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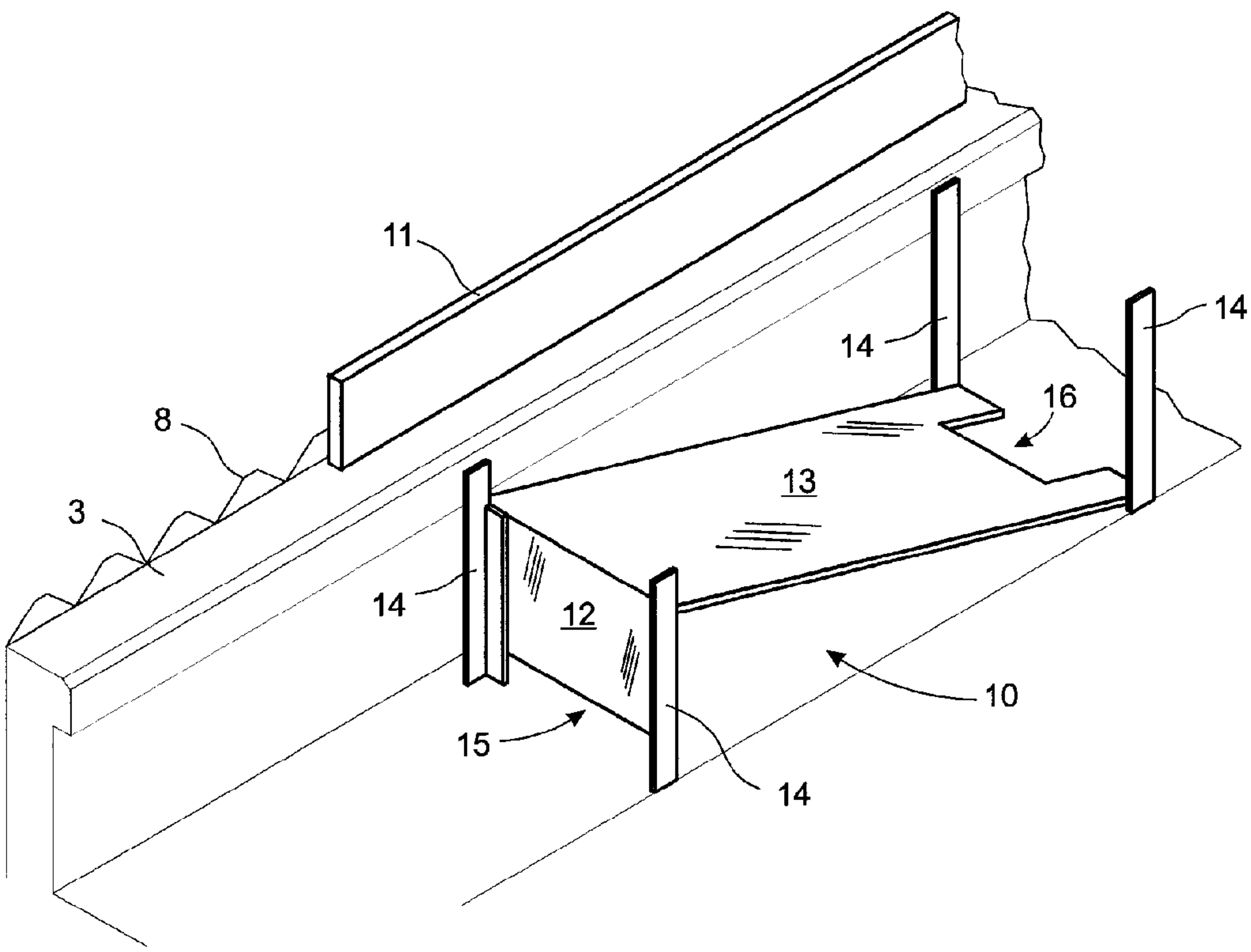

(57) Abrégé/Abstract:
An apparatus for use in a conventional wastewater treatment plant of the type including a clarifier with a launder for use upstream of an anaerobic treatment facility includes a dam assembly defined by a dam wall and a sluice ramp for mounting in the launder downstream of a control dam for minimizing turbidity and consequently oxygen uptake in the wastewater discharged from the launder. The apparatus reduces noise, emission of noxious and malodorous gases, loss of volatile fatty acids from the wastewater, uptake of oxygen into the wastewater and algae growth of in the clarifier.

ABSTRACT

An apparatus for use in a conventional wastewater treatment plant of the type including a clarifier with a launder for use upstream of an anaerobic treatment facility includes a dam assembly defined by a dam wall and a sluice ramp for mounting in the launder downstream of a control dam for minimizing turbidity and consequently oxygen uptake in the wastewater discharged from the launder. The apparatus reduces noise, emission of noxious and malodorous gases, loss of volatile fatty acids from the wastewater, uptake of oxygen into the wastewater and algae growth of in the clarifier.

TITLE

APPARATUS FOR USE IN A SEWAGE CLARIFIER

SUMMARY OF THE INVENTION

This invention relates to an apparatus for use in a conventional sewage clarifier upstream of an anaerobic treatment system.

The term "clarifier" as used herein means a primary or secondary clarifier used in a wastewater treatment plant (WWTP).

