF PARTICULATE MATERIAL

(57) Abstract

A blending apparatus, inexpensive in construction and requiring a minimum of recirculation, is today essential for economical and thorough blending of particulate material, for example, plastic pellets of virgin material and of pellets that have been reconstituted from recycled material. Construction of the blender is low in cost not only because the customary receiver, and its piping, conventionally installed below the blender are eliminated, but because the rigid baffle of the prior blender has been replaced by a virtual baffle (626) of particulate material, which forms a toroidal block within: the conically walls (610) of the blender; the converging blended conduits (602) adjacent thereto; and the structural supporting matrix. The baffle of particulate material (626) serves: 1) as a termination surface for the conventional perforated blending conduits; and 2) retains a toroidal annular volume of particulate material in position between the upper outer surface of the baffle and the inside wall of the blender.



BLENDER WITH VIRTUAL BAFFLE OF PARTICULATE MATERIAL

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

This invention relates to blenders and more specifically to methods and apparatus for thoroughly blending particulate or granular materials, a portion of the unblended material forming a toroidal block, constituting a virtual baffle to the downward flow of any particulate material except that passing through the blending tubes themselves.

DEFINITIONS

baffle--(noun) a plate, wall, screen, or other device to deflect, check, or regulate flow.

virtual baffle--herein defined as a barrier, formed of particulate material, in combination with a supporting structural matrix, to the downward flow of particulate material, except through blending tubes which penetrate the barrier.

matrix--herein defined as blender walls, metallic plates and cones, blending conduits, all coacting with the particulate material to provide the virtual baffle.

voussoir--(dict.) one of the wedge-shaped pieces forming an arch or vault. Used herein to graphically describe the cross section of the virtual baffle, at some point on the toroid or segment.

bridging--the tendency of particulate solids, flowing downward through a channel with converging sides, to bridge across the channel, blocking the channel, causing all of the material flowing out of the blender to flow through the blending tubes.

toroidal block--herein, a toroidal mass of particulate material, having a voussoir-like crossection, supported between the outer wall of the blender and the downwardly

SUBSTITUTE SHEET

2087178

2

converging metal baffles of FIGs. 6 and 9. Also called a toroidal or annular "keystone joist."

DESCRIPTION OF THE PRIOR ART

Prior to the advent of large scale use of polymers in such applications as continuous film or filament production, the needs of industry for precision blending of bulk solids products were met with mechanical tumbler, ribbon or screw blenders. Capacities of these units ranged from less than one cubic meter to over 100 cubic meters.

As the demand for plastics grew, it became apparent that much larger blender volumes were necessary to allow continuous production lines in plastics users' plants to operate without frequent shutdowns caused either by (1) variations in physical properties or (2) additive content inherent in the producer's production processes. This led to a demand for tumble blenders in the range of 700 cubic meter capacity.

The high cost of large tumble blender installations prompted industry-wide efforts to develop a blending capability in storage silos to comply with the product uniformity requirements of the polymer industry. A number of designs resulted, some silo blenders having capacities in the 3000 cubic meter range.

Efficient silo blenders are available today in two broad categories:

A. Gravity Blenders

These designs generally use either external or internal tubes having openings to allow solids in the bin to flow from the main silo body to a separate blend chamber below the silo. The tube openings in the main body of the silo are randomly located so that material drained into the blend chamber represents a typical composite of the material in the main silo body.

B. Internally Recirculated Blenders

These units rely on an external source of air to pick up material in the lower part of the silo body by an orifice arrangement, and convey it to the upper part of the main silo. The material flowing vertically down through the silo is randomly sampled by the openings in the tubes and agitated by inverted cones, resulting in homogenization of the silo contents after a period of time.

SUBSTITUTE SHEET

The performance of both Gravity Blenders and Internally Recirculated Blenders can be significantly improved by recirculation while the blender is being filled.

As storage bins or hoppers are filled with granular or particulate material, it often happens that an inhomogeneous distribution of material occurs. There may be several reasons for this result. In the first place, as material flows into a hopper, the material beneath the inlet nozzle piles up at the angle of repose of the material. In this case the larger particles often roll down the peak toward the sides of the hopper, leaving the finer particles in the central region. Inhomogeneity can also occur when the hopper is filled with different batches of the same material because of variations of composition of individual batches. When material is drawn off through an outlet at the bottom of the hopper, the material flows from the region directly above the nozzle. Thus the material will not be representative of the average characteristics of the material in the hopper.

Prior art attempts at a solution to this segregation problem typically included placing perforated blending tubes vertically within the hopper. Such tubes have openings spaced apart along their axes which allow material from all levels within the hopper to enter the tubes. The lower portion of the blending tubes communicate with the outlet nozzle so that a more nearly homogeneous mixture of the material issues from the outlet of the hopper.

In spite of many efforts to completely blend the particulate material, it is usually necessary in prior art blenders to specially treat at least the final portion of the discharge to achieve acceptable results. For example, U.S. Patent No. 4,923,304, discloses that the first and last few pounds are not used, but instead are withdrawn and later remixed with fresh ingredients, and re-poured, with these fresh ingredients, back into the dispensing apparatus.

3a

SUMMARY OF THE INVENTION

According to the invention there is provided a gravity blender having a cylindrical upper portion operable to receive and store a mass of particulate material, and a lower portion defining a downwardly converging conical section sealed to the lower cylindrical edge of the upper portion, the lower and upper portions being centered on a single vertical axis. A plurality of blending conduits extended downwards from the upper portion and continue downwardly adjacent the converging conical section, converging downwardly towards the vertical axis of the blender apparatus. The blending conduits have open lower ends which terminate in a generally circular and horizontal pattern, the convergence of the blending conduits and the conical walls of the lower section creating and supporting in operation a virtual baffle of particulate material in combination. The virtual baffle consists of voussoir-like accumulations of particulate material in the converging channels between the blending conduits and between the conical walls and the blending conduits. The baffle of particulate material remains in position until the blending tubes have begun to release the final portions of the particulate material through the blending tubes to blend with the particulate material of the virtual baffle as both pass into and through the lower portion of the bin.

In combination with a conventional hopper and conventional blending tubes, two embodiments disclosed herein can effectively blend a batch of particulate material, including the final portion of the batch. In a third embodiment, the operation of the full size blender is simulated, in an adjustable

2087178

4

laboratory size model, enabling experimentation with various particulate densities, compactabilities and annular gaps.

My invention does not require a separate blending chamber. It utilizes the tendency of particulate solids, flowing downward through a channel with converging sides, to bridge across the channel, blocking the channel, causing all of the material flowing out of the blender to flow through the blending tubes. Thus my invention assures that all of the material discharged from the blender represents a truly typical composite of the blender contents.

The three preferred embodiments disclosed in this specification rely upon the tendency of particulate solids, in flowing downward through a channel with converging sides, to bridge across the channel. Such bridging may occur in:

A. A toroidal block, having a voussoir-like crosssection, as shown in the blender of FIG. 6, and equivalent supporting structure for bridging by particulate materials, as shown in FIGs. 2, 4, 7, 8 and 10.

B. A similar toroidal block in the apparatus in FIG. 9, for confirming by empirical tests, the preliminary design proportions for a blender specifically contoured for the density, compactability, and other characteristics of the particulate material, or materials, to be blended;

C. A voussoir-like construction for the support of particulate material, as shown in the construction of FIGs. 7 and 11-13, in which the matrix of blending tubes, optional

inverted cones, and conical walls of the vessel provide a matrix for the support of the virtual baffle of particulate material.

