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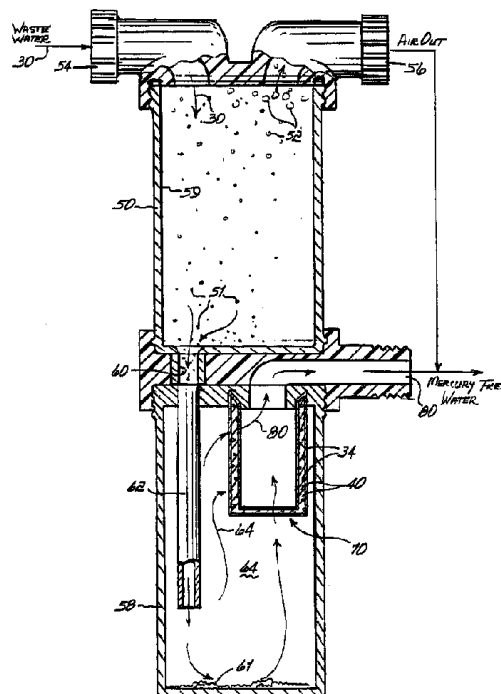
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(54) **DISPOSITIF ET PROCEDE DE TRAITEMENT DE FLUX DE DECHETS D'ORIGINE DENTAIRE**
(54) **DEVICE AND METHOD FOR TREATING DENTAL WASTE STREAMS**

(57)

A device and method for safe, efficient and easy decontamination of waste streams, particularly dental waste streams. The contaminated stream (30), which may contain toxic metals such as mercury, contacts the inventive unit (31, 70) that both physically and chemically filters contaminants in a single stage. The unit (31, 70) contains a contaminant binding resin (34) and a mechanical filter (14), which removes both soluble and insoluble forms of the contaminant. The device and method reduce contaminants to levels which meet regulatory agency requirements for toxic metals. The device and method also allow safe handling and transport of the contaminated unit (31, 70).





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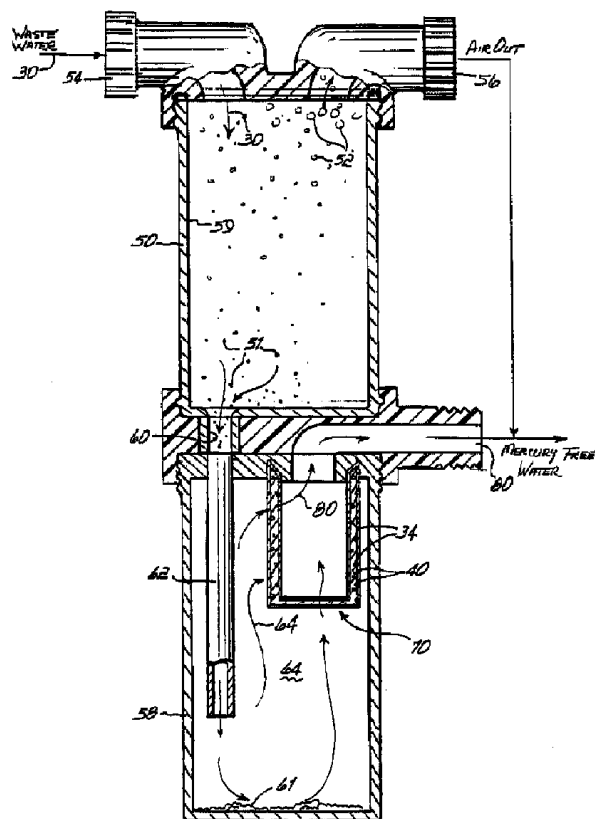
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(57) **Abrégé(suite)/Abstract(continued):**

