A powder such as an abrasive powder is delivered from a pressure vessel (10) having an outlet (14) in the floor communicating with a flow of pressurised gas. A container (20) of the particulate material is located within the pressure vessel and has an outlet (21) to dispense small portions of the particulate material. The material in the container is at substantially the same pressure as that in the pressure vessel itself.
Abstract: A powder such as an abrasive powder is delivered from a pressure vessel (10) having an outlet (14) in the floor communicating with a flow of pressurised gas. A container (20) of the particulate material is located within the pressure vessel and has an outlet (21) to dispense small portions of the particulate material. The material in the container is at substantially the same pressure as that in the pressure vessel itself.
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IMPROVED PNEUMATIC DEVICE

The invention relates to a pneumatic device arranged to deliver a particulate material. One illustrative example of the device is to pneumatically deliver abrasive or polishing dental powder material. More particularly but not exclusively the invention is useful in so-called micro-airabrasion, e.g. in dentistry.

It is one object of the invention to provide a device for this purpose which is clean and reliable and easy to maintain.

According to the invention in one aspect there is provided apparatus for pneumatically delivery particulate material to a dental tool, the apparatus comprising:

- a pressure vessel having an outlet in the floor communicating with a flow of pressurised gas;

- a replaceable container containing the particulate material to be delivered, the container being located in the vessel at a distance above the floor and having an outlet located above the vessel outlet and dimensioned to supply a small amount of particulate material to the vessel outlet;

- means for supplying pressurised gas into the vessel and for circulating the pressurised gas about the container so that the material in the container is at substantially the same pressure as in the remainder of the vessel, and

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• power means to vibrate the vessel to cause the small amount of particulate material to exit from the outlet to fall towards the vessel outlet and be pneumatically transported via a pipeline at substantially uniform pressure to the dental tool.

The container is replaceable, and provided as an accessory. This can be sealed to avoid the risk of contamination before installation in the vessel.

Preferably at least the upper part of the container has translucent or transparent walls. When the container is mounted in a pressure vessel which protrudes above a housing the operator, e.g. a dentist, can easily see the level of material in the container.

Preferably the vessel is vibrated by a motor. Preferably the apparatus includes at least one switch arranged to energise or de-energise the motor in synchronism with the supply of pressurised gas.

Preferably the access to the interior of the vessel is via a top cap which has a pressure resistant seal, for example by a bayonet fitting arrangement.

In another aspect the invention provides a method of delivering particulate material pneumatically to a dental tool, the method comprising:

• locating a container containing the particulate material in a pressure vessel having an outlet in the floor, the outlet communicating with a flow of pressurised gas leading to the dental tool, the container having an outlet
located above the vessel outlet and arranged to deliver a small amount of
the particulate material to the vessel outlet;

- supplying pressurised gas into the vessel to entrain particulate material
  from descending from the outlet of the container; and

- actuating power means to vibrate the vessel to cause particulate material
  to exit from the outlet of the container to the outlet of the vessel whereby
  the material is delivered pneumatically at substantially uniform pressure of
  the dental tool.

In another aspect, the invention provides a container for use in apparatus as defined,
the container containing dental particulate material, and having an exit port in the
floor above a platform which together define an open sided chamber, the chamber
being releasably sealed by a stopper, the top of the container also having a
releasable seal.

In order that the invention may be well understood it will now be described by way of
example only with reference to the accompanying diagrammatic drawings, in which:

Figure 1 is a plan view of one apparatus, partly in section;

Figure 2 is an elevation partly in section of one pressure vessel having a
container;

Figure 3 is a transverse view of the vessel of Figure 2 taken on lines III-III;
and

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Figure 4 is a vertical section through another container.

The same reference numerals are used to describe the same parts in the different embodiments with the addition of a prime.

The apparatus shown in Figure 1 to 3 comprises a housing 1 containing two pressure vessel assembly P (the number may be varied). Each assembly comprises a generally cylindrical pressure vessel 10 mounted above a motor 11, e.g. a linear pneumatic vibrator, arranged to vibrate the vessel. The vessel wall is made of a translucent or transparent plastics. The vessel has a sloping floor 12 leading to the mouth 13 of a channel 14 extending chordally of the vessel and open at its ends. The inner wall surface at the top of the vessel has recesses 15 arrange to receive arms or wings 16 at the outer top of a container or cartridge 20. (There is a flat at one side for polarisation purposes.) The arms 16 define an annular gap 17 about the container 20. The container holds the particulate material to be dispensed e.g. aluminium oxide or sodium bicarbonate powder for dental use. The container has a row of small exit ports 21 in its flat floor 22, the ports being vertically above the mouth 13 of the channel 14. (The container is supplied with a tear off lid not shown, and in that condition the outside of the floor 21 is taped over to seal the holes; these are both removed just before installation in the vessel.)

