ABSTRACT: An apparatus which utilizes a stream of gas to propel fine particles which is particularly useful in the manufacturing of dental restorations for functions such as cutting, cleaning and polishing, is disclosed. An abrasive powder is forced from a container by a stream of gas which first passes through the powder. The gas, after passing through the powder, flows through a tube disposed in the powder and then to a nozzle. An orifice disposed through the wall of the tube provides an even and continuous injection of powder into the stream of gas.
3,631,631

1. Field of the Invention

The invention relates to the field of pneumatic abrasive devices, particularly those utilized in the dental field.

2. Prior Art

Numerous devices have been disclosed in the prior art which utilize a stream of gas to propel an abrasive powder. These types of devices have been used in dentistry for polishing, cleaning and cutting dental restorations. One such device is disclosed in U. S. L. Pat. No. 3,084,444.

One of the principal problems with the prior art devices is that they do not provide a continuous, constant flow of powder. Typically, these devices become clogged and do not provide an even flow of powder in the stream of gas.

SUMMARY OF THE INVENTION

A pneumatic apparatus which utilizes a continuous stream of gas to propel fine particles is described. The fine particles which are typically abrasive powder are forced from a container through a nozzle by a stream of gas. A tube which is connected to a nozzle is disposed in the powder such that its upper end is above the level of powder in the vessel. An orifice is disposed through the wall of the tube near the bottom of the vessel. A stream of gas is injected into the lower end of the vessel through a check valve; this gas flows through the powder in the vessel and then into the upper end of the tube. As the gas flows through the tube, it causes powder in the vessel to be drawn into the stream of gas and to be subsequently delivered to the nozzle. The vessel is mounted on a platform and subjected to vibrations which agitate the powder in the vessel and assist in preventing the device from becoming clogged.

BRIEF DESCRIPTION OF THE DRAWING

The drawing illustrates in schematic form a pneumatic abrasive dental apparatus wherein the apparatus utilizes two vessels which are both illustrated in a cross-sectional view.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawing, an abrasive powder or the like is stored in containers or vessels 10 and 14 and is pneumatically pumped to nozzles 52 and 53, respectively. The vessels 10 and 14 may be ordinary medical vessels which are adaptable for sealingly containing a powderlike substance. Lid 11 threadingly engages vessel 10. An O-ring 12 which is disposed about an upper edge of vessel 10, between the vessel and lid, assures that the vessel is sealed and adaptable for being slightly pressurized. Likewise, vessel 14 has a lid 15 which threadingly engages vessel 14 and sealingly engages vessel 14 by means of O-ring 16. While in the drawing, both vessels 10 and 14 are illustrated as generally cylindrical members, they may in fact have any shape provided that they have an upper and lower end in which the tubes 18 and 20 may be disposed.

Vessel 10 contains a cylindrical tube 18 which is disposed from the upper end of the vessel to the lower end of the vessel. A small orifice 21 is disposed through the wall of tube 18, near the lower end, and allows upwardly material 24 to flow from the interior of the vessel to the interior of tube 18. While in the present embodiment only a single orifice 21 is illustrated, a plurality of orifices may be utilized. Likewise, a tube 20 is disposed from the upper end of vessel 14 to the lower end of that vessel, and an orifice 23 is disposed through the wall of tube 20 near the lower end of vessel 14. The vessels 10 and 14 and the tubes 18 and 20 may be ordinary metal parts manufactured utilizing commonly known techniques. The tubes 18 and 20 in the presently described embodiment of the invention have an inside diameter of approximately one-eighth inch.

The lower end of tube 18 is coupled to flexible tube 48 via line 46; the lower end of tube 20 is coupled to flexible tube 49 through line 47. The tubes 48 and 49 are coupled to nozzles 52 and 53, respectively. The nozzles 52 and 53 may be any commonly known nozzle adaptable for handling a stream of gas containing a fine powder. A handpiece 50 is coupled to nozzle 52 in order that the nozzle may be readily manually utilized. Likewise, a handpiece 51 is coupled to nozzle 53. The lines 46 and 47, flexible lines 48 and 49, and the nozzles 52 and 53 may be ordinary parts, which are commercially available.

A pinch valve 60 is disposed across both lines 48 and 49 and prevents the passage of gas through these lines, unless the valve is actuated, by pinching the flexible lines. Valve 60 may be an electrically or pneumatically operated valve or valves similar to valves 42 and 40 and may be used in place of valve 60.

