Aug. 4, 1970 R. A. WELCH 3,522,659

METHOD AND APPARATUS FOR TREATING SOLID MATERIAL IN PARTICULATE OR FIBROUS FORM

Filed May 14, 1968

FIG. 1

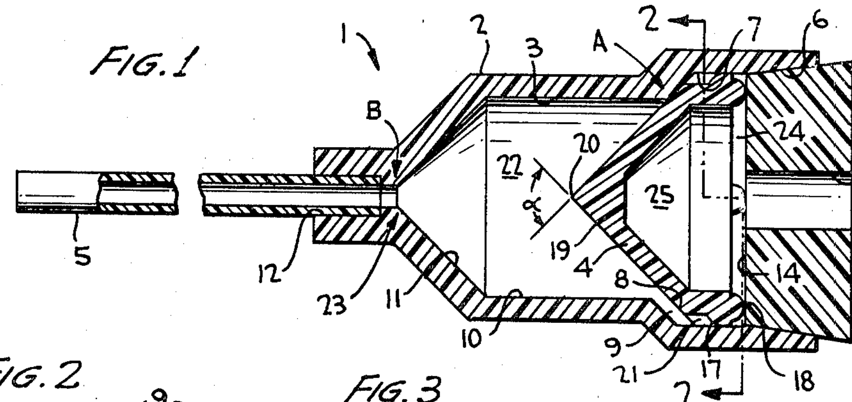


FIG. 2

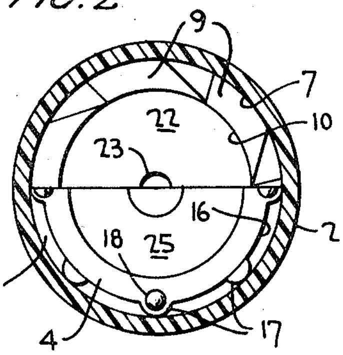


FIG. 3

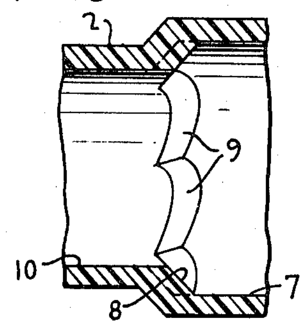


FIG. 5

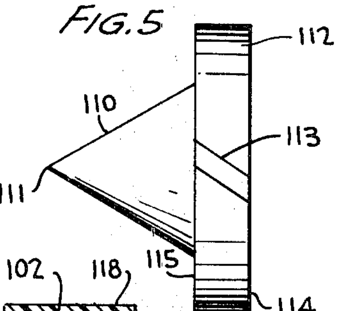


FIG. 4

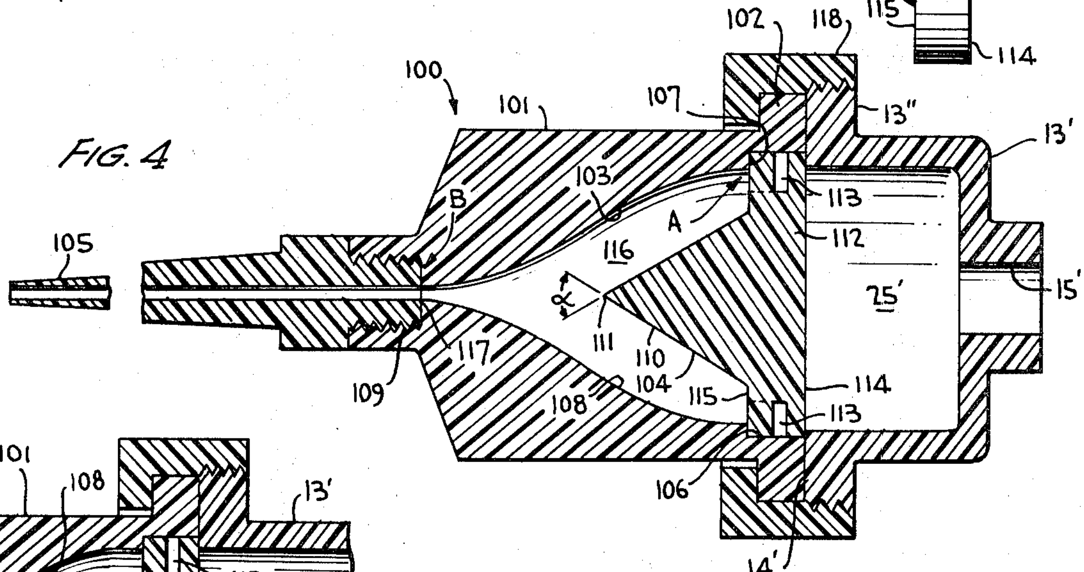
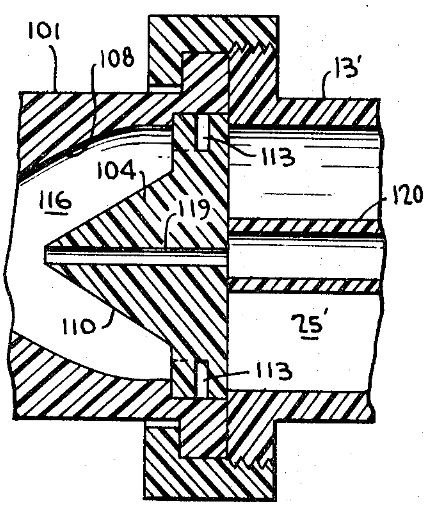