The outside wall surface at the top of the vessel 10 has shoulders 23 to be engaged in bayonet fitting manner with those inside a cap 30 having a pressure sealing rubber or plastics washer 31.
When the cap 30 is fitted on the vessel 10 the entire volume is contained and may be supplied with pressurised gas, e.g. air in a leak-proof manner via a pipeline leading to the channel 14. Such air can circulate about the container 20 and reach the material at the top of the container by passing through the gap 17.

Air supply lines lead from an external supply to both pressure vessels and then to a valve block 40 containing three pinch valves. One line leads to an exhaust container 41; the others lead to the handpiece. The compressed air is separated on entry, one branch is factory set to 7 bar max going to the infinitely variable air pressure control and the infinitely variable vibrator control is factory set to say 4 bar, and supplies all the control circuitry.

An output line leads to a dental tool, having a tungsten tip and an aperture through which the material is delivered.

In use, the dentist visually checks the level of material in the containers 20 through the transparent wall. He selects which material he wants, he then presses a switch, e.g. a foot-pedal, which opens the respective valve in the valve block 40. The motor 11 is energised to vibrate the respective vessel 10. Pressured air flows through the channel 14 entraining particulate material from the container 20 and via the line to the tool tip where it is used e.g. to micro-abrade damaged areas of the tooth, e.g. decay along the side of a fissure. The abrasion not only removes defective substance, but leaves a keying surface for a subsequently applied adhesive filling composition. When the dentist switches off, the air supply stops and the motor is de-energised but
压空气仍然存在于容器内。多余的材料被排出到排气筒40。

由于被压缩的空气始终存在于容器的全部体积中以及颗粒状材料在容器内的部分，因此没有出现压力激增现象。因此总是存在一种均匀的颗粒状材料的运输，颗粒状材料不会因为一个错误而造成混乱，又几乎没有浪费。因为被密封的容器被提供，因此存在低的污染风险。

在图4的实现中，容器或药筒20'具有单一的出口孔21'在地板22'的上方一个较低的平台50。地板22'的下方和平台50，以及垂直的墙壁51定义了一个房间，但它通过一侧52是开放的。房间的体积可以由墙壁51的高度和平台50的面积来变化。粉末P通过单一的出口孔21'落下到平台50并形成一堆松散的颗粒。当被压缩的空气被提供时，很简单地推动粉末掉到主要出口出的容器。

在容器20'中的粉末没有被压得这样紧以至于堵塞出口孔21'。空气压力可能是低的，大约7巴，这低于通常的水平。粉末可能被在低力作用下，例如，线性气动振荡器所振动。
The container will usually be shipped full of the particulate material with a plate-like stopper, not shown, filling the open chamber to prevent premature escape of the powder. This is removed just before installation in the main vessel. The top of the container is also covered by a releasable seal.

The apparatus enables the user to easily switch between types of cutting media in the different vessels. The system is totally pneumatic and can either work directly from an existing air supply, an independent compressor or from bottled gas, provided that the air pressure is within a specified input say of 5 to 8bar. This initiates the vibrators which start coincidentally with the output of air into the hand piece. Once the foot pedal is released, the air is instantly cut off and any residual air/powder mix is allowed to escape into a dust collecting exhaust vessel 40 situated at the rear of the unit. The output from the receptacles is controlled by the pinch valves which allow the abrasive powder to pass through without detriment to the pneumatic control devices. The general layout is such that servicing is simple and the parts are accessible. The housing can be easily be wiped cleaned with cleaners as recommended in the maintenance section of this manual.

The replaceable tips are made from high quality stainless tubing with tungsten carbide nozzles with a choice of 0.4mm, 0.6mm and 0.8mm diameter orifice.

To set up the device a high pressure hose, not shown, which is both flexible but non kinking, 4mm outside diameter of a suitable length is connected from the air supply to a push-in connector (not shown) at the back of the housing 1 and a foot control switch is connected to the two inlet compression fittings
situated at the back of the housing. The air should not be switched on until the following have been attended to:

1. The foot pedal sited in a convenient position.

2. The vessels are located in their recommended positions (fine in the left and medium in the right).

3. Both the caps secured.

4. The correct diameter nozzle screwed into the hand piece.

5. Protective eye wear is placed on the patient, the operator and the assistant(s).

6. Aspirators switched on and ready to use (intra oral and external).

7. Protective cape placed over the patients clothes.

1. When replacing the powder containers, ensure that the sealing strip at the bottom is completely removed before peeling off the top seal. Carefully lower the powder receptacle into the vessels guided by arms 16 ensuring that it is fully seated. Replace the caps, apply light downward pressure, turn in a clockwise direction until positive resistance is felt.
2. Turn on the air at the front of the housing. This will cause a hissing sound as the two vessels are charged with pressurised air.

