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(54) **PRECAST POROUS CONCRETE WITH CAST-IN CONDUITS**

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(57) **ABSTRACT**

The present invention is directed to a porous concrete system comprised of a porous concrete slab and one or more cast-in conduits, with at least one conduit including an adapter capable of connecting to a hose. In addition, the present invention is also directed to a porous concrete system comprising a plurality of porous concrete slabs, wherein each porous concrete slab contains one or more conduits embedded therein and at least one conduit in each porous concrete slab has an adapter that is connectable to a hose and wherein the porous concrete slabs are arranged in a manner where the conduits in one porous concrete slab are adjacent to the conduits in the neighboring porous concrete slab.

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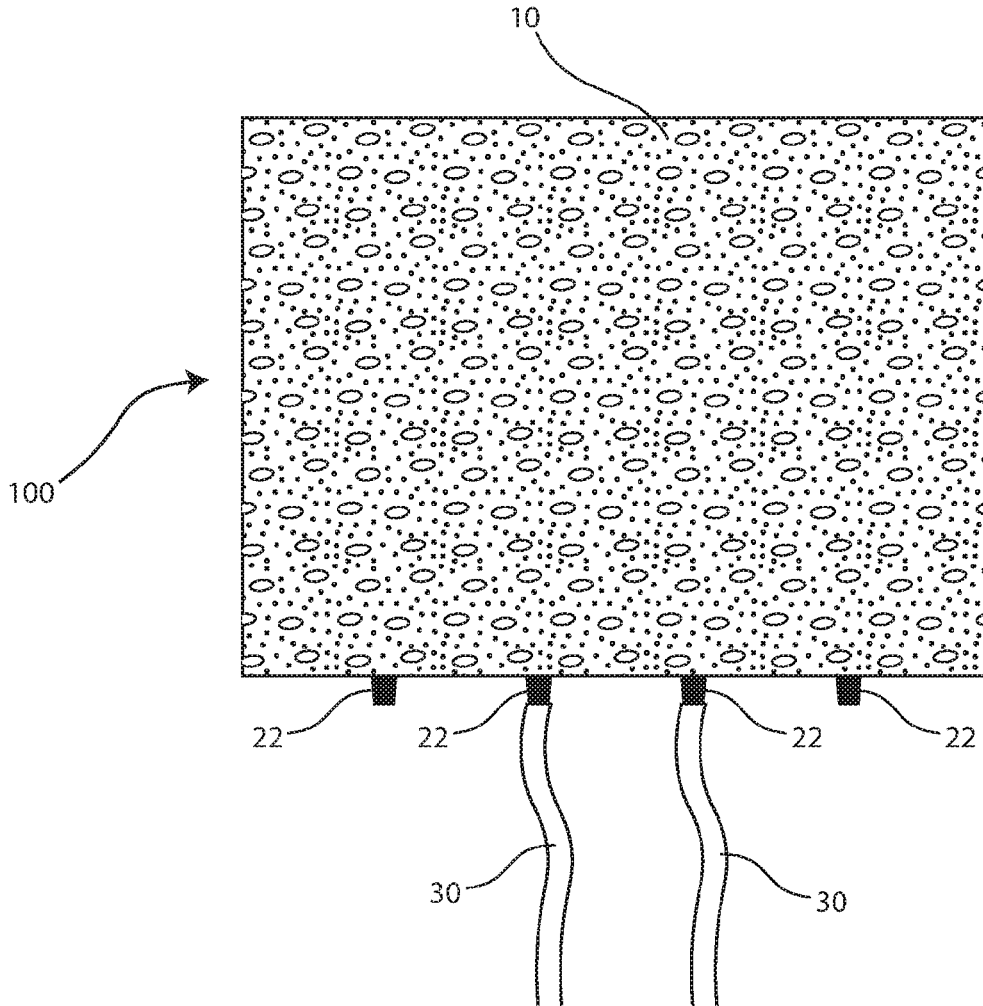