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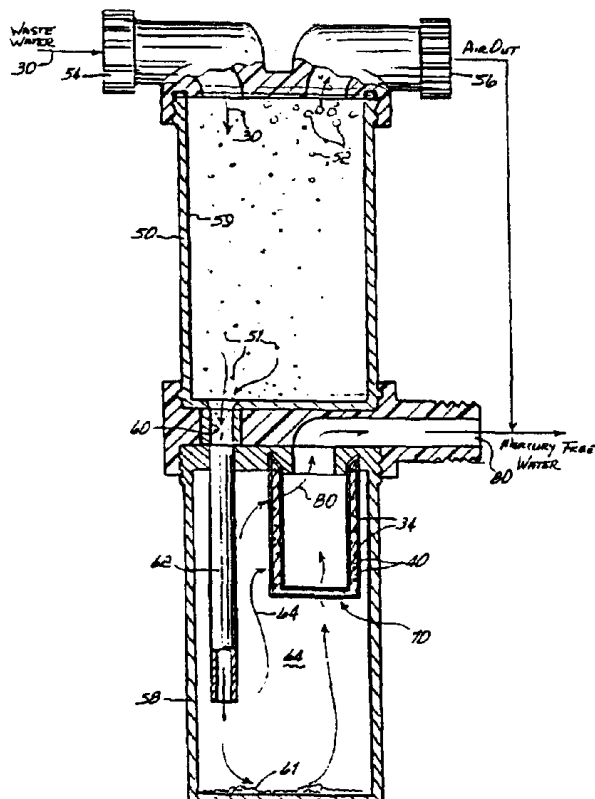
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(54) Title: DEVICE AND METHOD FOR TREATING DENTAL WASTE STREAMS



(57) Abstract: A device and method for safe, efficient and easy decontamination of waste streams, particularly dental waste streams. The contaminated stream (30), which may contain toxic metals such as mercury, contacts the inventive unit (31, 70) that both physically and chemically filters contaminants in a single stage. The unit (31, 70) contains a contaminant binding resin (34) and a mechanical filter (14), which removes both soluble and insoluble forms of the contaminant. The device and method reduce contaminants to levels which meet regulatory agency requirements for toxic metals. The device and method also allow safe handling and transport of the contaminated unit (31, 70).

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DEVICE AND METHOD FOR TREATING DENTAL WASTE STREAMS

This application claims priority from co-pending U.S. provisional application Serial No. 60/162,031, filed October 28, 1999.

Field of the Invention

The invention is a method and device for the removal of debris and contaminants from dental waste streams.

Background

5 Aqueous dental waste streams contain dental amalgam, saliva, blood, cellular tissue and pieces of dental appliances as part of a waste water slurry. Dental amalgam, which generally is a mixture of silver (34.5%), mercury (42.5%) and other metals (notably copper (8.0%), tin (15.0%) and zinc), is a common dental restorative material for use in the repair of teeth.

10 Pieces of amalgam are suctioned by the dentist from the patient's mouth and enter the waste stream from the dental operatory.

 Current methods to capture these particles employ amalgam traps. The traps, usually 40 mesh mechanical filters, physically trap and collect only the larger amalgam particles. The traps also do not remove any

15 of the soluble metal ions that may leach out from the amalgam as part of the

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usual dental operations, nor do they remove amalgam particles or other particles that are small enough to pass through the filter.

Since the traps are changed or cleaned only periodically, typically biweekly or monthly, trapped amalgam particles remain in the waste stream for extended periods of time. Hence, some metallic components of the amalgam, such as mercury, become water soluble and thereby enter the environment. This process is greatly accelerated by oxidizing disinfectants used to clean the dental operatory.

Mercury is classified as a toxic material by the Environmental Protection Agency. Discharge of mercury into the environment is regulated by governmental agencies. It has been estimated that dental operatories annually contribute over 30 million gallons of mercury-contaminated water through their waste streams into the environment. Current technologies are unable to capture the toxic portion of dental waste, including the soluble form of mercury as well as other solubilized amalgam metals, before it is discharged via waste lines into the environment. In fact, recent studies have shown that dental facilities contribute between 10 and 25% of the mercury that enters local publicly owned treatment works, many of which are struggling to meet mercury discharge requirements.

Previous methods for removing dissolved metal ions, more particularly for removing dissolved mercury ions from aqueous waste streams, include numerous electrolytic methods, chemical precipitation and filtration methods, vaporization and condensation methods, and related methods and associated devices. All of these approaches may work well on a relatively

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large industrial scale. However, these methods are too cumbersome, too expensive, and are not readily adaptable to a dental waste stream from a typical dental operator, which is generally small and may include one or more dentists (and dental chairs) and technicians.

5 Devices previously disclosed, such as in U.S. Pat. No. 5,795,159, relate to the removal of particulate matter and insoluble metals, including mercury, from dental waste streams, but do not address the soluble portion of these materials. A device and method for the removal of both insoluble and soluble metals from dental waste streams is disclosed in U.S. Patent.
10 No. 5,885,076; however, it is not readily incorporated into existing dental operatories and facilities because of its complexity. The devices described above, as well as other devices disclosed in the prior art, do not remove both soluble and insoluble contaminants, or require spatially separated steps and/or components that are connected with conduits to remove both soluble and
15 insoluble contaminants.