The "bridging principle" and the "virtual baffle" concept employed in the preferred embodiments are illustrated in the following drawings and explained in the specification.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 provides an elevational, sectional view through the center line of a typical blender of the prior art;

SUBSTITUTE SHEET

2087178

5

FIG. 2 provides an elevational, sectional view through the center line of one preferred embodiment of the gravity blender of the present invention;

FIG. 3 provides a schematic diagram of the hopper, piping and pumps, if required for extremely uniform blending within the gravity blender of the present invention;

FIG. 4 provides a sectional view from the vertical centerline through the exterior wall of the lower portion of the hopper of an alternate embodiment of the present invention, including a detail of a blending tube and a conduit for exhaust gases, or for structural purposes;

FIG. 5 is a section of the conduit of FIG. 4, illustrating the knife-like device for preventing accumulation of particulate matter on the top surface of the conduit;

FIG. 6 is a more detailed view of Embodiment A of the present invention, as combined with terminations of the conventional blending tubes;

FIG. 7 is a more detailed view of alternate Embodiments A and C of the present invention as combined with two convex surfaces for better blending of virtually all of the material to be blended;

FIG. 8 provides an elevational, sectional view through the center line of a gravity blender of an alternate embodiment A of the present invention, in which one basic convex surface is combined with a cylindrical device, developed further in FIG. 12-13, for further blending;

FIG. 9, Embodiment B, provides a vertical, sectional view through the center line of the test apparatus, which substantially duplicates the conditions within, and operations of blending of the present invention;

FIG. 10, Embodiment A, provides a sectional view from the vertical centerline through the exterior wall of the lower portion of the hopper of an alternate embodiment of the present invention, including a detail of a blending tube, but without a venting conduit for exhaust gases;

FIG. 11, Embodiment C, provides a fragmented elevational hemicylindrical inside view, through a section in the plane including the vertical centerline of a blender, utilizing a

SUBSTITUTE SHEET

2087178

6

virtual baffle of particulate material, supported partially on a matrix of converging blending tubes, and equipped with a small inverted cone. Two partial sectional details are provided;

FIG. 11A is a fragmentary section just inside the wall 1112, showing the ends 1114 of the blending tubes 1110 within the toroidal block 1130 of particulate material;

FIG. 11B shows various angles of cut off of the discharge ends 1114 of the blending tubes 1110;

FIG. 12, Embodiment C, provides an elevational hemicylindrical inside view, through a section in the plane including the vertical centerline of a blender, utilizing a virtual baffle of particulate material, supported solely on a matrix of converging blending tubes, without an inverted cone, but with a vertical tubular element; and

FIG. 13, Embodiment C, provides a generally horizontal sectional view through the blender of FIG. 12, at approximately the level of the virtual baffle of particulate material, supported partially on a matrix of converging blending tubes and the vertical tubular element 1240.

DESCRIPTION OF THE THREE PREFERRED EMBODIMENTS OF THE INVENTION

In providing a more detailed discussion of the three preferred embodiment of the invention, reference will be first made to components of the blending apparatus from the prior art, insofar as they differ from, or combine with, the new invention for improved and more efficient performance at lower cost.

In FIG. 1 is shown a drawing from Patent No. 3,268,215, issued to T.A. Burton for a Blending Apparatus on August 23, 1966. Illustrative of this prior art are tank or hopper 10, blending tubes 24, and separate receiver or collector manifold 28.

FIG. 2 shows the similarities and the differences between the prior art of FIG. 1 and the present invention. Similarities include a cylindrical housing 210 superimposed upon and sealed to a conical structure 211. Downcomer tubes 224 however, terminate in perforations 227 through the

SUBSTITUTE SHEET

inverted generally horizontal baffle 225, comprising part of the present invention. This means of termination is a significant improvement over the prior art shown in FIG. 1, in which tubes 24 pass entirely through the hopper 10 and terminate in receiver 28. In the annular area 226, between the converging walls of baffle 225 and structure 211, the accumulation of particulate matter forms a toroidal block to the passage of the particulate matter accumulating above the block.

The recirculating schemes of the prior art are shown in FIG. 3, diagrams 302 and 303.

My invention, as shown in its alternate embodiments, deals with the problem in novel fashion. In FIG. 2, and as more easily seen in FIG. 6, the blending tubes, of which tube 602 is an example, terminate in apertures 603. These apertures are formed in the convex surface 604. This means of termination is a significant departure from the prior art, as shown in FIG. 1, in which tubes 24 pass entirely through the hopper 10 and terminate in receiver 28.

Returning to FIG. 6, it should be noted that convex surface 604 is supported upon brackets 606, and is thus spaced away from the exterior cone 610 by an annular gap shown as 605. Now, if the surfaces 604, annular gaps 605, and apertures 603, are designed as will be shown in connection with the description of FIG. 9, the material to be blended will begin to fill the hopper 601, but will form a barrier at the annulus 605, past which barrier the particulate material will not descend, until blending tubes are evacuated.

As the blending operation being performed on the batch, or mixture, draws to a close, the level of the material will fall below the seam line 607, and then past a series of apertures 608. The discharge of material from the blender will then flow preferentially from the blending tubes 602, with essentially zero flow through the annulus 605 between the inverted cone and the vessel cone. Flow through this annulus 605 cannot occur until the supply of material coming from the blend tubes 602 is exhausted.

FIG. 9 is a diagram of the Test Apparatus, illustrating its similarity in construction to the blenders of the present invention. Material 901 is cross hatched for clarity. Material 902 is shown crosshatched at another

REPLACEMENT SHEET

angle. The inverted cone may be set in a position 911 and provides a smaller annular gap 903 than were it raised to a higher position, say 912.

Material 901 is first poured into the inverted cone, upright cone and standpipe at the start of test, filling volumes shown as underlined 1,2,3,4 and 5. Material 902 may be then put in to fill the remainder of the vessel and will fill to the annular surface 909, in "keystone fashion," as a toroidal block, or as a voussoir of particulate material.

Material 902 will not flow out of the vessel until the supply of Material 901 is exhausted. In order to make this principle work:

a. The flow of material from the center nozzle must be regulated by valve to a rate below that would cause voids to form in material 901.

b. Flow properties of material 901 and 902 should be similar.

The test procedure, if properly performed, can provide valuable information on the dimensions 903, 909, and other critical factors in full-size blender design.

FIG. 11 illustrates the use of an inverted baffle through which the blending tubes 1110 do not penetrate, but which is positioned in such a manner that a voussoir of particulate material is formed between converging surfaces in close proximity to each other. In this blender, particulate material is entrapped within the matrix of conduits 1110 and small inverted cone 1113 mounted on brackets 1106 within the cone of the outer wall 1112. The density, particle shape, compactability, and a host of indeterminate factors will cooperate to establish a toroidal block of material 1130, thus creating a virtual baffle of particulate material, supported partially on a matrix of converging blending tubes 1110, a small inverted cone 1113, and lower section wall 1112. It must be understood that this drawing is purely illustrative of the inventive concept, and that other variations are within the scope of the following claims.

FIG. 12 illustrates the accumulation of particulate material 1230 in this blender, when entrapped within the matrix of conduits 1210, and within the cone of the outer wall 1212. This embodiment is not equipped with an inverted cone 1113, but has instead a vertical tubular element 1240. A voussoir of particulate material 1230 will be formed, creating a virtual baffle, in the form of a toroidal block, between and among the structural members, including the central tubular structure 1240. The diameter of the tube 1240 is drawn too large in comparison with the area 1233 provided for discharge of the particulate material, but the concept is adequately presented.

The density, particle shape, compactability, and a host of indeterminate factors will cooperate to establish the position, volume, and mass of material 1230. These parameters will be those required to obtain a suitable toroidal block, utilizing a virtual baffle of particulate material, supported partially on a matrix of converging blending tubes 1210 and vertical tubular element 1240. It must be understood that this drawing is purely illustrative of the inventive concept, and that other variations are within the scope the following claims.

FIG. 13 provides a horizontal sectional view through the blender of FIG. 12, at approximately the level of the virtual baffle 1230 of particulate material, supported partially on a matrix of converging blending tubes 1210. Further support is provided by the vertical tubular structure 1240.

CLARIFICATION OF DIFFERENCES BETWEEN BAFFLES OF THE THREE PREFERRED EMBODIMENTS OF THIS INVENTION

In the embodiments disclosed in FIGs. 11-13, the blender uses a number of blending tubes or channels which terminate at the same elevation adjacent to a small inverted cone 1113 as shown in FIG. 11, or without an inverted cone as shown in FIGs. 12 and 13.

Although as shown in FIG. 6, the converging blending conduits provide only limited support to the blocking accumulation of the particulate material, in FIG. 11 the major part of the mass of particulate material is supported by the converging matrix of conduits. In FIGs. 12 and 13, the entire mass of particulate material is supported by the converging matrix of blending conduits and the vertical tubular element 1240.

SUBSTITUTE SHEET

2087178

10

Thus a very useful blender can be constructed which can be installed in silos at a much lower cost than blenders that rely solely on separate blend chambers as shown in FIG. 1.

