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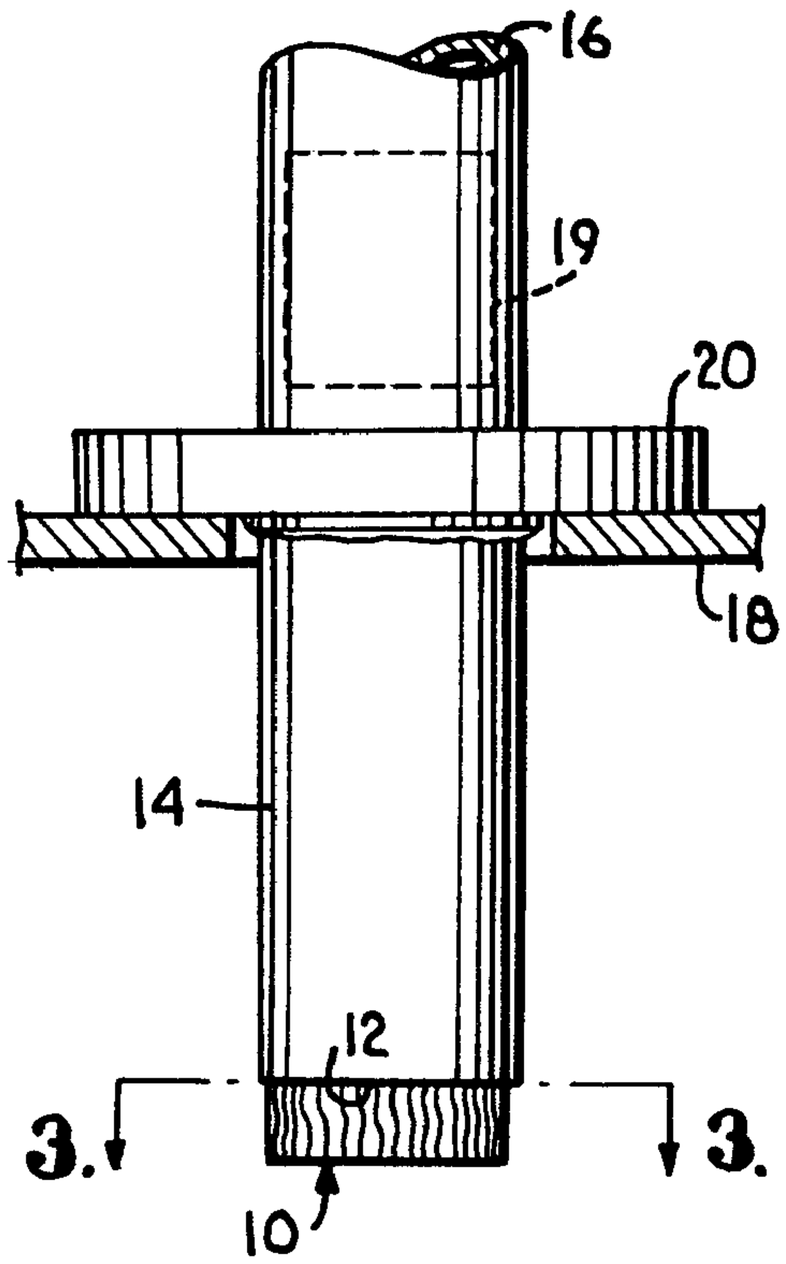
(71) Demandeur/Applicant:
KOCH-GLITSCH, INC., US

(72) Inventeurs/Inventors:
MCMILLEN, ROBERT E., US;
EWING, ROBERT E., US;
JAFFER, SHAFFIQ, US;
RALL, RICHARD R., US

(74) Agent: SMART & BIGGAR

(54) Titre : DISPOSITIF ET PROCEDE DE DISTRIBUTION D'UN FLUX DE FLUIDE DANS UN REACTEUR, UNE COLONNE OU UNE CUVE DE TRAITEMENT CHIMIQUE

(54) Title: APPARATUS AND METHOD FOR DISTRIBUTING FLUID STREAM WITHIN CHEMICAL PROCESS REACTOR, COLUMN OR VESSEL



(57) Abrégé/Abstract:
A fluid distributing element (10) is provided to facilitate the distribution and, optionally, mixing of one or more fluid streams. The element (10) has a plurality of radially aligned, corrugated plates (22, 22a, 22b) that form a plurality of fluid flow channels. Fluid streams entering the element (10) flow along the flow channels and exit the element (10) in a full cone spray pattern. The fluid streams can be directed by a conduit (14) to the fluid distributing element (10) which can be located partially within the outlet (12) of the conduit (14).

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(71) Applicant: KOCH–GLITSCH, INC. [US/US]; 4111 East 37th Street North, Wichita, KS 67220 (US).

(72) Inventors: RALL, Richard, R.; 415 Lancaster Court, Wichita, KS 67230 (US). JAFFER, Shaffiq; 2931 North Governor, Apt. 306, Wichita, KS 67226 (US). EWING, Robert, E.; 430 North Terrace, Wichita, KS 67208 (US). MCMILLEN, Robert, E.; 5720 N. Athenian, Wichita, KS 67204 (US).

(74) Agents: HURD, Michael, B. et al.; Shook, Hardy & Bacon L.L.P., One Kansas City Place, 1200 Main Street, Kansas City, MO 64105–2118 (US).