FIG. 1

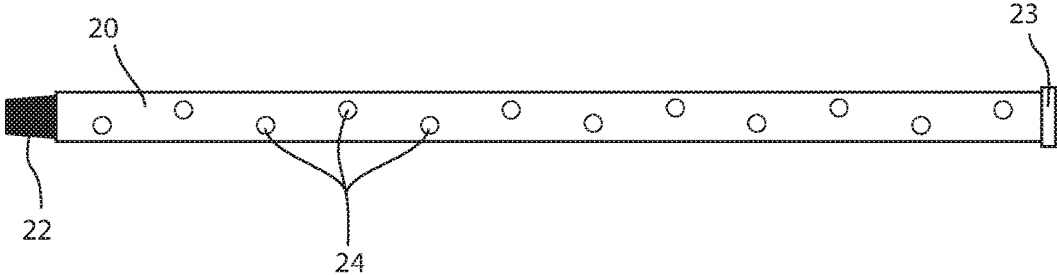
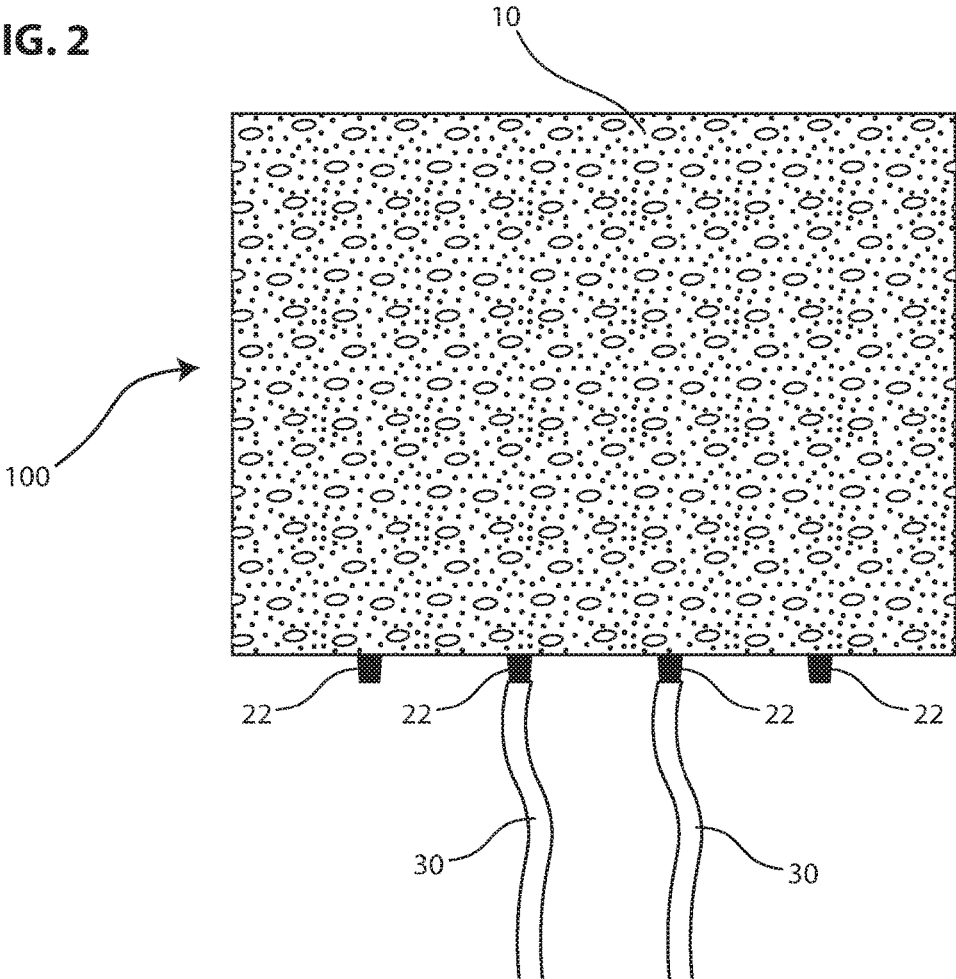


