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(54) **STORMWATER TREATMENT SYSTEM**

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B01D 29/90 (2006.01)
B01D 35/02 (2006.01)
B01D 29/48 (2006.01)

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B01D 29/902 (2013.01); **B01D 2201/06**
(2013.01); **B01D 29/48** (2013.01); **B01D 35/02**
(2013.01); **B01D 2221/12** (2013.01); **E03F**
5/14 (2013.01)

(58) **Field of Classification Search**

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B01D 29/48; B01D 35/02; B01D 2201/06;
B01D 2221/12

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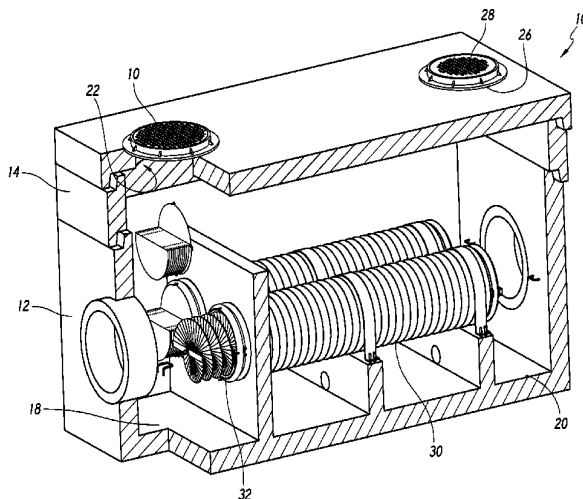
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(57) **ABSTRACT**

A stormwater treatment system includes water treatment media that defines a helical flow path within a conduit. The water treatment media may include a plurality of helical water treatment media components that are constructed and arranged to seal against an inside surface of the conduit. The individual helical water treatment media components may be installed in situ within the conduit when the conduit is positioned within a chamber having an access opening, and periodically removed and replaced by passing the components to the access opening. The components further may have a flexible frame, which allows the water treatment media to dynamically adjust to swelling of the filtration media and other forces that may occur during use. The performance of the system may be adjusted by adjusting the helical pitch of the helical water treatment media components.

17 Claims, 9 Drawing Sheets



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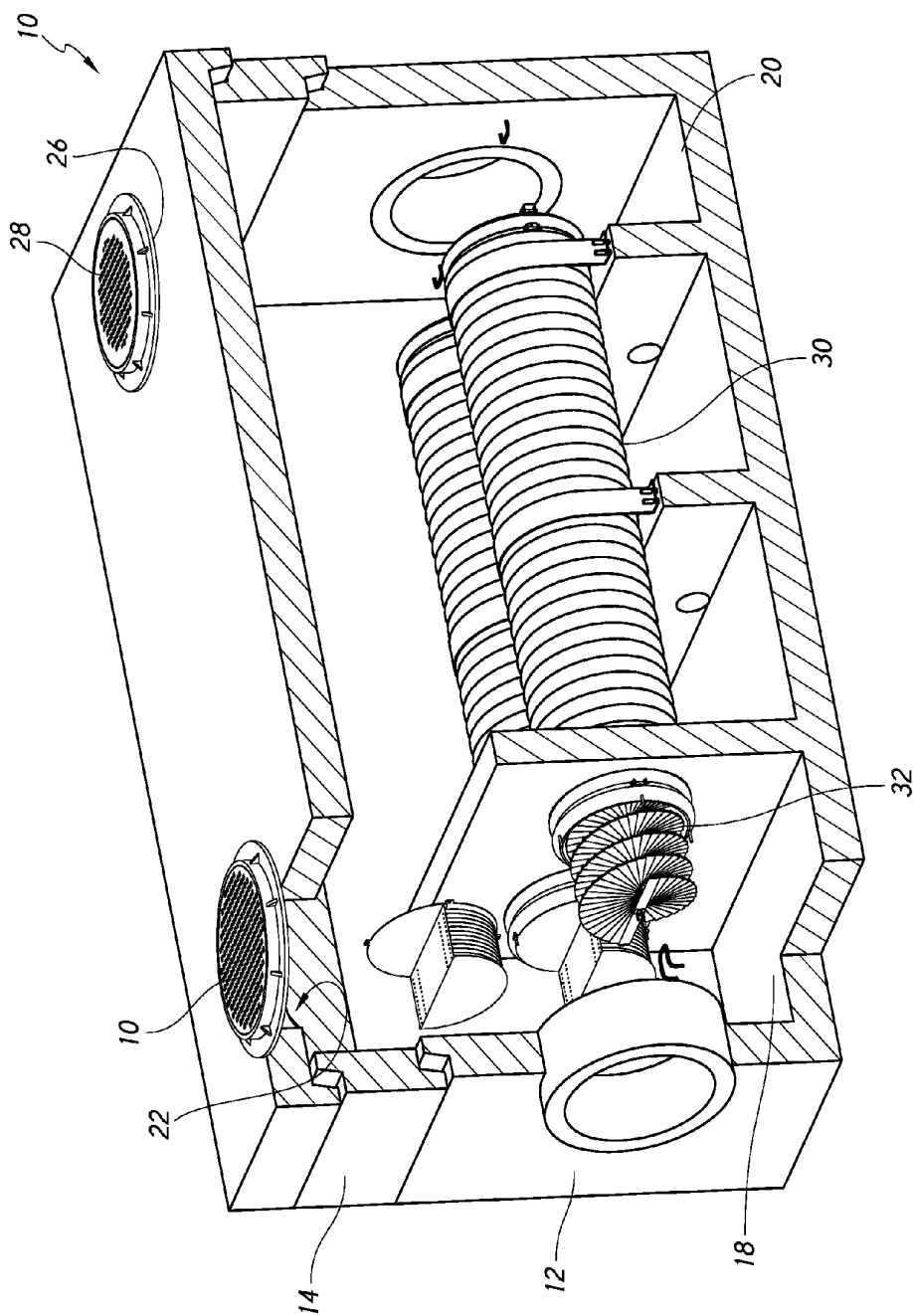


