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STORMPILLOW TECHNOLOGY - FILTRATION SYSTEM FOR STORMWATER TREATMENT OF RAINFALL RUNOFF

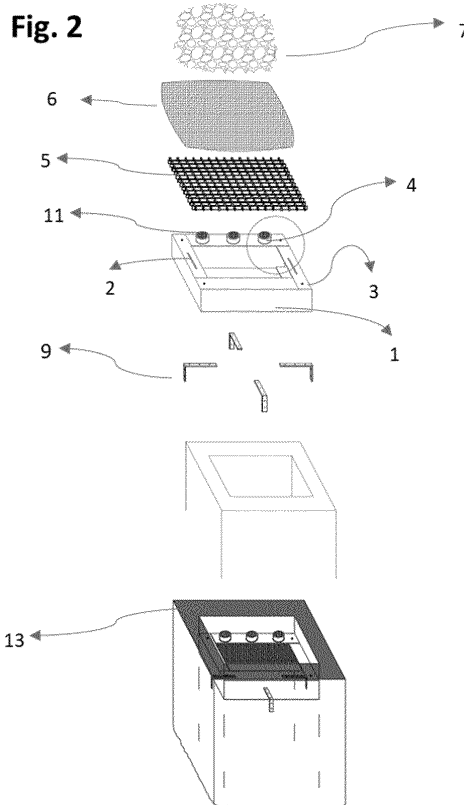
(57) The new system, Stormpillow, deals with contaminated runoff stormwater before it goes to the drainage channel and water bodies. A well-designed technology is fitted into a drainage inlet without modifying or manipulating the drainage or hydraulic infrastructure architecture. The Stormpillow design is adaptable to any size or shape of drainage architecture. Most pollutants such as hydrocarbons, microplastics, microplastic, heavy metals, coarse and small debris, and dissolved ones are removed by taking advantage of the filter media composition in the bag (pillowcase).

The main advantages of the system, which distinguish it from other similar systems on the market, are increased hydraulic efficiency, extremely low operation and maintenance (O&M) costs, ease of installation and maintenance, adaptability to any size and shape of the drainage system of the catchment, and the presence of the entire treatment media (granular activated carbon, zeolite, and perlite) in the pillowcase, which improves treatment efficiency. These advantages distinguish the system from other filtration technologies on the market.

The technology has a well-designed overflow mechanism equipped with trapping mesh (capturing debris and other coarse materials associated with the stormwater) that ensures the system's high efficiency in the face of high stormwater intensity and frequency.

In addition to being very easy to install, build, and maintain, Stormpillow is also quite relatively affordable. It is not only adaptable to any size and shape of the drain's inlet due to the highly practical design of Stormpillow's body (guiding frame), but there is also an adjustable design that provides the possibility of being modified on the site in the occasion that there is any error in the measurement of the dimension of the drain inlet or any other obstacle to setting up Stormpillow.

As a result of the filtering materials that are used in Stormpillow, contaminated stormwater runoff may be addressed on a large scale without having to take into consideration the hydraulic structure architectural design. In addition to being very effective at preventing pollution, the design of the overflow decreases the likelihood that polluted runoff will either be diverted around the system or overflow.



Description

APPLICATION FIELD

[0001] The following invention, STORMPILLOW, is a filtration system designed primarily for stormwater treatment with the goal of ensuring environmental protection for receiving waters as well as compliance with the sewage system's discharge limit. Drain inlets are the most common application for this technology. This technology, which was mainly developed to manage stormwater runoff quality, is characterized by decreased dimensions, flexibility in design and dimension, ease of installation and maintenance, as well as highly effective treatment performance in terms of treated runoff and depuration efficiency.

ISSUES

[0002] The following issues are matters of particular concern:

1. Because of the high rate of urbanization and industrialization, stormwater runoff resulting from the impervious area is one of the dangerous runoffs that cannot be discharged into water bodies without treatment. Stormwater runoff is mainly identified by the presence of contaminants such as total suspended solids, hydrocarbons, macroplastics¹ (0.49-10501 MPs/L-1), microplastics, toxic heavy metals, nutrients, and coarse and small debris.
2. Difficulty in installation and post-operation troubles are two of the most serious issues with existing related technologies on the market. Not only is the installation process difficult from an engineering and operational point of view, as well as obstructing area activity, but it also creates post-operational issues such as high debris loss, which causes drainage system blockage.
3. In order to ensure environmental safety, maintenance is critical. Maintenance activities are typically complex, high-priced, and time-consuming.
4. There is a considerable risk of overflowing due to a lack of appropriate engineering design since existing related technologies in markets are incapable of managing high rainfall intensity and frequency.