FIG. 6



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United States Patent Office 3,522,659 Patented Aug. 4, 1970

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METHOD AND APPARATUS FOR TREATING SOLID MATERIAL IN PARTICULATE OR FIBROUS FORM

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Filed May 14, 1968, Ser. No. 729,051
Int. Cl. F26b 3/00
U.S. Cl. 34—22 15 Claims

ABSTRACT OF THE DISCLOSURE

A method and apparatus for treating solid material in either particulate or fibrous form with a gas under pressure within a chamber defined by outer and inner boundary surfaces of revolution disposed in axial alignment, wherein the outer boundary surface has a relatively small diameter end portion thereof forming an outlet for the chamber and the inner boundary surface is of conically shaped configuration having the reduced diameter end portion thereof disposed in a spaced, facing relationship with respect to the chamber outlet. Pressurized gas is introduced into the chamber, as one or more defined streams or jets, and directed into initial surface engagement with one of the boundary surfaces at a point spaced from the chamber outlet along a line disposed obliquely of the axes of the boundary surfaces for the purpose of creating a gas flow pattern within the chamber suitable for various material treating processes.

The present invention is directed towards methods and apparatus for treating material within a chamber by directed jets of pressurized gas. The apparatus employed in the practice of the present invention is disclosed in part, but not specifically claimed, in my copending application Ser. No. 729,027 filed May 14, 1968, for Method and Apparatus for Dispensing Control Volumes Gas filed on even date herewith.

More particularly, the present invention is directed towards the provision of a family of material treating devices having utility in diverse material treating processes, wherein it is desired to agitate solid material in either particular or fibrous form by directed streams or jets of pressurized gas.

In accordance with the present invention, the apparatus includes a family of devices which define material receiving chambers, each of which is characterized by axially aligned outer and inner boundary surfaces of revolution, the outer boundary surface defining a chamber outlet and the inner boundary surface being of conically shaped configuration and having the reduced diameter end portion thereof disposed in a spaced, facing relationship to the chamber outlet. Also, in each device treatment of material within the receiving chamber is effected by introducing one or more defined streams or jets of pressurized gas into the chamber in surface engagement with one of the boundary surfaces in such a manner that such boundary surface functions to at least initially guide the gas along defined paths toward the chamber outlet, while the other boundary surface serves to restrict or control expansion of the introduced gas and to prevent or reduce the occurrence of flow bypass areas within the receiving

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chamber. Depending upon the process for which the devices are to be used, the gas introduced into the receiving chamber may be either inert or reactive with the material being treated and may be at any desired operating temperature.

Preferably, in each embodiment of the present invention the cross-sectional area of the material receiving chamber varies from minimal values adjacent the areas of the gas jet inlets and chamber outlet to a maximum value in the area of the reduced diameter end portion of the conically shaped inner boundary surface. This construction permits maximum expansion of the pressurized gas adjacent the reduced diameter end portion of the inner boundary surface, which has been found to permit maximum surface contact of the pressurized gas with the material being treated.

In one embodiment of the present invention, one or more defined streams of pressurized gas is introduced into the receiving chamber in initial surface engagement with the conically shaped inner boundary surface along a line disposed obliquely of the boundary surface axes.