FIG. 11 illustrates an alternate embodiment and a more economical method of construction than that of FIG. 7, achieved by eliminating the large baffle 704, and the "hard" terminations of the blending tubes in apertures in the sides of cone 704.

The matrix of converging downcoming blending tubes 1110 are mounted close to the conical wall 1112. Blending tubes 1110 do not terminate in apertures or hubs in the surface of cone 1113, but terminate in the approximate region delineated as 1114, which has a variable vertical range as shown by the two-headed arrow at 1123.

The base line of the lower end of cone 1113 may vary above or below a typical position 1114, as shown by bidirectional arrow 1123. If proper proportions are selected, such a grid of blending tubes converging toward plane 1114, in combination with the converging wall 1112 of the lower bin section 1101, can support a voussoir 1130 of particulate material, extending slightly downward or upward from reference plane 1114.

It is thus possible to achieve the blocking effect of the impervious baffle 604 of FIG. 6 without the expense of physically connecting (measuring, cutting and welding) the blending tubes to apertures in the surface of a large baffle, and in some cases the small baffle 1113 may not be needed. Please refer to FIG. 12.

In FIG. 11A, various terminations for the blending tubes may be employed. The intent of this disclosure is to illustrate the concept of a baffle primarily of particulate material, simpler to build and less costly in material. The specific terminations of blending conduits, patterns of the matrix, and use or nonuse of small convex cones are all minor variations contemplated in the general use of this invention.

In FIG. 12 is shown an embodiment which does not use the small inverted baffle or cone 1113, a preferred construction

SUBSTITUTE SHEET

being the structural tubing 1240. With some particulate materials, the conical wall 1112 in combination with the blending tube matrix 1110, may support the toroidal blocking mass of material 1120 without member 1240.

The section shown in FIG. 13 is typical of many usable designs. The intent of this disclosure is to illustrate the concept of a baffle primarily of particulate material, simpler to build and less costly in material. The specific terminations of blending conduits, patterns of the matrix, and use or nonuse of small convex cones are all minor variations contemplated in the general use of this invention.

SUBSTITUTE SHEET

CLAIMS

1. A gravity blender having a cylindrical upper portion operable to receive and store a mass of particulate material, and a lower portion defining a downwardly converging conical section sealed to the lower cylindrical edge of the upper portion, the lower and upper portions being centered in a single vertical axis, a plurality of blending conduits extending downwards from the upper portion, the blending conduits continuing downwardly adjacent said converging conical section and the blending conduits converging downwardly towards said vertical axis of said blender apparatus, wherein the blending conduits have lower open ends which terminate in a generally circular and horizontal pattern, said convergence of the blending conduits and said conical walls of the lower section creating and supporting in operation a virtual baffle of particulate material in combination, said virtual baffle consisting of voussoir-like accumulations of particulate material in said converging channels between the blending conduits and between the conical walls and the blending conduits, the baffle of particulate material remaining in position until the blending tubes have begun to release the final portions of the particulate material through the blending tubes to blend with the particulate material of the virtual baffle as both pass into and through the lower portion of the bin.

2. Gravity blender apparatus according to claim 1, further comprising an upwardly converging conical surface, having a maximal diameter substantially that of the diameter of the circular pattern of the lower open end of said conduits, the conical surface projecting upwards towards the circle of open conduit lower ends, said lower ends being spaced above a bottom of said conical surface, and in that the virtual baffle is formed solely by the particulate material supported upon a matrix of said converging blending conduits, said conical lower portion of the bin walls and said conical surface projecting upwards.

3. Gravity blender apparatus according to claim 1, further comprising within said lower portion a vertical tubular element centered axially therein, the virtual baffle being formed solely of said particulate material supported upon a matrix of said converging blending conduits, said conical lower portion of the bin and said tubular element.

1/9

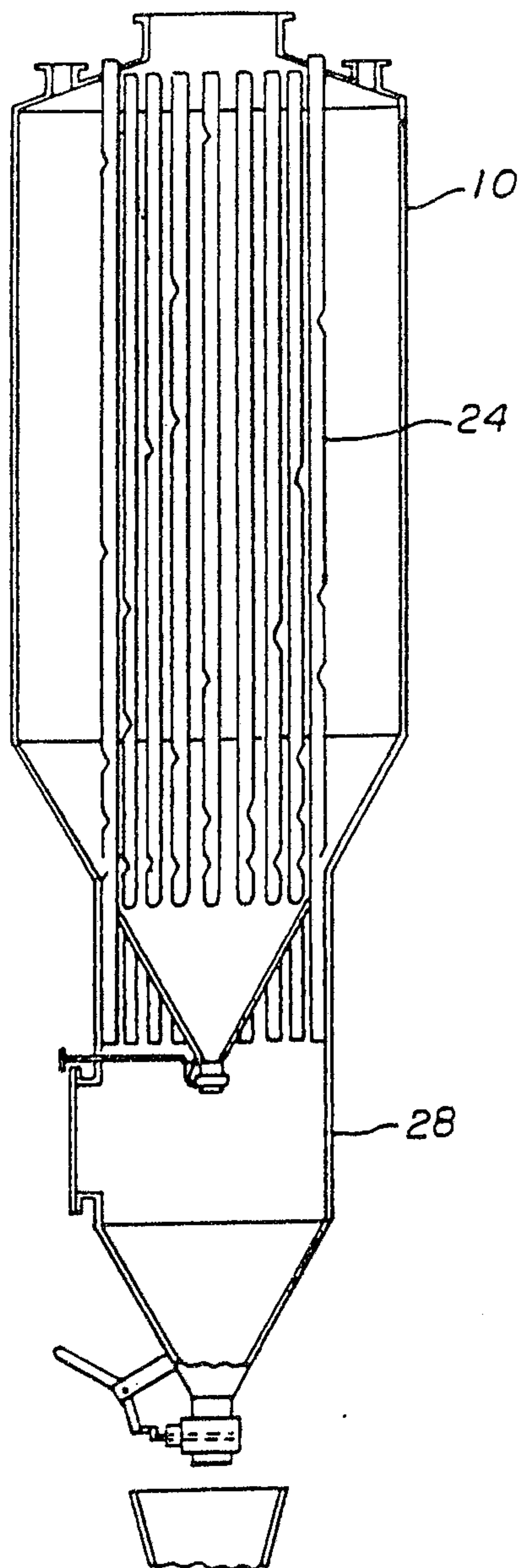


FIG. 1
(PRIOR ART)