FIG. 2



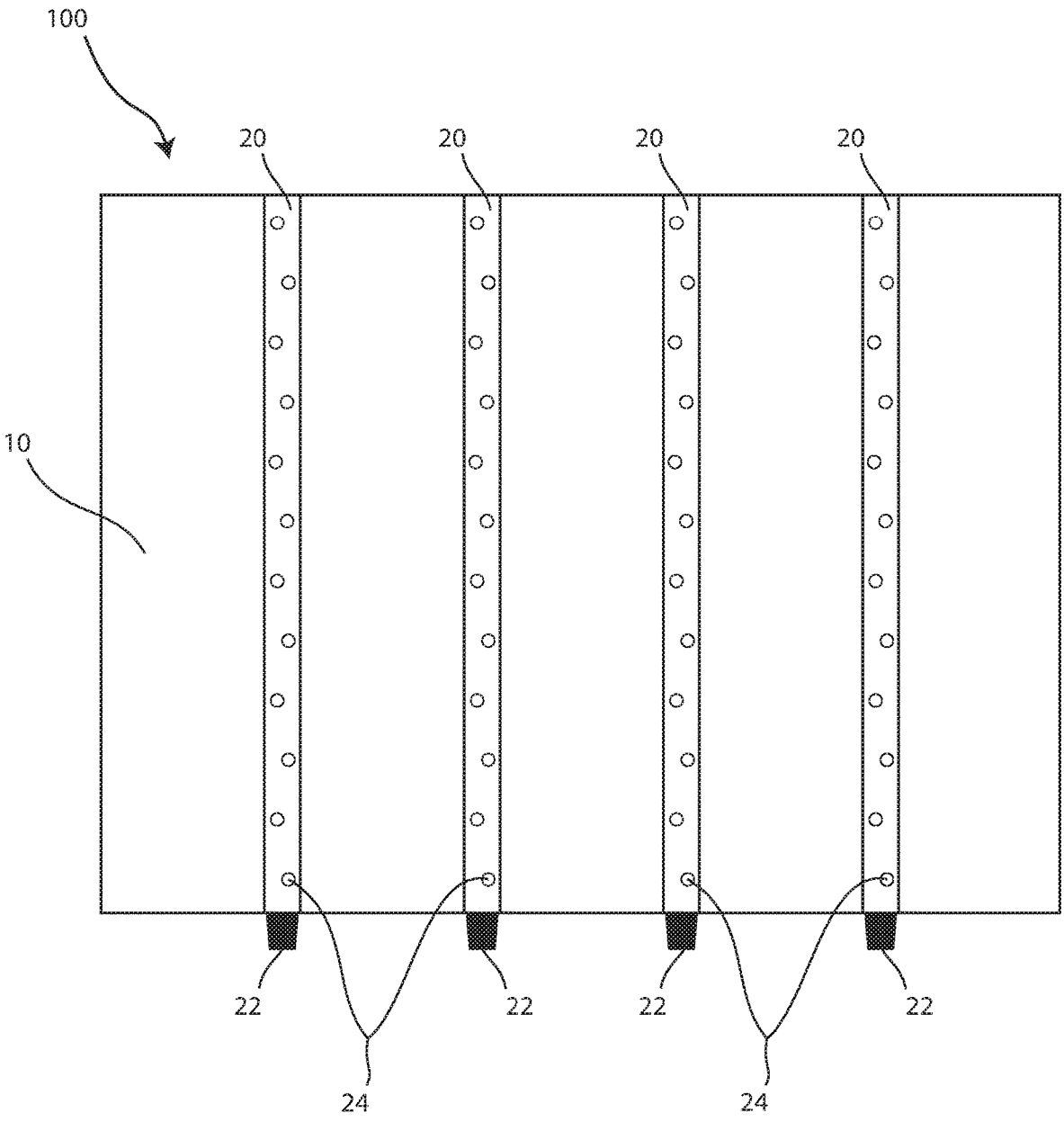


FIG. 3

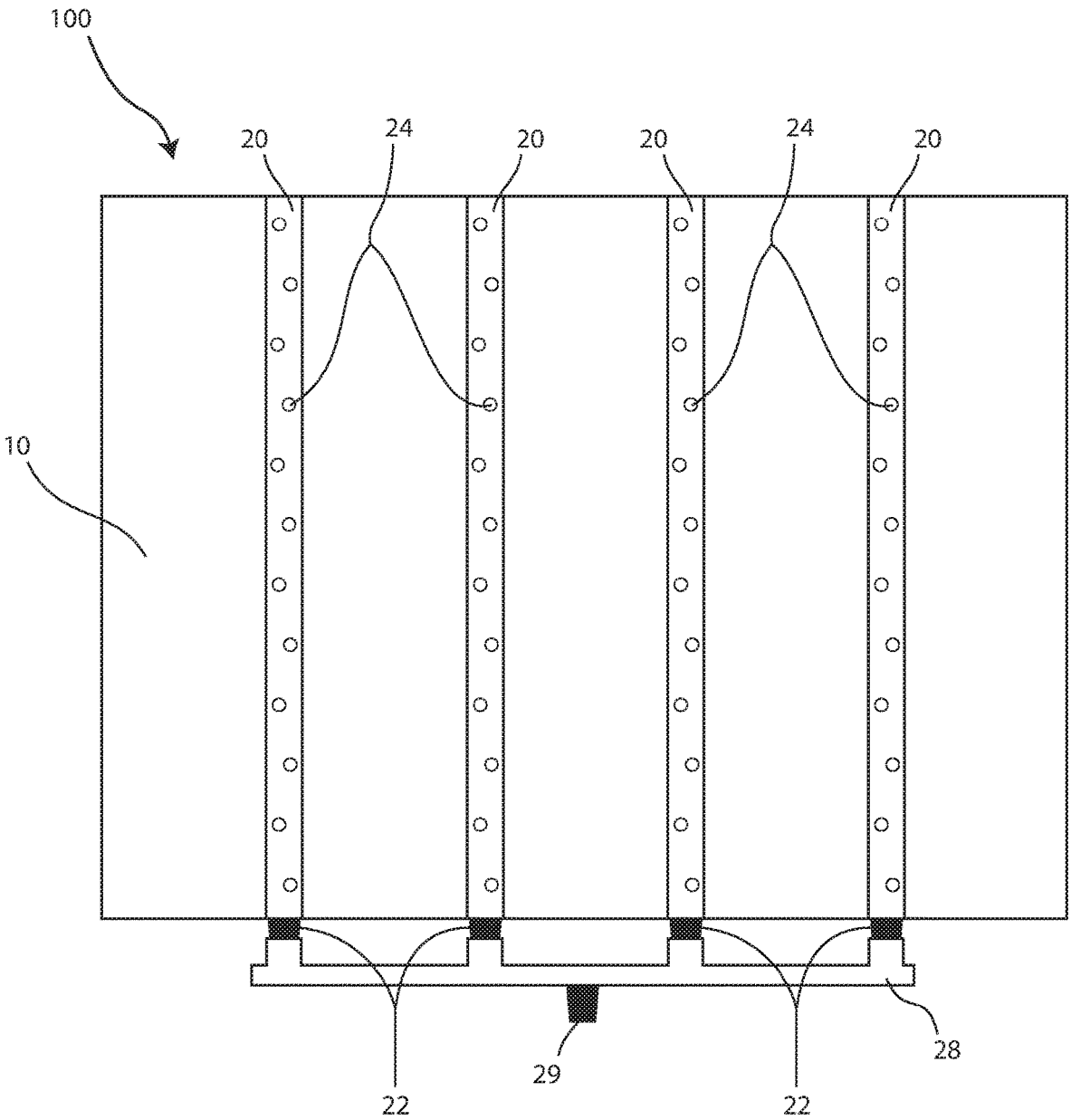


FIG. 4