In a second embodiment, the outer boundary surface of revolution is defined by revolving a line having compound curvature about the boundary surface axes, wherein the respective ends of such line are disposed parallel to such axes and define first and second end portions of the outer boundary surface. The first end portion of the outer boundary surface is disposed adjacent to the base portion of the conically shaped inner boundary surface and the second end portion of the outer boundary surface defines a chamber outlet. In this embodiment, one or more defined streams or jets of pressurized gas is directed into initial surface engagement with the first portion of the outer boundary surface along a line which is disposed obliquely of the boundary surface axes.

Preferably, in each embodiment the line along which the streams of pressurized gas are directed into engagement with the respective boundary surfaces also lies as nearly as possible within a plane disposed parallel to such surface at the point of initial engagement therewith.

Each of the embodiments disclosed may be employed to treat material received within the chamber in either a batchwise or continuous manner. When batchwise treatment is desired, a measured quantity of material is initially introduced into the receiving chamber and subsequently introduced jets of gas employed to treat and then eject the treated material through the chamber outlet. When a continuous material treating process is desired, the devices may be modified by providing a material inlet passageway which terminates at the reduced diameter and portion of the inner boundary surface and is aligned with the chamber outlet. Material to be treated and the pressurized gas are then simultaneously and continuously introduced into the receiving chamber and exit through the chamber outlet.

In order to demonstrate the general utility of the present invention, several diverse material treating processes will be described. In a first process, material to be treated is in the form of a powdered solid and jets of inert pressurized gas employed to fluidize the powdered solid and thereafter expel the solid from the receiving chamber in a fluidized stream. This procedure is disclosed generically in my copending application as having utility in the application of controlled dosages of powdered medicaments entrained within an inert carrier gas in the treatment of both humans and animals, and particularly with reference to the treatment of bovine mastitis which occurs in dairy cattle.

In a second process to be described by way of example, textile yarns, are continuously introduced into and withdrawn from the material receiving chamber and subjected to directed jets of pressurized gas while disposed within such chamber in order to perform either mechanical yarn treatments, e.g. entanglement, or chemical yarn treatments, e.g. dyeing.

The nature of the present invention will become more fully apparent by reference to the following description taken with the accompanying drawings in which:

FIG. 1 is a sectional view illustrating the first embodiment of the present invention;

FIG. 2 is a sectional view taken generally along the line 2—2 of FIG. 1;

FIG. 3 is a fragmentary view showing flow passages provided in the embodiment illustrated in FIG. 1;

FIG. 4 is a sectional view illustrating the second embodiment of the present invention;

FIG. 5 is a side elevational view of the conically shaped flow guide shown in section in FIG. 4; and

FIG. 6 is a fragmentary sectional view indicating the manner in which the first and second embodiments may be modified to permit the introduction of material to be treated continuously into the material receiving chamber.

To facilitate understanding of the present invention, the first and second embodiments thereof, which are shown in FIGS. 1–3 and FIGS. 4 and 5, respectively, will be described with particular reference to their use in treating solid material in powdered or particulate form in a batchwise manner. More particularly, reference is made to their use in applying accurately controlled dosages of powdered medicament in the treatment of bovine mastitis, wherein pressurized gas from any suitable source, such as an aerosol dispenser, not shown, is employed to fluidize the medicament and thereafter inject same in a fluidized stream into the udder of a cow. In practice, any suitable pressurized or carrier gas selected from the group including carbon dioxide, nitrous oxide, and fluorinated or fluoro chlorinated saturated hydrocarbons may be employed.

Illustrative of those medicaments which may be utilized in the treatment of bovine mastitis include steroids, such as prednisolone, dexamethasone, hydrocortisone, cortisone, prednisone and their derivatives, i.e. salts, esters or aldehydes; nitrofurans, such as nitrofurazone; sulfur drugs, such as sulfisoxazole and sulfamerazine; and antibiotics such as polymixin, bacitracin, procaine, pencillin G, dihydrostreptomycin, streptomycin, neomycin, tetracycline, chlortetracycline, kanamycin, novobiocin, oxytetracycline, chloramphenicol, erythromycin and their salts and derivatives. However, any medicament which has therefore been found effective against bovine mastitis may be utilized. It is preferred, however, to use a mixture of nitrofurazone and sulfisoxazole having a particle size ranging between 10 and 100 microns. The amount of medicament employed will, of course, vary depending upon the severity of the disease to be treated.