Conventional wastewater treatment plants (WWTPs) typically employ multi-stage processes for treating sewage. Typically, raw sewage is fed into one or more clarifiers in which heavy solids settle out of suspension by gravity. Because of the volume of raw sewage which must be handled inWWTPs and the necessity of reducing turbulence in the flow of the sewage, the clarifiers tend to be structures ranging between 10 and 300 feet in diameter, and are typically open to the atmosphere. Conventionally, the clarifier is circular (although rectangular clarifiers are known) and raw sewage is supplied to the clarifier through a centrally located pipe. As the sewage flows downstream away from the inlet pipe, it slows down and becomes sufficiently quiescent that heavy solids settle out. Frequently, lighter materials accumulate on the surface of the sewage as a scum layer, which can be removed by suitable dams or the like. Wastewater minus the heavy solids, flows over a weir which includes a series of V-shaped notches along its top edge (a V-notch weir) and cascades into a trough (a so-called "effluent launder") which surrounds the weir. The clarifier effluent may be directed into a secondary clarifier for further solid separation, or into other equipment for secondary and tertiary water treatment, which typically utilize microbiological processes.

Since secondary and tertiary water treatment processes have usually been aerobic, it has been desirable to introduce as much oxygen (0_2) into the clarifier effluent stream as possible. Accordingly, the weir and effluent launder of conventional clarifiers are typically constructed such that the wastewater overflowing the weir drops from a height of generally 2 - 4 feet into the effluent launder in order to maximize oxygen uptake by the wastewater prior to secondary treatment of the wastewater stream.

While effective at introducing oxygen into the effluent, conventional structures have several disadvantages. In particular, numerous odorous and noxious gases, such as hydrogen sulfide, ammonia, mercaptans, thioethers, indoles, skatoles, chlorine, carbon dioxide, carbon monoxide, and sulfur dioxide, are continuously released into the atmosphere. These gases constitute major safety and health concerns and are pollutants. Moreover, the continuous flow of water into the effluent launder generates substantial noise. Consequently, a WWTP tends to be a noisy, hazardous and odorous facility, especially in the vicinity of the clarifiers, resulting in numerous complaints by citizens, and often necessitating the installation and operation of costly odor containment and removal systems.

Furthermore, the conventional V-notch weir and effluent launder design is unsuitable where modern biological phosphorus removal (BPR) or biological phosphorus and nitrogen removal (BPNR) processes are to be used for subsequent processing of the wastewater downstream of the clarifiers. In BPR or BPNR processes, wastewater flows from the clarifiers to open-air reactors where biological removal of nitrogen and phosphorus takes place. Each reactor has three different process zones: anaerobic, anoxic, and aerobic. The first zone of each reactor is the anaerobic zone, in which the material being treated must have little or no dissolved oxygen (DO_2) and the highest possible concentrations of volatile fatty acids (VFAs) such as acetic, propionic and butyric acid. The anaerobic zone acts as a "biological selector" that permits the exclusive growth and reproduction of naturally-occurring phosphorus removal bacteria (such as *Acinetobacter* and *Pseudomonas*), which are also called BioP bacteria. These bacteria thrive under anaerobic conditions, and VFAs are the only food that BioP bacteria can utilize for their growth and reproduction. The higher the concentration of VFAs in the anaerobic zone, the greater the growth and reproduction of BioP bacteria and the more stable and efficient the BPR and BPNR treatment processes.

In the anaerobic zone, DO_2 must be kept as close as possible to 0 mg/L. Any DO_2 present will allow other wastewater microorganisms to consume the VFAs that must be reserved as substrates for the exclusive growth and reproduction of BioP bacteria. However, the conventional V-notch weir and effluent launder design in clarifiers is intended to maximize DO_2 in the wastewater downstream of the clarifiers. Moreover, significant quantities of VFAs are released into the atmosphere along with the malodorous gases described above, thereby reducing the materials which are essential to the growth and reproduction of BioP bacteria. Because of this deficiency in conventional clarifiers, and the high capital cost of replacing clarifiers, the utilization of BPR or BPNR processes has been severely limited, despite their improved efficiency.

An object of the present invention is to provide an apparatus for overcoming the above-noted deficiencies by achieving significant reduction in the production of noise, and the release of noxious gases and VFA's as compared to conventional clarifiers.

Accordingly, the present invention provides an apparatus including a dam assembly for installation in a sewage clarifier for flooding the effluent launder. The dam assembly includes a dam wall and a sluice ramp for mounting in the effluent launder. The dam wall includes a narrow opening at its base, and the sluice ramp includes a complementary opening, so that some water in the flooded effluent launder passes under the dam assembly, thereby preventing suspended solids from settling near the dam assembly. The majority of the wastewater stream flows over the top of the dam wall and down the sluice ramp. The sluice ramp is angled so that turbidity of the wastewater downstream of the dam assembly is minimized, thereby minimizing oxygen uptake by the wastewater. A control dam prevents wastewater from passing over the V-notch weir in the immediate vicinity (and downstream) of the dam assembly.

When used in a circular clarifier, a pair of dam assemblies are required, one on each side of the effluent launder outlet. This ensures that most of the effluent launder is flooded, and the required length of control dam is minimized.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is described below in greater detail with reference to the accompanying drawings, which illustrate a preferred embodiment of the invention, and wherein:

Figure 1 is a top view of a conventional clarifier;

Figure 2 is a cross section taken generally along line A-A of Fig. 1;

Figure 3 is a top view of the clarifier of Fig. 1 modified to include the apparatus of the present invention;

Figure 4 is a cross section taken generally along line B-B of Fig. 3;

Figure 5 is an isometric view of a dam assembly in accordance with the present invention; and

Figure 6 is a partly sectioned front view of a pair of dam assemblies in accordance with the present invention.