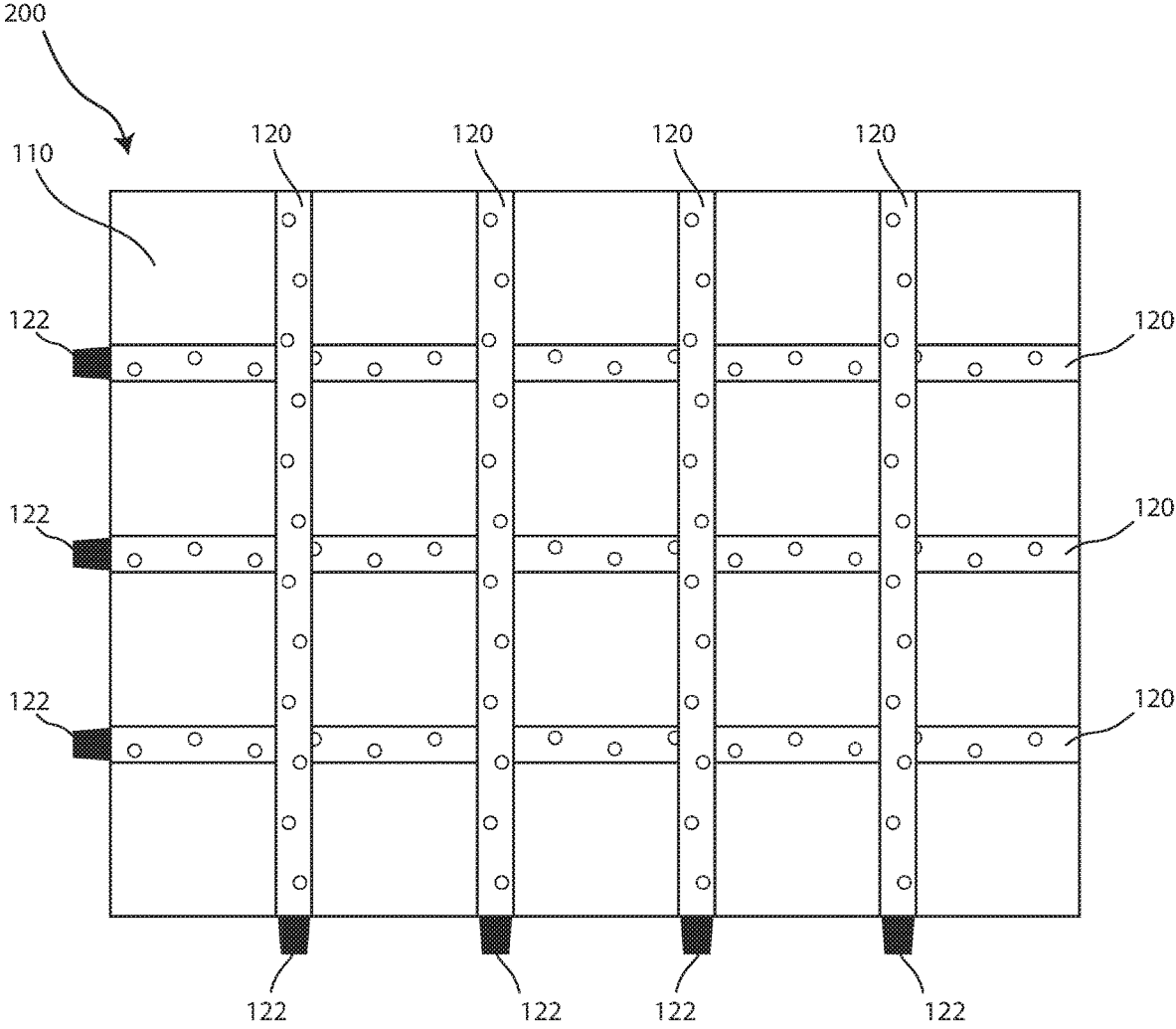


FIG. 5

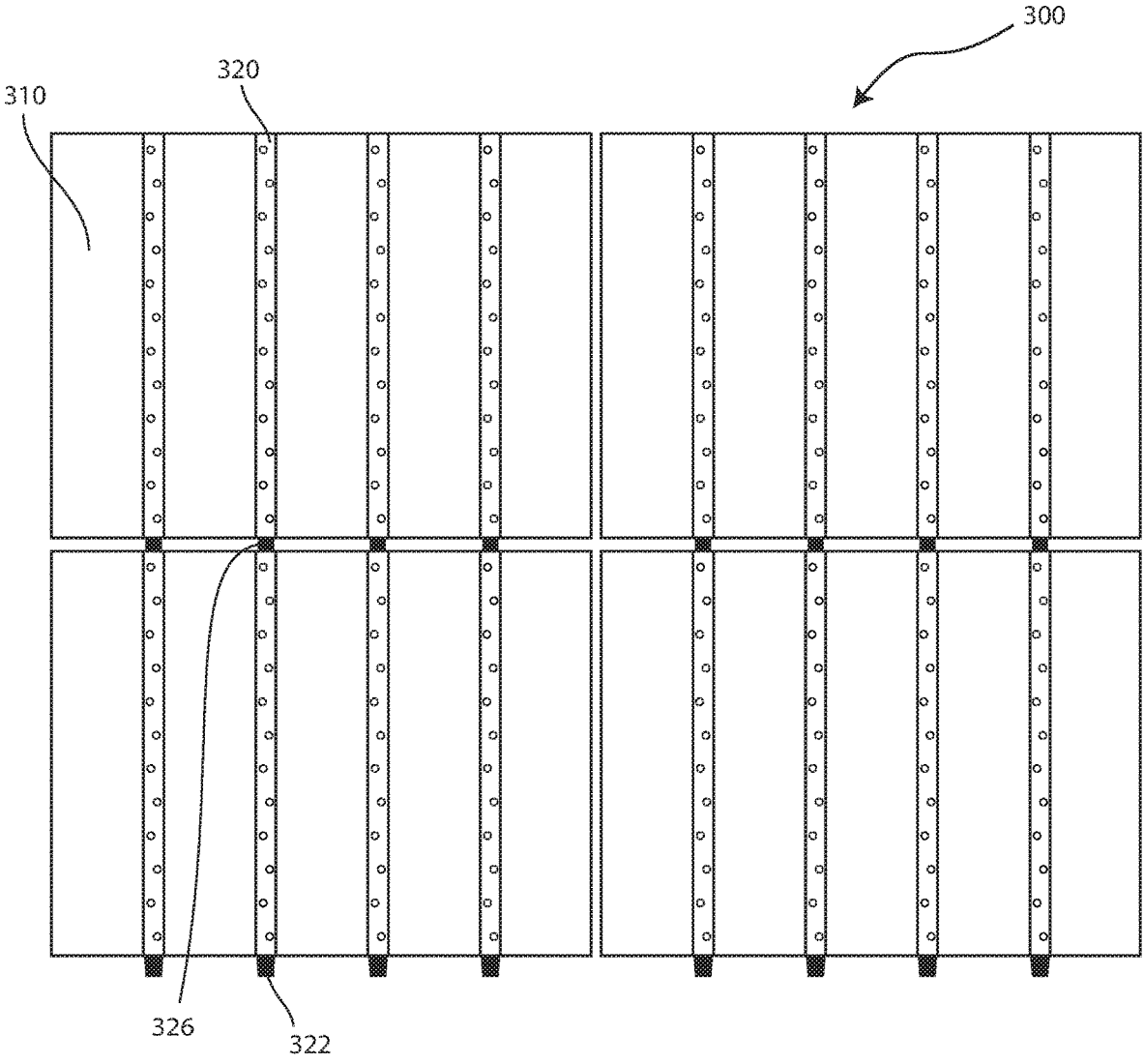
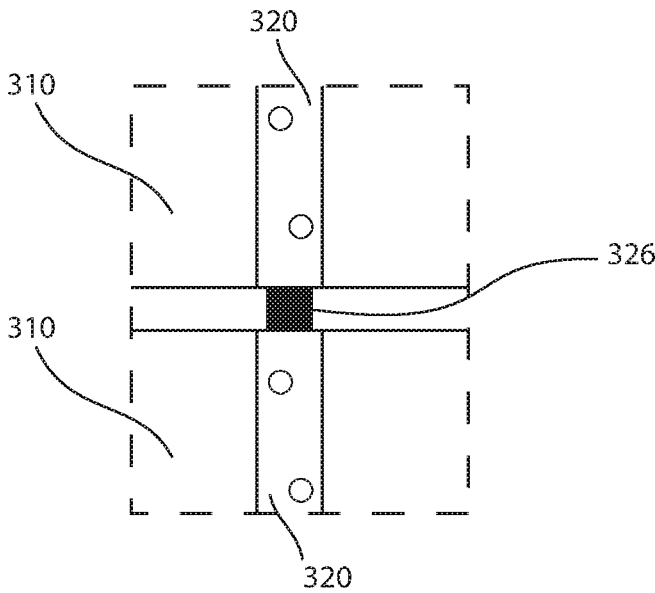