RESOLUTIONS AND PURPOSES

[0003] The ameliorative and innovative solutions for the critical points highlighted above, integrated into Stormpillow technology, include:

1. Treatment (physical, physicochemical and adsorption) of stormwater runoff flowing on impermeable surfaces through the simple installation of Stormpillows into existing catchments and the use of a selected mixture of filter media based on the

nature of the pollutants specific to the catchment, with the goal of removing runoff contaminations before they enter water bodies. Furthermore, the filter material used to fill the filter is unique to each location. In general, the media consists of a combination of zeolite, perlite, and granular activated carbon (GAC), as well as other media, depending on the pollution level in the catchment.

2. The runoff that flows into the drain's inlet may contain a range of pollutants such as mud, debris, fine and coarse rocks (2000 to 16000 pounds per acre²), hydrocarbons (e.g., oil, petroleum), heavy metals, and plastics (microplastics and macroplastics). In addition to these contaminants, runoff may include bacteria. The treatment of these pollutants in water bodies is addressed by Stormpillow's right filter media and appropriate design circumstances. As a result, after passing through the filter, fairly clean water enters the drainage system.

3. Stormpillow can be installed in a variety of areas, including airports, ports, and terminals, as well as general industrial sites, parking lots, service stations, restaurants, residences, and multi-family housing.

4. One of Stormpillow's benefits is its ease and quick installation. The technology is built in such a way that its size can be adjusted to the dimensions and the shape of the drainage system's existing structures. It has an extremely adjustable dimension which can be adjusted to the drain's inlet at the site thanks to design innovation.

5. There are no post-construction issues such as blocked drainage system channels due to complicated technology installation or being compelled to alter the architecture of the present drainage system.

6. Because Stormpillow is put directly in the drain intake, it avoids challenges connected to soil occupation and building site logistics, ensuring great treatment performance in terms of treated water at significantly lower costs than any other alternative. Stormpillow installation does not need intrusive civil and building work.

7. The existing related technologies face a significant maintenance issue. Despite the fact that most filter system maintenance is required, the majority of them have been abandoned due to their complicated design, which necessitates the expenditure of money and effort. As a result, maintaining these technologies takes a long time and is quite expensive. The design of the components of Stormpillow has been intended to meet this onerous problem. Maintenance operations are facilitated since Stormpillow is easily removable from the drainage inlet and thus minimizes the necessary workspace for maintenance and it only deals with the substitution of the filtering media.

8. The majority of existing related technologies are not built to deal with high frequency and intensity rainfall, which can result in floods and polluted water spreading. By creating the overflow system

equipped to capture pollution as well, Stormpillow is ideally built to reduce the possibility of overflowing and its harmful consequences.

9. Stormpillow functioning requires zero energetic costs.

DESCRIPTION

[0004] Stormpillow technology is a treatment (physical, physicochemical and adsorption) system filled with several media compositions depending on the application. This system can clean stormwater runoff, to guarantee environmental protection of the receiving water bodies. The advantages of the Stormpillow compared to other similar technologies in the market is:

- The contaminants associated to stormwater runoff from impervious areas can be treated extremely;
- The design of Stormpillow is adjustable to any drain inlet and fits with any shape and dimensions;
- It has an innovative adjustable design at-site to apply and easy to install;
- Highly easy and economic maintenance activity;
- A creative overflow design that also has a pollution-capturing design reduces the chance of overflowing in extreme situations. The number of overflows depends on the application.