Line 37 is coupled to a source of gas under pressure. The source of gas may be any one of numerous commercially available gas sources such as those produced by a pump or hose which are provided from a storage tank. The gas which is provided to line 37 under pressure may be carbon dioxide, nitrogen or similar inert gases. Air may also be utilized in the present application. The gas applied to line 37 should be dry and substantially free of moisture content. In the present embodiment, gas at a pressure of 80-90 p.s.i. has been found to be satisfactory for the operation of the apparatus. Regulator 38 which is coupled to line 37, may be any ordinary regulator adaptable for regulating and adjusting the flow of gas. The gas flowing through regulator 38 is adjustable by means of knob 39. The output from regulator 38 is coupled to T-coupler 54 and the output from coupler 54 is coupled to valves 40 and 42. Valves 40 and 42 may be ordinary valves which selectively allow or prevent the passage of gas. In the preferred embodiment of the present invention, valves 40 and 42 are electrically operated valves.

Switch 61, an ordinary electrical switch, is coupled to valve 42 by lead 43 and to valve 40 by lead 41. Switch 61 provides a means for selectively opening either valve 40 or 42 and hence allowing gas to flow into either vessel 10 or 14, as indicated by the left (L) and right (R) position on switch 61.

The output from valve 42 is coupled to the lower end of a vessel 14 via line 55 and check valve 36. The output from valve 40 is coupled to the lower end of vessel 10 via line 56 and check valve 34. Check valves 34 and 36 may be ordinary check valves which allow a stream of gas to pass in only one direction. Valves 34 and 36 allow gas from valves 40 and 42, respectively, to flow into vessels 10 and 14, respectively, but prevent gas or other materials from flowing out of the vessels into lines 55 and 56. Valves 34, 36, 40 and 42, lines 55 and 56, T-coupler 54, and regulator 38 may be ordinary parts which are commercially available.

Foot control 45 which is coupled to valve 60 via line 62 and provides a means for opening pinch valve 60, may be an ordinary foot control control known in the prior art. In the presently preferred embodiment, valve 60 is a pneumatically operated valve and is actuated with gas from line 37; foot control 45 provides a means for controlling the flow of gas to valve 60.

Vessels 10 and 14 are rigidly coupled to platform 26 and platform 26 is coupled to base 29 via springs 30. Thus, platform 26 is able to vibrate relative to the base 29. A vibrating means 32 is coupled to platform 26 and is adaptable for vibrating platform 26, thus causing the contents within vessels 10 and 14 to be agitated. Vibrating means 32 may be a commercially available electrically operated vibrator or may be a pneumatically operated vibration means which is operated from the source of gas under pressure supplied to line 37.

While in the presently preferred embodiment of the present invention only a single regulator means 38 is illustrated coupled to line 37, it is within the scope of the present invention to utilize two regulator means. For example, one regulator means could be coupled into line 55 and the other into line 56. This would allow the gas flowing into each of the vessels 10 and 14 to have a separate flow control.
In the presently preferred embodiment, two vessels 10 and 14 are utilized. Each of these vessels in this embodiment are utilized to contain a different material within the scope of the present invention to utilize a single vessel or a greater number of vessels on a single platform. Also, any number of vessels may be coupled to a single nozzle by utilizing T-connectors and additional valves.

In order to utilize the disclosed apparatus, an abrasive material is placed in either or both of the vessels 10 and 14 by removing lids 11 and 15, respectively. Any type of fine abrasive powder may be utilized; for example, aluminum oxide, glass shot, sand, sapphire dust, or similar material may be placed within these vessels. The vessels should be filled such that the length of material placed within the vessel is below the upper end of the tube 10 and 20 as is illustrated in the drawings. After an abrasive material is placed within the vessel, the lids are tightened onto the vessels to seal the vessels.

Assume that a source of gas has been applied to line 37 and that valve 40 is opened and also that control 45 is depressed, opening pinch valve 60, gas will flow through line 66 and check valve 34 into material 24 illustrated within vessel 10. The gas flows through the material 24, causing the material to be somewhat loosened and agitated, and then flows into tube 18 as is illustrated by flow lines 57. This occurs since the ambient pressure at nozzle 53 is less than the pressure of the gas applied to vessel 10. As the gas flows downward in tube 18, it causes material 24 to be drawn into orifice 21, and injected into the stream of gas. It has been found that by utilizing a tube such as tube 18, and an orifice 21, and by passing the gas through the material 24 before it enters the upper end of the tube 18, a continuous and even flow of material 24 is injected into the medium. It is of course within the drawings. Additionally, the vibrator 32 which is operated during this time, causing the materials 24 and 25 in vessels 10 and 14, respectively, to vibrate, assists the flow of the materials 24 and 25 into the stream of gas.