FIG. 1

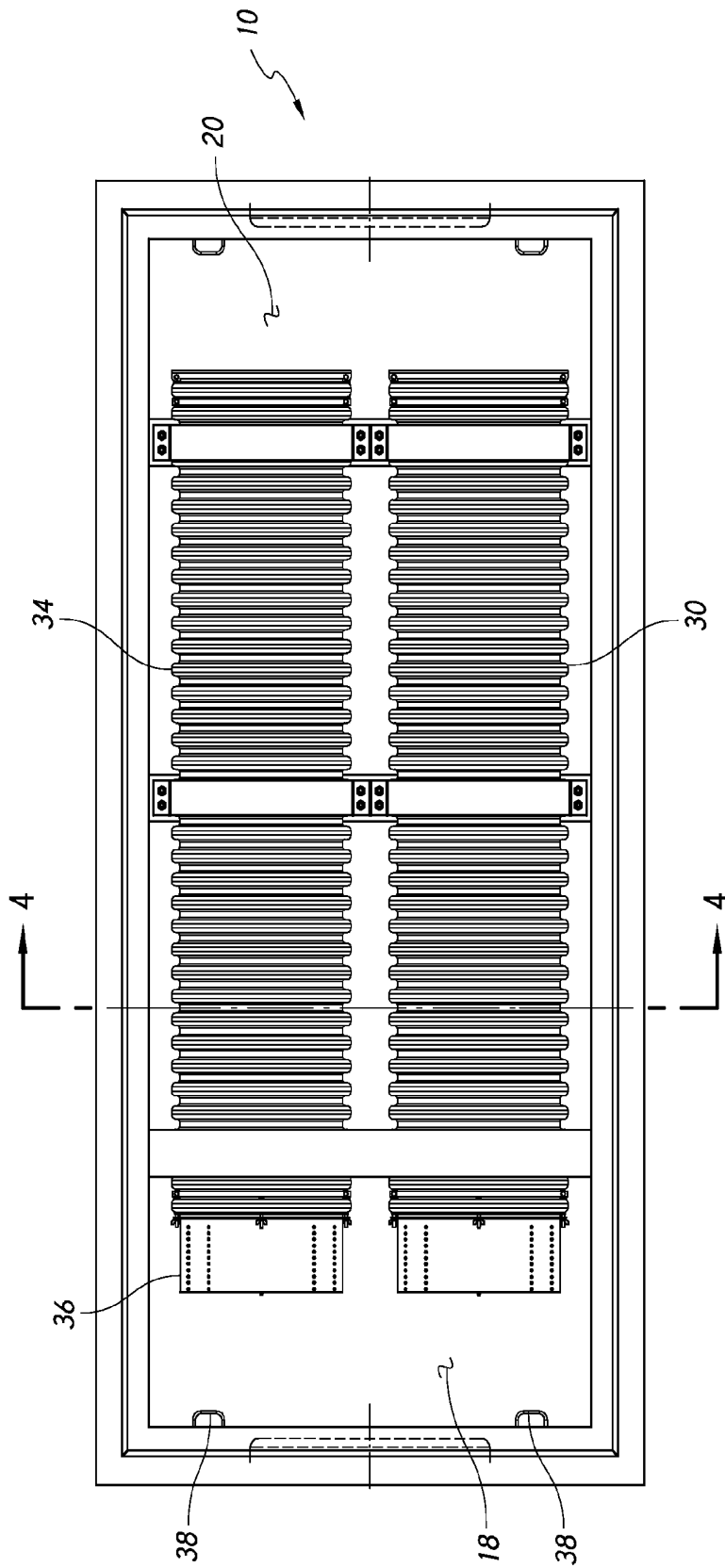


FIG. 2

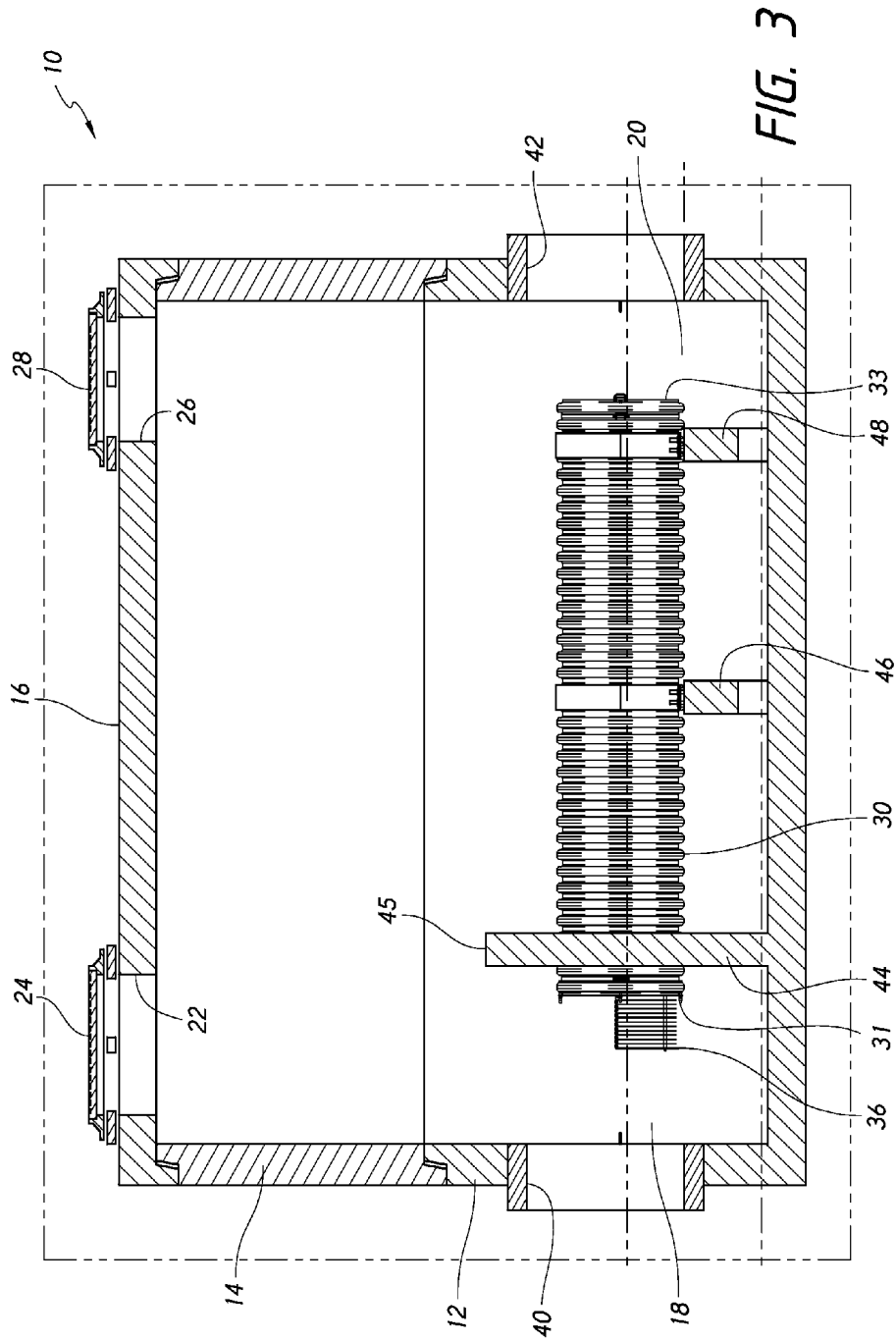


