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[54] SPRAYING DEVICE, MORE PARTICULARLY FOR ABRASIVE LIQUID COMPOSITIONS

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[52] **U.S. Cl.** **239/92,** 239/296, 239/412

[51] **Int. Cl.** **B05b 1/30**

[58] **Field of Search**..........239/88, 92, 410, 411, 412, 239/296; 251/61.1, 62, 331

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[57] **ABSTRACT**

A membrane gun for spraying abrasive liquids has a membrane supported around its full periphery in a chamber in the body of the membrane gun, a first surface of the membrane forming a wall of this chamber. A tubular member is supported in the chamber with a free end facing the membrane. A second surface of the membrane is acted on variably by a composite plunger of a single-acting pneumatic cylinder. The liquid is admitted to the chamber and must pass over the free end of the tubular member to enter the interior of their member and be expelled from the gun through a nozzle. Regulation of the plunger regulates the distance of the membrane from the tubular member and thus the flow through the gun. The pneumatic cylinder is arranged coaxially with the body of the gun to occupy the minimum lateral space.

4 Claims, 4 Drawing Figures

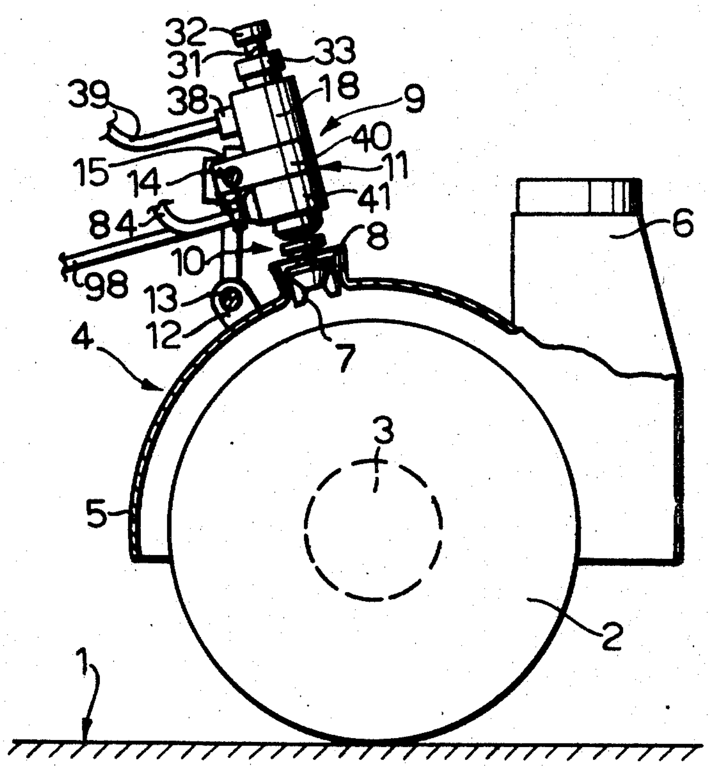

Fig.1

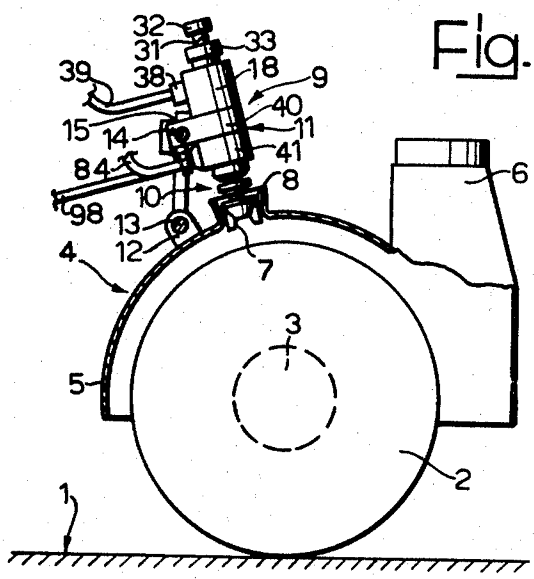
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Fig.4