Now referring particularly to FIG. 1, it will be seen that in the first embodiment there is provided a device, generally designated as **1**, which includes an integrally formed molded plastic body **2** having a through axially extending opening **3** which is adapted to receive a flow guide, generally designated as **4**, and a nozzle or tube **5**. Opening **3** is defined by a tapered wall mounting portion **6**, a cylindrical wall portion **7**, a second tapered wall portion **8** having a plurality of slot recesses **9**, a second cylindrical wall portion **10**, a third tapered wall portion **11**, and a stepped nozzle supporting wall portion **12**.

Device **1** may be connected to a suitable source of pressurized gas, not shown, by any suitable means such as frusto-conical mounting plug **13**, which is adapted to be received within opening **3** in frictional surface engagement with tapered wall mounting portion **6**. For various other possible coupling arrangements, reference may be made to my copending application mentioned above. By referring to FIG. 1, it will be understood that plug **13** is provided with an end surface portion **14** which is adapted to cooperate with second tapered wall portion **8** to facilitate positioning of flow guide **4** in the manner to be hereinafter more completely described, and a through axial bore **15** to afford flow communication between a source of pressurized gas and the interior of device **1**.

Flow guide **4** is shown in FIGS. 1 and 2 as including a cylindrical wall portion **16** having a plurality of circumferentially spaced, radially extending spacing projections **17** and axially extending spacing projections **18**, and a conically shaped wall portion **19** having a reduced diameter end portion **20**. Guide **4** may be frictionally retained within opening **3** with the cylindrical wall **16** thereof maintained in a centered spaced relationship with respect to opening cylindrical wall portion **7** by radially extending spacing projections **17**. When thus positioned, the surface of wall portions **7** and **16** cooperate to define an annular pressurized gas flow passageway **21**, and the surface of conically shaped wall portion **19** is disposed in a parallel abutting relationship with second tapered wall portion **8** and serves to laterally close slot recesses **9** provided therein. If desired, permanent positioning of flow guide **4** within opening **3** may be effected by thermal or adhesive bonding.

It will be understood that when the device is assembled in the manner described, there is defined a material receiving chamber **22** having an outer boundary surface of revolution formed by body opening wall portions **10** and **11**, and an inner boundary surface of revolution formed by the conically shaped surface **19** of flow guide **4**; the axes of the respective boundary surfaces being disposed in alignment. For purposes of reference, the outer boundary surface is shown in FIG. 1 as having a first end portion of relatively large diameter, designated as A, which is disposed adjacent the base of the conically shaped inner boundary surface, and a second end portion of relatively small diameter, designated as B, which defines the outlet for chamber **22**.

It will be understood by referring to FIGS. 1, 2 and 3 that slot recesses **9**, when laterally closed by the conically shaped surface of guide **4**, define a plurality of passageways which are adapted to direct gas passing through flow passageway **21** in the material receiving chamber **22** as defined streams or jets of pressurized gas along flow lines disposed obliquely of the axes of the inner and outer boundary surfaces. Preferably, the flow lines lie within planes disposed substantially parallel to the conically shaped inner boundary surface adjacent the outlet ends of recesses **9**. Thus, the gas streams which intially engage that portion of flow guide **4** which defines the inner boundary surface at the outlet ends of recesses **9**, tend, due to surface effects, to follow the contour of the conically shaped inner boundary surface along spiral-like paths which eventually tend to merge into one radially defined gas stream adjacent the outlet **23** of chamber **22**.

It has been found that by providing a conically shaped flow guide, wherein the cone angle α is approximately 90°, in the combination with gas streams or jets arranged in the manner described, there is obtained an unexpected increase in the fluidizing capabilities of such streams over that obtained when such streams are merely directed into chamber **22** along paths disposed obliquely of the axes of the inner and outer boundary surfaces.

While flow guide **4** is shown in FIG. 1 as being conical, it will be understood that it may be frusto-conical, as indicated in the case of the modification shown in FIG. 6. In this respect, it appears that the most critical design consideration is to provide a conical flow guide section immediately adjacent the point at which gas is introduced into chamber **22** in order to achieve a desirable initial gas flow pattern, coupled with a chamber design which provides maximum chamber cross-sectional area and thus maximum flow expansion adjacent the reduced diameter end portion **20**.