FIG. 3

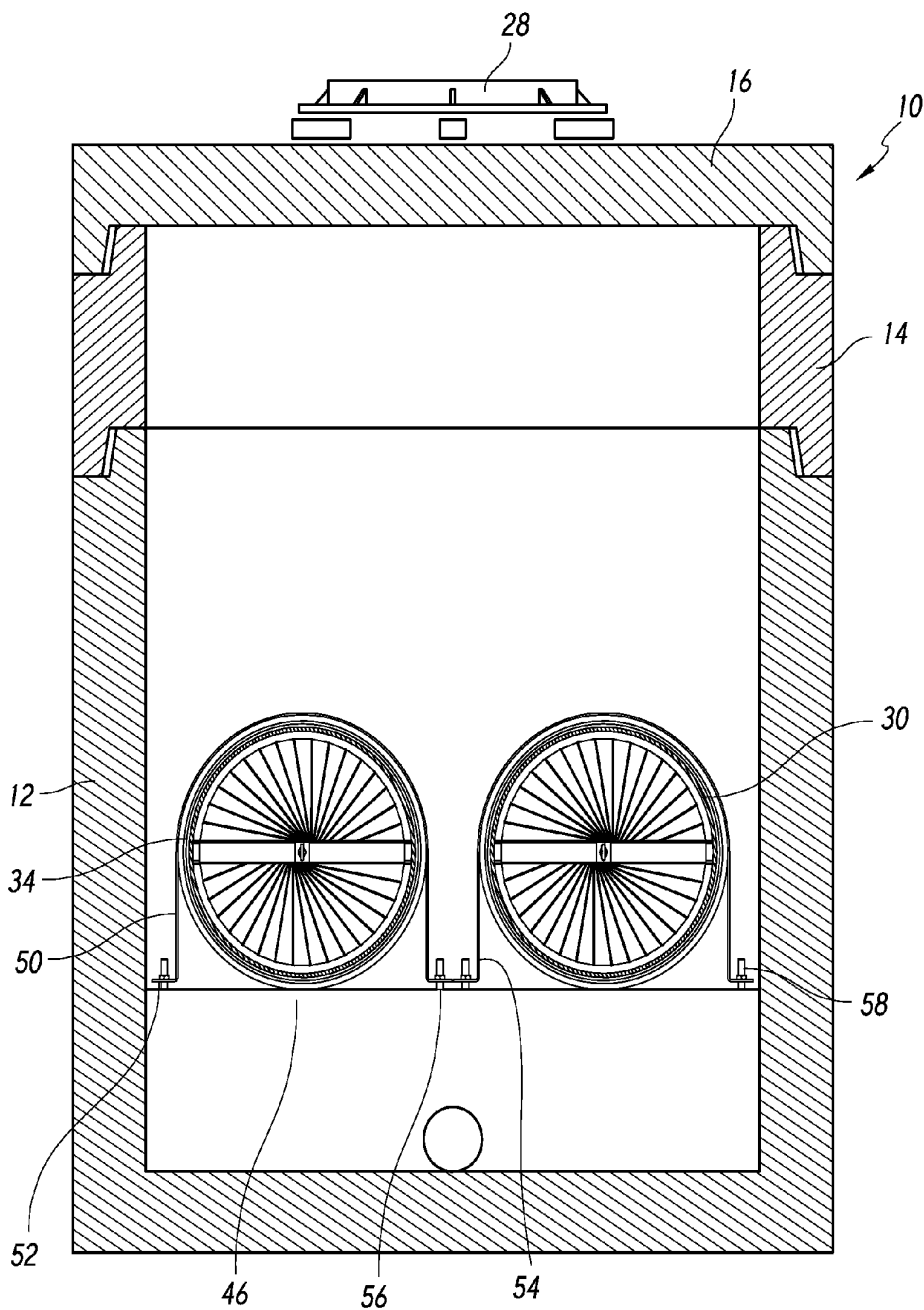
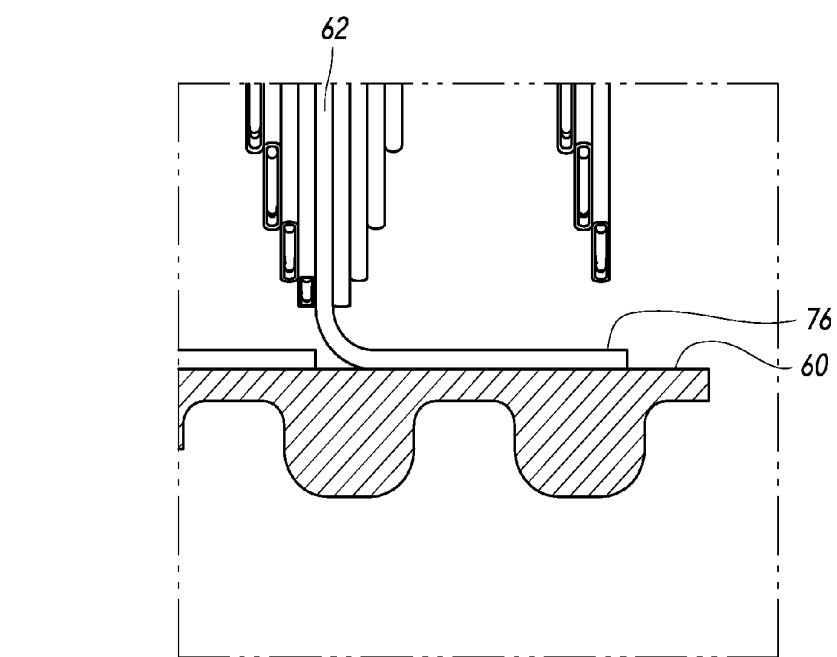