To utilize the apparatus, the nozzles 52 and 53 may be held manually around the workpiece and the stream of gas containing the abrasive material when contacting the workpiece cuts, polishes, or removes materials, depending on the type of abrasive used and the hardness of the workpiece.

Different types of abrasives may be placed within vessels 10 and 14 so that the apparatus may be utilized to perform different functions. For example, an abrasive adaptable for cutting may be placed within vessel 10 and an abrasive adaptable for polishing may be placed within vessel 14. The selection of the material placed within the vessels 10 or 14 is of course made by switch 61 which will alternately allow gas applied to line 37 to flow into vessel 10 or 20.

The rate at which the gas flows through the apparatus and hence, the rate at which the abrasive material within the vessels is delivered to a nozzle, may be readily controlled by knob 39 of regulator 38.

The apparatus is particularly useful in dental laboratories for such applications as the manufacturing of dental restorations where there is a requirement to remove, cut, or polish hard materials such as ceramic, steel, copper, brass, gold, platinum, glass and similar materials. Some typical applications to which the apparatus may be utilized in the dental industry are carving porcelain, rolling fossa, removing porcelain, removing surface oxide and polishing.

I claim:
1. A pneumatic abrasive cutting apparatus comprising:
   a closed vessel having a lower end and an upper end,
   a source of gas under pressure,
   a check valve interconnecting said lower end of said vessel and said source of gas such that gas may flow into said vessel,
   a tube mounted in said vessel from said upper end of said vessel to said lower end of said vessel, said tube having at least one orifice disposed through its wall; and
   a nozzle, coupled to the end of said tube disposed at said lower end of said vessel, whereby abrasive from said vessel is drawn into said orifice by the flow of gas through said tube and is delivered to said nozzle under pressure.

2. The pneumatic abrasive cutting apparatus defined in claim 1 wherein said orifice is disposed through the wall of said tube near the lower end of said tube.

3. The pneumatic abrasive cutting apparatus defined in claim 2 wherein a regulator, to regulate the flow of gas, is interconnected between said source of gas and said check valve.

4. The pneumatic abrasive cutting apparatus defined in claim 3 wherein said vessel is connected to vibration means, for vibrating an abrasive in said vessel.

5. The pneumatic abrasive cutting apparatus defined in claim 4 wherein said vessel contains a manually removable top which sealingly engages said vessel to allow said vessel to be readily loaded with abrasive.

6. A pneumatic abrasive cutting apparatus comprising:
   a base;
   a platform movably coupled to said base;
   a first and second closed vessel, each having a lower end and an upper end for containing an abrasive, both mounted on said platform;
   a source of gas under pressure;
   a regulator means, for regulating the flow of gas from said source of gas, connected to said source;
   a first check valve connected to the lower end of said first vessel, for allowing gas to flow into said vessel;
   a second check valve connected to the lower end of said second vessel, for allowing gas to flow into said vessel;
   a first tube mounted in said first vessel from said upper end of said vessel to said lower end of said vessel, said tube having at least one orifice disposed through its wall;
   a second tube mounted in said second vessel from said upper end of said vessel to said lower end of said vessel, said tube having at least one orifice disposed through its wall;
   a first valve interconnecting said regulator with said first check valve;
   a second valve interconnecting said regulator with said second check valve;
   control means for selectively opening and closing said first and second valve;
   a first nozzle, coupled to the end of said first tube disposed at said lower end of said first vessel;
   a second nozzle, coupled to the end of said second tube disposed at said lower end of said second vessel;
   a vibrator, coupled to said platform for vibrating the contents of said first and second vessels;
   whereby material from said first and second vessels may be selectively delivered to said first and second nozzles.

7. The pneumatic abrasive cutting apparatus defined in claim 6 including a foot control for allowing gas to flow from said vessels to said nozzles.

8. The pneumatic abrasive cutting apparatus defined in claim 6 wherein said orifice in said first and second tubes is disposed near the bottom of said first and second vessels.

9. In a pneumatic cutting apparatus utilizing a source of gas under pressure to force an abrasive from a closed container, the improvement comprising:
   a check valve interconnecting said source of gas with the bottom of said container, adaptable for allowing gas to flow into said container; and
   a tube disposed from the upper end of said container to the lower end of said container, said tube having at least one orifice disposed through its wall, near the bottom of said container;

   whereby a line coupled to said lower end of said tube receives a flow of gas containing said abrasive.

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