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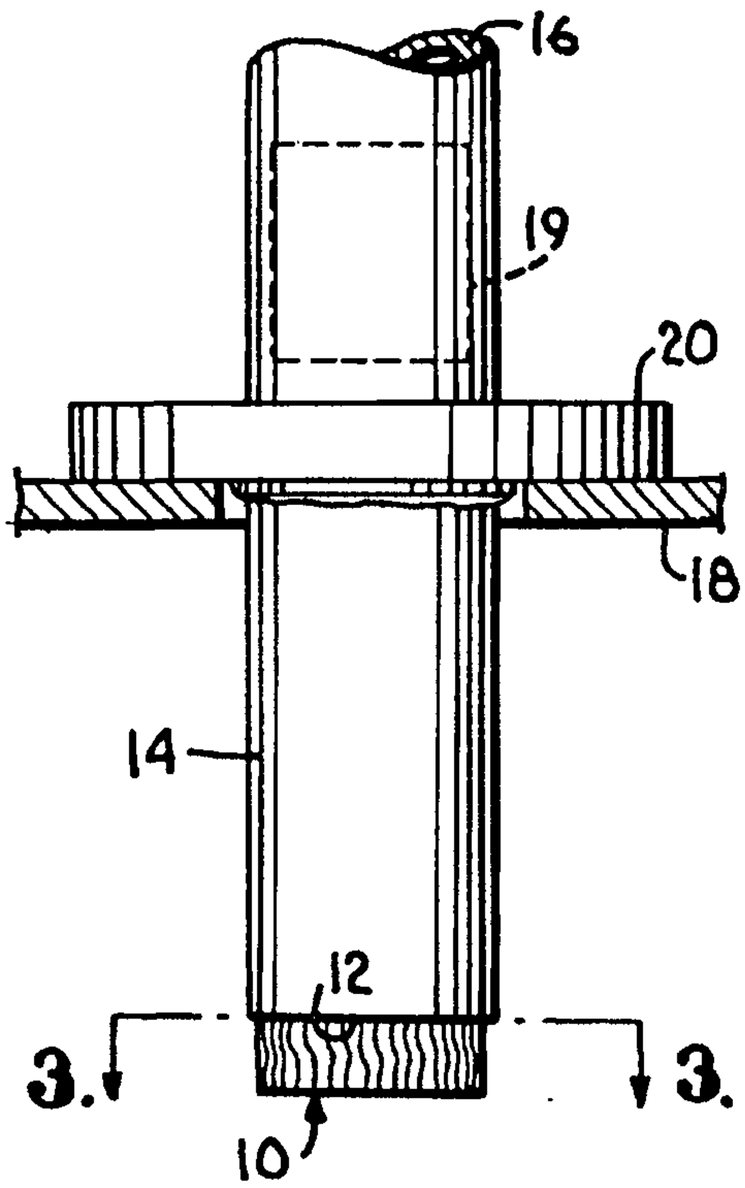
A fluid distributing element (10) is provided to facilitate the distribution and, optionally, mixing of one or more fluid streams. The element (10) has a plurality of radially aligned, corrugated plates (22, 22a, 22b) that form a plurality of fluid flow channels. Fluid streams entering the element (10) flow along the flow channels and exit the element (10) in a full cone spray pattern. The fluid streams can be directed by a conduit (14) to the fluid distributing element (10) which can be located partially within the outlet (12) of the conduit (14).



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APPARATUS AND METHOD FOR DISTRIBUTING FLUID STREAM WITHIN CHEMICAL PROCESS REACTOR, COLUMN OR VESSEL

BACKGROUND OF THE INVENTION

The present invention relates generally to chemical and petrochemical process reactors, columns, vessels and the like and, more particularly, to an apparatus and method for facilitating distribution of a fluid stream within such reactor, column or vessel.

In many types of chemical processes, it is important to uniformly distribute one or more downwardly flowing fluid streams across the upper surface of underlying bed of material, such as random or structured packing elements or catalyst beds. This uniform distribution is important in order to minimize unwanted channeling of the fluid streams through portions of the underlying material and to ensure efficient use of the underlying material. An example of one such approach to obtaining uniform distribution of a mixed phase stream is disclosed in U.S. Patent No. 5,403,561 which utilizes chimney structures mounted on a horizontally extending tray. The chimneys have an outlet end that extends below the tray and a ribbon shaped as a conical helix is positioned below the outlet end for producing a conical spray onto the underlying bed of contact material.

SUMMARY OF THE INVENTION

In one aspect, the present invention is directed to a fluid distributing element comprising a plurality of sheets disposed radially about a center axis. The sheets typically have radially outer ends that lie in a common circular plane so that the element forms the shape of a cylinder. The sheets have corrugations that extend at an angle to the center axis and define fluid flow channels having inlets at one end and outlets at an opposite end, typically the lower end. The corrugations in adjacent sheets extend in parallel or cris-crossing fashion so that fluid streams flowing along the channels form a full cone spray pattern as the fluid is discharged from the fluid flow channel outlets. The element is normally positioned at an outlet of a fluid-carrying conduit, but can also be positioned at a flow opening in a tray, plate or other structure. While the fluid distributing element is preferably used in connection with downwardly flowing fluid streams, it may be readily used in connection with fluid streams flowing horizontally or at other angles.