Thus, a device and method that can be easily incorporated into existing systems for removing waste stream contaminants, such as metal ions found in dental operator waste, is needed.

Summary of the Invention

20 While the invention has numerous applications, it is particularly described herein for use in efficiently and effectively removing contaminants from dental waste resulting from procedures conducted on patients in dental offices.

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The invention provides a single stage unit which provides a dual effect: it removes both soluble and insoluble contaminants from dental waste streams. This is an advantage over existing systems which either do not provide the dual effect, or require two stages to achieve the dual effect.

5 In particular, the invention contemplates the combination of chemical and mechanical purification of a waste stream in a single stage. Waste is introduced directly for mechanical and chemical purification without passing through any intermediary conduits, passageways, or other connections. In this way, a two-part purification can be carried out in a single
10 stage device that is easily incorporated into an existing waste line without interconnections of plural devices.

Structurally, a screen mechanically retains particulates and/or insoluble contaminants from the waste stream, and a closely adjacent resin chemically retains soluble contaminants from the waste stream. In various
15 embodiments, the invention incorporates an air/water separation chamber, a sedimentation chamber, and introduction of a sanitizing or disinfecting agent.

In use, the invention is readily connected to an existing waste stream to remove dental debris and contaminants, including both insoluble and soluble ions such as mercury, silver, copper, and related dental amalgam
20 metals. The invention is sufficiently compact to fit in a dental office's mechanical closet, and does not interfere with operation of the dental vacuum system. The invention provides dentists with a cost-effective, single waste removal device that ensures the permanent capture of both particulate and solubilized metals, such as mercury as well as other contaminants, from dental

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waste streams. No additional expensive mechanical or filtration equipment is required, nor is an additional motive force of a pump. No additional plumbing is required, since the unit may simply be spliced into an existing vacuum line. The apparatus and materials of construction are robust to vacuum pressure, oxidants, and other sanitizing agents.

Furthermore, the resin incorporated or contained in the inventive device is not regenerated; therefore, no regeneration chemicals are required, nor is there creation of hazardous liquid waste from regeneration. The apparatus allows dentists to continue to use amalgam in their practice, while greatly lowering the risk of contaminating the environment with mercury and other dissolved metals contained in the amalgam. Used devices, or portions thereof, can be retorted, thus permitting recovery of mercury that, otherwise, would be released into the environment.

The invention thus lowers toxic metal ion concentrations in dental waste streams. By combining the actions of air/water separation, sedimentation, mechanical filtration and/or chemical filtration, the invention achieves lower effluent concentration of metals than amalgam traps alone.

Other aspects and advantages of the invention will be apparent in view of the following drawings, detailed description, and examples.

20 Brief Description of the Figures

FIG. 1 is an exploded view of a trap apparatus currently used in dental practice.

FIG. 2 is as axial cross sectional view of an assembled trap apparatus shown in FIG. 1

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FIG. 3 is a perspective view of a screen containing a contaminant binding resin as in FIG. 1.

FIG. 4 is a front view partially in cross section of an alternative filter comprising a porous molded cup containing a contaminant binding resin.

5 FIG. 5 is a schematic cross sectional view of an alternative embodiment of the inventive device.

FIG. 6 is another alternative embodiment of the invention.

Detailed Description

In one embodiment, the inventive device is designed to fit into an
10 apparatus that is used currently in dental practices to trap contaminants. Contaminants include, but are not limited to, amalgam components, biological contaminants, particulates, organic contaminants, etc. The device is intended to be used upstream of the vacuum pump, that is, on the vacuum side of the pump in the vacuum line in a dental office. The device either augments or
15 replaces the mesh screen component of currently used devices.

With reference to FIGS. 1 and 2, a dental waste stream 30 flows in the direction of the arrows through trap 31. The waste 30 flows into the trap 31 through an opening 26 on the side of a trap head 22, then is directed downward through an opening 24 in the center of the head 22, through a
20 mesh screen 14, radially outward and upward to the head 22 and out through opening 28 of the head 22.