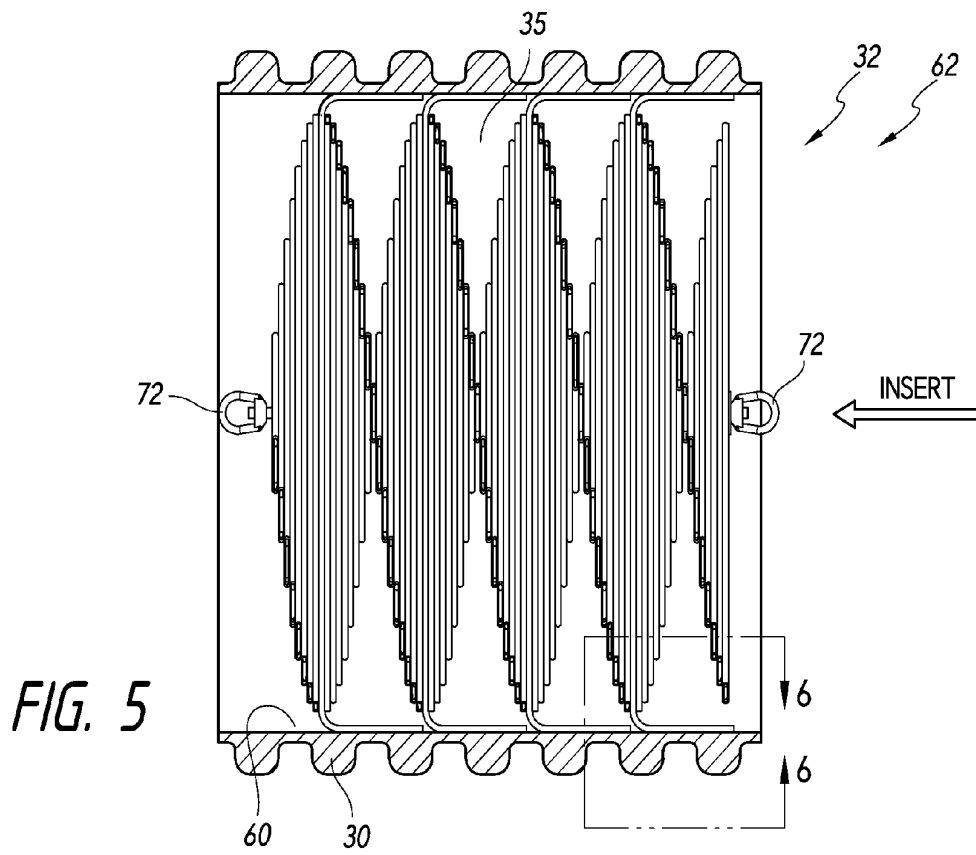
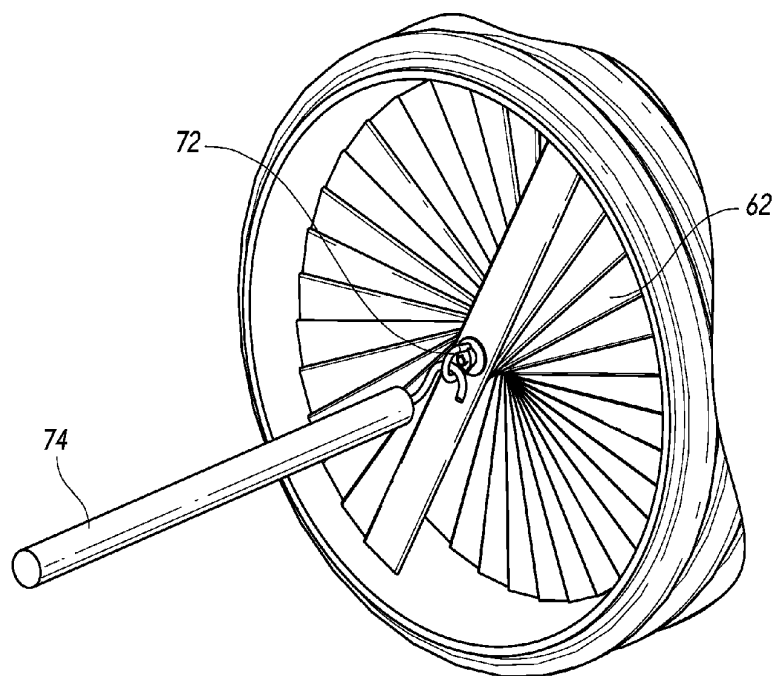