In another aspect, the invention is directed to a method of effecting a more uniform distribution of fluid onto a surface of a bed of material, such as packing or catalyst, by flowing one or more fluid streams through the fluid flow element described above. If a single fluid distributing element is used, it is positioned to cause the full cone spray pattern to extend across substantially the entire surface of the bed of material. If more than one fluid distributing element is used, they are arranged so that the spray patterns partially overlap and cover substantially the entire bed surface. The fluid streams may contain more than one phase, such as vapor, liquid and/or particulate solid phases, which advantageously become mixed together as they flow through and are discharged from the fluid distributing element.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings which form a part of this specification and are to be read in conjunction therewith and in which like reference numerals are used to indicate like parts in the various views:

FIG. 1 is a fragmentary side elevation view of a fluid distributor containing a radial distributing element constructed in accordance with the present invention;

FIG. 2 is a fragmentary side elevation view of the fluid distributor showing the radial distributing element on an enlarged scale;

FIG. 3 is a top plan view of the radial distributing element;

FIG. 4a is a side elevation view of the radial distributing element taken in vertical section along line 4a-4a of FIG. 3 in the direction of the arrows and showing an adjacent pair of corrugated plates;

FIG. 4b is a side elevation view similar to FIG. 4a but showing an alternate embodiment of the radial distributing element;

FIG. 5 is a side elevation view of the radial distributing element taken in vertical section along line 5-5 of FIG. 3 in the direction of the arrows and showing a corrugated plate;

FIG. 6 is a side elevation view of a vessel taken in vertical section to show the internal positioning of the fluid distributor of the present invention;

FIG. 7 is a fragmentary side elevation view of another vessel taken in vertical section showing a plurality of the fluid distributors positioned on an internal tray; and

FIG. 8 is a top plan view of the vessel taken in horizontal section and showing, somewhat schematically, the fluid spray distribution from the fluid distributors.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings in more detail, and initially to FIGS. 1-5, a fluid distributing element of the present invention is designated broadly by the numeral 10 and is shown positioned at a lower outlet 12 of a fluid conduit 14 such as a pipe and tubing. The fluid conduit 14 is vertically aligned and is formed by a cylindrical outer wall 16 that is supported on a surface 18 by a flange 20. As will be subsequently described, the surface 18 may be an outer shell of a vessel or a tray or other structure within the vessel. Optionally, a conventional static mixing element 19 may be positioned in the fluid conduit upstream from the fluid distributing element 10.

The fluid distributing element 10 comprises a plurality of individual plates or sheets 22 that are arranged radially about a hub 24 positioned at a center axis of the element 10. At least some of the sheets 22 are fixed at their radially inner ends 26 to the hub 24 by welding, brazing or other securing means or may be integrally formed with the hub by casting, molding or other suitable processes. Other of the sheets 22 need not be directed fixed to the hub 24 and may simply be secured to and carried by those sheets which are fixed to the hub. In the illustrated embodiment, alternating sheets 22a are fixed to the hub 24 and carry the remaining sheets 22b whose inner ends 26 are spaced from the hub.

The sheets 22 have radially outer ends 28 that preferably lie in a common circular plane so that the fluid distributing element 10 has a cylindrical configuration. Alternative configurations, such as cone-shaped, are possible and may be preferred in certain applications. The radial length and the vertically height of the sheets 22 are preselected for the intended applications in which the element 10 will be used. When used in conjunction with the fluid conduit 14, the radial length of the sheets 22 is preferably less than the inner diameter of the conduit outer wall 16 so that the fluid distributing element 10 may be inserted within the conduit 14 a preselected distance at

the outlet 12. In some applications, the sheets are sized to extend across substantially the entire inner diameter or cross section of the conduit, while in other applications there will be a substantial gap between the outer ends 28 of the sheets and the conduit wall 16. The height of the sheets 22 must also be sufficient to allow a lower portion of the element 10 to extend below the conduit 14 to achieve the desired spray pattern of fluid exiting the element 10. While the element 10 will normally be maintained in a fixed longitudinal position within the conduit, suitable mechanisms (not shown) may be provided to permit the element's longitudinal position within the conduit to be varied as desired.

In order to achieve the desired full cone spray pattern for fluid exiting the fluid distributing element 10, the sheets 22 are formed with corrugations 30 that are inclined at one or more preselected angles, such as between 15 and 60 degrees, to the vertical center axis of the element. The corrugations 30 form fluid flow channels that have upper inlets and lower outlets. The corrugations 30 on adjacent sheets may be arranged in a cris-crossing fashion, so that corrugations and fluid flow channels on adjacent sheets are inclined in opposite radial directions as best seen in FIG. 4a. Alternatively, the corrugations may be arranged in parallel on adjacent sheets as shown in FIG. 4b. While some the corrugations 30 on adjacent sheets 22 are shown in contact with each other, this need not be the case in all instances. Instead, the corrugations on adjacent sheets may be spaced apart and/or planar sheets may be interposed between adjacent corrugated sheets.

The sheets 22 may be formed from any suitable materials, including those materials commonly used for structured packing elements. For example, the sheets may be formed from sheet metal, wire screen or gauze, plastics, and ceramics. The sheets 22 may also be provided with apertures (not shown) to facilitate mixing and distribution of the fluid stream by allowing it to pass through the corrugated sheets 22. Surface treatments such as grooves, fluting and the like may also be provided on the sheets 22.

The hub 24 may be formed from the same materials selected for sheets 22 and may have many different configurations depending upon the intended application. The hub 24 is typically of solid cylindrical construction to completely block the flow of fluid through the hub or it may be a hollow cylinder that is open at both ends to permit the downward passage of fluid. The outer wall of the hollow cylinder may be fluid impermeable or it may be formed from wire screen or gauze or may include suitable

apertures to permit fluid to flow through the walls of the cylinder. The lower end of the hub 24 may be flared outwardly or have another flow directing shape to facilitate the desired fluid spray pattern issuing from the fluid distributing element 10.