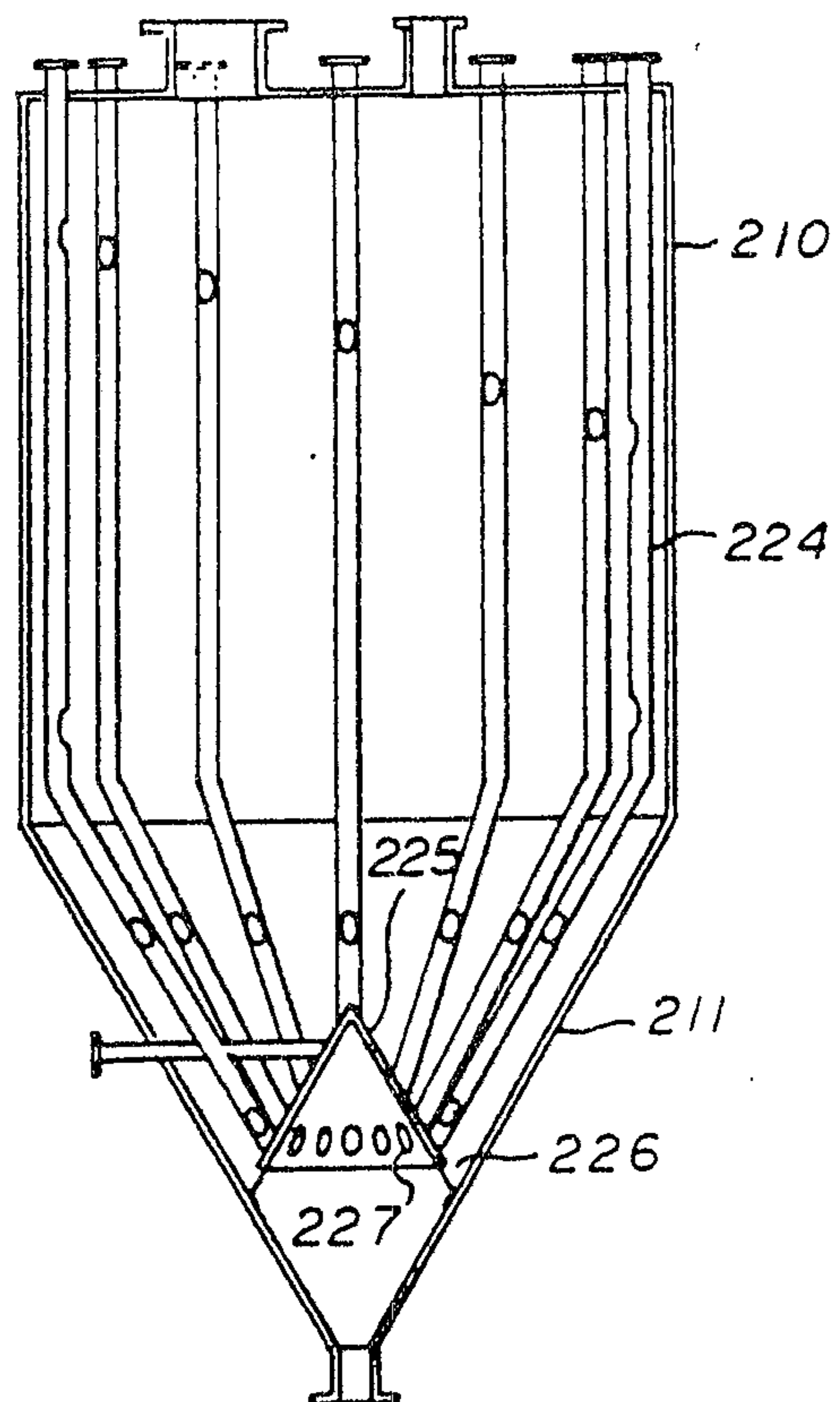


FIG. 2

SUBSTITUTE SHEET

2/9

FIG.3

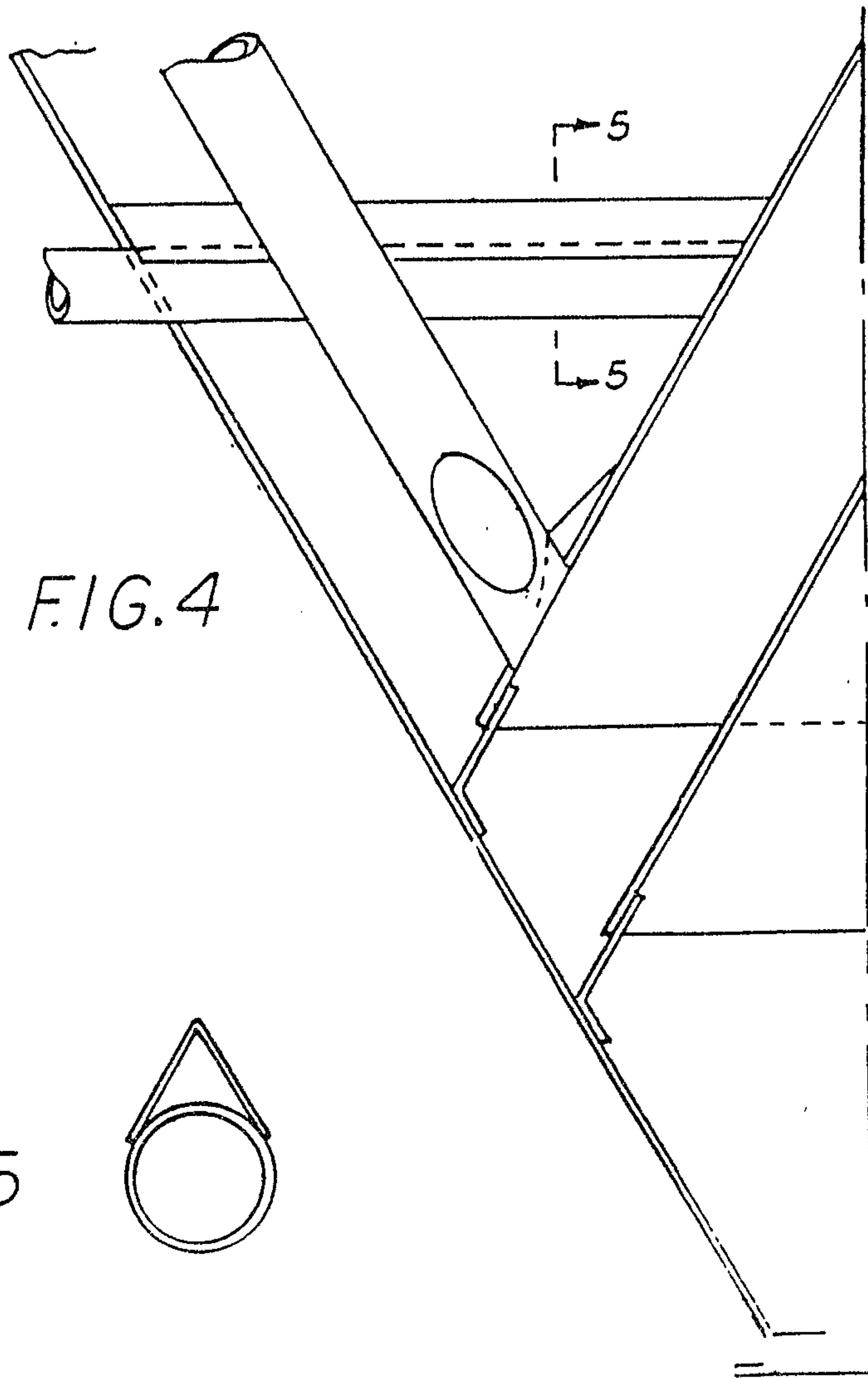
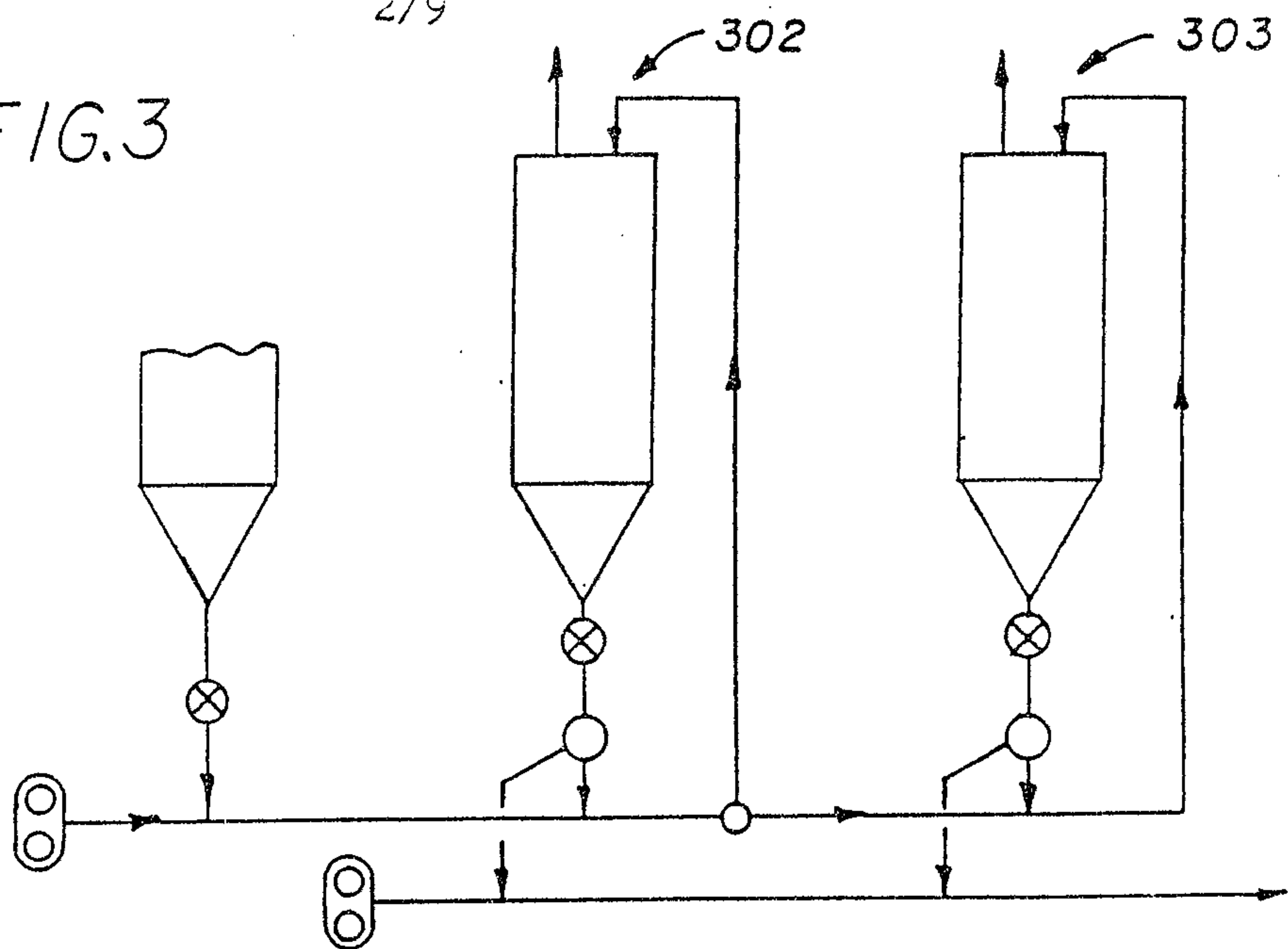
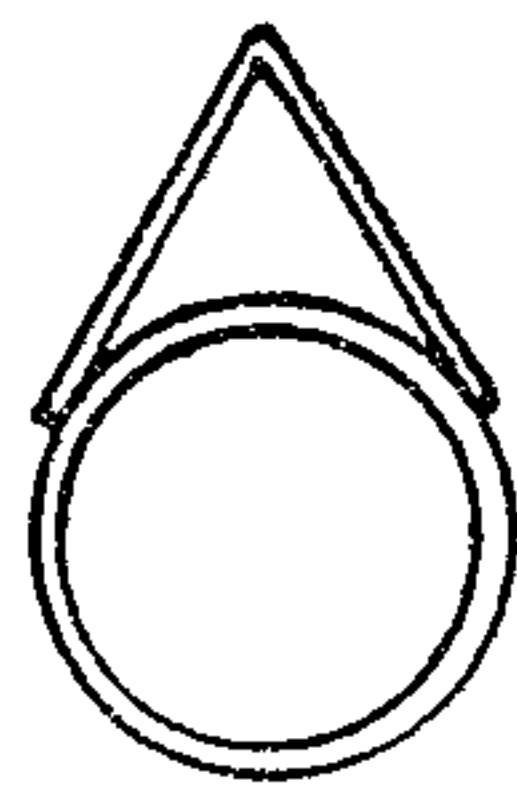