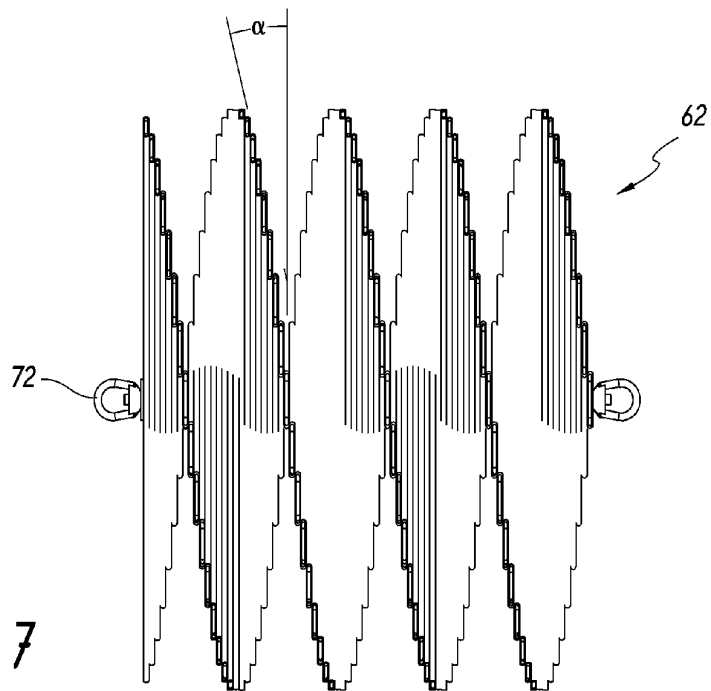
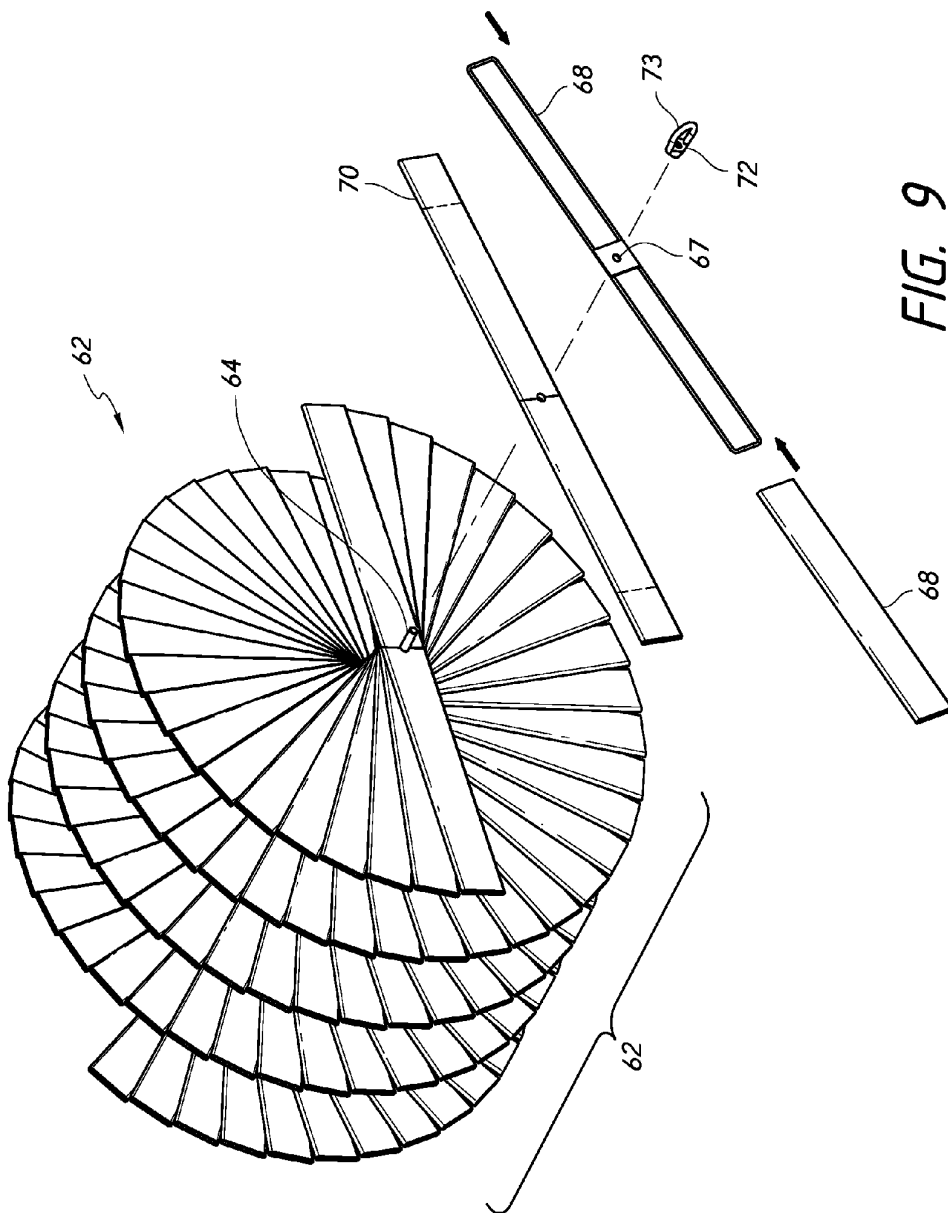