The screen 14 is located within a container 10. A gasket 18 is used between the head 22 and container 10. The trap head 22 has a fitting with a threaded connector 24 to the container 10, and threaded openings 26,

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28 for fittings to provide a means of delivering the waste stream 30 to and from the trap 31. A threaded cap 39 (shown in phantom in FIG. 1) for container 10 is capable of hermetically sealing the container 10 once it has been used and contains trapped contaminants such as amalgam. After use
5 and when the trap 31 is to be removed, the container 10 is detached and the head 22 is replaced with the cap 39. The hermetically sealed used container 10 can then be safely transported and delivered to an appropriate recovery or disposal facility.

With reference to FIG. 3, a cylindrical mesh screen 14 as
10 contained in a standard trap is modified to include a contaminant binding resin 34. The resin 34 is a metal binding resin, particularly a mercury absorbing resin, one suitable example of which is Keyle:X[®] resin, manufactured by and available from SolmeteX (Billerica, MA). Other mercury absorbing resins, however, may be used, for example, Duolite GT-73 (Rohm and Haas,
15 Philadelphia, PA), Ionac SR-4 (Sybron, Birmingham, PA), S-930 (Purolite, Bala Cynwyd, PA), Mersorb (ALCOA, Pittsburgh, PA), and Lewatit TP 214 (Bayer AG Leverkusen, Pittsburgh, PA). The particular resin does not form part of the inventive system and method.

The resin 34 may be contained in a device, such as a rectangular
20 pleated flexible polypropylene mesh bag 32, that is wrapped around the screen 14 (FIG. 2). Alternatively, the bag 32 a resin-containing device, may be sized to fit within the container 10 of the trap 31. In this embodiment, the screen 14 is rendered unnecessary by incorporating or imbedding the contaminant binding resin 34 directly into a molded, porous (foam-like or related) cup 36

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that is sized and shaped to fit into the container 10 of the trap 31, as shown in FIG. 4. The cup 36 contains about 80 grams of resin 34 and fits in the trap 31.

The trap 31 may be porous or permeable, and may be disposable
5 or reusable. The trap 31 containing the contaminant binding resin 34 in any embodiment may also contain a powder, fiber, glass or a related substrate designed or selected for the removal of soluble and insoluble contaminants, such as mercury, from dental waste streams. The trap 31 may also contain a sanitizing or oxidizing material 40, such as an iodated resin.

10 In yet another embodiment of the invention, and with reference to FIG. 5, a separate three phase contaminant-removing system is disclosed. In this embodiment, the waste flow 30 initially enters an air/liquid separation chamber 50 via inlet port 54. The air/liquid separator chamber 50 is of sufficient volume to slow down the flow of air 52 in waste flow 30 enough
15 to allow the entrained solids and liquids 51 to drop to the bottom of the chamber 50. Air is removed through a port 56 at the top of the air/liquid separation chamber 50. This allows the liquid waste flow 30 to pass into a settlement chamber 58 for contaminant removal with no interruption to a dental vacuum system. Liquid waste flow 30 continues through an opening
20 60 in the bottom of the air/liquid separation chamber 50. The air/liquid separation chamber 50 may be coated with a hydrophobic or oleophobic material 59 to minimize foaming and bubble formation in the waste flow 30.

The settlement chamber 58 is located below, preferably directly below, the air/liquid separation chamber 50. It is sufficiently large to allow

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enough residence time for the particulate matter 61 in the waste flow 30 to settle to the bottom of the chamber 58. The waste flow 30 enters the settlement chamber 54 via a tube 62 extending from the air/liquid separation chamber 50 to about two-thirds of the way into the settlement chamber 58.

5 This allows the path of the waste flow 30 to be in an upflow mode as liquid accumulates. The heavier solids and particulate matter 61 settle to the bottom of the chamber 54, while the clarified liquid 64 rises toward the top of the chamber 54.

The clarified liquid 64, free of large particulates and sedimenting
10 material but still containing soluble contaminants and smaller particulates, then flows through a contaminant binding resin 34. The resin 34 is contained in a molded insert or cup 78 located near the top of the chamber 54. The interstitial spaces of the porous molded resin insert or cup 78 may be small enough to perform mechanical filtration on the remaining particulate. The
15 treated liquid, now containing reduced levels of contaminants, then exits through a line 80 for recombination with the air stream. The port 56 in the air/liquid separation chamber 50 through which air was removed is connected to line 80.