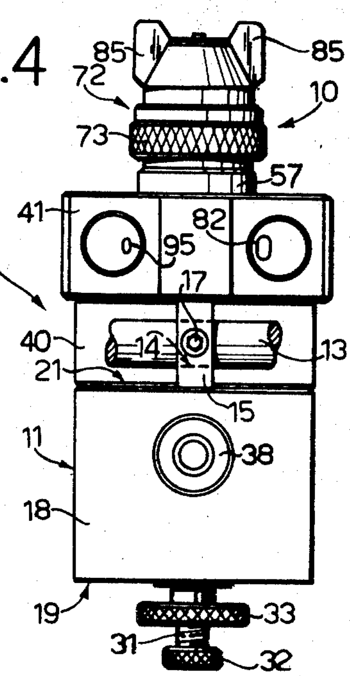
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Fig. 2

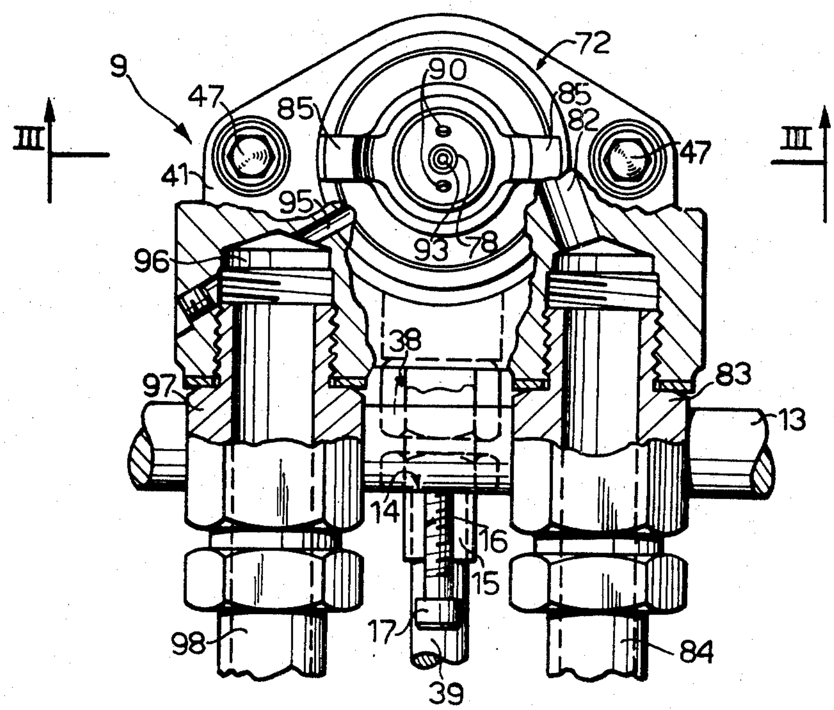

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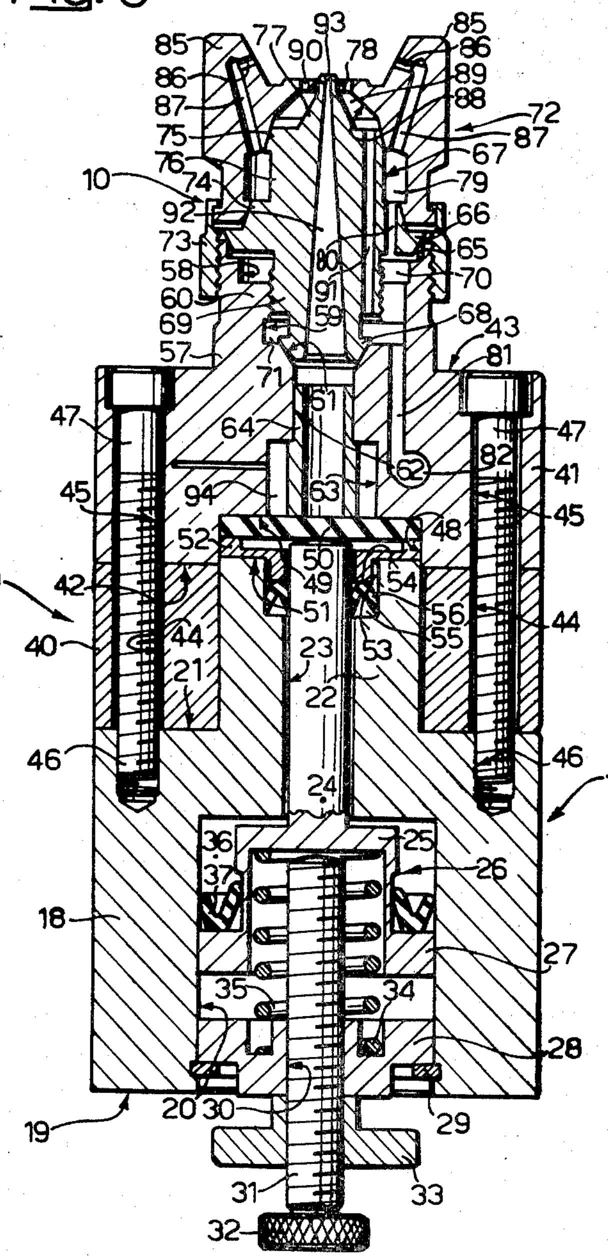
Fig. 3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SPRAYING DEVICE, MORE PARTICULARLY FOR ABRASIVE LIQUID COMPOSITIONS