FIG. 4







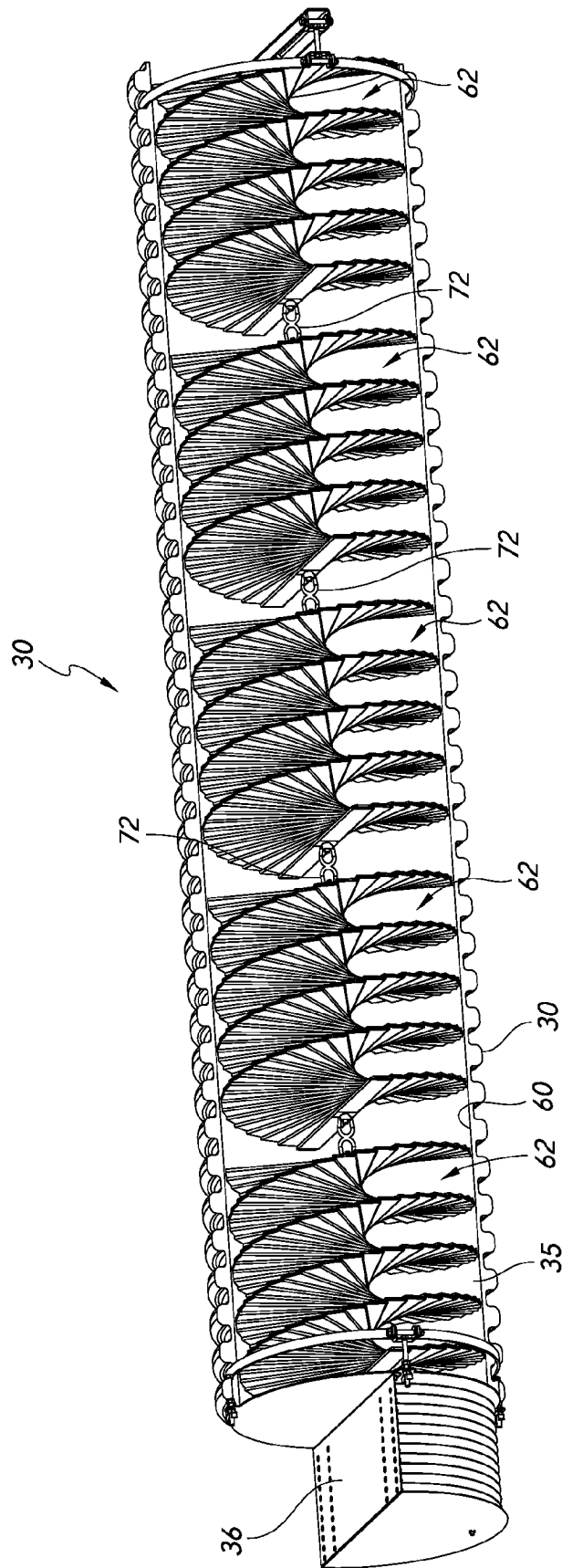


FIG. 10

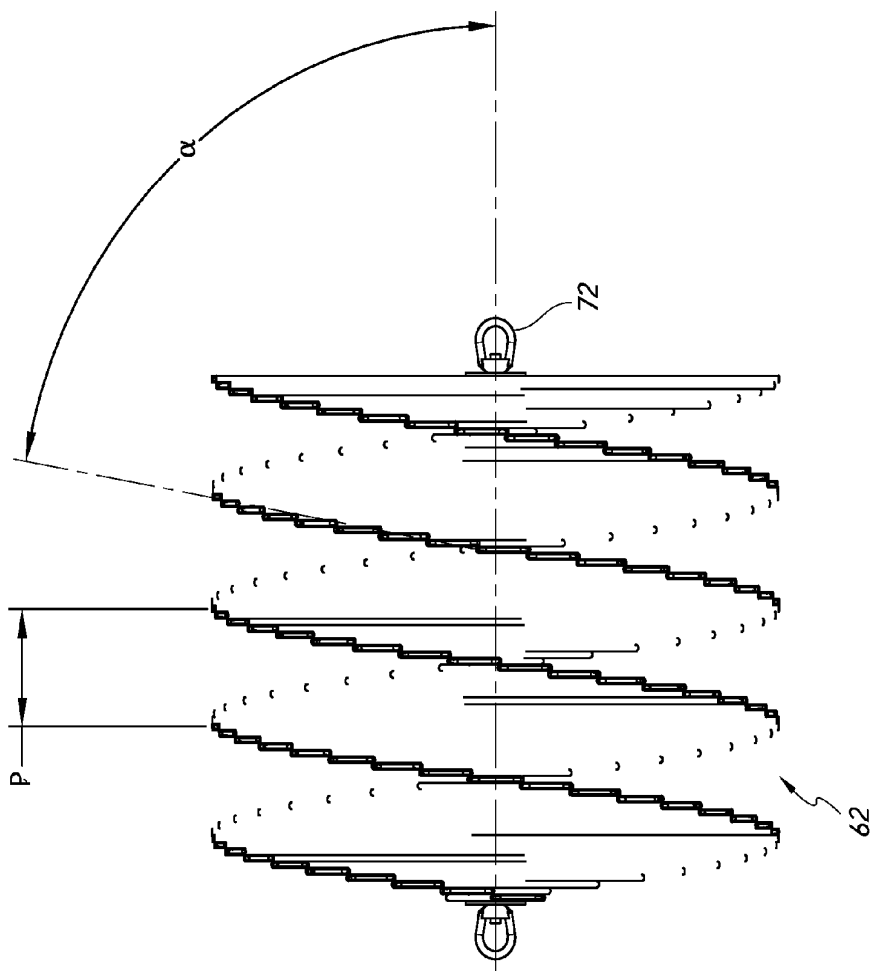


FIG. 11

STORMWATER TREATMENT SYSTEM

This is a continuation of U.S. Nonprovisional patent application Ser. No. 13/092,427, filed Apr. 22, 2011, the entire disclosure of which is hereby incorporated by reference as if set forth fully herein.

BACKGROUND OF THE INVENTION**1. Field of the Invention**

This invention relates generally to the field of environmental remediation of stormwater. More specifically, this invention relates to an improved modular filtration system for a stormwater system.

2. Description of the Related Technology

Stormwater that is created by storm runoff in heavily developed areas is typically channeled into storm drainage systems that eventually drain into nearby streams, creeks, rivers or other bodies of water. For purposes of this document, stormwater includes not only storm runoff, but other sources of wastewater such as rinse water and melting snow and ice.

Paved surfaces that bear automobile traffic typically become coated with significant pollutants such as heavy metals and volatile organic compounds, both under normal traffic conditions and in particular when motor vehicle accidents occur. When normal rain or snowfall occurs, these pollutants tend to be swept away with the runoff stormwater and eventually lead to contamination of the bodies of water that eventually receive them. Such contamination has become a significant environmental issue in many areas. In addition, a significant amount of sediment and debris such as bottles and cans tends to be swept away by stormwater runoff. Some of the debris is heavier than water, and some of it has the tendency to float. Stormwater filtering systems have to be able to effectively filter both types of debris, in both ordinary and elevated flow conditions.

Depending on the location of a stormwater system inlet, the primary environmental concern may be pollutants or it may be sedimentation and larger debris.

Systems exist for filtering stormwater runoff that are effective to some extent in removing debris from stormwater and in removing certain other pollutants, such as hydrocarbons. For example, U.S. Pat. No. 6,080,307 discloses a storm drain insert that contains one basket for the collection of debris as well as a canister that contains a hydrophobic, compliant, oil-absorbent copolymer material that is said to be effective in removing oil from the stormwater. Additional systems for removing pollutants such as heavy metals from stormwater have been commercialized by Fabco Industries Inc., the assignee of this application.

The removal of sedimentation and larger debris from stormwater requires a system that is simple to install and to service, since the collected sedimentation and debris will have to periodically be removed from the system. Water treatment media such as filtration media will also have to be periodically inspected and replaced.

In any type of water treatment system, there is a trade-off between the amount of stormwater that the system can effectively process and the efficiency of the water treatment. In other words, for a given system, the greater the amount of stormwater to be processed, the less effective the treatment can be. Accordingly, it is advantageous to be able to design a system that is scalable for the anticipated flow rates in order to optimize water treatment efficiency and longevity of the system.

A need exists for an improved system and process for processing sediment and debris laden stormwater that can be

optimized for anticipated conditions, that is effective under all conditions, that is suitable for filtering all kinds of debris, and that is moreover inexpensive to deploy and cost-effective to service.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the invention to provide an improved system and process for processing sediment and debris laden stormwater that can be optimized for anticipated conditions, that is effective under all conditions, that is suitable for filtering all kinds of debris, pathogens, nutrients, oils and grease and that is moreover inexpensive to deploy and cost-effective to service.

In order to achieve the above and other objects of the invention, a stormwater treatment system according to a first aspect of the invention includes structure defining a first chamber for receiving stormwater; structure defining a second chamber; a conduit communicating the first and second chambers; and stormwater treatment media positioned within the conduit, the stormwater treatment media defining a substantially helical flow path for stormwater that passes through the conduit from the first chamber to the second chamber.

A method of treating stormwater according to a second aspect of the invention includes steps of deploying stormwater treatment media that defines a substantially helical flow path within a conduit; and passing stormwater through the conduit.

A modular helical water treatment media component according to a third aspect of the invention includes a flexible frame; and water treatment media attached to the flexible frame, the water treatment media being constructed and arranged to engage and substantially form a seal against an inner surface of a stormwater conduit, the water treatment media further defining a helical flow path for stormwater passing through the conduit.