In use, the fluid distributing element 10 receives one or more fluid streams which enter the inlets and flow along the fluid flow channels defined by corrugations 30 before exiting through the outlets of the channels in a type spray pattern known as a full cone spray. The cris-crossing orientation of the corrugations 30 also facilitates mixing of the fluid streams, such as when vapor and liquid streams are present and/or when particulate solids are present in the streams. The fluid streams are normally directed to the element 10 by fluid conduit 14, but it will be appreciated that the conduit 14 need not be used in applications where the element 10 is simply positioned within an opening formed in a plate or other structure through which fluid passes.

Turning to FIG. 7, it can be seen that the fluid distributing element 10 can be used at an inlet 32 to a vessel 34 such as a chemical or petrochemical reactor or column. The conduit 14 is positioned at the inlet 32 formed in the vessel shell 36 and feeds one or more fluid streams to element 10 which is positioned at the conduit outlet 12. The fluid streams exiting from the element 10 are then sprayed in a full cone pattern across the entire cross section of an underlying bed 38 of material such as random or structured packings, catalysts, heat exchanger tube sheets, mist eliminators or molecular sieves to achieve uniform distribution of the fluid streams. It will be appreciated that the element 10 can also be positioned at other locations within the open interior region of the vessel to facilitate distribution and mixing of the fluid streams at such locations within the vessel.

In another application, as illustrated in FIGS. 7 and 8, a plurality of fluid distributing elements 10 and conduits 14 are positioned in spaced apart relationship on a horizontally disposed tray 40 positioned within the vessel 34. The upper ends of the conduits 14 are open to permit fluid, such as liquid which accumulates on the tray 40, to enter the conduits and flow downwardly to feed the fluid distributing elements 10. The fluid is then discharged from the elements 10 in a plurality of full cone sprays that cover the cross section of the underlying bed 38, as illustrated somewhat schematically in FIG. 8.

From the foregoing, it will be seen that this invention is well adapted to attain all the ends and objective hereinabove set forth together with other advantages which are inherent to the structure.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

Since many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

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1. An apparatus for distributing fluid streams within a vessel, said apparatus comprising: a fluid distributing element comprising a plurality of sheets extending along and disposed radially about a center axis, said sheets having inner ends and outer ends and corrugations which extend at an angle to said center axis and define fluid flow channels, at least some of the corrugations of the sheets being in cris-crossing and contacting relationship with at some of the corrugations of adjacent ones of the sheets, said sheets further having a preselected length from said inner ends to said outer ends and wherein said sheets extend radially along substantially all of said preselected length.

2. The apparatus of claim 1, wherein said outer ends of the sheets lie in a common circular plane.

3. The apparatus of claim 1, wherein at least some of the inner ends of said sheets are joined to a center hub.

4. The apparatus of claim 3, wherein said hub has a solid core which blocks the flow of fluid.

5. The apparatus of claim 3, wherein said hub is hollow and has opposed ends which are open to the flow of fluid.

6. The apparatus of claim 5, wherein said hub is generally cylindrical and one of said ends is flared.

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7. The apparatus of claim 1, including a conduit defined by an outer wall and having an inlet through which one or more fluid streams may enter the conduit and an outlet through which said one or more fluid streams may exit the conduit, and wherein said fluid distributing element is positioned at said outlet.

8. The apparatus of claim 7, wherein said fluid distributing element is positioned partially within said conduit and extends outwardly beyond said outlet of the conduit.

9. A vessel comprising: a shell defining an at least partially open interior region; a fluid conduit defined by an outer wall and having an inlet through which one or more fluid streams enters the conduit and an outlet through which said one or more fluid streams exits the conduit, said fluid conduit having at least said outlet positioned within said shell in the open interior region; and a fluid distributing element positioned at said outlet and comprising a plurality of sheets disposed radially about a center axis, said sheets having corrugations which extend at an angle to said center axis and define fluid flow channels.

10. The vessel of claim 9, including a bed of material within said open interior region and underlying said fluid conduit outlet end.

11. The vessel of claim 10, wherein said bed of material is selected from the group consisting of random packing, structured packing and catalyst.

12. The vessel of claim 9, including a plurality of said fluid conduits extending through a tray positioned within said open interior region, the outlet ends of the fluid

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conduits being positioned below said tray and having said fluid distributing elements positioned at the outlets of said fluid conduits.

13. The vessel of claim 9, wherein at least some of said fluid distributing elements are positioned partially within said fluid conduits and extend outwardly beyond said outlets of the fluid conduits.

14. A method of distributing one or more fluid streams within a vessel comprising a shell defining an at least partially open interior region, said method comprising: introducing said one or more fluid streams into one or more fluid distributing elements each comprising a plurality of sheets disposed radially about a center axis, said sheets having corrugations which extend at an angle to said center axis and define inclined fluid flow channels having inlets at one end and outlets at an opposite end; flowing said one or more fluid streams along said fluid flow channels; and discharging said one or more fluid streams from said outlets to form a generally conical spray of discharged fluid.

15. The method of claim 14, including introducing said one or more fluid streams into one of said fluid distributing elements from a conduit defined by an outer wall, said one fluid distributing element being positioned at least partially within said outer wall of the conduit.

16. The method of claim 15, wherein said one or more fluid streams comprise a vapor stream and a liquid stream and including the step of mixing said vapor and liquid streams as they flow along said fluid flow channels and are discharged from said outlets.

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17. The method of claim 16, wherein said fluid distributing element is only partially positioned within said conduit.

AMENDED SHEET

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FIG. 3.