This invention relates to a spraying device for abrasive liquid compositions.

The use of abrasive liquid compositions for polishing has become common. These compositions differ greatly from one another in their characteristics, and their viscosity, which is a very important factor as regards spraying, varies from 6,000 to 180,000 cps.

Spray guns of the type used for spraying paints and the like were at first used for spraying abrasive liquid compositions. In these guns a needle valve capable of being actuated from outside is provided in a duct through which the material to be sprayed is supplied, and the supply of material is regulated by means of this valve. When this material consists of an abrasive liquid composition the excessive wear to which the needle valve is subjected makes the gun unserviceable in a short time, and it is therefore clear that the gun is unsuitable for this purpose.

The guns described above were thus of little practical utility, and were soon replaced by spraying devices more suitable for abrasive liquid compositions and known as membrane guns. The membrane gun generally comprises an elongated substantially cylindrical body having inside it a duct which communicates at one end with the supply system and at the other end with an ejector nozzle. The body is also provided with a generally radial connector incorporating a duct through which compressed air is supplied. Inside the duct through which the abrasive composition is supplied there is usually a transverse diaphragm which cooperates qt its edge with the surface of a membrane. The membrane when in contact with this diaphragm closes the supply duct, whereas the membrane when separated from the diaphragm permits the abrasive composition to pass between the membrane and the free edge of the diaphragm.

A device for controlling the open position of the membrane is arranged radially on the cylindrical body. This device is generally of the "all or nothing" type or, more rarely, consists of a pneumatic cylinder and regulating device, of very cumbersome structure and difficult to manipulate, which is adapted to permit the membrane to assume more than one open position. The regulating device acts on the membrane so as to limit the displacement of the membrane, the arrangement being such that the membrane, when not displaced completely blocks the duct through which the abrasive material is supplied.

For very low operating pressures, the side of the membrane remote from the diaphragm is provided with a projection adapted to connect the membrane with the control device. In this case the abrasive liquid composition is supplied at a pressure which does not permit resilient deformation of the membrane itself.

During the polishing operations the membrane guns are generally mounted on a casing known as a hood which covers one or more polishing drums. These drums are rotatably mounted on a shaft and are disposed tangentially to the surface to be polished.

The membrane guns described above have numerous disadvantages. Above all, the abrasive composition feed is generally axial, whereas the atomizing air feed and the device for controlling the position of the membrane are arranged radially and spaced apart from one another. As a consequence, the group of supply ducts connected to the gun is very bulky and does not permit easy and convenient arrangement of this gun on the hood.

Another disadvantage of the known membrane guns is that, because of the bulk of the device for controlling the position of the membrane, the diaphragm is located at a relatively great distance from the ejector nozzle. Consequently, when the membrane blocks the supply duct at the end of the spraying operation there is a considerable quantity of abrasive composition downstream of the diaphragm, and if the viscosity of the abrasive composition is below a certain value this abrasive composition drips out.