FIG.4

FIG.5



SUBSTITUTE SHEET

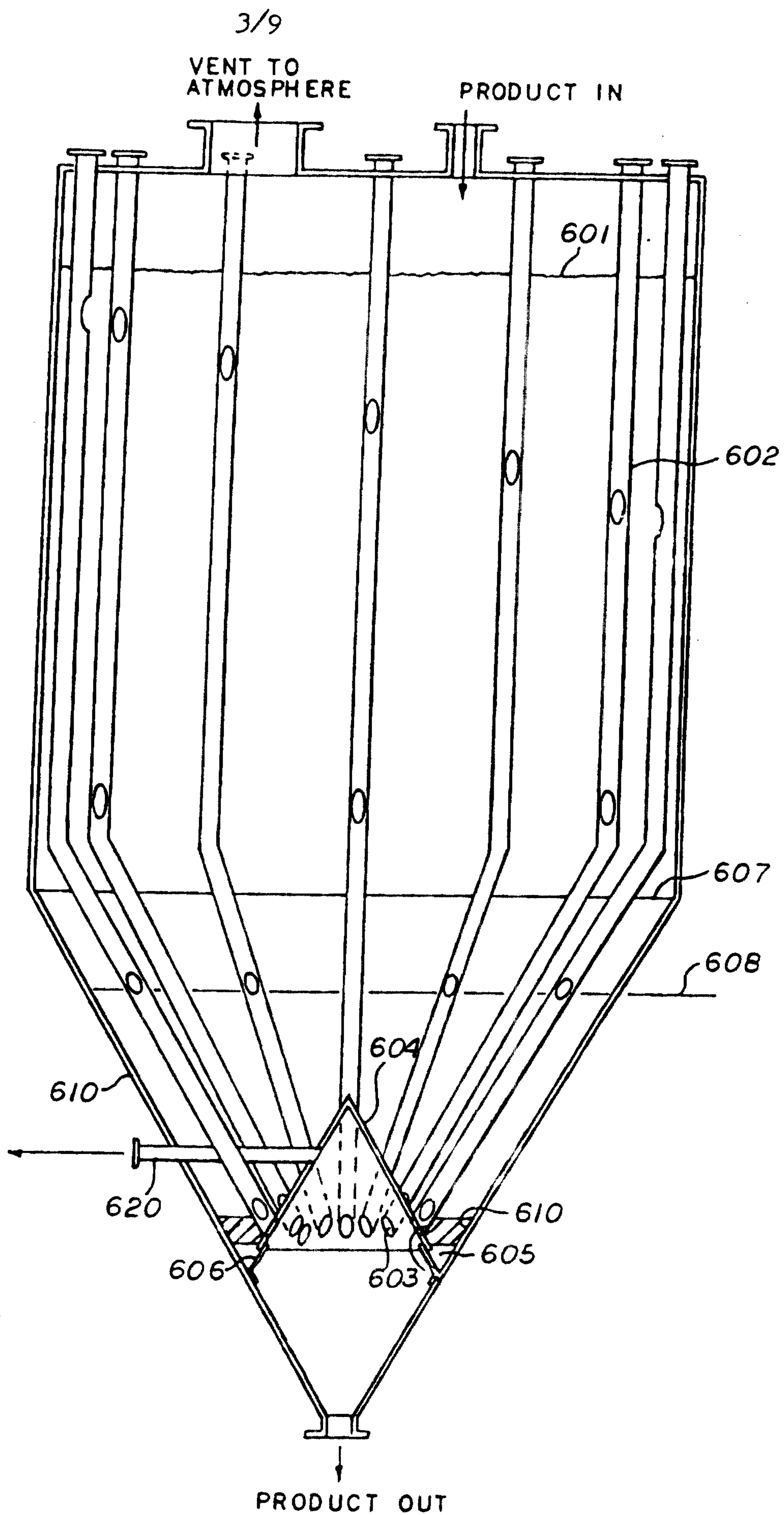
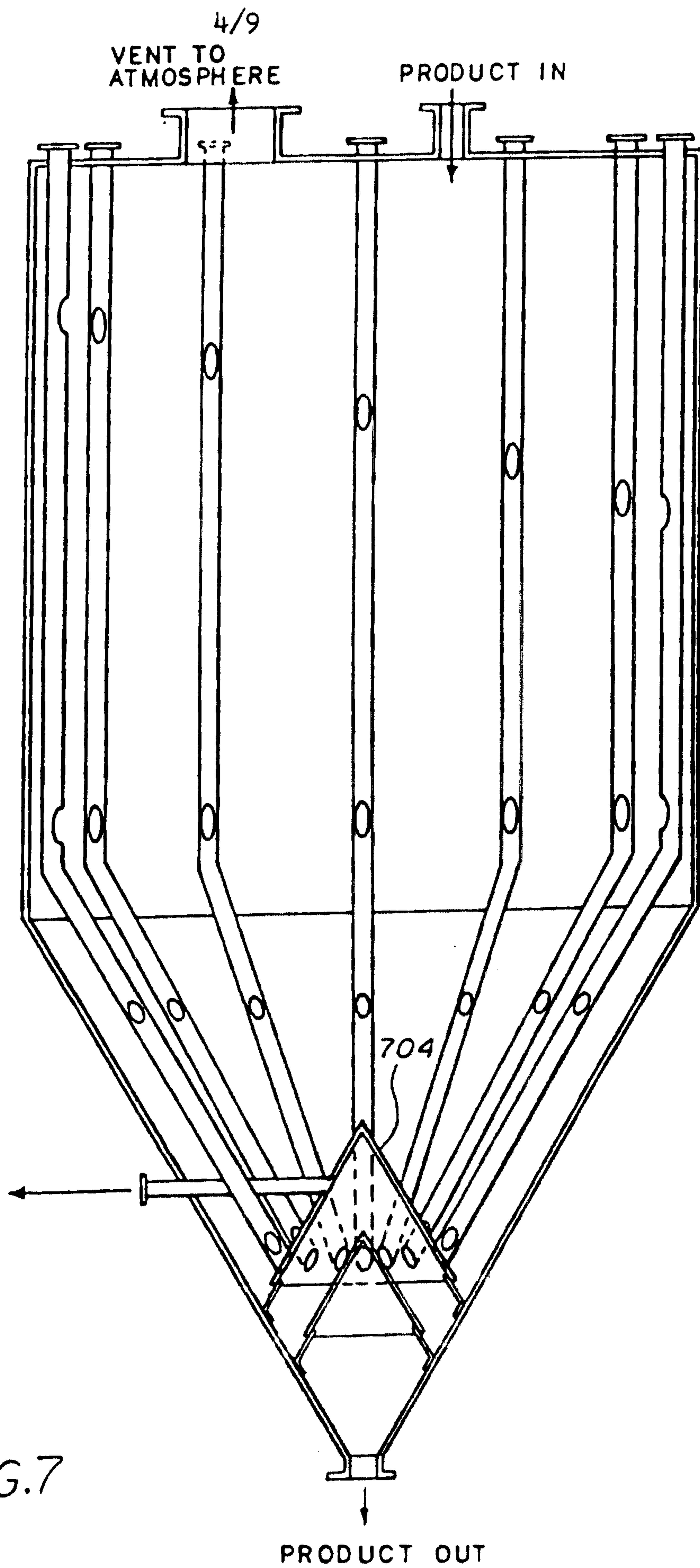