The contaminant binding resin 34 contained in an insert 70 that
20 is positioned to permit the liquid 62 to either flow over or percolate through the resin 34 before exiting from the settlement chamber 54. The insert 70 may be porous or permeable, and may be disposable or reusable. The insert 70 contains one or more contaminant binding resins 34, as previously described, and may also contain powder, fiber, glass or a related substrate

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designed or selected for the removal of soluble and insoluble contaminants, such as mercury, from dental waste streams 30. The insert 70 may also contain a carbon based adsorbent or related material. The insert 70 may also contain a sanitizing or oxidizing material, such as an iodated resin 40. The

5 iodated resin 40 provides microbial control for increased safety and convenience to the dental worker, while also ensuring the appropriate speciation of the dissolved mercury or other metals for optimal metal binding.

The insert 70 entraps particulate matter and acts as a mechanical filter. One embodiment of the insert 70 incorporates an inert binder such as

10 high density polyethylene to form the metal binding resin 34 into a rigid porous insert 72. Another embodiment of the insert 70 incorporates a porous container or vehicle, which may be, for example, a heat sealed flexible screen pouch 74 that is filled with a metal binding resin 34, as shown in FIG. 6.

The trap 31 or insert 70 or sedimentation cartridge 54 may be

15 sent to an approved retort/recovery facility when the binding capacity of the resin is exhausted, or at defined or periodic times. The sedimentation chamber 58 is easily detached, for example, by threads, pins and a gasket system, from the air/liquid separation chamber 50 and from inflow and outflow lines. The entire cartridge, containing contaminant-laden solids and soluble contaminants

20 bound to the adsorbent resin 34, is sent for retorting.

An advantage of the present invention is that the waste stream 30 need not pass through a packed resin bed for effective metal removal. Rather, the waste stream 30 passing over the resin 34 via percolation, with resin 34 in a container 32 surrounding a screen 14, in a porous cup 36, or in

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an insert 70, results in sufficient contact with the resin to permit binding of the contaminants.

Table 1 shows the test results of a typical dental waste stream 30 before and after treatment with one embodiment of the present invention 5 containing the Keyle:X® resin.

TABLE 1

Sample Date	Influent to System Total Hg (ppm)	Effluent from System Total Hg (ppm)	Mercury Removal (%)
Day 1	4,290.0	106.0	97.5%
Day 2	1,190.0	5.3	99.6%
Day 3	585.0	1.0	99.8%
Day 4	1,570.0	25.5	98.4%
Day 5	6,130.0	69.0	98.9%
Day 6	20,500.0	17.2	99.9%
Day 7	2,720.0	12.8	99.5%
Average	5,283.6	33.8	99.1%

As shown by the levels of mercury remaining in dental waste after treatment with a separator containing the inventive trap, the inventive trap is effective in reducing total mercury concentrations by about two orders of magnitude.

Table 2 shows the test results of a soluble mercury stream with concentrations before and after treatment with the cup embodiment of the invention.

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TABLE 2

	Porous Cup #1	Porous Cup #2	Porous Cup #1	Porous Cup #2
Flow Rate	150 ml/min	150 ml/min	50 ml/min	50 ml/min
Influent (ppb)	154	170	152	254
5 Effluent Sample 1 (ppb)	1.0	1.3	0.7	2.2
Effluent Sample 2 (ppb)	1.5	2.0	0.7	2.1
Effluent Sample 3 (ppb)	1.6	2.2	0.7	2.2
Effluent Sample 4 (ppb)	1.9	3.2	0.5	1.7
Effluent Sample 5 (ppb)	2.3	3.8	0.6	2.9
10 Effluent Sample 6 (ppb)	1.7	2.5	0.6	2.1

As shown by comparison of mercury levels in the influent and effluent, the inventive device is effective in removing mercury concentrations down to the part per billion level, and reducing soluble mercury concentrations on the order of two orders of magnitude.

It should be understood that the embodiments of the present invention shown and described in the specification are only preferred embodiments of the inventor who is skilled in the art and are not limiting in any way. Therefore, various changes, modifications or alterations to these embodiments may be made or resorted to without departing from the spirit of the invention and the scope of the following claims.

What is claimed is:

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1. A method for removing at least one contaminant from a contaminated dental stream comprising contacting said contaminated stream with a combined physical and chemical filtration unit under conditions sufficient to remove said contaminant from said stream to yield a
5 decontaminated waste stream.
2. The method of claim 1 including connecting said unit in-line with an existing contaminated stream.
3. The method of claim 1 comprising contacting a stream contaminated with a metal.
4. The method of claim 3 wherein said metal is selected from the group consisting of mercury, tin, silver, copper, and combinations thereof.
5. The method of claim 1 wherein said physical filtration removes an insoluble contaminant in said stream and said chemical filtration removes a soluble contaminant in said stream.
6. The method of claim 1 including directing said contaminated stream into a chamber for separating air before contacting said stream with said unit.