Since the diaphragm is arranged transversely in the supply duct, it is also subjected to heavy wear. In membrane guns the diaphragm is generally formed integrally with the cylindrical body, and therefore rapid wear of the diaphragm leads to rapid wear of the gun itself, so that the costs are high.

Known membrane guns are generally employed in automatic polishing plants in which a plurality of guns are used and are fed simultaneously by one pressure system and in which the consumption of the abrasive composition is controlled by two timing devices which set the beginning and the end of the spraying process. Since all the guns are connected to the same supply system and since the pressure drops in the connections leading to each individual gun differ from one gun to another, each gun consumes a larger or smaller quantity of abrasive composition according to whether the pressure at which it is fed is larger or smaller. The consequences of this fact map be very serious in that they may cause non-uniform polishing of a workpiece.

In order to avoid this disadvantage in the known membrane guns it would be necessary to regulate the rates of consumption of the abrasive composition in accordance with the pressure drops in the supply system on each of the guns used so as to obtain uniform consumption of the abrasive material and therefore uniform polishing. In order to obtain this it would be necessary to adopt the expensive solution of providing each gun with two timing devices adapted to regulate the beginning and the end of the period of consumption of the abrasive composition.

In order to eliminate this disadvantage, in one known membrane gun the position of the membrane is controlled by single-acting pneumatic cylinder, and the projecting length of the rod of this cylinder is regulable from outside. In this way, by varying the aperture through which the abrasive composition passes it is possible to regulate the quantity of material sprayed, thus compensating for the non-uniformities of feed pressure which are found in the various guns mounted on the same protective cap. But because of the position of the pneumatic control cylinder; this regulation of the projecting length of the rod is very difficult and not very accurate. It must also be noted that when a pneumatic control cylinder of the type described above is used, the times which the membrane takes to return to the closed position are very long and do not permit compositions of very high viscosity to be sprayed under the best conditions.

The invention provides a spraying device for an abrasive liquid composition, comprising an elongated body having a longitudinal axis, a nozzle for ejecting abrasive compositions and atomizing air, the nozzle being connected longitudinally to one end of the body, a passage leading from the exterior into the body and communicating with the nozzle, the abrasive composition being adapted to be admitted through such passage and expelled through the nozzle, a membrane located in such passage, and regulating means for varying the position of the membrane in order to vary the flow of abrasive composition through the passage; with the improvement that the regulating means includes a longitudinally arranged single-acting pneumatic cylinder having a plunger adapted to co-operate with the membrane, and a pin member arranged longitudinally and being adjustable from outside the body to limit the permissible movement of the plunger.

In the drawings:

FIG. 1 is a diagrammatic cross section through a protective hood provided with a spraying device of the invention,

FIG. 2 is a front elevation view on an enlarged scale of the spraying device of FIG. 1, partly broken away to show interior construction;

FIG. 3 is a view on line III — III of FIG. 2, and

FIG. 4 is a side view in elevation of part of the spraying device of FIGS. 1 to 3.

FIG. 1 shows a workpiece **1** to be polished. A plurality of polishing drums **2** rotatably supported by a shaft **3** are disposed tangentially to the surface of the workpiece. The polishing drums are protected by a protective hood **4** which consists of a cylindrically curved sheet **5** connected to a suction device (not shown in the drawing) through a connecting duct **6**. The protective hood **4** has a plurality of radial holes **7** each provided externally with an inlet funnel **8** rigid with the sheet **5**.

The end part of a spraying device **9** is arranged in each hole **7** and inside the funnel **8**. This device comprises an elongated cylindrical body **11** located outside the hood **4** and an ejector nozzle **10** extending axially from the body **11** and projecting into the funnel **8**.