[0005] Stormpillow components are as follows:

- Filter media (7). By passing through the material, stormwater overcomes the filtration process and adsorption of contaminants, with the removal of also the dissolved substances. It's typically made of a combination of zeolite, perlite, and granular activated carbon (GAC), as well as other media, depending on the pollution matrices in the catchment.
- The filter media is wrapped in a flexible pillowcase (6) with a sufficient mesh size (e.g. 3 mm) to avoid interfering with the filtration process and preventing filtering material loss in the drainage outlet. The pillowcase containing the filter media is a container in a guiding frame (1). The shape and dimension of the guiding frame, and consequently the amount of filtering material, are proportioned and adaptable to the dimension of the drainage inlet.
- Stormpillow has the benefit of being very adjustable on-site. This means that not only is the dimension of the Stormpillow defined by the dimensions and shape of the drain entrance, but it can also be adjusted on-site to the size of the drain inlet if the measurements are inaccurate. In case of rectangular shape, the guiding frame (1) is divided into two L pieces, one of them with overflow has one adjustable sign (14) and the other L piece includes two adjustable signs (14) that may be adjusted as necessary.
- The pillowcase in the guiding frame is supported by a mesh laying plate (5), with a mesh size suitable

(e.g 3,5 cm) to not interfere with the filtration process as well as to not be washed out the filter media.

- The internal perimeter of the guiding frame is covered with a sealing (12) to ensure the hydraulic seal of the system and avoid leakages of non-filtered water down in the inlet drains.
- The guiding frame has two handles (2) to ensure easy installation and maintenance activity.
- The guiding frame's two L pieces are secured with a suitable number of elements of junction (3). There are also clevis pins with split pins (15) for assembling the adjustable sections. These clevis pins properly set up the Stormpillow framework after calculating the appropriate dimension and size of the guiding frame (1) on-site. This enables the guiding frame's dimension flexibility.
- The guiding frame is fixed in the drainage inlet thanks to four holding brackets (9), suitable to hold the weight of the entire Stormpillow structure.
- The guiding frame is equipped with a suitable number of overflows (4). The number and the height of the overflow is proportional to the stormwater runoff flow and the dimensions of the guiding frame. In case of intense rainfall events, if the water reaches the height of the overflow, it will flow inside the guiding frame and down in the drainage inlet through the bottom holes (8). The number of the bottom holes is also proportional to the stormwater runoff flow and the dimensions of the guiding frame and furthermore to the number of overflows.
- The overflows are covered with a trapping mesh (11), to avoid the guiding frame being filled with gross solids, like leaves, sticks, stones, big debris, street garbage, and gross sand.
- The internal structure of the guiding frame has holes (10) to facilitate the management of overflows in case of intense rainfall events.

Claims

1. The Stormpillow is a novel stormwater treatment technique for retrofitting existing catchment basins that is both convenient and revolutionary.
2. The Stormpillow comprises:
 - Stormpillow is equipped with a "guiding frame" which, in addition to supporting the pillowcase, directs the runoff through the filtering media thanks to its shape.
 - The guiding frame has the possibility of being adaptable at the site thanks to the innovation of "Adjustable Design".
 - The rainwater runoff is forced through a filtering layer composited by typically granular activated carbon (GAC), Zeolite, perlite, and/or other compositions. The volume percentage of each com-

ponent depends on the necessities of the catchment and treatment necessities.

- Stormpillow is supplied with a wide mesh laying plate made of fiberglass, suitably fixed to the internal walls of the drain in order to make installation and maintenance easy.

- The filtering media is wrapped inside a technical pillowcase, made of machine-woven plastic thread with double overlapping mesh, able to retain coarse material without slowing down the water flow and to reduce the risk of overflowing thanks to its particular design.

- The entire system has a great overflow design and the bottom holes. Owing to overflow engineering, equipped to capture debris, the risk of bypassing polluted runoff is reduced.

3. Treatment with Stormpillow is effective against even the finest solids and dissolved pollutants such as hydrocarbons, organic pollutants, microplastic, heavy metals, and coarse and small debris by physical and physicochemical. the innovation point of the Stormpillow is that its installation is simple and flexible, but the implications are significant. There is no need to change the drainage system's basic architecture, and hydraulic network, and guarantees a high result for a minimum investment.

4. The Stormpillow is an in-house storm drain treatment device that treats the rainwater runoff in a direct and continuous manner from the perspective of the quality of the water. The innovative potential of the system lies in its capacity to be designed in such a way so that it can be constructed exactly to the dimensions of each storm drain. A further innovation that makes a significant difference is having an adjustable design that is incredibly customizable, in which the dimensions may be altered on location as well.