FIG. 6

FIG. 7



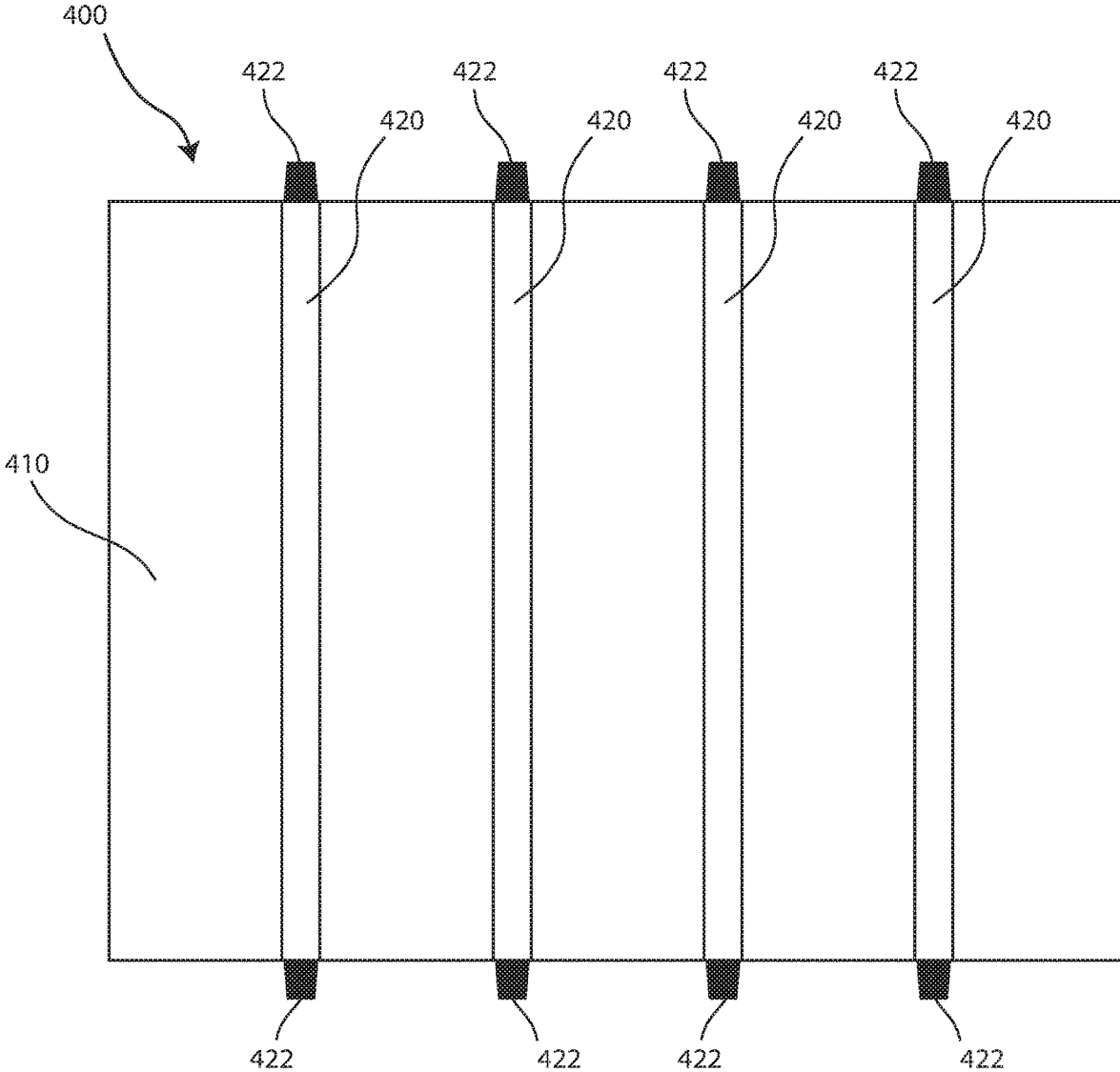


FIG. 8

PRECAST POROUS CONCRETE WITH CAST-IN CONDUITS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application 62/484,941, filed Apr. 13, 2017, the disclosure of which is herein incorporated by reference.