DETAILED DESCRIPTION

For ease of understanding the present invention, the features of a conventional clarifier are described first with reference to Figs. 1 and 2. As shown in Fig. 1, a conventional clarifier indicated generally at 1 includes a cylindrical settling tank 2 having a cylindrical outer wall 3. An inlet pipe 4 in the bottom center of the settling tank 2 is used to introduce raw sewage into the clarifier 1. A trough or effluent launder 5 defined by the wall 3 and an outer cylindrical wall 6 surrounds the tank 2. Wastewater is discharged from the launder 5 via an outlet 7 for further processing. A weir 8 with V-shaped notches therein (hereinafter a V-notch weir) is mounted on the top end of the wall 3. A surface dam 9 is often mounted inside the settling tank 2 to prevent floating materials from reaching the V-notch weir 8.

In use, raw sewage (which may have been previously filtered to remove grit and the like) is introduced into settling tank 2 through the inlet pipe 4 and flows outwardly as indicated by the arrows 20. As the wastewater flows outwardly, it slows down and becomes sufficiently quiescent that suspended solids are separated from the water by gravity. When the wastewater reaches the wall 3, it flows over the top of the wall past the V-notch weir 8 and cascades into the effluent launder 5. In this case, the V-notch weir 8 serves to regulate water flow and introduce turbulence into the wastewater. In order to further increase turbulence, the top end of the wall 3 can be shaped to ensure that the wastewater falls free of the wall 3 (through a drop of typically 2-4 feet) into the effluent launder 5. When the freely falling wastewater enters the stream of water flowing in the launder5, a large amount of air entrainment and turbulence is generated, thereby maximizing the introduction of O_2 into the wastewater. At the same time, significant amounts of malodorous noxious gases (such as hydrogen sulfide, ammonia, mercaptans, thioethers, indoles, skatoles, chlorine, carbon dioxide, carbon monoxide, and sulfur dioxide) and VFAs are released into the atmosphere.

Referring to Figs. 3 and 4, the apparatus of the present invention causes flooding of most of the effluent launder 5, and guiding of wastewater to the outlet 7 of the launder 5 in such a manner as to reduce turbulence and hence air entrainment. In the preferred embodiment, this is accomplished by means of a pair of dam assemblies indicated generally at 10 mounted in the effluent launder 5 proximate the outlet 7, and a control dam 11 mounted on the wall 3 in the vicinity of the dam assemblies 10.

Referring to Fig. 5, each dam assembly 10 includes a dam wall 12 and a sluice ramp 13 mounted in the launder 5 by means of legs 14. The dam wall 12 includes a narrow opening indicated generally at 15 at its base, and the sluice ramp includes a complementary opening indicated generally at 16, so that some water in the flooded launder 5 passes under the dam assembly 10, thereby preventing suspended solids from settling near the dam assembly 10. The majority of the wastewater stream flows over the top of the dam wall 12 and down the sluice ramp 13. The sluice ramp 13 is angled so that turbidity of the wastewater downstream of the dam assembly 10 is minimized, thereby minimizing oxygen uptake by the wastewater. The control dam 11 prevents wastewater from passing over the V-notch weir 8 in the immediate vicinity and downstream of the dam assembly 10.

As shown in Fig. 6, a dam assembly is provided on each side of the launder outlet 7. This ensures that most of the launder 5 is flooded, and the length of the control dam 11 required is minimized.

The dam assemblies 10 can be constructed of any suitable material such as steel, aluminum or plastic. If desired, the dam wall 12 and the sluice ramp 13 can be curved to match the profile of the launder 5 to minimize any gaps between the dam wall 12 and the sluice ramp 13 and the walls of the launder. Sealing members (not shown) can be employed to further reduce turbulent leakage of water between the dam wall 12 and sluice ramp 13 and the walls of the launder 5. These improvements in the design of the dam assemblies can be expected to yield improved performance in terms of reduced O_2 uptake and release of noxious gasses. However, in practice, satisfactory performance has occurred when using simple rectangular dam assemblies with fairly substantial gaps between the sluice ramp 13 and the walls of the effluent launder.

In the illustrated embodiment, the legs 14 are connected to the front and rear ends of the dam assembly, and extend substantially the full height of the launder 5. It is understood, however, that the legs can readily be replaced by small lugs (not shown) for directly connecting the dam wall and the sluice ramp to the walls of the launder 5 using bolts, screws or the like.

Example Installation

By the end of December 1997, 14 primary clarifiers at the 500,000 m^3/day Bonnybrook BPNR wastewater treatment plant in Calgary, Alberta had been modified in accordance with the present invention. Side-by-side testing and comparison between primary clarifier No. 13 which was modified in accordance with the present invention and primary clarifier No. 14 which was not modified, showed the following process and environmental benefits of the present invention:

- losses of VFAs from wastewater to the atmosphere is reduced by 83 %;
- oxygen transfer to the waste water is reduced by 70 %; and
- noise levels and intensity of malodors are dramatically reduced.

The present invention can also be employed in the effluent launders of secondary clarifiers of any WWTP to substantially reduce not only noise levels and malodors, but also the profuse growth of algae which typically occurs on concrete walls, other surfaces and peripheral weirs of the effluent launders. Algae are unsightly and difficult and time consuming to remove. Algae also disrupt weir flow balance, decrease effluent quality in terms of CBOD5, TSS, TP, NH_3-N, etc., reduce ultraviolet light disinfection efficiency, and increase annual operating and maintenance costs of electricity, lamp cleaning and lamp replacement. By creating submerged flow conditions in the effluent launder, the present invention reduces the penetration and availability of sunlight, thus substantially reducing surface area on which algae growth takes place.