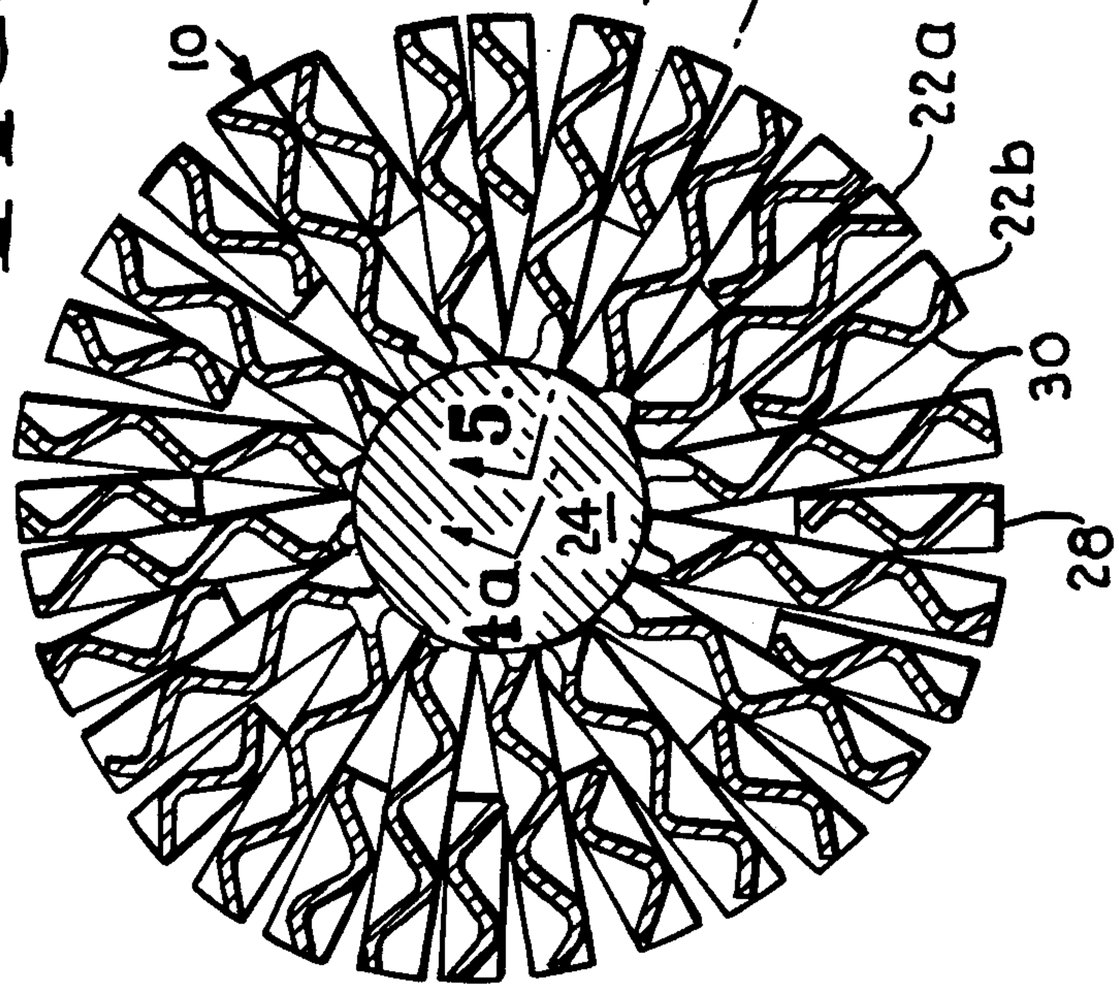


FIG. 4b.

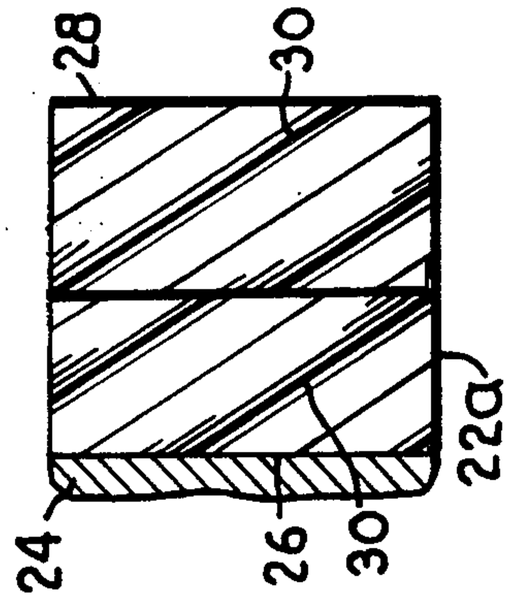


FIG. 4a.

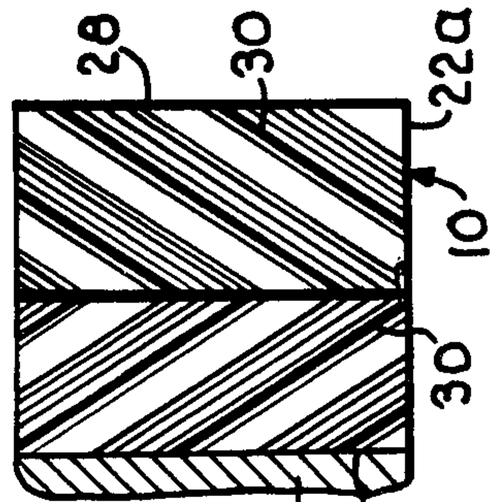


FIG. 5.