FIG.6



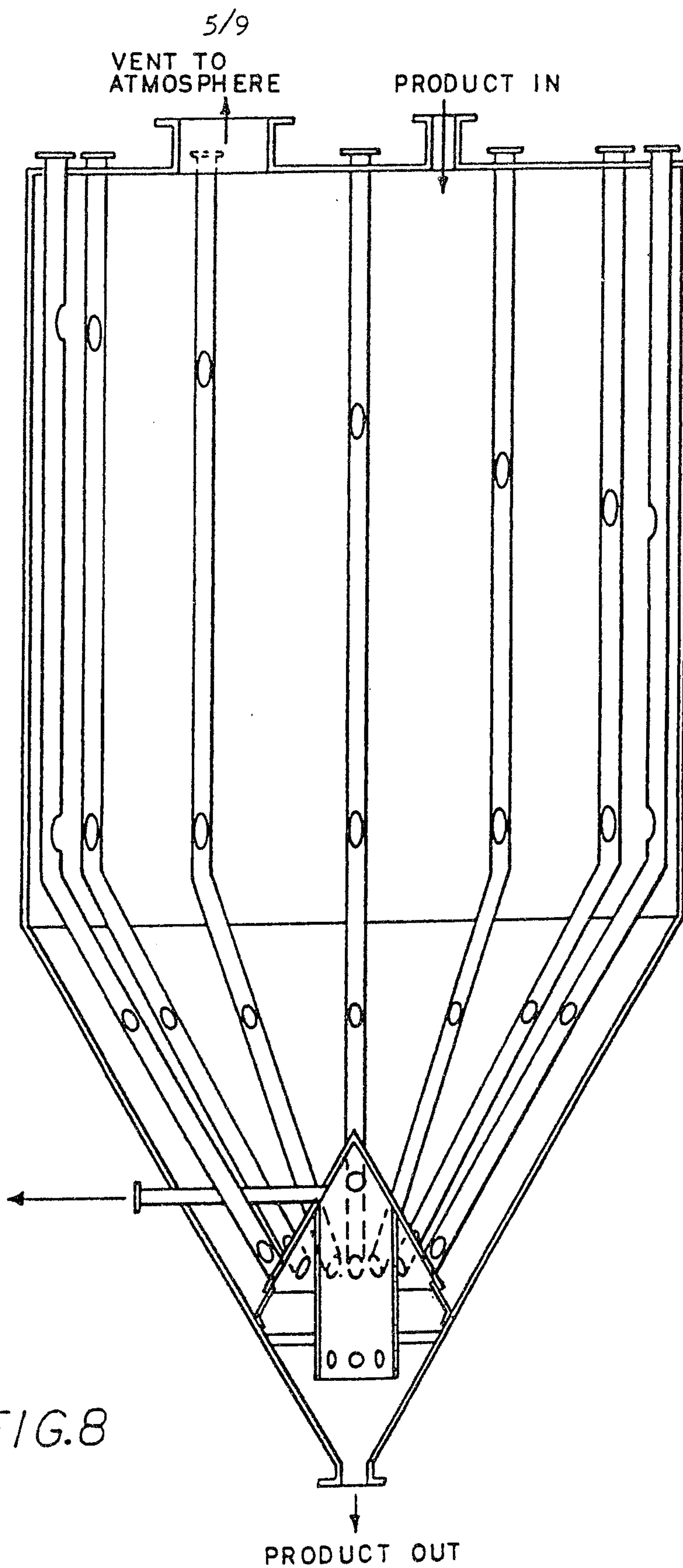


FIG. 8

SUBSTITUTE SHEET

6/9

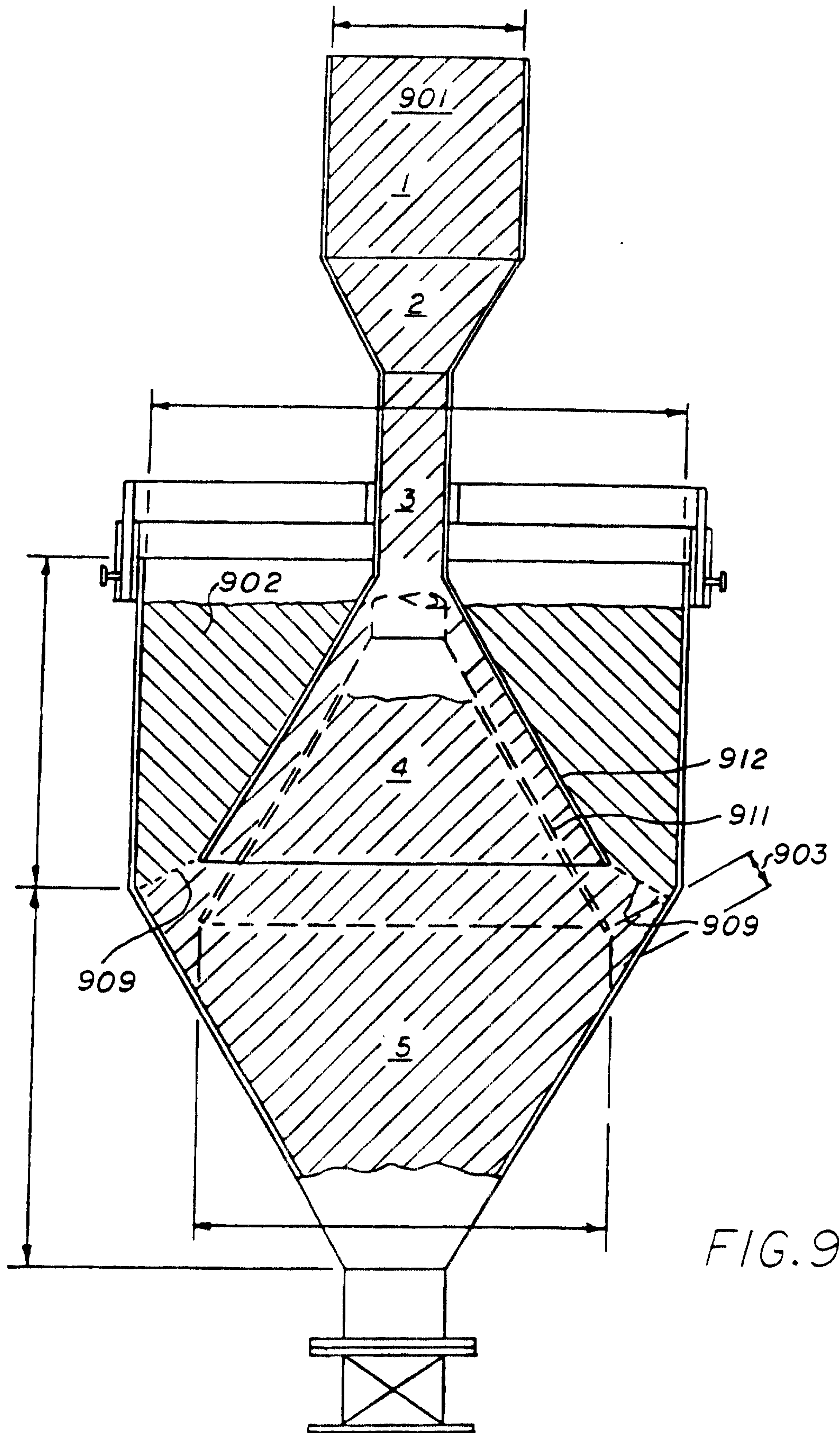