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7. A method for decreasing a concentration of least one contaminant present in soluble and insoluble forms in a waste stream comprising exposing said stream to a filtering unit wherein said insoluble form of said contaminant is physically retained by said filtering unit and said soluble form of said
- 5 contaminant is chemically retained by said filtering unit under conditions wherein contact of said waste stream with said filtering unit decreases said contaminant concentration.
8. The method of claim 7 including contacting a stream containing dental waste.
9. The method of claim 8 including contacting a stream containing dental amalgam.
10. The method of claim 8 including percolating said stream through said filtering unit.
11. The method of claim 8 including flowing said stream over said filtering unit.
12. The method of claim 8 including decreasing said contaminant concentration so that said stream contains less than 10 ppb of said contaminants.

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13. A method for treating contaminants from a dental stream comprising
- 5 exposing said stream to a unit containing at least one contaminant binding resin and a mechanical filter in line with said stream under conditions sufficient to decrease a concentration of said contaminants in said stream,
- removing said unit from said contaminated stream, and
- confining said contaminated resin and filter in said unit.
14. The method of claim 13 including exposing said stream to said unit a plurality of times before removing and confining said unit.
15. The method of claim 13 further comprising retorting said removed unit.
16. The method of claim 13 including exposing said stream containing at least one metal contaminant.

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17. A method for removing at least one contaminant from a contaminated dental comprising
- directing said contaminated stream into a first deaeration chamber to form a deaerated stream and thereafter to an adjacent sedimentation
- 5 chamber to form a clarified stream, and
- contacting said deaerated clarified stream with a unit contained in said sedimentation chamber, said unit containing at least one contaminant binding resin and a filter to form a decontaminated stream.
18. The method of claim 17 wherein said deaerated clarified stream percolates through said resin.
19. The method of claim 17 wherein said deaerated clarified stream flows over said resin.
20. The method of claim 17 further comprising aerating said decontaminated stream.

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21. An apparatus capable of sequestering at least one contaminant from a contaminated dental stream comprising a unit containing at least one contaminant binding resin and a filter, said unit insertable in-line with said contaminated stream to contact said stream and thereby sequester said
5 contaminant.
22. The apparatus of claim 21 wherein said unit is located in a chamber for sedimenting said contaminant before contacting said stream with said resin and filter.
23. The apparatus of claim 21 wherein said filter is a molded porous cup.
24. The apparatus of claim 21 wherein said resin is a metal binding resin.
25. The apparatus of claim 21 further comprising a sanitizing material.
26. The apparatus of claim 21 further comprising an oxidizing material.
27. The apparatus of claim 21 wherein said resin is iodinated.

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28. The apparatus of claim 21 including a deaerating chamber disposed upstream of said resin and said filter.