3. Select the material to use by turning the switch either to "FINE" or "MEDIUM" (which refers to the vessels).

4. Set the air pressure and mixture controls.

5. Select and fit nozzle to the hand piece.

The device is now ready for use as soon as the foot switch is depressed.

It is advantageous to switch the device off when not in use. Apart from preventing accidental switching on by treading on the foot switch, it also preserves the integrity of the pinch valves. The exhaust vessel 40 collects all the residual particles left in the system. This should be emptied at the end of every surgery.

The device is very versatile, as illustrated by the following:

Cleaning: Switch to "FINE" (sodium bicarbonate) air pressure 6bar mixture 1.5bar, nozzle φ0.6-0.8mm.

Scaling: Switch to "MEDIUM" (50μm aluminium oxide) air pressure 4bar, mixture 1.5bar, nozzle φ0.6-0.8mm. finish as with “Clean” setting.
Fissure sealant:  Switch to "MEDIUM" (50μm aluminium oxide) air pressure 6bar, mixture 1.5bar, nozzle φ0.4-0.6mm.

Cavity Prep.:  Switch to "MEDIUM" (50μm aluminium oxide) air pressure 6bar, mixture 2bar, nozzle φ0.4-0.6mm (depending on size of pre.)

Root planning:  Switch to "MEDIUM" (50μm aluminium oxide) air pressure 6bar, mixture 1.5bar, nozzle φ0.6/0.8mm. finish as with "Clean" setting.

Orthodontics:  Switch to "MEDIUM" (50μm aluminium oxide) air pressure 4bar, mixture 1.5bar, nozzle φ0.8mm.
WHAT IS CLAIMED IS:

1. Apparatus for pneumatically delivering particulate material to a dental tool, the apparatus comprising:
   - a pressure vessel (10) having an outlet (13) in the floor (12) communicating with a flow of pressurised gas;
   - a replaceable container (20, 21') containing the particulate material to be delivered, the container being located in the vessel (10) at a distance above the floor (12) and having an outlet (21, 21') located above the outlet (13) and dimensioned to supply a small amount of particulate material to the outlet (13);
   - means for supplying pressurised gas into the vessel (10) and for circulating the pressurised gas about the container (20, 20') so that the material in the container (20, 20') is at substantially the same pressure as in the remainder of the vessel (10), and
   - power means to vibrate the vessel (10) to cause the small amount of particulate material to exit from the outlet (21, 21') to fall towards the outlet (13) and be pneumatically transported via a pipeline at substantially uniform pressure to the dental tool.

2. Apparatus according to claim 1, wherein the chamber (20, 20') is removably sealed by a releasable seal to provide a transportable container containing particulate material.

3. Apparatus according to claim 1 or 2, wherein the access to the interior of the vessel is via a top cap which has a pressure resistant seat.

4. Apparatus according to claim 3, wherein the cap is engaged with the top of the vessel by a bayonet fitting arrangement.
5. Apparatus according to any one of claims 1 to 4, wherein at least the upper part of the container has translucent or transparent walls.

6. Apparatus according to any one of claims 1 to 5, including a pressure receptacle to receive any particulate material in the pipeline left when the supply of gas is switched off.

7. Apparatus according to any one of claims 1 to 6, wherein the chamber (20') is open sided and has a platform (50) below a single exit port (21') which is arranged so that the particulate material will descend from the outlet on to the platform (50).

8. A method of delivering particulate material pneumatically to a dental tool, the method comprising:
   • locating a container containing the particulate material in a pressure vessel having an outlet in the floor, the outlet communicating with a flow of pressurised gas leading to the dental tool, the container having an outlet located above the vessel outlet and arranged to deliver a small amount of the particulate material to the vessel outlet;
   • supplying pressurised gas into the vessel to entrain particulate material from descending from the outlet of the container; and
   • actuating power means to vibrate the vessel to cause particulate material to exit from the outlet of the container to the outlet of the vessel whereby the material is delivered pneumatically at substantially uniform pressure to the dental tool.

9. A container (20, 20') for use in an apparatus according to claim 1, the container containing dental particulate material, and having an exit port (21') in the floor above a platform (50) which together define an open sided chamber, the port (21') chamber being releasably sealed by a stopper, the top of the container also having a releasable seal.