CLAIMS:

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1. An apparatus for use in a wastewater treatment plant of the type including a clarifier having an effluent launder, said apparatus comprising:

a dam wall for installation in said launder capable of at least partially flooding said launder; and

a sluice ramp for installation in said launder on the downstream side of said dam wall in the direction of effluent flow through said launder for minimizing turbidity and consequently air entrainment of wastewater flowing past said dam wall.

2. An apparatus according to claim 1, wherein said clarifier includes a V-notch weir and said apparatus includes a control dam proximate said V-notch weir for preventing flow of wastewater past said weir in the area of said dam wall, said sluice ramp and an outlet from said effluent launder.

3. An apparatus for use in a wastewater clarifier of the type including an enclosing wall, a weir mounted on said wall and an effluent launder for receiving wastewater overflowing said weir, said apparatus comprising:

a control dam for mounting on said enclosing wall; and

at least one dam assembly mounted in said launder downstream of said control dam in the direction of wastewater flow, said dam assembly including a dam wall and a sluice ramp for reducing turbidity and consequently oxygen uptake in the wastewater discharged from the clarifier.

4. An apparatus according to claim 3, wherein said dam wall is a vertical wall and extends the width of said launder when installed therein.

5. An apparatus according to claim 4, wherein said dam wall is the same height as said launder.

6. An apparatus according to claim 3, 4 or 5, including gaps in the bottom of each said dam wall and said ramp, whereby a portion of the wastewater flows under said dam assembly to prevent an accumulation of solids upstream of said dam assembly.

7. An apparatus according to claim 3, wherein said sluice ramp slopes downwardly from a top end of said dam wall to the floor of the launder in the direction of wastewater flow.

8. An apparatus according to claim 7, wherein said dam wall and said ramp include passages allowing a portion of the wastewater to flow beneath said dam assembly for preventing an accumulation of solids upstream of said assembly.

9. An apparatus according to claim 3, including two dam assemblies located in said launder on opposite sides of an outlet for discharging wastewater from said launder, said control dam extending above said two dam assemblies at least for the length of said assemblies, whereby most of the effluent launder is flooded and no wastewater overflows said weir in the vicinity of said dam assemblies.

FIGURE 1
(PRIOR ART)