The hood **4** is provided externally with a bracket **12** adjacent each hole **7**, the bracket connecting one end of a support bar **13** pivotally to the hood. The other end of the bar **13** is mounted in a hole **14** in a bracket **15** extending radially from the cylindrical body **11** and rigid with this body. Inside the bracket **15** there is an internally screw-threaded hole **16** (FIG.2) accommodating a screw **17** adjustable from outside to secure the cylindrical body **11** in a predetermined position with respect to the hood **4**. As is best seen in FIG. 3, the cylindrical body **11** comprises a plurality of parts, the first of which is a body **18** located at the end remote from the nozzle **10**. The body **18** is substantially cylindrical and has a flat end surface **19**, a cylindrical cavity **20** being formed coaxially in the body **18** and ending at the surface **19**. On its end opposite the surface **19**, the body **18** has a flat annular surface **21** from which a cylindrical projection **22** extends axially. Inside the projection **22** is a coaxial bore **23**, that communicates with the cavity **20**.

A cylindrical rod **24** is slidably mounted inside the hole **23** and extends into the cavity **20** where it is integrally connected to an end wall **25** of a cup-shaped body **26**. The free end of this body is provided with a flange **27** bounded externally by a cylindrical surface disposed in sealing contact with the cylindrical surface of the cavity **20**. The length of the rod **24** is such that when the end wall **25** of the body **26** touches the end surface of the cavity **20**, a short section at the free end of the rod **24** extends outside the projection **22**.

The open end of the cavity **20** is closed by a disc **28** which is prevented from leaving the cavity **20** by a circlip **29** mounted inside this cavity **20**. The disc **28** is provided with a central threaded hole **30** into which a threaded pin **31** is screwed. The end of this pin outside the cavity **20** is provided with a knurled head **32**, and the end of the pin inside the cavity **20** is adapted in certain conditions to engage the end wall **25** of the body **26**. A knurled locking ring **33** screwed on to the pin **31** is located between the head **32** and the disc **28**.

The disc **28** is provided internally with an annular groove **34** which is coaxial with the pin **31** and accommodates the end of a helical spring **35**. The other end of the spring **35** is introduced into the body **26** and bears against the end wall **25**. The end portion of the cavity **20**, together with the flange **27** and the external cylindrical surface of the body **26**, define an annular chamber **36** which is sealed by means of a seal **37**. The chamber **36** communicates with the exterior through a radial duct (not shown in the drawing) formed inside the body **18** and communicating with a connector **38** (FIGS. **1**, **2**, **4**, **5**) adapted to permit a compressed air supply tube **39** to be connected to the body **18**. The compressed air supplied through the tube **39** will be referred to as "control air."

The cylindrical body **11** also includes an annular body **40** (FIG. 3) fitting around the cylindrical projection **22** and having an external diameter equal to the external diameter of the body **18**, and a cylindrical body **41** of which the external diameter is equal to that of the body **18**. The cylindrical body **41** is bounded at its ends by two flat surfaces **42** and **43** and is arranged in contact with the annular body **40**.

For interconnecting the bodies **18**, **40** and **41**, holes **44** and **45** are formed in the bodies **40** and **41** and extend through these bodies coaxially with blind screw-threaded holes **46** formed in the surface **21** of the body **18**, to accommodate screw-threaded bolts **47**.

A cylindrical cavity **48** formed in the surface of the body **41** has a diameter equal to the external diameter of the projection **22** and is partly occupied by the end portion of this projection **22**. The cavity **48** has a flat end surface **49**. A membrane **50** of disc shape is arranged against this surface and is adapted to come into contact centrally with the free end of the rod **24**.

The full periphery of the membrane **50** is kept in contact with the surface **49** by means of a raised rim **52** of a disc **51** arranged inside the cavity **48**. The disc **51** bears against the end surface of the projection **22**; a central tubular projection **53** integral with the disc fits round the rod **24** and is located inside an enlarged end part **54** of the bore **23**. By means of its projection **53** the disc **51** closes the cavity **54** and forms the outer boundary of an annular chamber **55** which communicates with the annular chamber **36** through the gap between the rod **24** and the cylindrical surface of the bore **23**. The chamber **55** is sealed at its end nearest the membrane **50** by means of a seal **56**.