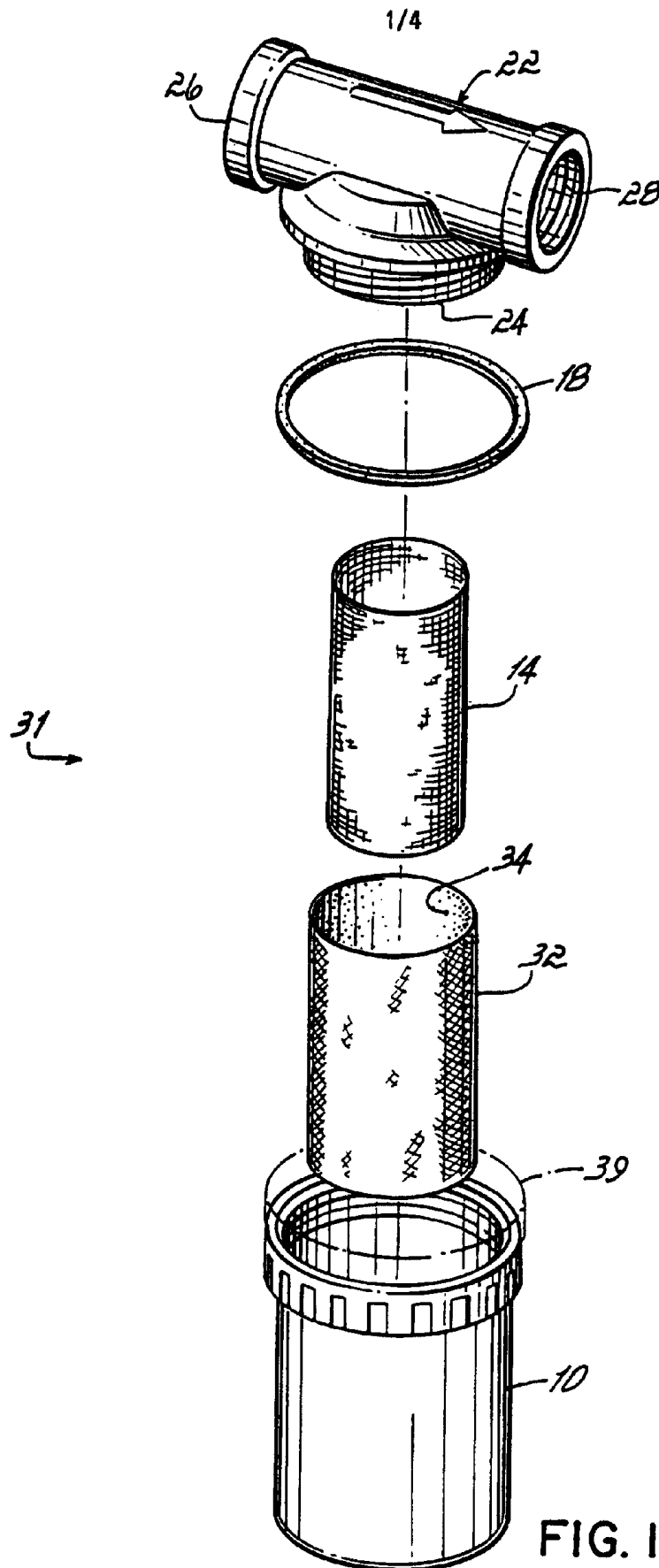


FIG. 1

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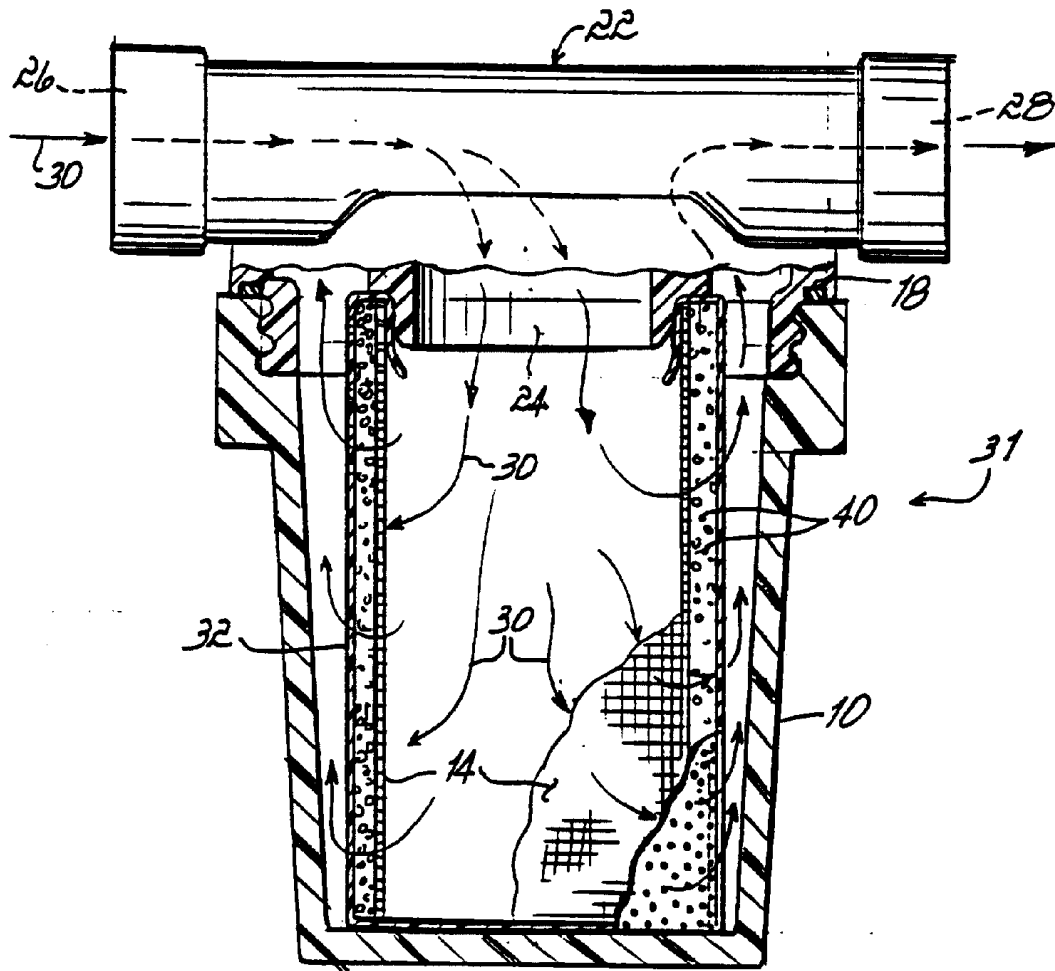