These and various other advantages and features of novelty that characterize the invention are pointed out with particularity in the claims annexed hereto and forming a part hereof. However, for a better understanding of the invention, its advantages, and the objects obtained by its use, reference should be made to the drawings which form a further part hereof, and to the accompanying descriptive matter, in which there is illustrated and described a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view depicting a stormwater treatment system that is constructed according to a preferred embodiment of the invention;

FIG. 2 is a fragmentary top plan view of the stormwater treatment system that is shown in FIG. 1;

FIG. 3 is a longitudinal cross-sectional view of the stormwater treatment system that is shown in FIG. 1;

FIG. 4 is a cross-sectional view taken along lines 4-4 in FIG. 2;

FIG. 5 is a longitudinal cross-sectional view depicting a component of the system that is shown in FIG. 1;

FIG. 6 is an enlarged view of a portion of FIG. 5;

FIG. 7 is a side elevational view of a component of the system that is shown FIG. 1;

FIG. 8 is a diagrammatical depiction of a method of deploying and maintaining a stormwater treatment system of the type that is shown in FIG. 1;

FIG. 9 is an assembly drawing depicting a filter segment that is used in the system that is shown in FIG. 1;

FIG. 10 is a fragmentary cross-sectional view depicting one portion of the stormwater treatment system that is shown in FIG. 1; and

FIG. 11 is a diagrammatical depiction of one portion of the stormwater treatment system that is shown in FIG. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

Referring now to the drawings, wherein like reference numerals designate corresponding structure throughout the views, and referring in particular to FIG. 1, a stormwater treatment system 10 that is constructed according to a preferred embodiment of the invention includes a base portion 12, a riser portion 14 and a top slab portion 16, each of which is preferably fabricated from a reinforced precast concrete material. The purpose of the riser portion 14 is to ensure that the access openings 22, 26 discussed below are accessible from grade level. In some cases, it is not necessary to use the riser portion 14. In those cases, the top slab portion 16 fits directly on the base portion 12.

Stormwater treatment system 10 includes structure defining a first influent chamber 18 for receiving stormwater and a second effluent chamber 20 into which treated stormwater is released.

The top slab portion 16 has a first access opening 22, positioned substantially over the first chamber 18, that is closable by a removable cover 24 and a second access opening 26, positioned substantially over the second chamber 20, which is closable by a removable cover 28.

The stormwater treatment system 10 includes at least one conduit 30 communicating the first and second chambers 18, 20. Stormwater treatment media 32 is preferably positioned within the conduit 30. The stormwater treatment media 32 advantageously defines a pair of substantially helical flow paths 35, best shown in FIG. 5, for stormwater that passes through the conduit 30 from the first chamber 18 to the second chamber 20. Stormwater treatment media 32 also preferably has a substantially helical shape, as may be seen in FIG. 5. In the preferred embodiment, stormwater treatment media 32 is shaped as a double helix.

In the preferred embodiment, stormwater treatment system 10 further includes a second conduit 34, which also communicates the first and second chambers 18, 20 and has stormwater treatment media 32 positioned therein.

Each of the first and second conduits 30, 34 preferably has a strainer and diffuser assembly 36 mounted adjacent to an inlet opening 31 of the respective conduit 30, 34. Each of the conduits 30, 34 further include a second, outlet opening 33 which is in communication with the second, effluent chamber 20.

The inner wall of the stormwater treatment system 10 may be provided with a pair of anchors 38 for releasably holding a deployment and recovery tool 74, which will be discussed in greater detail below in conjunction with FIG. 8.

The stormwater treatment system 10 further includes an inlet 40 for admitting stormwater into the first, influent chamber 18 and an outlet 42 for permitting treated stormwater to exit the second, effluent chamber 20. The first chamber 18 is partially defined by a wall 44 that is part of the base portion 12 and includes an upper edge 45. The space that is defined between the upper edge 45 of the wall 44 and the underside of the top slab 16 forms an emergency bypass or overflow path that permits untreated stormwater to pass from the first chamber 18 to the second chamber 20 without entering either of the conduits 30, 34.

The base portion 12 further includes first and second saddle portions 46, 48, which support the first and second conduits 30, 34. In the preferred embodiment, the first and second conduits 30, 34 are both positioned so that they are substantially horizontal, with their inlets 31 being at substantially the same elevation as their outlets 33.

As FIG. 4 shows, brackets 50, 54 are preferably used to secure the conduits 30, 34 and position relative to the saddle portions 46, 48, with connectors 52, 56, 58 being used to secure the brackets 50, 54 to the respective saddle portion 46, 48.

As FIG. 5 shows, each of the conduits 30, 34 preferably has a substantially smooth inner surface 60. The stormwater treatment media that is positioned in either of the conduits 30, 34 is preferably embodied as a plurality of filter segments 62, each of which has a substantially helical shape having a pitch defined by an angle α , which is shown in FIG. 11. Preferably, the angle α is substantially within a range of about 65 degrees to about 87 degrees, more preferably substantially within a range of about 70 degrees to about 85 degrees and most preferably substantially within a range of about 75 degrees to about 82 degrees.

Filter segments 62 also have a pitch P, shown in FIG. 11, that is preferably substantially within a range of about 2 inches to about 10 inches, more preferably substantially within a range of about 3 inches to about 9 inches and most preferably substantially within a range of about 4 inches to about 8 inches.

According to one advantageous aspect of the invention, the treatment performance of the stormwater treatment media 32 may be preset or adjusted by setting or varying the pitch of the individual filter segments 32. By increasing the pitch, a greater flowrate becomes possible, but with less effective filtration. By decreasing the pitch, the design flow rate becomes less but the filtration is more effective.

Preferably, each of the individual filter segments 32 is sized so that it may be inserted and withdrawn through the access opening 22. Each of the filter segments 32 is preferably constructed so as to be slidable along the substantially smooth inner surface 60 of the respective conduit 30, 34 when it is being inserted and removed from the conduit 30, 34, and further is constructed to flexibly engage the inner surface 60 and seal against the inner surface 60 so as to define a constrained helical flow path 35. The filter segments 32 are preferably deployed within the respective conduits 30, 34 in situ, in a manner that will be described in greater detail below.

Referring to FIG. 9, which is an assembly view of a filter segment 62 that is constructed according to a preferred embodiment of the invention, the filter segment 62 includes a longitudinally extending threaded rod 64, which is used to connect a plurality of helical elements 70. Each of the helical elements 70 includes a flexible wire frame 66 having a hole 67 for receiving the threaded rod 64. A media sleeve 68 is fitted over each end of the flexible wire frame 66. In the preferred embodiment, the media sleeve 68 is fabricated from filtration media, such as a foam material or a fabric material. Depending on the target pollutant, Open Cell Foam (Bacteria, Nutrients, Heavy Metals) or Hydrophobic Fabric (Hydrocarbons) may be used.

The filter segment 62 accordingly defines a double helix having two separate helical flow paths 35. Stormwater can move from one end of one of the flow paths 35 to a second, opposite end, or it can penetrate the media sleeve 68 and enter into the second flow path 35, thereby being filtered.

All filters tend to blind over time. In most filter systems, this results in the front filters blinding first, preventing water from reaching the subsequent filters. However, the helical

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filter system described herein is unique in that has the front portion of the helix begins to blind due to pollutants, the water will naturally climb through the helical filter path **35** is necessary, thereby contacting fresh media as needed. Over the life of the filter, this results in an evenly spent filter. In other words, efficient use of the filtration media is optimized.