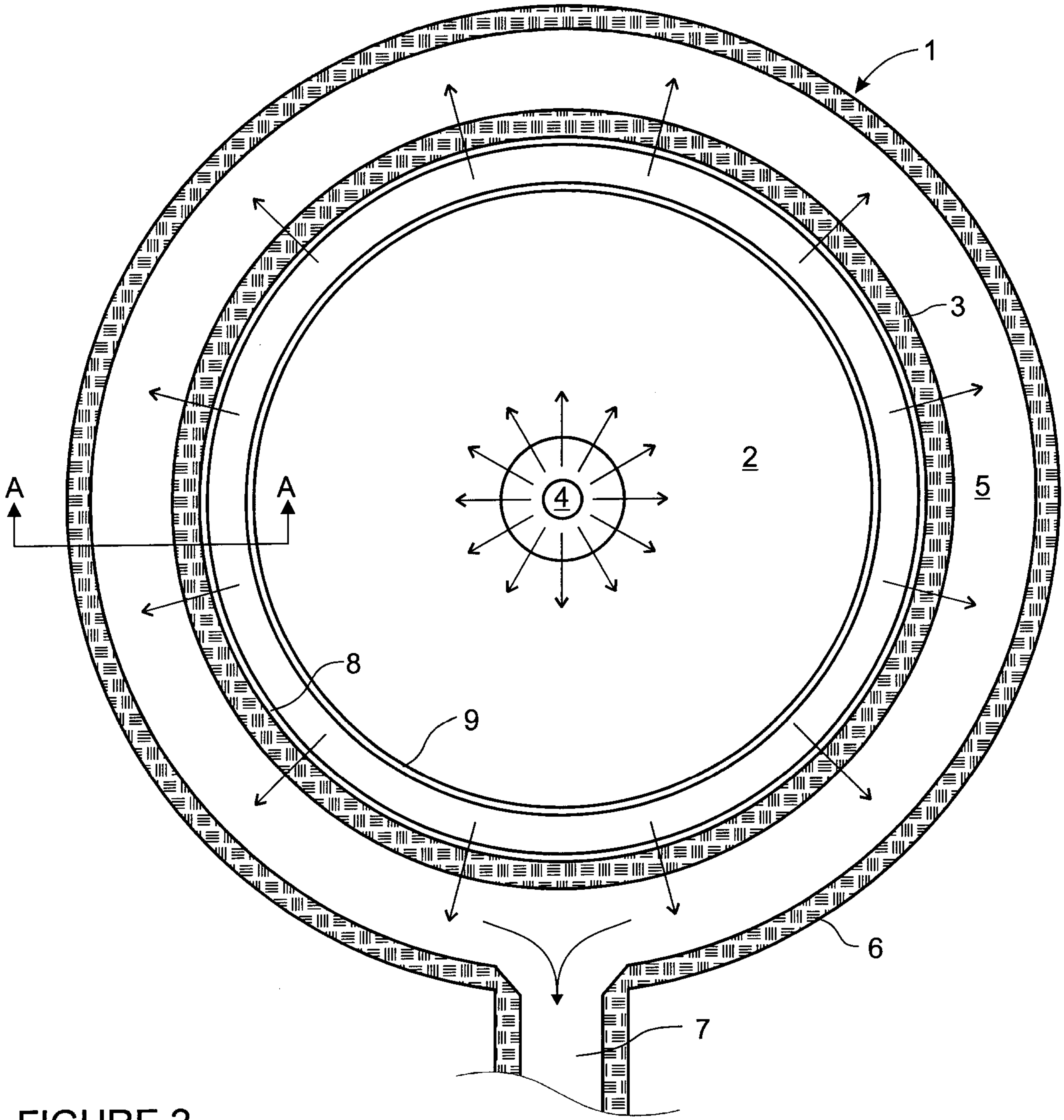
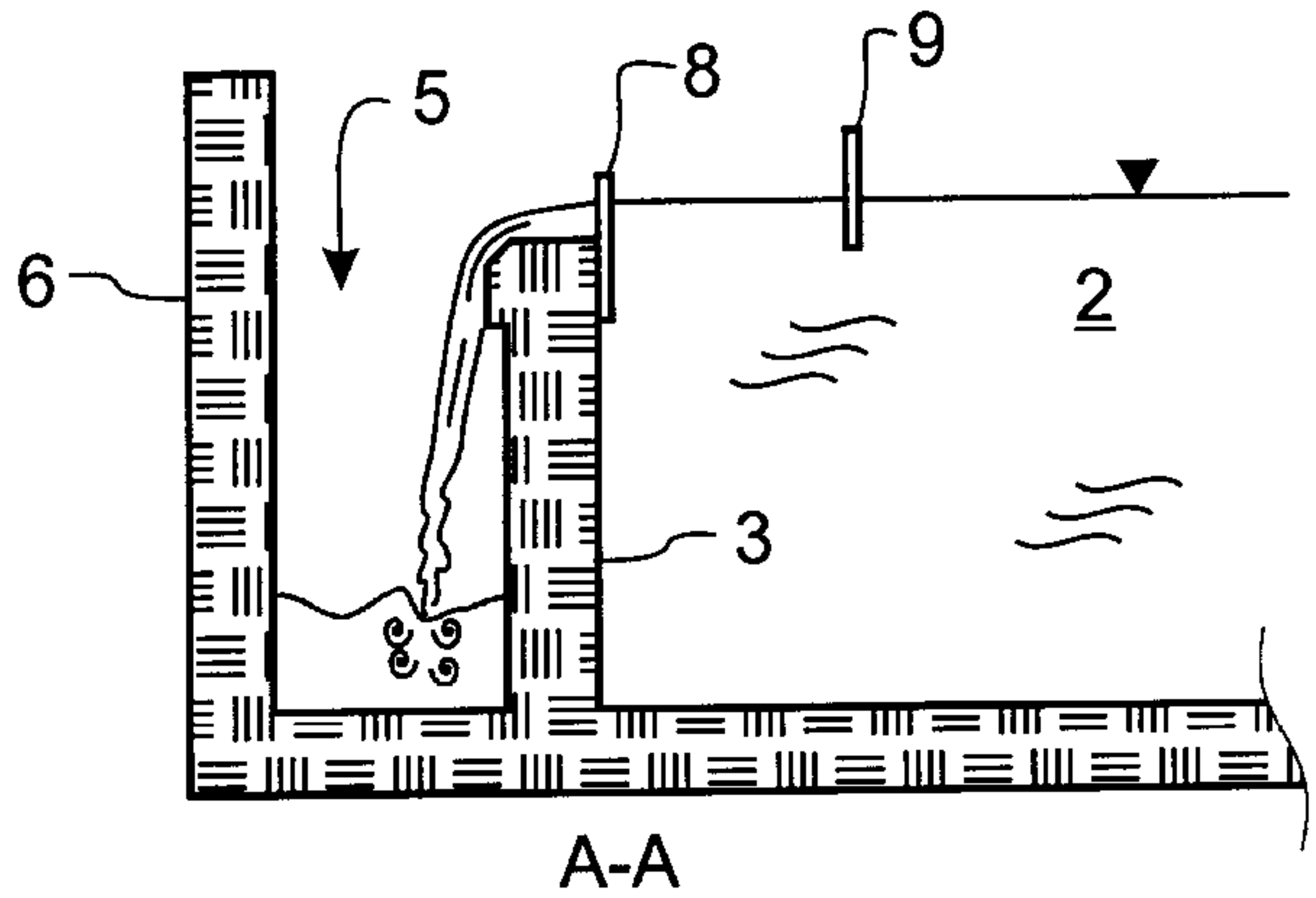


FIGURE 2
(PRIOR ART)