5. Maintenance is extremely simple and cost-effective which is the innovative point of the Stormpillow. In addition to cleaning the system, only the filtering media needs to be replaced and the "pillowcase" needs to be recovered if necessary.

6. The Stormpillow guarantees the following results:

- Reduction of stormwater runoff's hazardous constituents (e.g. small and coarse particles, dissolved contaminants, microplastics, and so on);

- Installation does not need to modify the hydraulic capacity of the drainage system;

- It can be applied to every type and size of a storm drain on the market and/or manufactured thanks to its adjustable design;

- Assembling with the possibility of being adjustable at the site, make the Stormpillow more effective.

fective.

- It requires little effort and is cost-effective to maintain;

- It guarantees a high treatment capacity without the risk of overflowing and bypassing the runoff. In extreme events, in the case of overflow, the overflow design has the capacity of capturing the debris as well.

Amended claims in accordance with Rule 137(2) EPC.

1. A stormwater infiltration pillow **characterised by:**

- a) Frame body dimensioned and adapted to fit within a drainage inlet obstructing at least a portion of said drainage inlet, to allow undisturbed stormwater runoff discharge under overflow conditions.

- b) Layer of fluid-permeable filter material, resting within the frame body.

- c) Two (2) mesh laying plates dimensioned and adapted to fit respectively above and below the layer of filter material, to retain said filter material within the frame body.

- d) Holding brackets positioned below the frame body, dimensioned to sustain the weight of the frame body, mesh laying plates and filter material layer.

2. The stormwater infiltration pillow of claim 1 wherein said layer of filter material consists of a mixture of granular activated carbon (GAC), zeolite and perlite, or other mixtures of filter media depending on the expected pollutants to be treated by the stormwater infiltration pillow.

3. The stormwater infiltration pillow of claim 1 wherein said frame body comprises of removable plates so that the layer of filter material can be removed without disassembling the mesh laying plates from the frame body.