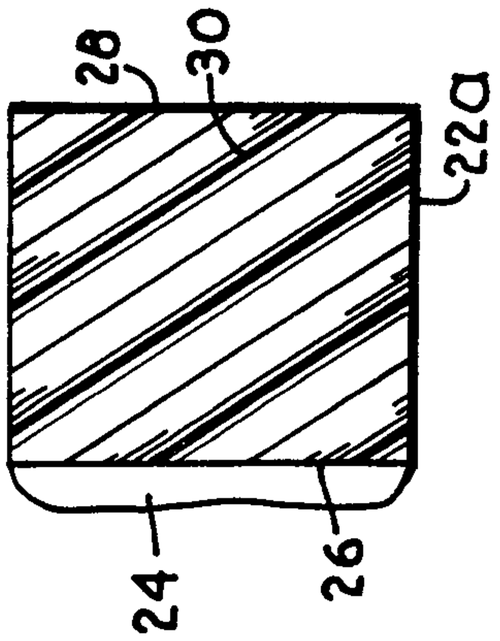


FIG. 2.

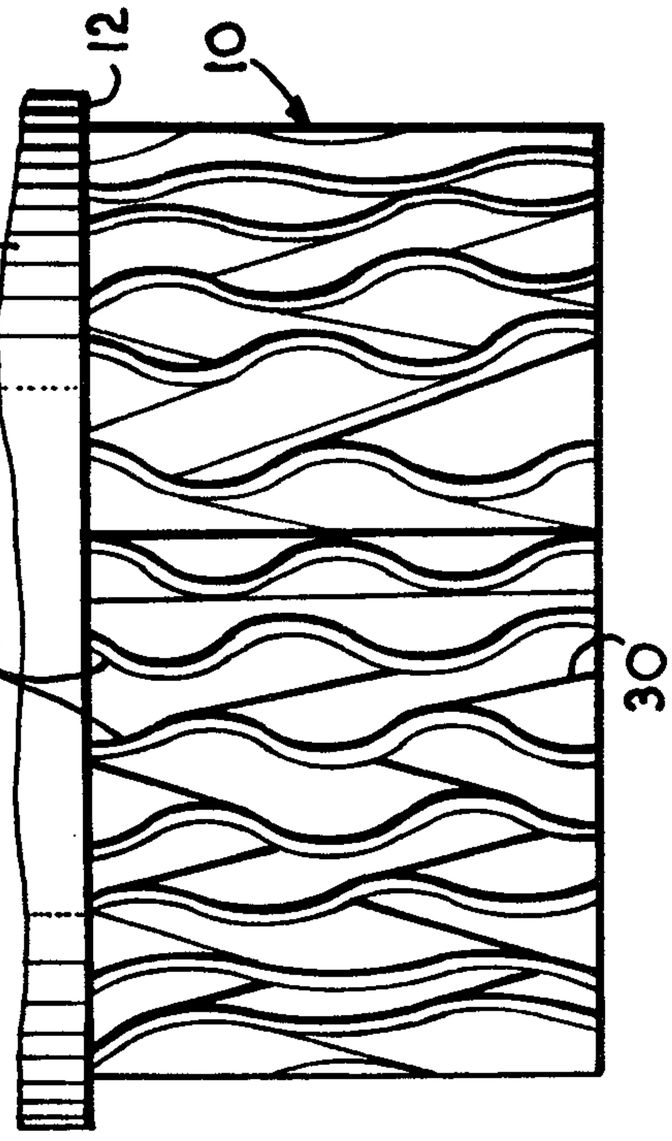
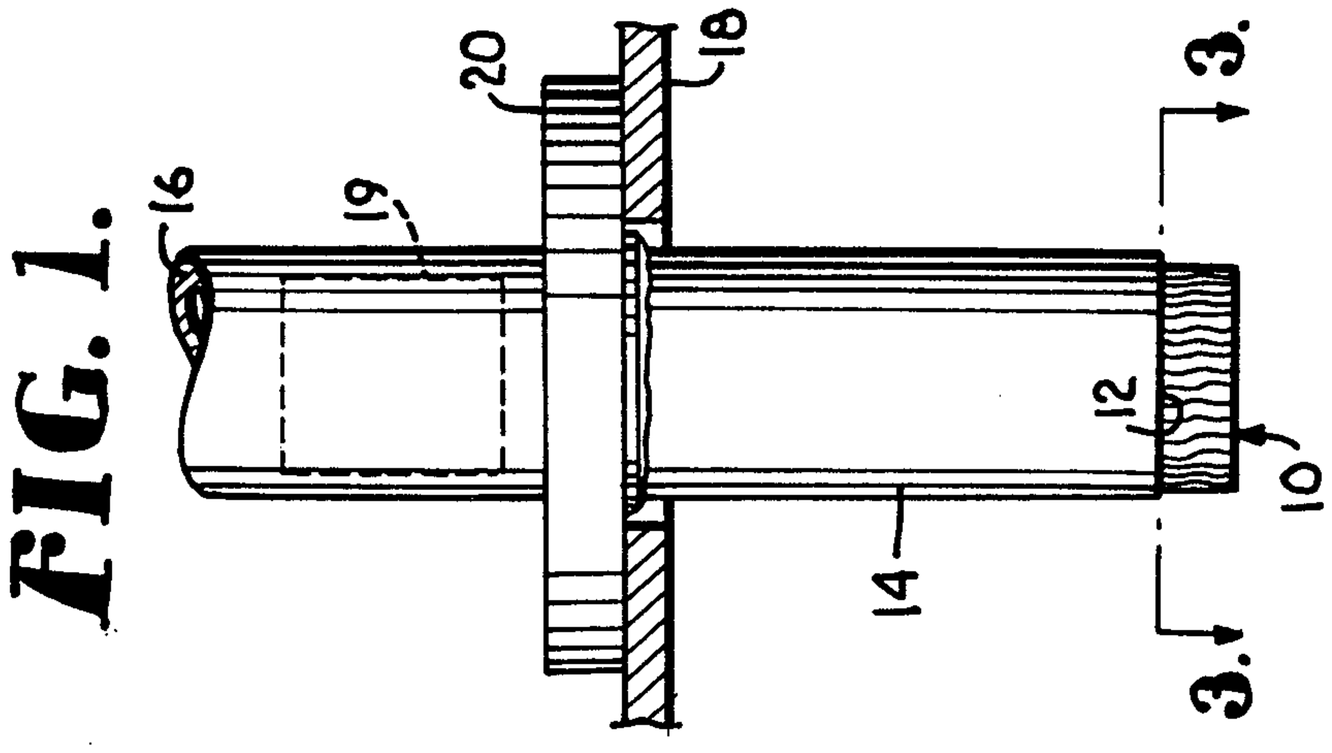