BACKGROUND

1. Field of the Invention

[0002] The present invention pertains to the field of porous concrete systems. Specifically, this invention relates to porous concrete systems that comprise porous concrete slabs and cast-in conduits to improve the ability to clean and warm the porous concrete slabs and provide the ability to channel stormwater runoff to a desired location.

2. Discussion of Background Information

[0003] Nonporous surfaces, such as asphalt and concrete, make up a significant portion of any given developed area. The surface could be a parking lot, road, or sidewalk. Although these surfaces enable transportation without the problems associated with unpaved surfaces, such as the erosion of dirt roads, they present separate issues given that nonporous surfaces are not able to replicate soil's key functions, such as water management and filtration. The inability to replicate these functions creates problems for, and can negatively impact, surrounding areas. For example, when a rain event occurs, nonporous surfaces prevent the stormwater from flowing naturally through the surface into the soil. Efforts are made to direct the stormwater into collection areas such as drains, culverts and swales, where further filtration may take place. However, because it is difficult to direct the flow of runoff from these nonporous surfaces, inevitably a portion of the stormwater escapes and runs off into surrounding areas. Unfortunately, stormwater runoff often includes a host of pollutants—litter, fertilizer, gasoline, salt and sand—anything that may have been residing on the nonporous surface. When these pollutants are introduced into the surrounding groundwater, tributaries, streams or reservoirs, they can negatively impact the environment.

[0004] Beyond just the pollutants themselves, nonporous surfaces can also negatively impact the temperature of stormwater runoff. Specifically, it is common for nonporous surfaces to retain the heat resulting from long periods of exposure to the sun. When a rain event occurs, soaking a warm nonporous surface, the resulting runoff is heated as it moves across the nonporous surface. This warm runoff then finds its way into the surrounding environment and can upset the delicate balance of aquatic environments by, for instance, warming surrounding water systems.

[0005] In contrast to nonporous surfaces, porous concrete is a type of concrete that has a high porosity and allows for stormwater to infiltrate back into the ground naturally by passing directly through the concrete, thereby reducing pavement runoff. It is commonly used in parking areas and areas with relatively light traffic. Porous concrete also has the beneficial effect of filtering stormwater and may reduce pollutant loads entering into streams, ponds and rivers. Over time, however, the porosity can become substantially dimin-

ished as the porous material becomes clogged with sediment, debris, or other materials that prevent the stormwater from flowing through the pavement.

[0006] Additionally, although porous concrete primarily conveys stormwater directly downward through the slab and into the ground in a vertical direction, there are situations where it would be beneficial to direct the flow of stormwater in alternative directions. For example, channeling stormwater in a horizontal direction may reduce the impact of stormwater on the bed underlying the porous concrete slab.

[0007] Furthermore, in cold climates, ice or snow frequently build up on top of, or occasionally inside of, the porous slab, greatly diminishing its effectiveness. In certain circumstances, this accumulation of snow and ice presents an opportunity where it would be advantageous to have a means for melting the snow or ice so that the resulting water may filter through the porous concrete slab.

[0008] What is needed, therefore, is a system that may be used for cleaning the sediment, debris and other materials from the porous concrete slab, with or without removing the slab from its installed position. What is further needed is a system that allows for the discharge of stormwater in a non-vertical direction. What is yet further needed is a system capable of melting ice or snow on or in a porous slab.

SUMMARY OF THE INVENTION

[0009] The present invention solves the problems associated with maintaining porous concrete slabs by providing a system capable of facilitating the cleaning and heating of porous concrete slabs. In addition, the present invention addresses problems associated with stormwater runoff by providing a system capable of channeling stormwater in a horizontal direction within a porous concrete slab.

[0010] The present invention is directed to a porous concrete system that comprises a porous concrete slab and one or more conduits embedded therein, with at least one conduit having an adapter that is connectable to a hose. The one or more conduits may be perforated and may be arranged substantially parallel or in a grid pattern in the porous concrete slab. In addition, one or more of the conduits may be connected to each other and share a common adapter.

[0011] The present invention is further directed to a porous concrete system comprising a plurality of porous concrete slabs, wherein each porous concrete slab contains one or more conduits embedded therein and at least one conduit in each porous concrete slab has an adapter that is connectable to a hose. The porous concrete slabs are arranged in a manner where the conduits in one porous concrete slab are adjacent to the conduits in the neighboring porous concrete slab. Further at least one conduit in one of the porous concrete slabs is connected to the adjacent conduit in the neighboring porous concrete slab. The conduits may be perforated and may be arranged substantially parallel or in a grid pattern in each porous concrete slab.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] These and other features, aspects and advantages of the present invention will become better understood with reference to the following description, appended claims, and accompanying drawings where:

[0013] FIG. 1 is a top view of a perforated conduit of the present invention.

[0014] FIG. 2 is a top view of an embodiment of a porous concrete system of the present invention.

[0015] FIG. 3 is a top view of a horizontal cross section of an embodiment of a porous concrete system of the present invention.

[0016] FIG. 4 is a top view of a horizontal cross section of an embodiment of a porous concrete system of the present invention.

[0017] FIG. 5 is a top view of a horizontal cross section of an embodiment of a porous concrete system of the present invention.

[0018] FIG. 6 is a top view of a horizontal cross section of an embodiment of a porous concrete system of the present invention.

[0019] FIG. 7 is a detail view of the horizontal cross section of the embodiment of the porous concrete system depicted in FIG. 6.