When device **1** is mounted on mounting plug **13**, axially extending projections **18** of flow guide **4** are preferably disposed in abutting engagement with surface **14** of plug **13** and cooperate therewith to define radially extending passageway **24**, and to positively maintain flow guide **4** in surface engagement with second tapered wall portion **8**. Preferably, the rearwardly facing surface of flow guide **4** is hollowed out to form a cavity **25**, the sidewalls of which tend to equalize distribution of gas passing through plug aperture **15** radially through passageway **24**. Thus, pressurized gas is relatively uniformly distributed in sequence to passageway **21** and recesses **9**.

Material to be treated is preferably placed in chamber **22** prior to positioning of flow guide **4** within body opening **3**. Alternatively, material may be placed in chamber **22** after positioning of the flow guide either through tube **5** or through apertures, not shown, provided in either plastic body **2** or flow guide **4**.

FIG. 4 illustrates a second embodiment of the present invention wherein the treating device, generally designated as **100**, incorporates various possible design variations of the structure of treating unit **1**. Further, in FIG. 4, dissimilar device mounting means are shown as including a fitting **13'** which is provided with a threaded, cup-shaped mounting portion **13'**, which additionally functions to define a pressurized gas distributing cavity **25'**. Fitting **13'** is further provided with a bore opening **15'** to permit pressurized gas to be admitted into cavity **25'**, and a forwardly facing annular surface **14'**.

Treating device **100** generally includes an integrally formed body **102** having an integrally formed radially extending flange portion **101** and a through axially extending opening **103**, which is adapted to receive a flow guide **104** and a tube or nozzle **105**. Opening **103** is defined by a cylindrical wall portion **106**, a radially extending shoulder defining wall portion **107**, a curved wall portion **108**, and a wall portion **109** adapted to threadably receive tube **105**.

Flow guide **104** shown in FIGS. 4 and 5 as being in the form of a solid body having a conically shaped surface portion **110** which defines reduced diameter end portion **111**, and a radially extending flange portion **112** which is provided with a pair of slot recesses **113** which define through flow passages between flange surfaces **114** and **115**. In FIG. 4, flow guide **104** is shown as being centered within through opening **103** by cylindrical wall portion **106** in abutting engagement with radially extending wall portion **107**. When so positioned, cylindrical wall portion and radially extending wall portion **107** function to laterally close slot recesses **113** to define a plurality of pressurized gas directing passageways extending between guide flange surfaces **114** and **115**.

By again referring to FIG. 4, it will be understood that body **101** and flow guide **104** cooperate to define a material receiving chamber **116** having an outer boundary surface of revolution formed by curved wall portion **108** and an inner boundary surface of revolution formed by the conically shaped surface **110** of flow guide **4**; the axes of the respective boundary surfaces being aligned. As in the case of treating device **1**, the outer boundary surface is shown in FIG. 4 as having a first end portion of relatively large diameter, designated as A, which is disposed adjacent the base of the conically shaped inner boundary surface, and a second end portion of relatively small diameter, designated as B, which defines outlet **117** of chamber **116**.

It will be understood that the outer boundary surface formed by curved wall portion **108** is defined by revolving

about the axis of body **101** a line of compound curvature having its respective ends which define the first and second end portions of the outer boundary layer, disposed parallel to the body axis. While various curved surface designs are possible, I have found that excellent results are obtained by revolving a compound curved line having the coordinates tabulated below, wherein point 0 is designated as A, point 10 is designated as B and the radius is measured from the axis of body **101** to an appropriate point on the curve.

Points:	Radius
0	.437
1	.421
2	.406
3	.390
4	.312
5	.250
6	.187
7	.125
8	.093
9	.062
10	.062

In the above tabulation, the distance between points is 0.125 inch and the radius is measured in inches. An inner boundary surface having utility with an outer boundary surface approximated by the above tabulation would include a cone having an angle α of 60° wherein the reduced diameter portion or apex is positioned on the boundary surface axes radially of point 4.

Material receiving chamber **116** may be modified to accommodate either increased or decreased gas flows by merely multiplying both the spacing between points and the radii given above by any desired common factor and employing a cone height sufficient to maintain the apex portion of the inner boundary surface at approximately point 4.