FIG. 1.



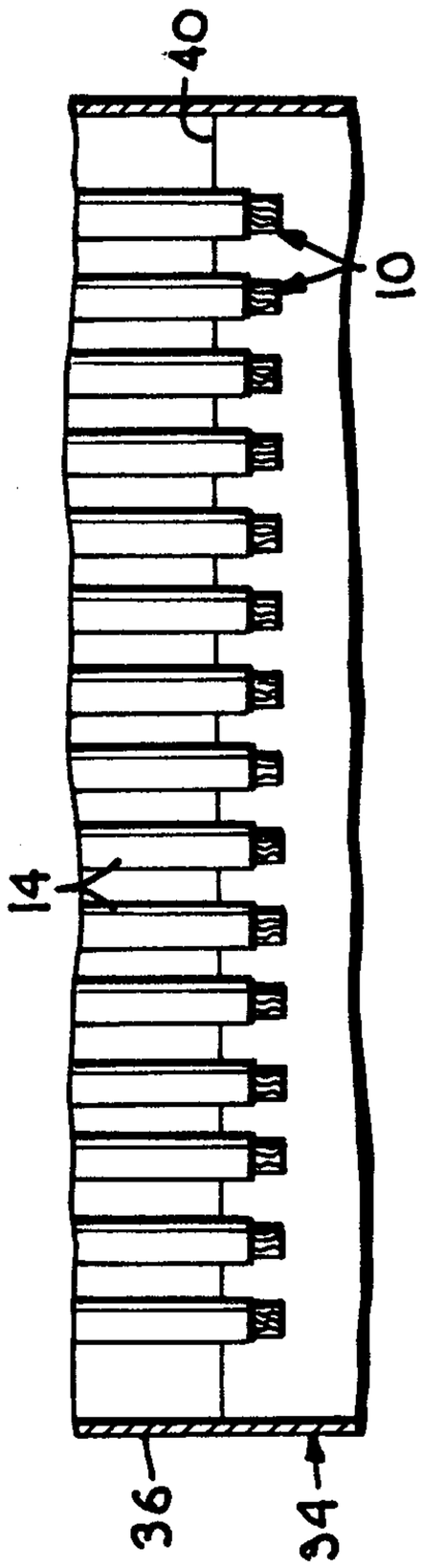


FIG. 7.

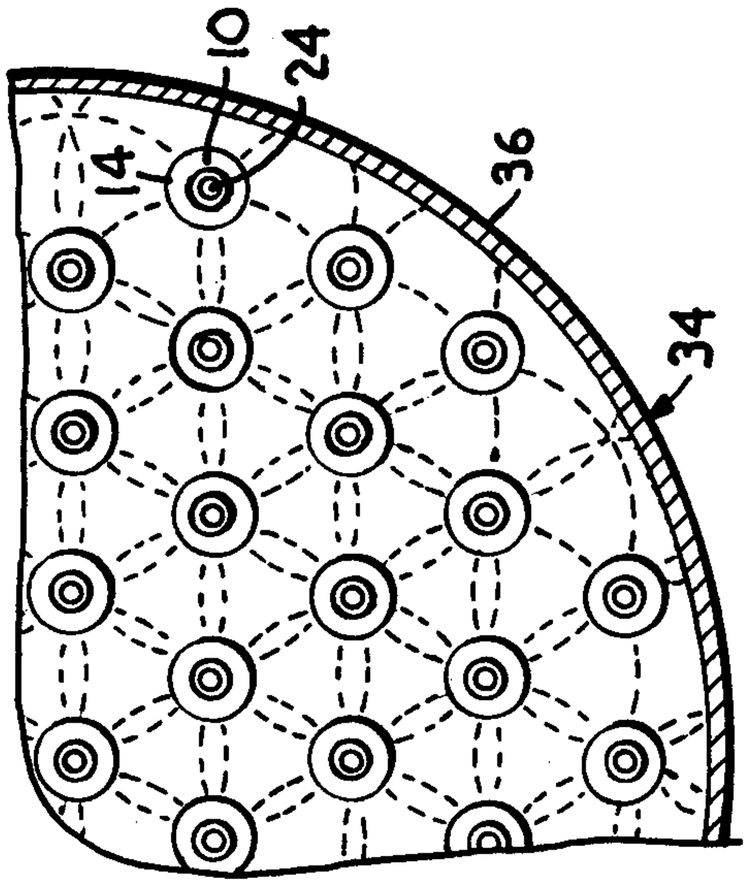


FIG. 8.