[0020] FIG. 8 is top view of a horizontal cross section of an embodiment of a porous concrete system of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0021] The present invention will now be described more fully in detail with reference to the accompanying drawings, in which the preferred embodiments of the invention are shown. This invention should not, however, be construed as limited to the embodiments set forth herein; rather, they are provided so that this disclosure will be complete and will fully convey the scope of the invention to those skilled in the art.

[0022] FIGS. 1-3 depict a first embodiment of the porous concrete system 100 of the present invention. Specifically, one or more conduits 20 are embedded within a porous concrete slab 10. As depicted, an adapter 22 is attached to one end of each of the conduits 20. The adapter 22 is located at the end of the conduit 20 on an outer edge of the porous concrete slab 10. The adapter 22 may be male, extending beyond the edge of the porous concrete slab 10, or the adapter 22 may be female. In some embodiments of the invention, the conduit 20 extends the complete width of the porous concrete slab 10. In these embodiments, while the first end of the conduit 20 will be attached to an adapter 22, the second end of the conduit 20 may be attached to either an adapter 22 or a cap 23, depending on the intended implementation of the porous concrete system 100. Alternatively, where the conduit 20 does not extend the full width of the porous concrete slab 10, the second end of the conduit 20 may include a cap 23 or an adapter 22, or as a person of skill in the art will appreciate, the second end of the conduit 20 may simply be embedded within the porous concrete slab 10 without either a cap 23 or an adapter 22. Where a cap 23 is utilized, the cap 23 may be any suitable cap 23 known in the art that is capable of sealing the second end of the conduit 20. For example, the cap 23 may be a plug.

[0023] The conduits 20 of the porous concrete system 100 include a plurality of perforations 24. Accordingly, the conduits 20 may be any suitable type of pipe, hose or tubing that may be perforated and is capable of mating with an adapter 22. The length of the conduits 20 is preferably substantially the same as the width of the porous concrete slab 10, such that the ends of the conduit 20 are each substantially flush with the edge of the porous concrete slab 10. For example, a standard four-foot wide porous concrete

slab 10, would utilize conduits 20 of about four feet in length. In addition, the diameter of the conduits 20 may be selected based on the desired implementation. For example, some implementations will prefer a smaller diameter conduit 20 in the range of about $\frac{3}{8}$ to $\frac{3}{4}$ inches. Other implementations will prefer slightly larger conduits 20, ranging up to approximately two inches in diameter, while some embodiments will utilize conduits 20 with diameters larger than two inches. Furthermore, it will be appreciated that while it may be preferred that the length of the conduits 20 of the porous concrete system 100 is substantially similar to the width of the porous concrete slab 10, the conduits 20 may be of any length provided that the adapter 22 is accessible.

[0024] As described above, the conduits 20 include a plurality of perforations 24. Similar to the size of the conduits 20, the number of perforations 24 in the conduit 20 may be selected based on the requirements of the chosen implementation. In addition, the perforations 24 may be any size and may be arranged in any pattern as known to one of skill in the art. For example, a conduit 20 with a length of four feet may include ninety-six perforations 24, the perforations 24 being configured in six rows of sixteen perforations 24 and spaced approximately evenly apart. However, this example is illustrative only and a chosen implementation may prefer a greater or lesser number of perforations 24. In addition, the arrangement of the perforations 24 may be arranged in varying patterns, depending on the amount and direction of filtration that is desired. For example, in porous concrete systems 100 designed for areas where the stormwater is known to contain significant debris or pollutants such that more filtering capacity is anticipated, it may be advantageous to have more perforations 24 in the conduits 20. Additionally, it may be advantageous to have perforations 24 oriented in one or more directions. For example, it may be beneficial to have perforations 24 located on the top of the conduit 20 such that the perforations 24 are oriented substantially upward once the conduit 20 is embedded within the porous concrete slab 10, leaving the portion of the conduit 20 facing downward solid and capable of serving as a channel for water to travel through the porous concrete slab 10. Alternatively, as an additional example, the perforations 24 may be located on the sides of the conduit 20, such that the perforations 24 are oriented substantially horizontally, but not located on the top or the bottom.

[0025] The conduits 20 may be connected to a hose 30 by way of the adapter 22. A suitable hose 30 may be used to force hot air into the porous concrete slab 10 to dry the porous concrete slab 10, heat the porous concrete slab 10 and, in some instances depending on the type of debris, blow debris outward through the porous concrete slab 10. Alternatively, a suitable hose 30 may be used to backwash the porous concrete slab 10 with liquid, forcing the debris out from a number of directions and, importantly, in directions other than the natural top to bottom direction that stormwater naturally flows through the porous concrete slab 10. Because stormwater naturally filters from top to bottom, using pressure to wash debris out in alternative directions has a greater impact on restoring the porosity of the concrete. High pressure air or water is particularly effective. In addition, specialized cleaning solutions may be used in situations where the removal of specific pollutants is desired.

[0026] In some embodiments, the conduits 20 may function to provide low resistance channels within the porous

concrete slab **10** so that it is possible to route water in a substantially horizontal direction. For example, in embodiments where the perforations **24** are located on the top, but not the bottom, of the conduits **20**, a portion of the stormwater percolating through the porous concrete slab **10** will enter the conduits **20** through the perforations **24** and will then travel through the conduits **20** in a substantially horizontal direction. This arrangement will permit the porous concrete system **100** to effectively channel a portion of the stormwater to a known and suitable location, such as to a swale. In such embodiments, the conduits **20** may or may not include an adapter **22**.