Device **100** may be mounted on fitting **13'** by a threaded locking ring **118**, which is adapted to clamp flange **102** in fluid sealing engagement with surface **14'** of mounting portion **13"**.

In operation of the second embodiment, filling of the material receiving chamber may be effected in the same manner as that described with reference to the first embodiment. However, in the second embodiment, pressurized gas introduced into cavity **25'** from a suitable source of pressure, not shown, is directed into material treating chamber **116** by recesses **113** into initial surface engagement with the outer boundary surface along lines disposed obliquely of the boundary surface axes and lying within planes which are preferably substantially parallel to the first end portion of the outer boundary surface at points adjacent the outlet ends of recesses **113**. Thus, it will be seen that streams or jets of gas upon emerging from recesses **113** tend to follow or be guided by the outer boundary surface along spiral-like paths which eventually tend to merge adjacent chamber outlet **117**.

Also, as in the first embodiment, the inner and outer boundary surfaces of revolution cooperate to define a material receiving chamber which functions to produce a reverse venturi effect, that is, to produce a greater flow cross-section adjacent the mid-point of the chamber, which is in the area of the reduced diameter portion **111**, than adjacent the inlet and outlet ends thereof. This results in both increased gas volume and reduced gas velocity at such mid-point. Such variable flow cross-sectional design, coupled with the gas streams directed in the manner described, produces unique gas flow patterns having excellent fluidizing and opening capabilities.

In operation of either of devices **1** or **100**, the quantity of material placed within the receiving chamber thereof determines the pressure and quantity of the gas to be admitted into the receiving chamber for the purpose of effecting complete fluidization and discharge of such material through the chamber outlet as a fluidized stream.

When employing these devices in a process for treating bovine mastitis, the quantity of medicament placed within the treating chamber is determined by the seriousness of the infection to be treated.

EXAMPLE I

A thoroughly mixed medicament consisting of 200 milligrams of nitrofurazone and 400 milligrams of sulfisoxazole having a weight average of 20 microns was introduced into the chamber **22** of device **1**. Tube **5** was introduced into the udder to be treated and thereafter 20 cc. of Freon 12 at about 70 p.s.i. was introduced into chamber 22. The medicament was found to be completely fluidized and discharged from the chamber, and the medicament uniformly distributed throughout the udder. The milkout time for several like treatments was found to vary from between one and three days.

EXAMPLE II

A thoroughly mixed medicament consisting of 200 milligrams of nitrofurazone, 400 milligrams of sulfisoxazole and 250 milligrams of lactose having an overall weight average of about 50 microns was introduced into chamber **116** of device **100**. Tube **105** was introduced into the udder to be treated and thereafter 20 cc. of Freon 12 at about 70 p.s.i. was introduced into the chamber **116**. The medicament was found to be completely fluidized and discharged from the chamber, and the medicament uniformly distributed throughout the udder. The milkout time for several like treatments was found to vary between about one and three days.

FIG. 6 illustrates how the several embodiments of the present invention, and the second embodiment in particular, may be modified to permit material to be continuously introduced into material receiving chamber **116**. In this modification, flow guide **104** is provided with a through axially extending bore **119** which is disposed in alignment with the axes of the respective boundary surfaces and has an outlet end in the area of the reduced diameter end portion **111**. A suitable tube **120**, which is disposed in axial alignment with bore **119** and suitably affixed to flange surface **114**, is employed to prevent contact of the material to be treated with the pressurized gas during passage of the material through fitting cavity **25'**. It will be readily apparent that the device illustrated in FIG. 1 may be similarly modified by providing an axially extending bore opening in flow guide **4** and a suitable material conveying tube which is affixed to the flow guide and extends rearwardly through bore opening **15**.

While the modification illustrated in FIG. 6 may, if desired be employed to either continuously or intermittently introduce powdered or particulate solid material into receiving chamber **116** in accordance with the method of treating bovine mastitis mentioned above, it has been found to have particular utility in the treatment of multiple filament and staple textile yarns.

