(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 814 211 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
29.12.1997 Bulletin 1997/52

(51) Int Cl.[6]: **E03F 5/24**, E03F 5/20

(21) Application number: 97201805.5

(22) Date of filing: 16.06.1997

(84) Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE

(30) Priority: 17.06.1996 NL 1003359

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(54) Flame extinguisher for a free-head sewer

(57) Flame extinguisher for a free-head sewer comprising two vertical containers (2,4), each having a connection to a sewer pipe (1,5), which are connected in a communicating manner by a connecting pipe (3), which in each of the containers has an outlet at a lower level than the connection to the sewer pipe in the container concerned, the area of a perpendicular cross-section of the connecting pipe (3) being at most 50% of the area of a perpendicular cross-section of each of the containers and the difference in height between the lowest point of the connection to the sewer pipe and the highest point of the connecting pipe's outlet being at least 0.3 m in each container.

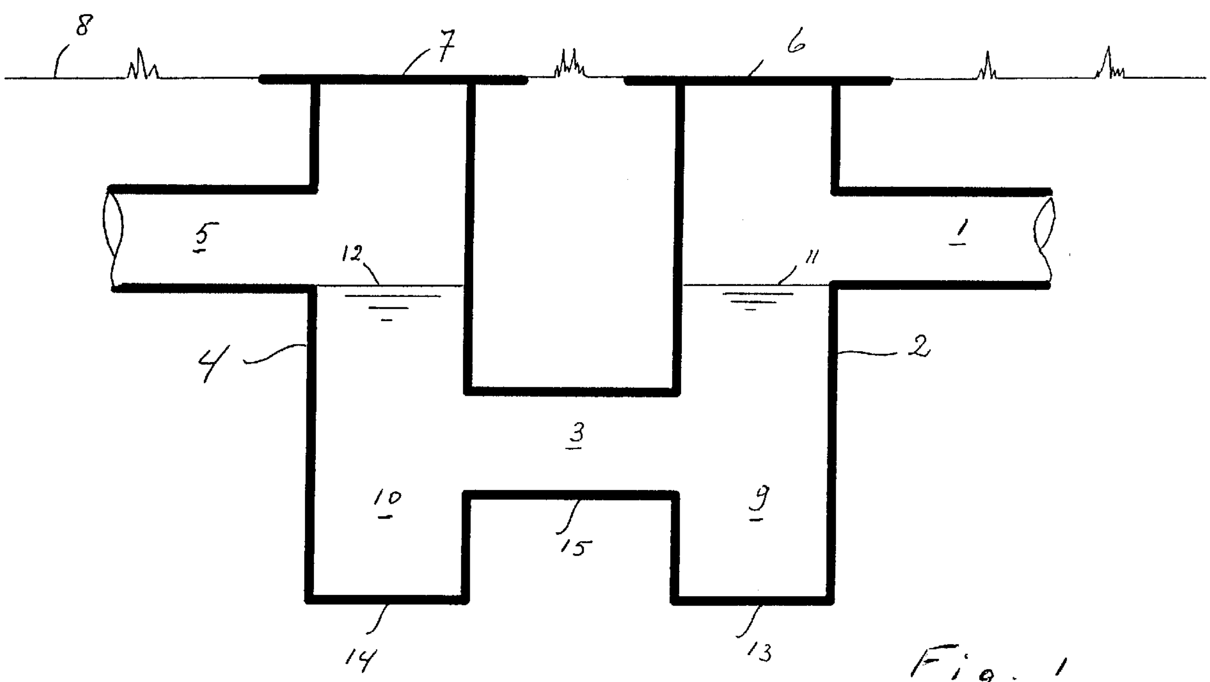

Fig. 1

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Description

The invention relates to a flame extinguisher for a free-head sewer.

Sewers are generally used in the form of a pipe system for the discharge of waste liquids from domestic, built-up and industrial environments; two main types can be distinguished. The first type is the flooded sewer, characterised by the fact that the sewer is at any moment entirely filled with liquid. This calls for special provisions such as pumps and buffers for dealing with fluctuations in the supply. The second type is the free-head sewer, in which the flow is maintained by differences in height in the pipe system. This type does not require extra provisions like the first-mentioned type. In the case of free-head sewers, the pipes are for a substantial part of the time, depending on the supply of waste liquid, not entirely filled with liquid. A layer of gas or vapour is then present above the liquid. In many cases this layer of gas consists substantially of air, but in domestic sewers rotting processes may lead to the formation of combustible and explosive gases. In industrial waste streams, too, the risk of vapour formation in the discharging sewer system as a result of the presence of combustible substances therein cannot be excluded. Chance ignition of a combustible or explosive gas or vapour mixture in a sewer system may lead to fire or explosion, which may then propagate through the sewer and spread over a large area. This may lead to major hazards and considerable damage. In an industrial environment a disaster at a certain point may be the cause of a fire or explosion, which may then propagate through the sewer system to different locations and may there, too, lead to hazardous situations.

There is therefore a need for provisions for preventing the propagation of fire and explosions through free-head sewers.