As FIG. **6** shows, at least one of the media sleeves **68** is preferably long enough so as to bend against the smooth inner surface **60** of the conduit **30, 34** and form a seal with respect to the surface **60**.

A connector **72** having an eye hook **73** is threaded over each end of the threaded rod **64** for holding the assembly together. As FIG. **8** illustrates, the eye hook **73** may be engaged by the end of the tool **74** in order to insert or remove the filter segments **62** from the inside of the respective conduit **30, 34**.

The stormwater treatment system **10** benefits from regular maintenance intervals to remain effective as a stormwater filter. Maintenance requirements and frequency are dependent on the pollutant load characteristics of the site of deployment. The influent and effluent chambers **18, 20** should be cleaned of any collected oil, trash, debris and sediment that may inhibit filter performance. Inspection personnel may access the interior of the system **10** through the access openings **22, 26** in order to periodically inspect the condition of the system **10**, including the stormwater treatment media **32**.

If replacement of the helical filter segments **62** is determined to be necessary, the access covers **24, 28** will be removed, permitting venting of the interior chamber of the system **10**. The interior of the chambers **18, 20** may be cleaned with the use of an external vacuum device, such as a vacuum truck.

Removal of the helical filter segments **62** is preferably performed from the first, influent chamber **18**. A ladder is used to enter the influent chamber **18**, and the diffuser assembly **36** is removed from each of the conduits **30, 34**. Each diffuser assembly **36** is preferably attached to the housing by means of releasable fasteners such as wing nuts. A pair of pliers may be required to loosen the wing nuts.

With the diffuser assembly **36** removed, the helical filter segments **62** are exposed and can be pulled directly out of the respective conduit **30, 34**. In the preferred embodiment, each conduit **30, 34** will include five separate helical filter segments **62**. The individual helical filter segments **62** are preferably not directly connected to each other. The tool **74** is preferably used to engage the eye hooks **73** of the respective filter segments **62** in order to remove the helical filter segment **62** from the respective conduit **30, 34**. In the event that one of the helical filter segments **62** cannot be removed manually using the tool **74**, one or more of the anchors **38** may be used in conjunction with a mechanical force amplifying device such as a ratchet pulling device or crank puller.

The filter segments **62** are preferably removed one at a time and located under the access opening **22**, where they may be lifted out of the system **10** through the access opening **22**. A mechanical lifting device may be used in order to lift the filter segments **62** out of the system **10**. Advantageously, the eye hook **73** is constructed so as to be able to bear the full weight of a saturated filter segment **62**.

After the filter segments **62** have been removed, the interior of the respective conduit **30, 34** is inspected for damage. Any sediment and debris is removed prior to inserting new filter segments **62**.

The new filter segments **62** are preferably lowered through the access opening **22** with the aid of a mechanical lifting device, with the full weight of the filter segments **62** being borne by the eye hook **73**. Each of the filter segments **62** is

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carefully pushed into the respective conduit **30, 34**. Each of the filter segments **62** is preferably assembled (stacking the wire frames) in a counter-clockwise direction. This allows the filter segment **62** to be installed in the conduit **30, 34** in either direction and insures that the helical paths **35** through the conduit **30, 34** are in a continuous direction. Once the filter segments **62** are properly positioned within the respective conduit **30, 34**, as is shown in FIG. **10**, the diffuser assembly **26** is replaced.

It is to be understood, however, that even though numerous characteristics and advantages of the present invention have been set forth in the foregoing description, together with details of the structure and function of the invention, the disclosure is illustrative only, and changes may be made in detail, especially in matters of shape, size and arrangement of parts within the principles of the invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

What is claimed is:

1. A method of treating stormwater, comprising steps of:
 - deploying stormwater treatment media that defines a substantially helical flow path within a stormwater conduit positioned within a walled chamber;
 - passing stormwater into said chamber and through the stormwater conduit; and
 - providing an overflow path that permits untreated stormwater to pass through said chamber while bypassing said treatment media in said conduit.
2. A method of treating stormwater according to claim 1, wherein the stormwater treatment media has a substantially helical shape, and further comprising a step of selecting a pitch of the substantially helical shape of the stormwater treatment media in order to set a treatment performance of the stormwater treatment media.
3. A method of treating stormwater according to claim 1, further comprising a step of mounting the stormwater treatment media on a flexible frame prior to deploying the stormwater treatment media within the conduit.
4. A method of treating stormwater according to claim 1, wherein the step of deploying stormwater treatment media within a conduit comprises inserting a plurality of modular helical water treatment media components sequentially into the conduit.
5. A method of treating stormwater according to claim 1, wherein the step of deploying stormwater treatment media within a conduit is performed in situ.
6. A method of treating stormwater according to claim 1, wherein the chamber has an access opening, and wherein the step of deploying stormwater treatment media within the conduit comprises passing the stormwater treatment media through the access opening.
7. A method of treating stormwater according to claim 6, wherein the stormwater treatment media comprises a plurality of modular helical water treatment media components, and wherein the step of deploying the treatment media within the conduit comprises passing the individual components through the access opening.
8. A method of treating stormwater according to claim 7, further comprising a step of removing at least one of the modular helical water treatment media components from the conduit and passing it through an access opening.
9. A method of treating stormwater according to claim 8, wherein the modular helical water treatment media component includes connection structure, and wherein the step of removing the component from the conduit is performed by engaging the connection structure with a tool.

10. A method of treating stormwater according to claim 1, wherein the water treatment media defines two flow paths, each of which is helical in shape.

11. A modular helical water treatment media component, comprising:

a flexible frame mounted within a stormwater conduit positioned within a walled chamber;

water treatment media attached to the flexible frame, the water treatment media being constructed and arranged to engage and substantially form a seal against an inner surface of said stormwater conduit, the water treatment media further defining a helical flow path for stormwater passing through the conduit; and

an overflow path within said chamber for permitting stormwater to bypass said water treatment media in said conduit.

12. A modular helical water treatment component according to claim 11, further comprising connection structure that is constructed and arranged to be releasably engaged by a tool

in order to move the modular helical water treatment media component relative to the conduit.

13. A modular helical water treatment component according to claim 11, wherein the flexible frame comprises flexible wire.

14. A modular helical water treatment media component according to claim 11, wherein the water treatment media comprises filtration media.

15. A modular helical water treatment media component according to claim 14, wherein the filtration media comprises a foam material.

16. A modular helical water treatment media component according to claim 15, wherein the filtration media has a modular construction.

17. A modular helical water treatment media component according to claim 11, wherein the water treatment media defines two flow paths, each of which is helical in shape.

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