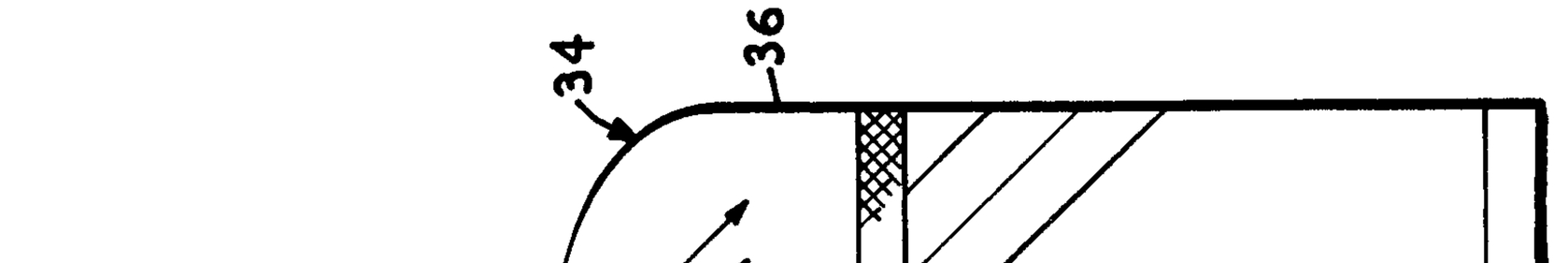
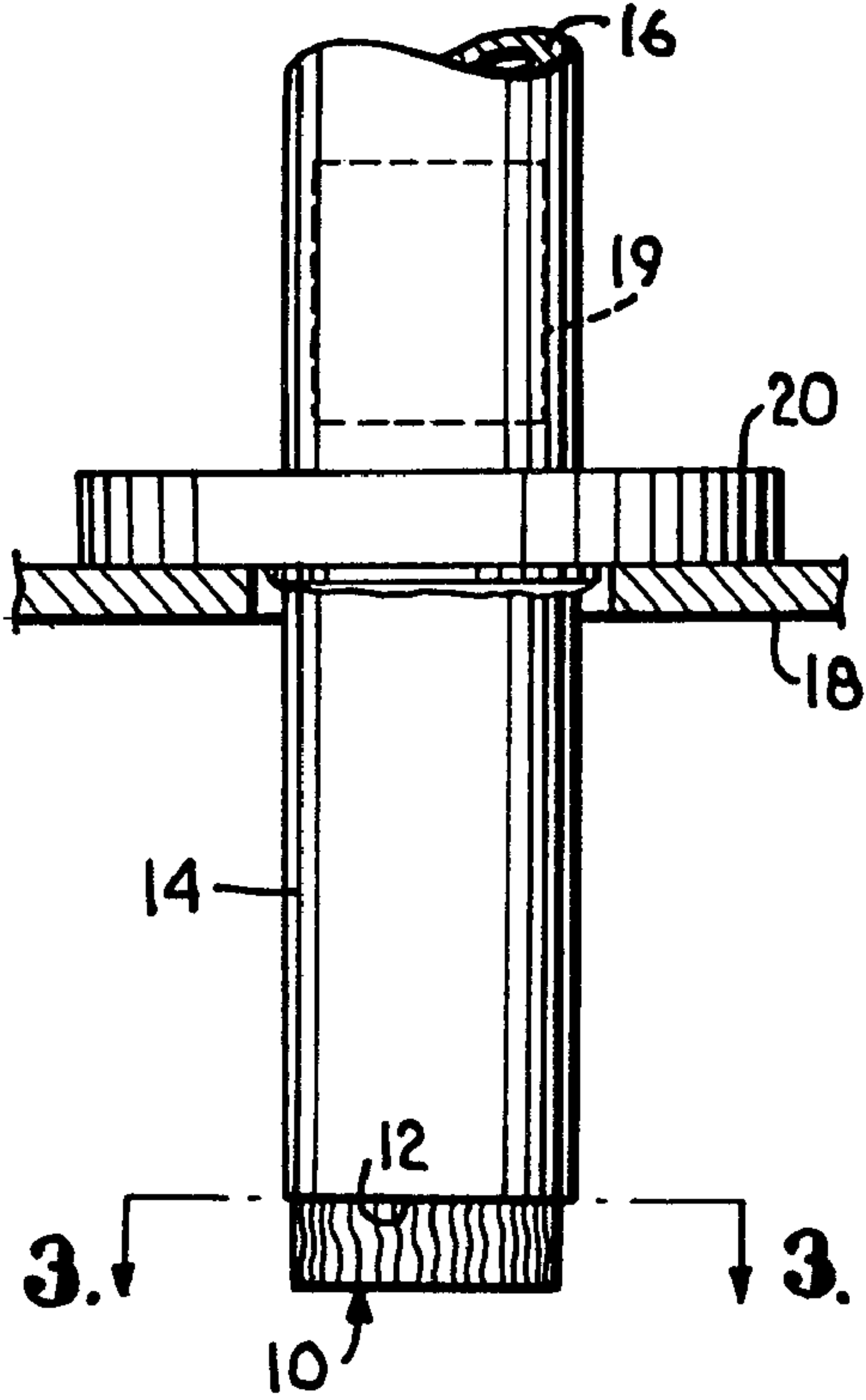


FIG. 6.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