The invention now meets this need because the flame extinguisher comprises two vertical containers, each having a connection to a sewer pipe, which are connected in a communicating manner by a connecting pipe, which in each of the containers has an outlet at a lower level than the connection to the sewer pipe in the container concerned, the area of a perpendicular cross-section of the connecting pipe being at most 50% of the area of a perpendicular cross-section of each of the containers and the difference in height between the lowest point of the connection to the sewer pipe and the highest point of the connecting pipe's outlet being at least 0.3 m in each container.

Such a flame extinguisher incorporated in a sewer pipe proves to be capable of preventing the propagation of fire phenomena entering the flame extinguisher via one of the connections to the sewer pipe, via the other connection to a further part of the sewer system. This proves to apply both for brief, intensive phenomena occurring in the system such as explosions or detonations and for slower, relatively long-term non-explosive fire phenomena. With the fire extinguishers according to the invention a sewer system can be split up into compartments that are separated from one another for explosions and fire phenomena. For a person skilled in the art it is clear that the invention may also be embodied in systems comprising several supply or discharge sewer pipes, which are each connected to their own container, with which more connecting pipes than the connection between the containers provide the desired configuration.

The flame extinguisher according to the invention is incorporated in a horizontal part of a generally underground - sewer pipe and connects the supplying part of the sewer pipe to the discharging part thereof. The terms 'supplying' and 'discharging' here relate to the normal flow direction of the liquid through the sewer seen from the flame extinguisher. The supplying and discharging parts of the pipe are each connected to one of the flame extinguisher's containers. The container extends vertically above and beneath the sewer pipe. The top of the container is preferably at ground level, and can at the top end be sealed with a cover, rendering the interior of the container accessible for inspection and cleaning operations. There may also be a vent to the atmosphere. The bottom of the container lies at a lower level than the sewer pipe and the container hence constitutes a reservoir for the liquid flowing from the supplying part of the sewer pipe. The container's shape is not of essential importance and may be for example round, square or polygonal. The diameter or the smallest side of the container is preferably at least 0.3 m larger than the corresponding dimension of the supply or discharge pipe when the latter is between 0.2 and 0.6 m, and at least 0.4 m larger in the case of sewers with pipe diameters exceeding 0.6 m. The two containers need not be the same, but if the flame extinguisher is to work in both directions, each container must per se meet the requirements imposed with respect to this in the present application. This holds both for the absolute dimensions and for the dimensions related to the supply or discharge pipe connected to the container.

Suitable materials for the container are for example metals, such as iron, steel or aluminium, concrete, stone and plastic. The most important requirement imposed on the container's material is resistance to a long residence time underground and to the substances to be discharged via the sewer.

The two containers are connected by a connecting pipe and hence constitute a system of two communicating vessels. The area of a perpendicular cross-section of the connecting pipe is preferably smaller than that of the supply sewer pipe. The length of the connecting pipe is not critical, but is preferably at least 0.5 times, and more preferably at least twice, the diameter of the container. The connecting pipe's connections to the containers are preferably angular, which is understood to mean not curved and not rounded. This proves to improve the flame-extinguishing properties. The connecting pipe is preferably straight, because such a pipe proves to show a higher resistance to flame transfer from one container to the other than for example a curved pipe. The container preferably extends to below the bottom of the connecting pipe's outlet. The distance from said bottom to the container's base is preferably at least 0.1 times, and more preferably at least 0.2 and even 0.5 times, the container's diameter or smallest dimension. The presence of an amount of sewer liquid below the lowest point of the connecting pipe's outlet proves to provide better flame extinction. It is suspected that such a structure will cause inflowing gas bubbles to split up into smaller bubbles than in a structure in which no liquid is present below the level of said outlet. The application of irregularities in the connecting pipe's wall, for example in the form of ridges or teeth, proves to have a comparable favourable effect.

The supplying and discharging parts of the sewer pipe are connected to one another by the containers and the connecting pipe. The liquid that flows from the supply pipe into one of the containers flows through the connecting pipe into the other container and, when the level in that container becomes sufficiently high, out of the other container into the discharging part of the sewer pipe. Because the lowest point of the connection to the sewer pipe lies at a higher level than the highest point of the connecting pipe's outlet, the supplying and discharging parts of the sewer pipe are separated from one another by a liquid plug which fills the connecting pipe and the lowest parts of the containers. It has been found that the difference in height between said highest and lowest points must be at least 0.3 m for the flame extinguisher to perform its flame- and explosion-extinguishing function as required. Preferably this difference in height is at least 0.5 m.

In a normally operating sewer system the area between said highest and lowest points will be entirely filled with liquid. If for some time no or little liquid is supplied through the sewer, the liquid level may become lower, for example as a result of evaporation. For the flame extinguisher to perform efficiently, the liquid level may not drop to a level less than 0.15 m above the highest point of the connecting pipe's outlet. Preferably this minimum level is at least 0.25 m. In a sewer that involves a risk of explosion or fire it will hence have to be ensured that sufficient liquid is supplied to maintain the liquid level required for efficient performance of the flame extinguisher.