FIG. 9

7/9

VENT TO
ATMOSPHERE

PRODUCT IN

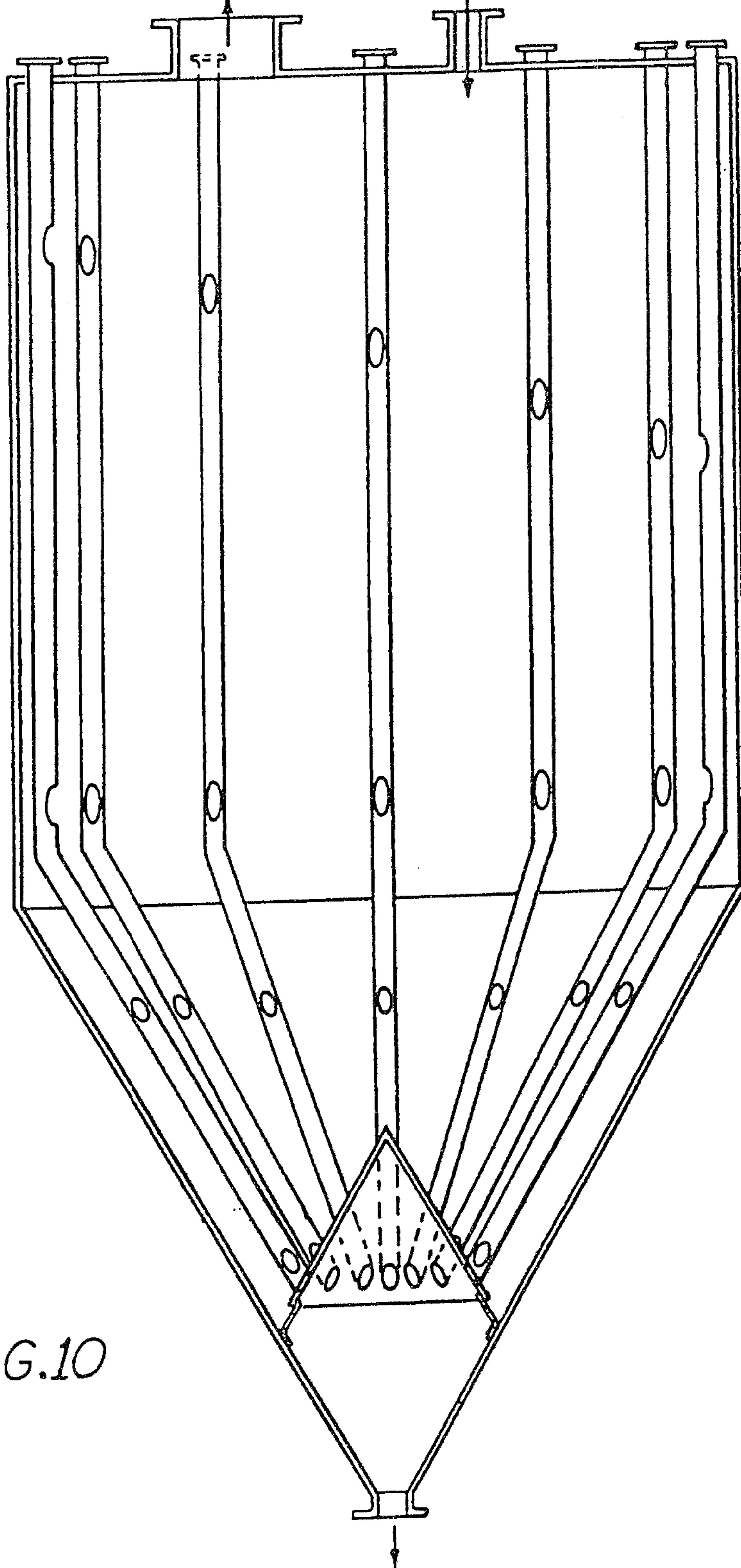
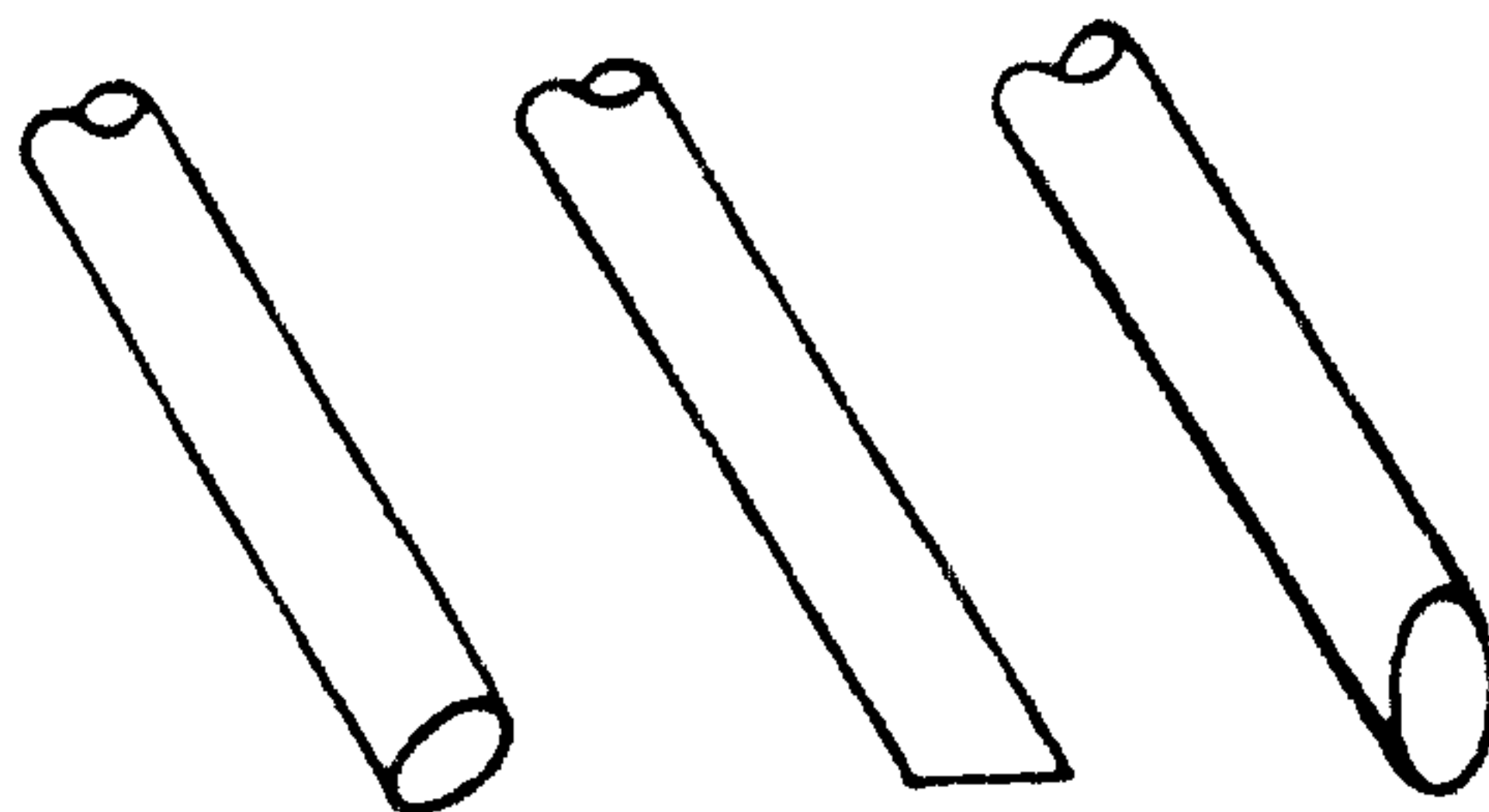