A-A

FIGURE 3

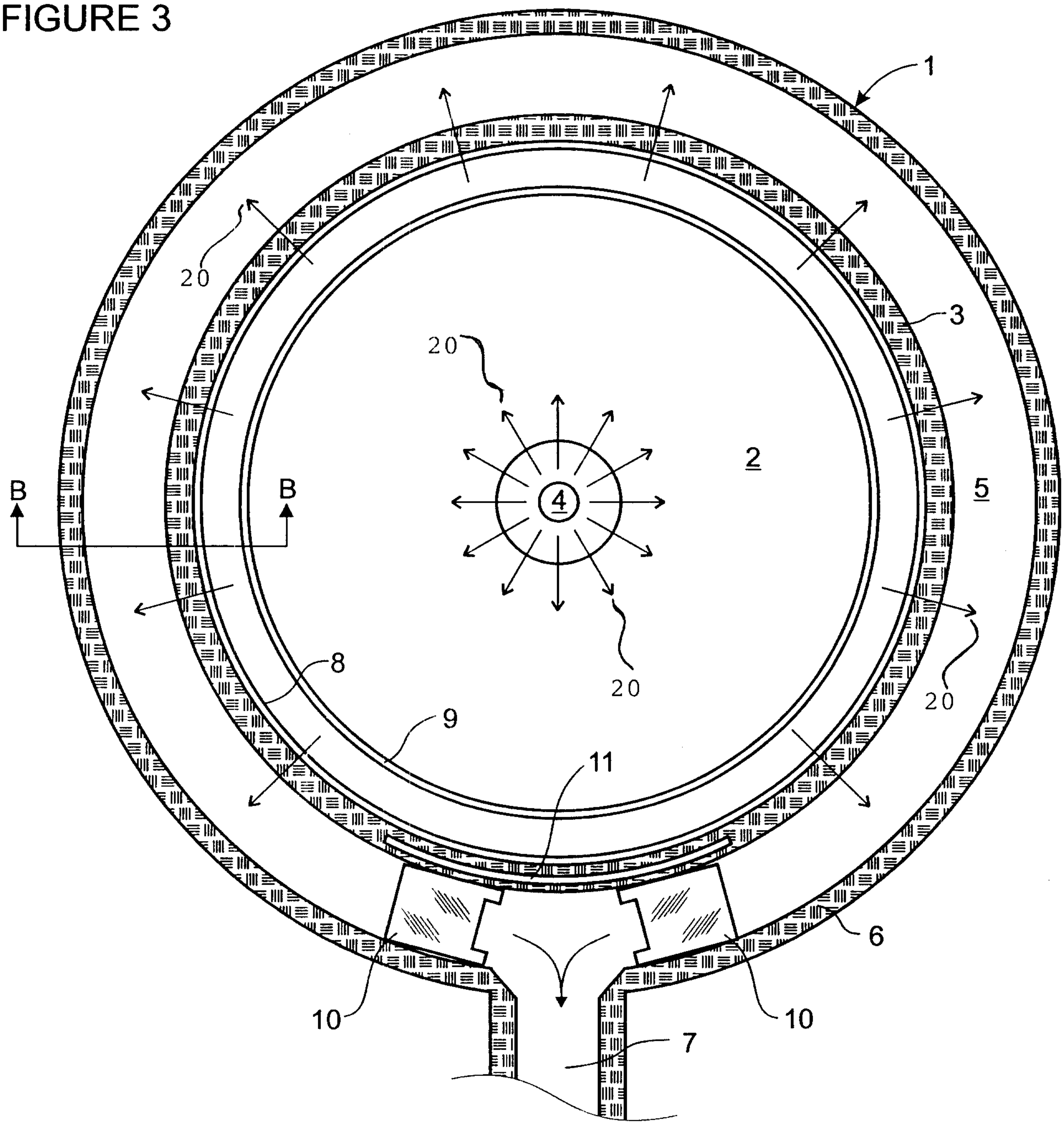