A substantially cylindrical projection **57** coaxial with the cylindrical body **11** extends from the surface **43** of the cylindrical body **41**. A coaxial cavity formed inside the projection **57** is provided with two annular grooves **58** and **59** separated from one another by an internally screw-threaded annular projection **60**. At its inner end the cavity in the projection **57** terminates in a frusto-conical hole **61** communicating with a cylindrical hole **62** in the body **41**, the other end of this hole **41** communicating with a cylindrical cavity **63** closed at one end by the membrane **50**. A tubular body **64** is fixed in the hole **62**, and projects into the cavity **63**. It is adapted to contact with the membrane **50** when the pressure on both sides of the membrane is equal.

A seal **65** is arranged at the end of the cavity defined by the groove **58** inside the projection **57**, and co-operates with a frusto-conical section **66** of an internal body **67** of the nozzle **10**. The body **67** extends into the interior of the projection **57** and ends in a frusto-conical section **68** that co-operates with the surface of the hole **61**. The body **67** also has a screw-threaded section **69** that co-operates with the screw-threaded projection **60** so as to secure the body **67** against axial movement with respect to the cylindrical body **41**. The outer surface of the body **67** inside the projection **57** bounds two annular chambers **70** and **71** defined by the grooves **58** and **59**.

In addition to the body **67**, the nozzle **10** includes a cap **72** secured to the end of the projection **57** of the cylindrical body **41** by means of a ring **73** screwed on to a screw-threaded end of this projection **57**. The cap **72** has two internal frusto-conical surfaces adapted to co-operate with two annular frusto-conical projections **74** and **75** of the internal body **67** which are separated from one another by a cylindrical section **76**.

At its free end the internal body **67** terminates in a conical section **77**. This section projects outside through a hole **78** formed centrally in the end of the cap **72**. The projections **74** and **75**, the section **76** of the body **67** and the internal surface of the cap **72** bound an annular chamber **79** which communicates with the chamber **70** through an axial duct **80** formed inside the body **67**. An axial duct **81** formed inside the cylindrical body **41** provides communication between the chambers **70** and **71** and between these chambers and a duct **82** perpendicular to the axis of the cylindrical body **41**. The duct **82** leads to the outside and is connected through a connector **83** (FIG. 2) to an external tube **84** through which atomizing air is supplied.

Two axial projections **85** extending from the end wall of the cap **72** are located outwardly of the hole **78** in diametrically opposite positions with respect to this hole and inclined outwards.

Each of the projections **85** has a generally radial hole **86** (FIG. 3) communicating with the annular chamber **79** through a duct **87**. The cap **72** has a frusto-conical surface **88** round the conical section **77** of the body **67**. This surface is spaced away from the surface of the section **77** and in conjunction with that section, with the annular projection **75** and with the end wall of the cap **72**, bounds an annular chamber **89** communicating with the atmosphere through a plurality of holes **90**. The annular chamber **89** communicates with the annular chamber **71** through an axial duct **91**.

A duct **92** of conical shape formed inside the body **67** is coaxial with and passes through this body. The duct **92** ends in an outlet hole **93** of small cross-sectional area and communicates at the other end with the interior of the tubular body **64**.

The outside surface of the tubular body **64** located inside the cylindrical cavity **63**, together with the surface of this cavity and the membrane **50**, bound an annular chamber **94**. This chamber is adapted to be placed in communication with the interior of the tubular body **64** by axial deformation of the membrane **50**.

The annular chamber **94** also communicates with the exterior through a radial duct **95** (FIG.5) and a duct **96** perpendicular to the axis of the cylindrical body **41** and formed inside this body. The duct **96** is connected through a connector **97** with a tube **98** adapted to supply the abrasive composition to the interior of the annular chamber **94**.

OPERATION OF THE DEVICE

The device **9** described above operates in the following way. When the device is not in operation, neither the atomizing air nor the control air are supplied to the device whereas on the other hand the abrasive composition fills the annular chamber **94**. This chamber is closed by the membrane **50** which is forced by the rod **24** to close the end of the tubular body **64**. The rod **24** is pressed against the membrane **50** by the spring **35**.