Fig. 2

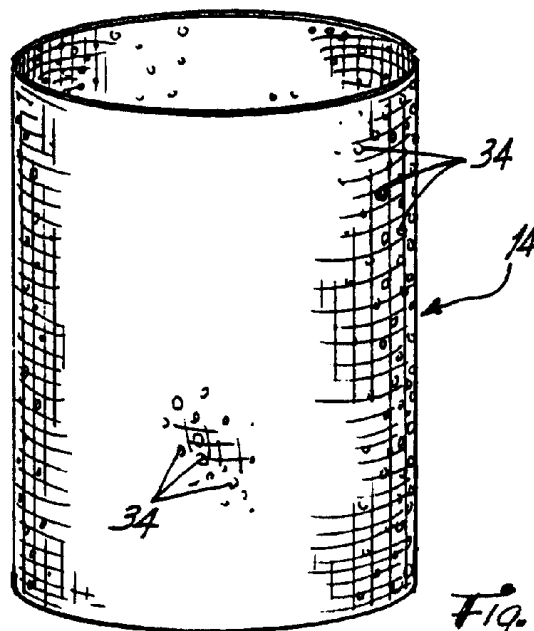
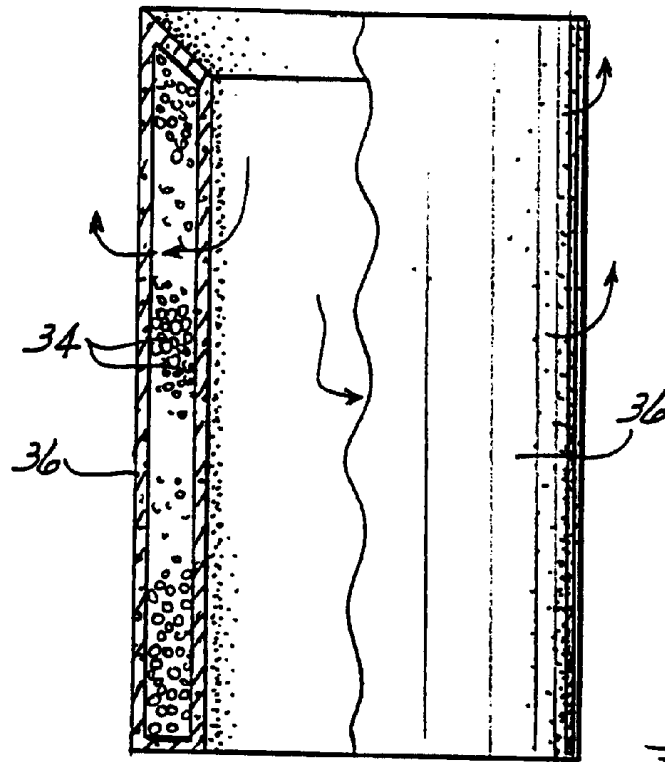
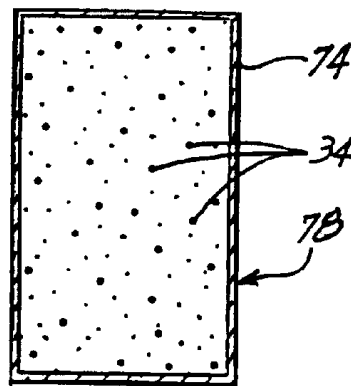


Fig. 3

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