For instance, multi-filament yarn may be treated by the apparatus shown in FIG. 6 to produce a textured yarn product having alternate thick and thin portions spaced along the length of the treated yarn bundle. To achieve a textured yarn product, a gas, such as air under pressure, would be continuously introduced into cavity **25'** and multi-filament yarn from a suitable source, not shown, would be continuously fed into chamber **116** through tube **120** and withdrawn therefrom through tube **105** along a straight line path by first and second pairs of forwarding rollers, respectively, also not shown. The speed of the forwarding roller pair may be intermittently adjusted to permit the rate of feed to intermittently exceed the rate of yarn withdrawal thereby permitting the individual filaments of over-fed portions of the yarn to be freely separated from each other and whipped around by the gas flow to form convolutions or loops which are thereafter retained in the yarn upon withdrawal thereof from chamber **116**. The convolutions or loops impart bulkiness to the yarn by maintaining the filaments in spaced relation.

It has also been found that the treating devices of the present invention may be employed to effect the interlacing or entanglement of yarn continuously along the length thereof by continuously drawing multi-filament yarn under slight tension through tube **120**, chamber **116** and tube **105**; introducing a first pressurized gas, such as air, continuously into cavity **25'**; and continuously introducing a jet of pressurized gas, such as air, into chamber **116** through a nozzle, not shown, disposed substantially perpendicular to the path of yarn through the chamber at a point between reduced diameter portion **111** and outlet **117**. In operation, the pressurized gas introduced into cavity **25'** operates upon the filaments of the conveyed yarn to effect opening thereof and the jet of gas introduced through the side wall of chamber **116** functions to reorient individual filaments within the opened yarn bundle to effect relative displacement and interlacing thereof.

Alternatively, both multi-filament and staple yarns may be subjected to dyeing treatment within the treating chambers defined by the devices of the present invention by continuously passing the yarns to be treated through the chamber and continuously introducing either a vaporized dyeing agent or a finely divided dyeing agent entrained within a pressurized gas into the chamber in order to effect both opening of the yarn and intimate association of the dyeing agent with the individual yarn filaments or fibers.

Still further, the devices of the present invention may be employed to produce a wrapping on a core yarn. When used in this manner, a core yarn is continuously fed axially through the treating chamber under slight tension and a wrap, either in continuous filament or staple form, is introduced through a suitable opening in the side wall of the chamber. Rotating movement of the core yarn caused by action of the pressurized gas jets acts to draw the wrap into the chamber and effect wrapping thereof about the core.

While there has been described various embodiments of the present invention and certain modifications thereof, numerous additional variations will likely occur to one skilled in the art in view of the foregoing discussion. Accordingly, I wish to be limited only by the scope of the appended claims wherein what is claimed is:

1. A device for treating material with a gas under pressure, said device having a chamber, means in said chamber adapted to receive material to be treated, said chamber being defined in part by outer and inner boundary surfaces of revolution having axes disposed in alignment, said outer boundary surface having a relatively large diameter first end portion and a relatively small diameter second end portion, said second portion defining a chamber outlet, said inner boundary surface being of conically shaped configuration having a base portion thereof disposed adjacent said outer boundary first end portion and having a reduced diameter end portion thereof disposed in a facing spaced relationship with respect to said chamber outlet; and means defining at least one pressurized gas passageway having an inlet to said chamber at a point in the area of said outer boundry first end portion and said inner boundary base portion, said passageway positioned to direct a defined stream of pressurized gas into initial surface engagement with one of said boundary surfaces along a line disposed obliquely of said boundary surface axes.

2. A device according to claim **1**, wherein said reduced diameter end portion is apertured to define an inlet to said chamber for material to be treated.

3. A device according to claim **1**, wherein said one boundary surface is said outer boundary surface.

4. A device according to claim **3**, wherein said outer boundary surface is defined by revolving a line having compound curvature about said outer boundary axis, the respective ends of said line which when revolved define said first and second end portions being disposed parallel to said outer boundary axis.

5. A device according to claim **4**, wherein said reduced diameter end portion is apertured to define an inlet to said chamber for material to be treated.

6. A device according to claim **1**, wherein said one boundary surface is said inner boundary surface, and said line along which said stream of pressurized gas is directed lies within a plane disposed substantially parallel to said inner boundary surface at the point of initial surface engagement therewith.