Before spraying commences, the ring **33** is unscrewed and by means of the head **32** the pin **31** is rotated so as to be located in the required axial position inside the cavity **20**. The axial position of the pin **31** depends on the quantity of abrasive composition which it is required to spray and on the pressure at which this composition is supplied. When the required axial position is reached, the pin **31**, is locked by retightening the ring **33**. This defines the possible movement of the rod **24**, of the cup-shaped body **26**, and therefore of the membrane **50**, and so adjusts the size of the passage which establishes communication between the annular chamber **94** and the abrasive composition outlet duct **92**. This passage is formed between the membrane **50** and the free end of the tubular body **64** when the membrane **50** is axially deformed under the pressure of the abrasive composition and comes into contact with the free end of the rod **24**.

This adjustment makes it possible to compensate for any load losses in the ducts through which the abrasive composition is supplied to the various devices **9** mounted on the same hood **4**, so as to equalize the delivery of all the device **9**.

When the spraying begins, the tubes **39** and **84** (FIG. 2) supply the device **9** with control air and atomizing air at the same time. The atomizing air passes through the tube **84** and the connector **83** to the interior of the duct **82**, from which it passes through the duct **81** (FIG. 3) into the annular chamber **71**. Same of the atomizing air passes from these along the passage **91** to reach the interior of the annular chamber **89**. From there it passes out through the holes **90** and mixes with the abrasive composition emerging through the hole **93**.

The other atomizing air inside the chamber **71** passes through the duct **80** into the annular chambers **70** and **79** and from the second of these it passes through the ducts **87** to the outlet holes **86** formed in the projections **85**.

The control air, on the other hand, passes through the connector **38** (FIG. **2**) into the annular chamber **36** (FIG. **3**) and exerts a pressure on the cup-shaped body **26**, forcing this body to slide inside the cavity **20** against the action of the spring **35** until the free end of the pin **31** is in contact with the internal surface of the end wall **25** of the body **26**.

The sliding movement of the body **26** and therefore of the rod **24** axially frees the membrane **50** so that, under the thrust due to the abrasive composition under pressure inside the chamber **94**, the membrane is deformed so as to move away from the end of the tubular body **64**. The deformation of the membrane **50** thus permits the abrasive composition to pass into the duct **92** and escape through the outlet holes **93**.

The volume of abrasive composition contained inside the duct **92** and inside the tubular body **64** is very small, so that the disadvantage of dripping of the abrasive material when the device is not in operation is practically eliminated.

The tubular body **64**, being a separate member mounted in the cylindrical body **41**, can easily be replaced when worn out by the abrasive material passing through it.

What I claim is:

1. A spraying device for an abrasive liquid composition, comprising an elongated body having a longitudinal axis, a nozzle for ejecting abrasive composition and atomizing air, the nozzle being connected longitudinally to one end of the body, a passage leading from the exterior into the body and communicating with the nozzle, the abrasive composition being adapted to be admitted through such passage and expelled through the nozzle, a membrane located in such passage, and regulating means for varying the position of the membrane in order to vary the flow of abrasive composition through the passage; said regulating means including a longitudinally arranged single-acting pneumatic cylinder having a plunger adapted to co-operate with the membrane, and a pin member arranged longitudinally and being adjustable from outside the body to limit the permissible movement of the plunger, said passage including a chamber in which is secured a tubular member having a free end exposed in said chamber, said abrasive composition being adapted to flow over said free end before reaching the nozzle, the membrane being supported around its full periphery in the body with a first of its surfaces defining a wall of said chamber facing the free end of the tubular member, the plunger of the pneumatic cylinder being adapted to bear on a portion of the second surface of the membrane opposite the free end of the tubular member to regulate the distance of the membrane from the free end of the tubular member and thus regulate the flow of abrasive composition.

2. The spraying device of claim **1**, in which the body has a duct connecting the chamber outside the tubular member to the exterior, this duct being adapted to be connected to a source of abrasive composition.

3. The spraying device of claim **1**, in which the tubular member is replaceably mounted in the body.

4. The spraying device of claim **1**, including resilient means biasing the plunger of the pneumatic cylinder towards a position in which the plunger presses the membrane against the free end of the tubular member to prevent flow of abrasive composition, and including means adapted to admit compressed air to such cylinder to overcome the resilient means.

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