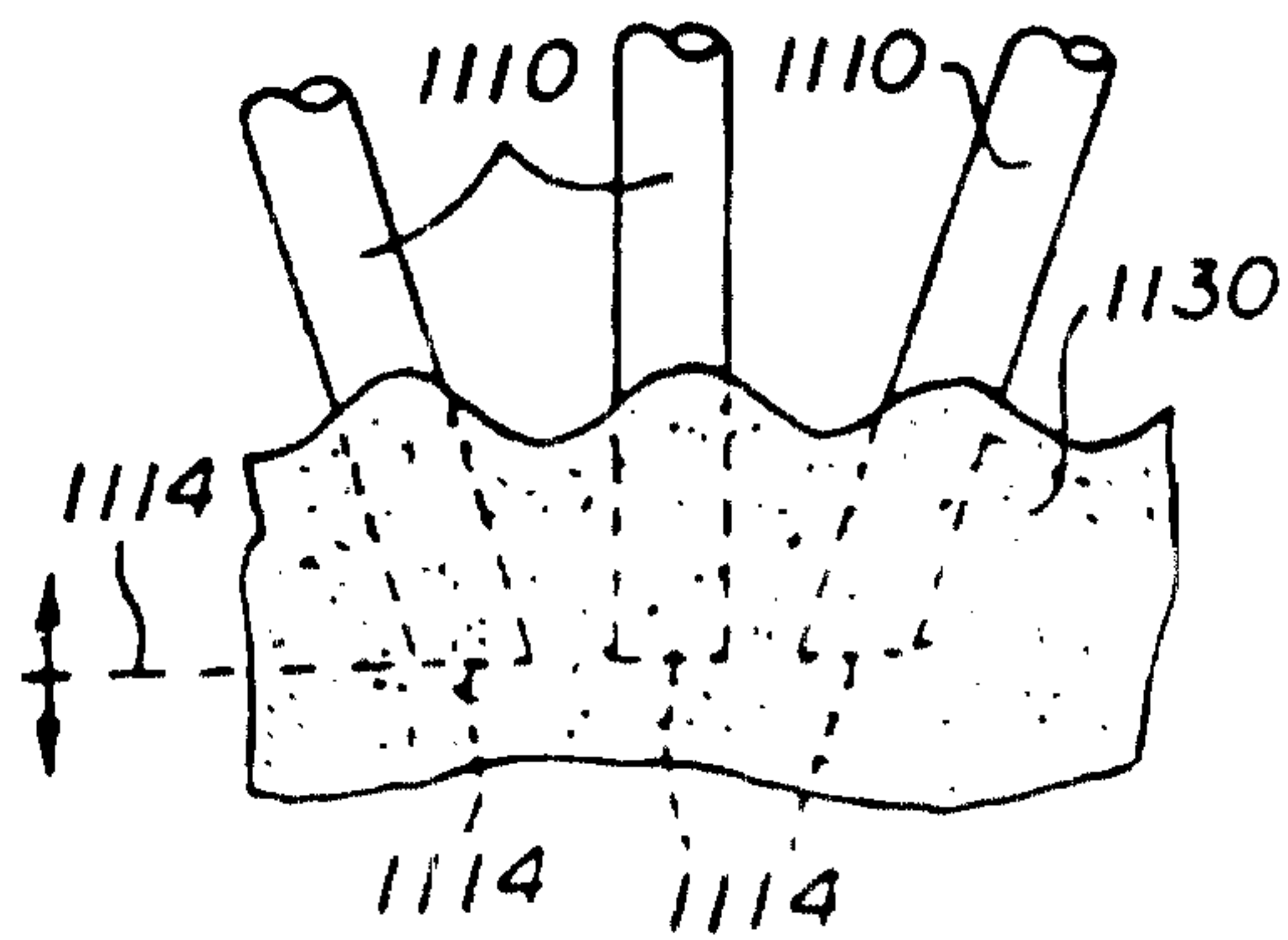
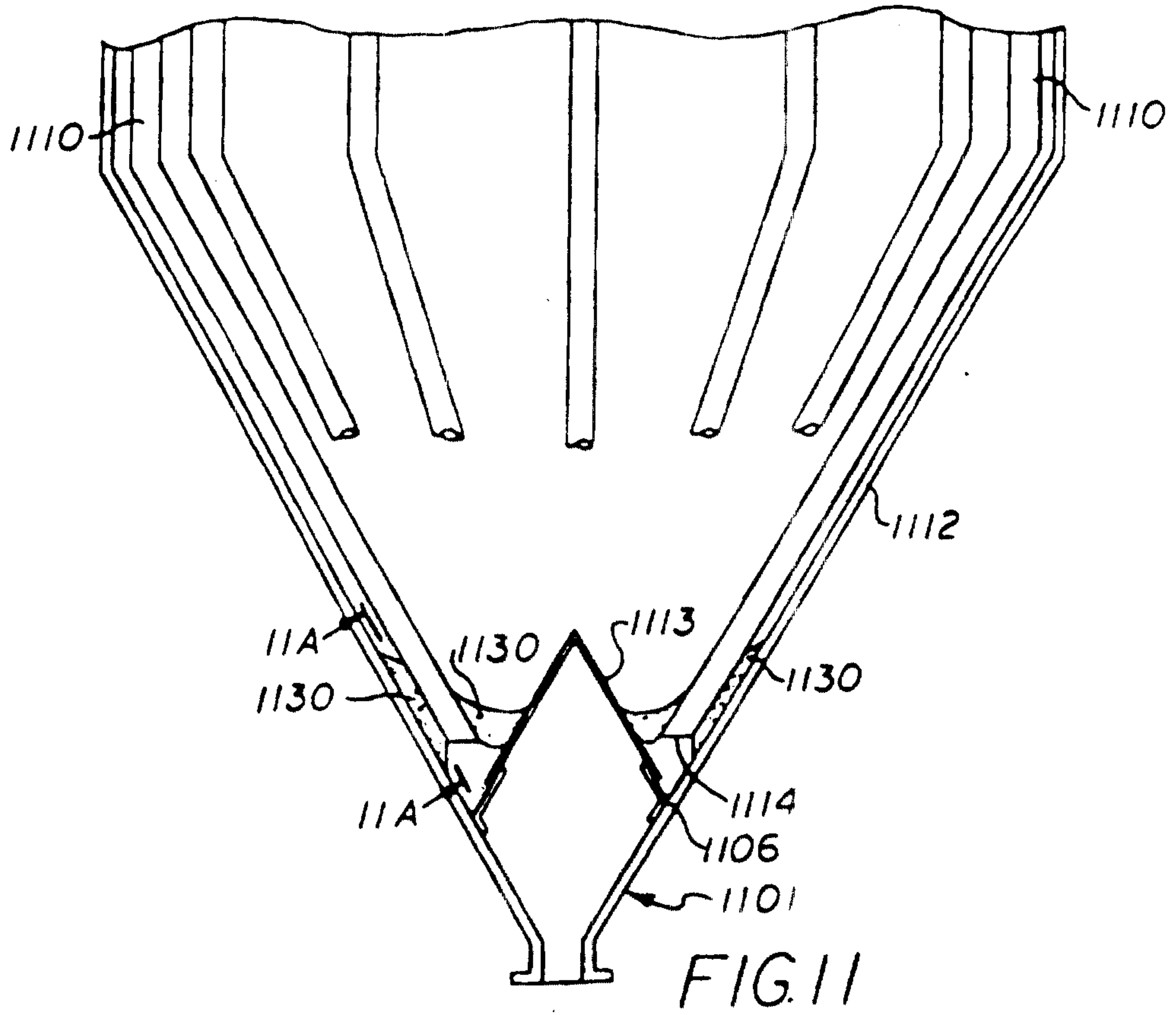


FIG.10

PRODUCT OUT

SUBSTITUTE SHEET

8/9



9/9