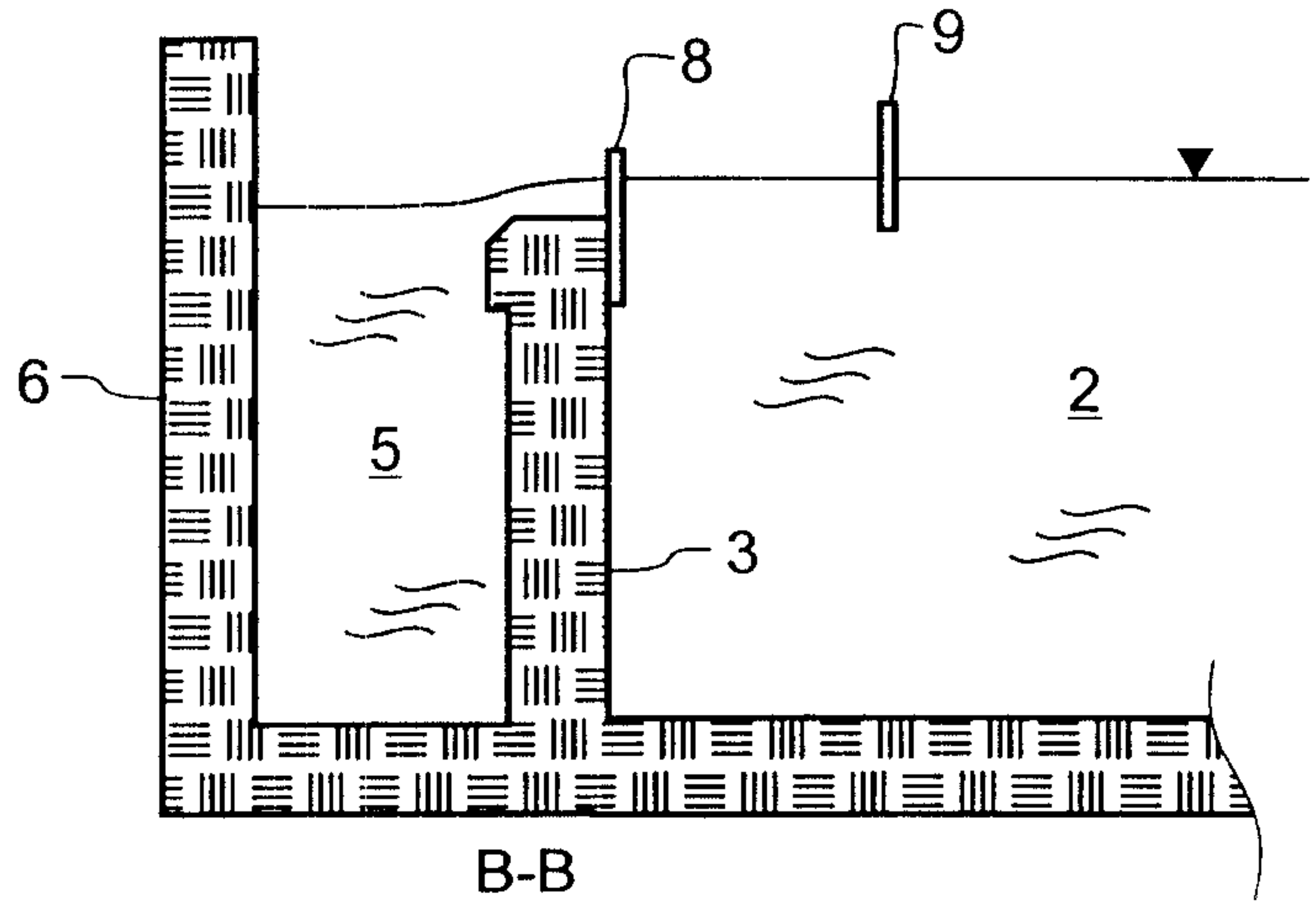
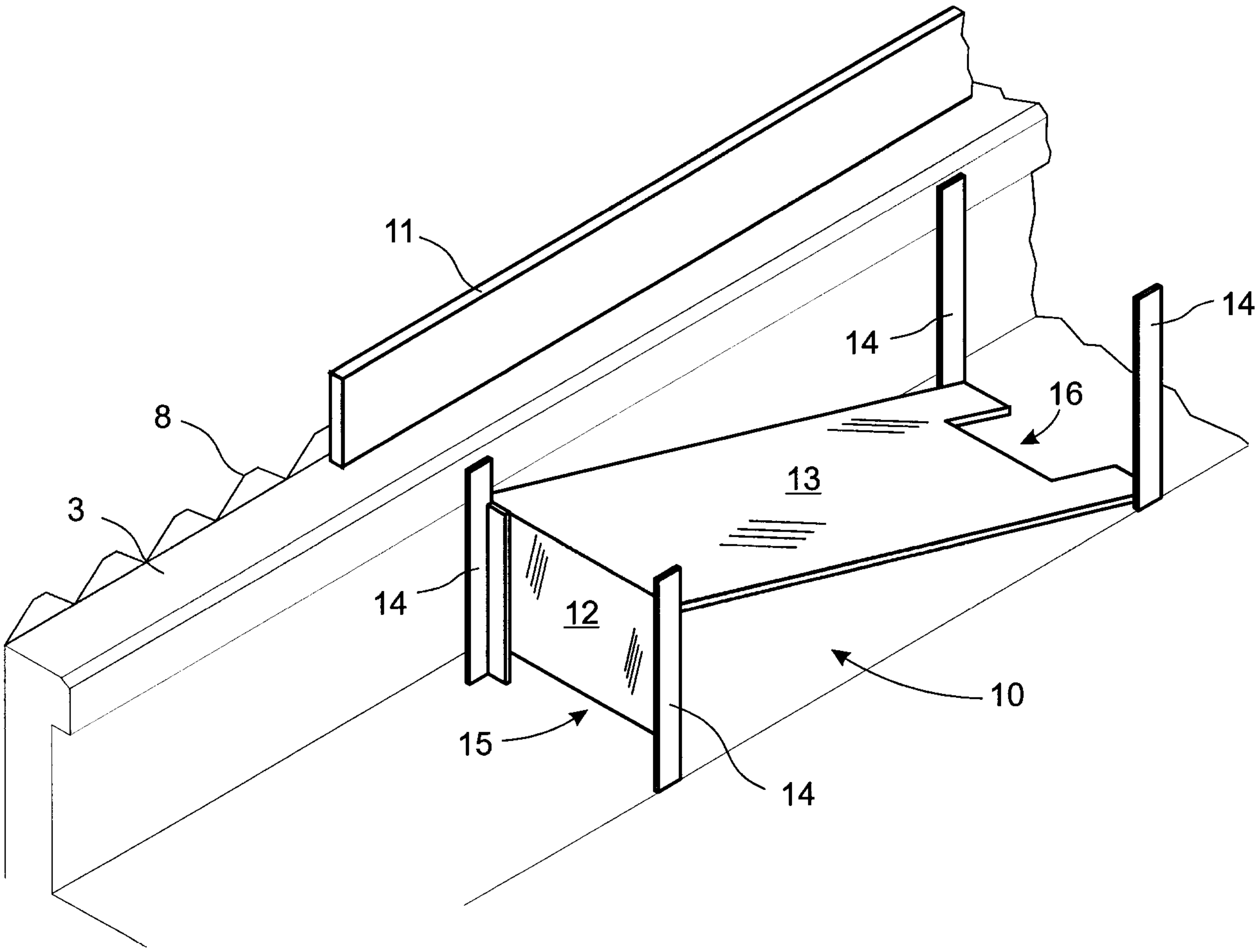