7. A device for treating material with a gas under pressure, comprising a member having a through opening defined at least in part by first and second adjacently disposed surfaces of revolution arranged in axial alignment, said second surface of revolution having a first relatively large diameter end portion disposed adjacent said first surface of revolution and a second relatively small diameter end portion; a flow guide disposed with said opening in axial alignment with said surfaces and in surface engagement with said first surface of revolution, said flow guide having a conically shaped surface portion arranged with the reduced diameter end portion thereof in a spaced facing relationship with respect to said second end portion, at least a portion of said conically shaped surface portion being disposed radially inwardly of said second surface of revolution and cooperating therewith to define at least in part a material treating chamber having an outlet defined by said second end portion, at least one of said flow guide and said member defining a pressurized gas passageway having an inlet end and an outlet end, the outlet end of said passageway being disposed at a point in the area of said conically shaped surface portion and said first end portion, said passageway positioned to direct a defined stream of pressurized gas through said outlet thereof into said treating chamber and into surface engagement with one of said conically shaped surface portion and said second surface of revolution along a line disposed obliquely of the axes of said surfaces of revolution; and means to connect said inlet end of said passageway to a source of pressure.

8. A device according to claim **7**, wherein said flow guide and said first surface of revolution of said member cooperate to define said passageway.

9. A device according to claim **7**, wherein said flow guide is provided with a through bore opening disposed in alignment with said surface axes and passing through said reduced diameter end portion, said bore opening being adapted to direct material to be treated into said treating chamber.

10. A device according to claim **8**, wherein said first and second surfaces of revolution are connected by a substantially radially extending annular through opening wall portion; said flow guide is provided with a radially extending annular flange adjacent the base of said conically shaped surface portion, said radially extending annular flange having a radially facing marginal surface portion disposed in engagement with said first surface of revolution and axially spaced first and second side faces, said first side face being disposed in surface engagement with said radially extending annular wall portion; and said pressurized gas passageway is defined by a slot recess disposed in said radially facing marginal surfce of said flange portion and extending between said side faces thereof along a line disposed obliquely of said surface axes, said slot recess being laterally closed to define said inlet and outlet ends of said passageway by said first surface of revolution and said radially extending annular wall portion.

11. A device according to claim **10**, wherein said second surface of revolution is defined by revolving a line having compound curvature about said surface axes, the respective ends of said line which when revolved define said first and second end portions of said second surface being disposed parallel to said surface axes, and said passageway being adapted to direct said defined stream of pressurized gas into initial surface engagement with said first end portion of said second surface of revolution.

12. A device according to claim **8**, wherein said first surface of revolution is flared radially outwardly with respect to said first end portion of said second surface of revolution to form a frusto-conical annular surface portion disposed in surface engagement with said conically shaped surface portion of said flow guide, and said pressurized gas passageway is defined by a slot recess disposed in said frusto-conical annular surface and terminating at said first end portion of said second surface of revolution, said slot recess being laterally closed by said conically shaped surface portion to define said inlet and outlet ends of said passageway, and said passageway positioned to direct a defined stream of pressurized gas into initial surface engagement with said conically shaped surface portion.

13. A device according to claim **12**, wherein said flow guide includes a substantially cylindrically shaped surface portion adjoining said base of said conically shaped surface portion, and said member opening is further defined by a third surface of revolution adjoining said first surface of revolution at a point disposed radially of said flow guide cylindrical surface portion, said flow guide being centered in axial alignment with said surfaces of revolution by spacer means extending between said third surface of revolution and said flow guide cylindrical surface portion defining a flow path for pressurized gas, and said inlet end of said passageway being disposed in communication with said flow path.

14. A method of treating material including the steps of providing a chamber defined in part by outer and inner boundary surfaces of revolution having axes disposed in alignment, said outer boundary surface having a relatively large diameter first end portion and a relatively small diameter second end portion defining a chamber outlet, said inner boundary surface being of conically shaped configuration having a base portion thereof disposed adjacent said outer boundary first end portion and having a reduced diameter end portion thereof disposed in a facing spaced relationship to said chamber outlet; placing material to be treated in said chamber; and directing a defined stream of pressurized gas into said chamber through a gas inlet disposed in the area of said outer boundary first end portion and said inner boundary base portion and into initial surface engagement with one of said boundary surfaces, said stream being initially directed along a line disposed obliquely of said boundary surface axes.

15. A method of claim **14**, wherein said reduced diameter end portion of said conically shaped surface is apertured to define a material inlet opening for said chamber aligned with the axes of said boundary surfaces, and including the step of passing material to be treated continuously into said chamber through said material inlet opening, while simultaneously directing a defined stream of pressurized gas into said chamber through said gas inlet.

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LLOYD L. KING, Primary Examiner

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