[0027] Each conduit **20** may have its own individual adapter **22** to allow each conduit **20** to connect directly to its own hose **30**. Alternatively, two or more conduits **20** may be connected to each other in a manner where the two or more conduits **20** share a common adapter **22**. For example, two or more conduits **20** may be connected to each other such that only one, or only a subset, of the conduits **20** have an adaptor **22** that connects to a hose **30**. In addition, while a hose **30** is the preferred means of connecting to the adapter **22**, it may be advantageous, as depicted in FIG. 4, to utilize a manifold **28** that connects multiple conduits **20** and provides a single manifold adapter **29**. It will be appreciated by one of skill in the art that the manifold **28** may be connected via the adapters **22** located on the conduits **20**. Alternatively, the manifold **28** may be connected directly to the conduits **20**, removing the need for the adapters **22**.

[0028] As depicted in FIG. 5, the present invention encompasses conduits **120** arranged in multiple directions within the porous concrete slab **110**. For example, a second embodiment of a porous concrete system **200** of the present invention includes conduits **120** arranged in a grid pattern. Such an arrangement can be advantageous for several reasons. For example, the increased density of conduits **120** will increase the surface area where air steam or water may be forced into the porous concrete slab **110** for cleaning, heating or drying. In addition, this arrangement enables captured stormwater to efficiently travel in multiple directions across the horizontal plane of the porous concrete slab **110**.

[0029] Turning to FIG. 6, a third embodiment of a porous concrete system **300** is depicted. In the porous concrete system **300**, multiple porous concrete slabs **310** are arranged next to each other such that the conduits **320** of neighboring porous concrete slabs **310** are adjacent. Once positioned, the adjacent conduits **320** may be connected. As shown in the detail view depicted in FIG. 7, the conduits **310** are connected via a connector **326**. The connector **326** is any connector known in the art. In addition, the connector may be an adapter **322**, or the connector **326** may be a separate component so long as the connector **326** connects the adjacent conduits **320**. Depending on the desired direction of flushing and debris clearing, one side of the conduits **320** may have inlet valves for receiving air or water while another end of the conduits may have outlet valves or be pluggable with a suitable cap **23**.

[0030] Turning to FIG. 8, another embodiment of a porous concrete system **400** utilizes conduits **420** that are solid and not perforated. The conduits **420** can connect to an external source of heated water or steam in the same manner as the embodiments discussed previously and convey heat throughout the porous concrete slab **410** in order to dry the porous concrete slab **410** or to warm the porous concrete

slab **410** during freezing conditions. Alternatively, the conduits **420** can be utilized as containers to hold specific compounds known to assist in the process of heating and cooling the porous concrete slab **410**. For example, the conduits **420** may be filled with paraffin oil. While the conduits **420** are depicted with adapters **422** on both ends, one will appreciate that as described for the previously discussed embodiments, each conduit **420** may have only one adapter **422** or two or more conduits **420** may be connected to each other and share one or more common adapters **422**.

[0031] It is noted that the foregoing examples have been provided merely for the purpose of explanation and are in no way to be construed as limiting of the present invention. While the present invention has been described with reference to exemplary embodiments, it is understood that the words, which have been used herein, are words of description and illustration, rather than words of limitation. Changes may be made, within the purview of the appended claims, as presently stated and as amended, without departing from the scope and spirit of the present invention in its aspects. Although the present invention has been described herein with reference to particular means, materials and embodiments, the present invention is not intended to be limited to the particulars disclosed herein; rather, the present invention extends to all functionally equivalent structures, methods and uses, such as are within the scope of the appended claims.

What is claimed is:

1. A porous concrete system comprising:
 - a porous concrete slab containing one or more conduits embedded therein, at least one conduit having an adapter that is connectable to a hose.
2. The porous concrete system of claim 1 wherein the one or more conduits are perforated.
3. The porous concrete system of claim 2 wherein the one or more conduits have a diameter of about $\frac{3}{8}$ inches to about 2 inches.
4. The porous concrete system of claim 3 wherein the one or more conduits have a diameter of about $\frac{3}{8}$ inches to about 1 inch.
5. The porous concrete system of claim 1 wherein the length of one or more of the conduits is less than the width of the porous concrete slab, such that at least one end of at least one of the conduits is embedded within the porous concrete slab.
6. The porous concrete system of claim 2 further comprising a cap secured to at least one of the one or more conduits.
7. The porous concrete system of claim 1 further comprising a manifold connected to a plurality of the one or more conduits.
8. The porous concrete system of claim 1 wherein the conduits are arranged substantially parallel.
9. The porous concrete system of claim 1 wherein the conduits are arranged in a grid pattern.
10. The porous concrete system of claim 1 wherein two or more of the conduits are connected to each other and share a common adapter.
11. A porous concrete system comprising:
 - a plurality of porous concrete slabs, wherein each porous concrete slab contains one or more conduits embedded therein and at least one conduit in each porous concrete slab has an adapter that is connectable to a hose and

wherein the porous concrete slabs are arranged in a manner where the conduits in one porous concrete slab are adjacent to the conduits in the neighboring porous concrete slab;

a connector connecting at least one of the conduits in one porous concrete slab with the adjacent conduit in the neighboring porous concrete slab.

12. The porous concrete system of claim **11** wherein the conduits are perforated.

13. The porous concrete system of claim **11** wherein the conduits are arranged substantially parallel in each porous concrete slab.

14. The porous concrete system of claim **11** wherein the conduits are arranged in a grid pattern in each porous concrete slab.

15. The porous concrete system of claim **11** wherein the conduits are arranged substantially parallel in at least one of

the porous concrete slabs and the conduits are arranged in a grid pattern in at least one of the porous concrete slabs.

16. The porous concrete system of claim **11** wherein the conduits are perforated.

17. The porous concrete system of claim **11** wherein two or more of the conduits in at least one of the porous concrete slabs are connected to each other and share a common adapter.

18. The porous concrete system of claim **11** further comprising a cap secured to at least one of the conduits.

19. The porous concrete system of claim **11** wherein the length of one or more of the conduits is less than the width of the porous concrete slab, such that at least one end of at least one of the conduits is embedded within the porous concrete slab.

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