Fig. 1

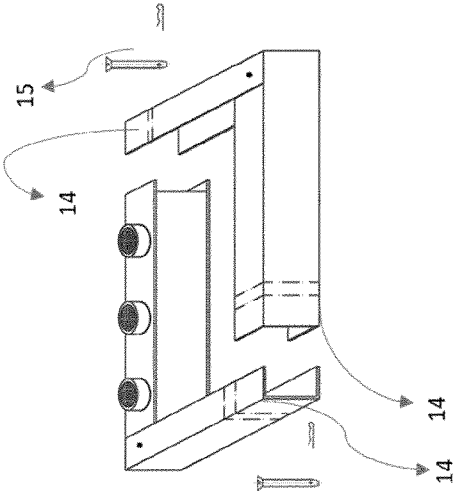


Fig. 2

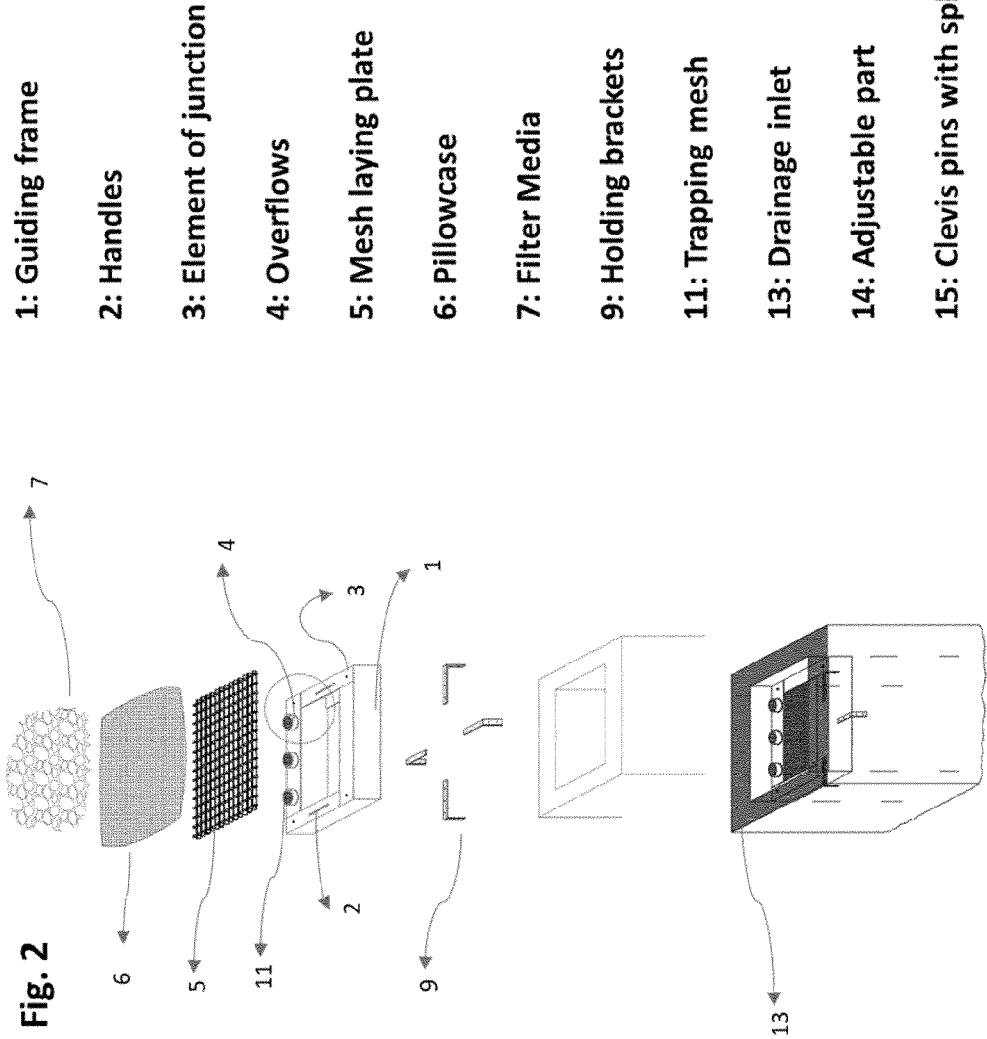
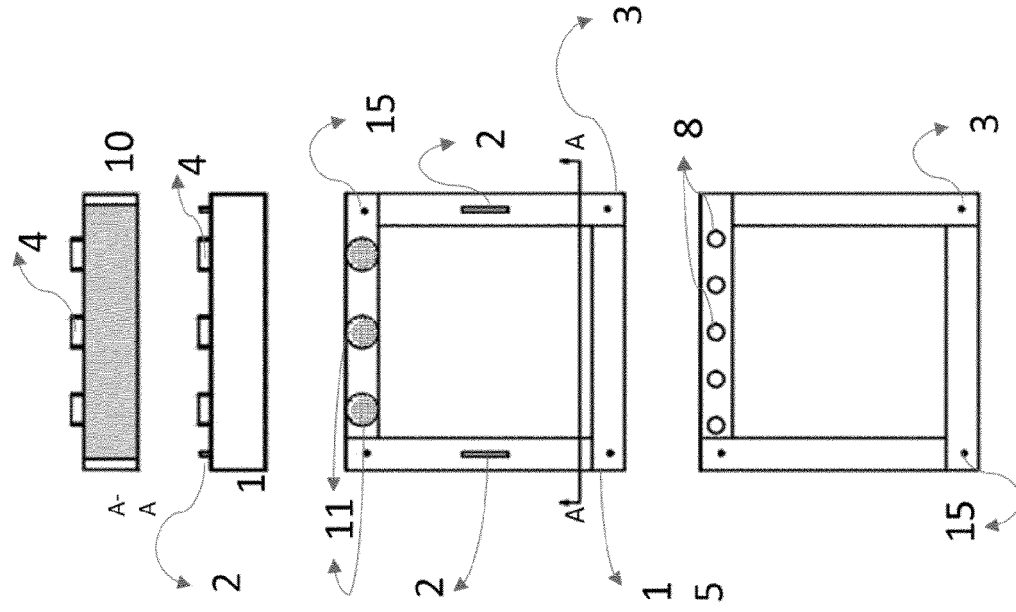