FIGURE 4



B-B

FIGURE 5



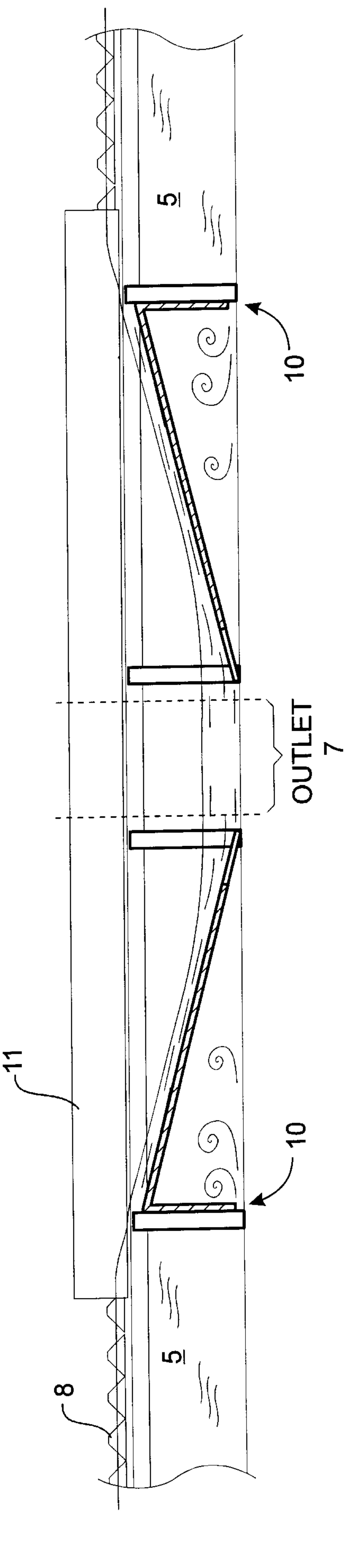
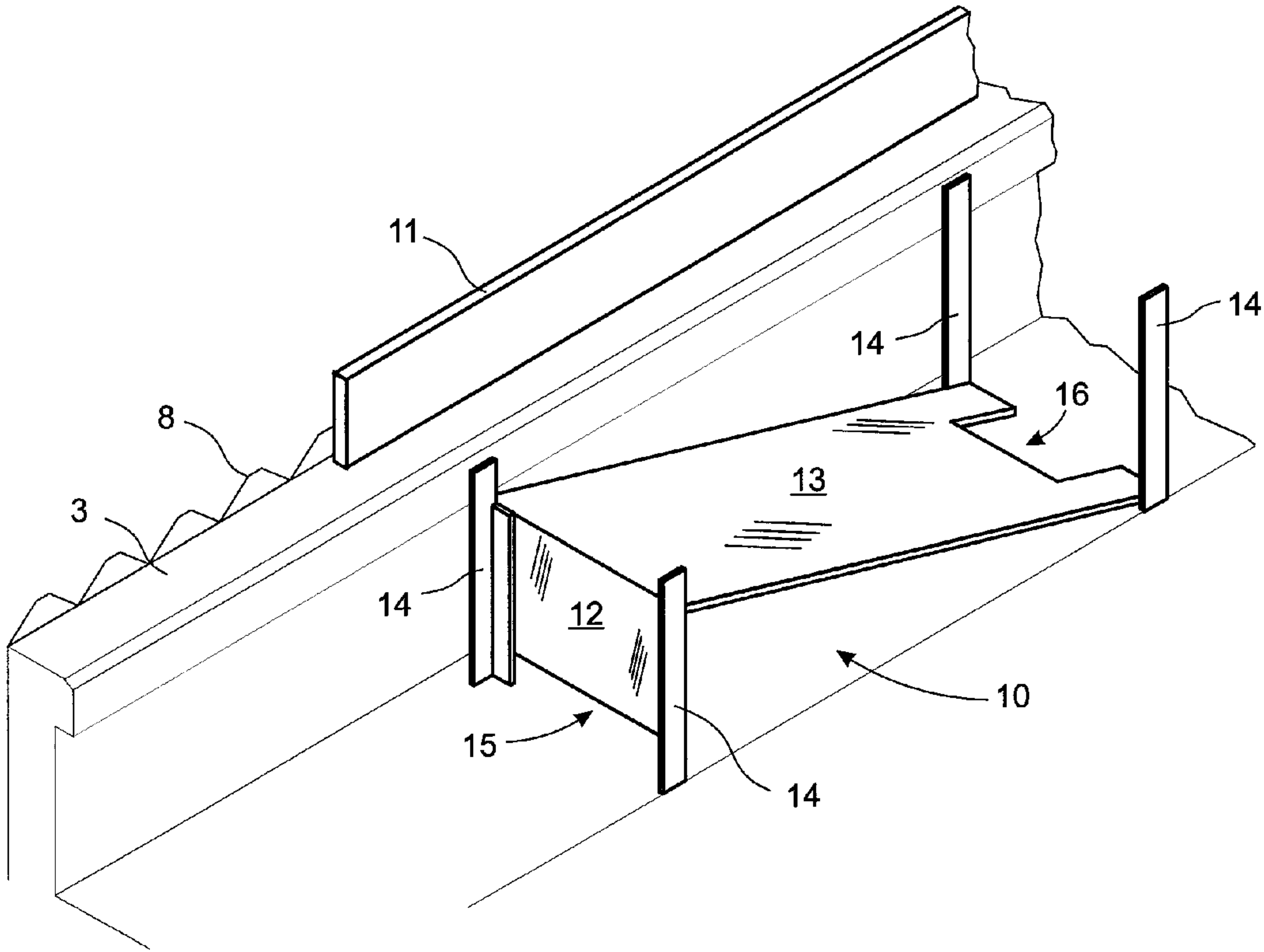


FIGURE 6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