Fig. 3



1: Guiding frame

2: Handles

3: Element of junction

4: Overflows

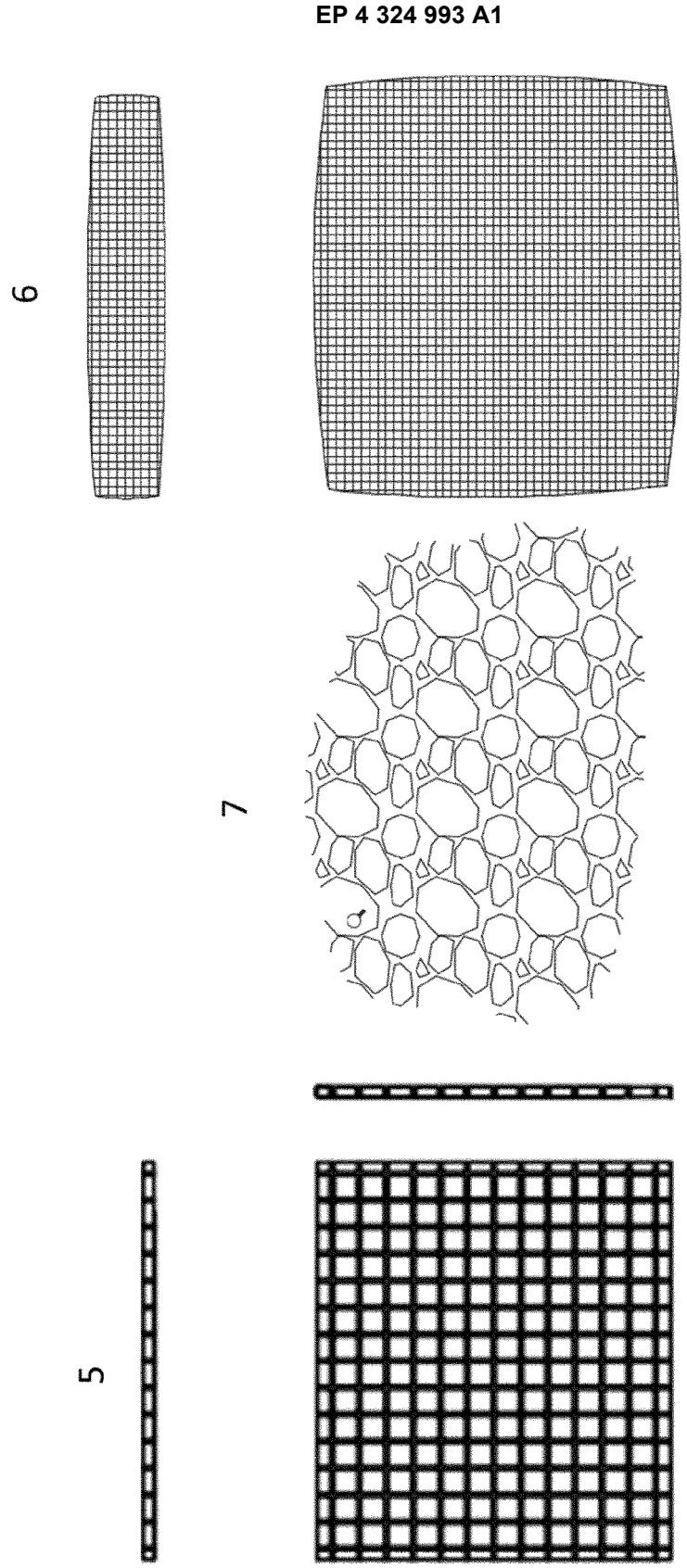
8: Bottom holes

10: Internal holes

11: Trapping mesh

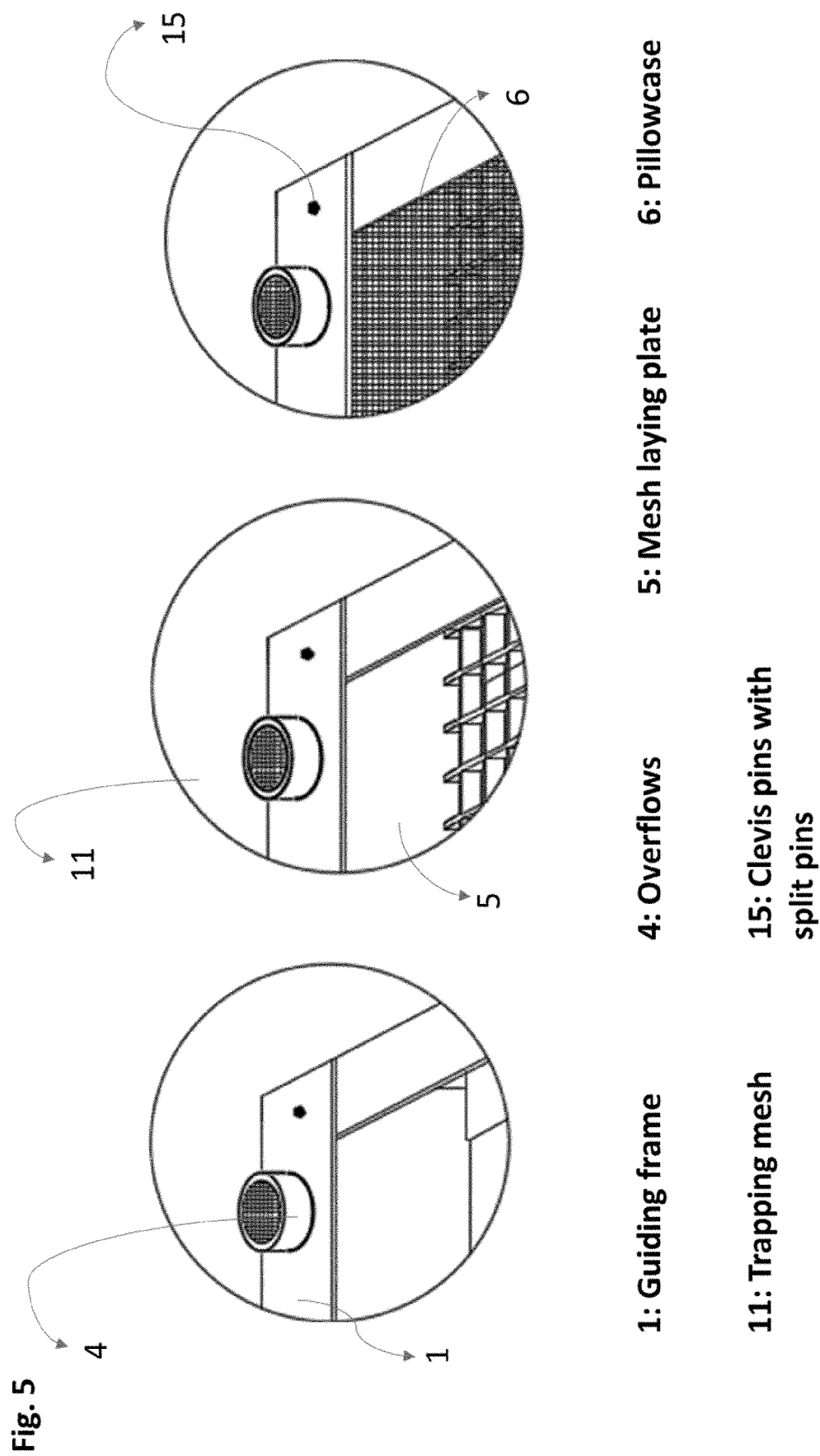
15: Clevis pins with split pins

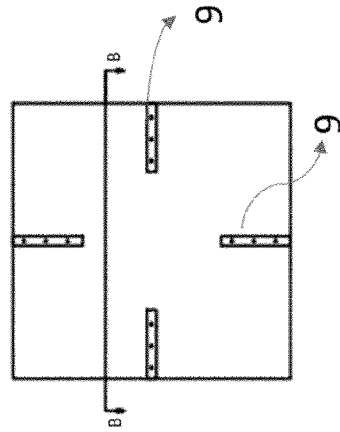
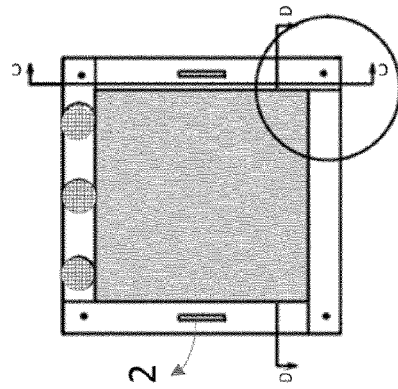
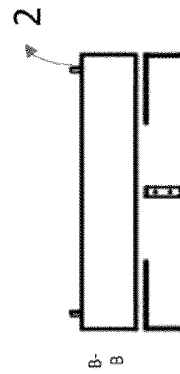
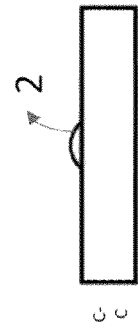
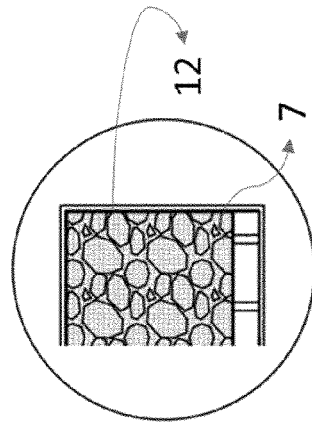
Fig. 4



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5: Mesh laying plate 6 : Pillowcase 7: Filter Media





2: Handles

7: Filter Media

9: Holding brackets

12: Sealing layer



PARTIAL EUROPEAN SEARCH REPORT

Application Number

under Rule 62a and/or 63 of the European Patent Convention.
This report shall be considered, for the purposes of
subsequent proceedings, as the European search report

EP 22 19 0862

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	CN 110 359 541 A (XU YONGFENG) 22 October 2019 (2019-10-22) * paragraphs [0001] - [0066]; figures 1-6 *	1, 2	INV. E03F5/04
A	WO 2021/025740 A1 (NEW PIG CORP [US]) 11 February 2021 (2021-02-11) * paragraphs [0001] - [0027]; figures 1-13 *	1, 2	
A	US 2013/299402 A1 (ROGAHN DON [US]) 14 November 2013 (2013-11-14) * abstract; figures 1-14 *	1, 2	
A	US 2002/021939 A1 (ALLARD DOUGLAS PAUL [US]) 21 February 2002 (2002-02-21) * abstract; figures 1-16 *	1, 2	
A	US 6 270 662 B1 (GIBSON DARRELL JAMES [US] ET AL) 7 August 2001 (2001-08-07) * abstract; figures 1-6 *	1, 2	
	----- -/--		TECHNICAL FIELDS SEARCHED (IPC) E03F

INCOMPLETE SEARCH

The Search Division considers that the present application, or one or more of its claims, does/do not comply with the EPC so that only a partial search (R.62a, 63) has been carried out.

Claims searched completely :

Claims searched incompletely :

Claims not searched :

Reason for the limitation of the search:

see sheet C

1

EPO FORM 1503 03.82 (P04E07)

Place of search	Date of completion of the search	Examiner
Munich	17 May 2023	Posavec, Daniel
CATEGORY OF CITED DOCUMENTS		
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		
T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document		

INCOMPLETE SEARCH
SHEET C

Application Number

EP 22 19 0862

Claim(s) completely searchable:

-

Claim(s) searched incompletely:

1, 2

Claim(s) not searched:

3-6

Reason for the limitation of the search:

In the reply, dated 17-03-2023, to the invitation, dated 18-01-2023, to file a statement indicating the subject-matter to be searched, pursuant to Rule 63(1) and 62(1) EPC, the applicant filed a statement consisting of reworded claims. These claims are considered merely as explanations in respect of the originally filed claims (see the Guidelines, B-VIII.3.2.2). The applicant has not indicated whether the search should be based on the searchable part of the scope of the independent apparatus claim 2 or 4.

Therefore, the search has been performed on the searchable part of the scope of the independent process claim 1 and the searchable part of the scope of the independent apparatus claim 2.

The applicant's attention is drawn to the fact that the application will be further prosecuted on the basis of subject-matter for which a search has been carried out and that the claims should be limited to that subject-matter at a later stage of the proceedings (Rule 63(3) and Rule 62a(2) EPC).

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

17-05-2023

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