If a non-explosive fire should now break out for example in the supplying part of the sewer pipe, it will also propagate in the direction of the flame extinguisher. The gases released in the combustion and the heat produced by the combustion will force the gases present in the sewer pipe between the flame front and the flame extinguisher in the direction of the flame extinguisher. These gases, which will not be burning at first, will exert pressure on the surface of the liquid in the container on the side of the flame extinguisher facing the fire. This surface will consequently be pressed down, as a result of which the surface in the other container will rise, and a portion of the liquid present there will flow into the sewer pipe connected to this container. If the surface of the liquid in the first container has now been pressed down so far that the highest point of the connecting pipe's outlet comes to lie above the surface of the liquid in one container, the inflowing gas will be forced to the other container via the connecting pipe. It has been found that this non-burning gas will rise through the liquid present in the second container, forming bubbles in the process. When the gas reaches the surface of the liquid it will enter the free area above the surface of the liquid and from there the sewer. At a certain moment the flame front may reach the other container via the open area in the connecting pipe. At that moment all the non-combusted gas has already been expelled, as described above. The burning gas at the flame front then proves to rise through the liquid as it flows into the second container, disintegrating into bubbles, just like the non-burning gas. If the liquid level in the other container meets the requirements imposed above, the combustion will be extinguished during the formation of the bubbles and the further rising through the liquid. The first burning gas hence arrives non-burning and cooled at the surface of the liquid in the other container and proves to be incapable of igniting the gas present there. This ensures that the combustion phenomena cannot pass the flame extinguisher.

If combustion phenomena of an explosive character occur on one side of the flame extinguisher, the liquid mass in the flame extinguisher according to the invention having the critical dimensioning described above proves to possess a resistance to rapid displacements such that it constitutes a very great resistance to the shock wave accompanying explosive combustion. The shock wave proves to be virtually completely reflected by the surface of the liquid and no, or virtually no, gas transport takes place through the connecting pipe between the two containers. The small amount of burning gas that may after all reach the other container via the connecting pipe proves to be split up into bubbles as described above and to extinguish on its way up through the liquid.

The flame extinguisher according to the invention thus constitutes an effective barrier against combustion phenomena, ensuring that these phenomena are isolated in the part of a sewer in which they originated.

The invention will be elucidated will reference to the following figures, in which Fig. 1 is a vertical cross-section of a flame extinguisher according to the invention in the case of regular flow and Fig.2 is the same flame extinguisher in which the liquid in one container has been pressed down to just below the top of the connecting pipe.

In Fig. 1, 1 is a supply pipe of a sewer that is connected to a container 2. This container 2 is connected to a second container 4 via a connecting pipe 3. Container 4 is connected to discharging sewer pipe 5. The containers have covers 6 and 7, whose tops are flush with ground level 8. The lowest parts 9 and 10 of containers 2 and 4 and connecting pipe 3 are filled with liquid to the surfaces of the liquid 11 and 12. The bases 13 and 14 of the containers 2 and 4 are at a lower level than the bottom 15 of connecting pipe 3, as a result of which an amount of liquid is present in both containers below the lowest point of the connecting pipe.

Fig. 2 shows the situation in which the surface of the liquid 11 in container 2 has been pressed down to below the top of the connecting pipe 3. Consequently, gas can flow in the direction indicated by arrow 17 to container 4, where it disintegrates into bubbles 18, which are discharged in an extinguished and cooled condition to sewer pipe 5.

It is clear from both figures that the flame extinguisher has a symmetrical design and performs its function irrespective of the direction from which the combustion phenomena arrive. As already indicated above, a symmetrical design is in fact not necessary for efficient performance in two directions.

The invention will be further elucidated with reference to the following examples.

<u>Example I</u>

The flame-extinguishing properties were tested of a flame extinguisher as shown in Figure 1 having the following dimensions:

- diameters of sewer pipes 1 and 5: 600 mm;
- diameters of containers 2 and 4: 1200 mm;
- diameter and length of connecting pipe 3: 600 and 1000 mm, resp.
- distance from bottom of supply pipes to top 16 of connecting pipe: 1000 mm;
- distance from bottom 15 of connecting pipe to bases 13 and 14 of the containers: 200 mm;
- total height of containers: 3500 mm.

The flame extinguisher was filled with water up to the bottom of pipes 1 and 5. The area between the surface of the liquid and the covers 6 and 7 was filled with an explosive mixture of propane and air. The mixture in one, first, container was ignited and it was investigated whether the mixture in the other, second, container would also be ignited. The sewer pipe was blinded on the first side to prevent the discharge of pressure from the flame extinguisher. Water and gas could be freely discharged on the second side. The tests were carried out at different propane-air ratios of 4:96, 6.5:93.5 and 7.5:92.5. Each of the tests was carried out both by igniting the propane-air mixture at the top of the first container and immediately above the surface of the liquid. A same series of tests was carried out with the difference that the containers were now filled with water to a level 250 mm above the top 16 of the connecting pipe. In this second series only the situation in which the gas mixture was ignited immediately above the surface of the water was investigated, which situation had emerged as the most critical case from the first series. All the tests were carried out in three-fold. In all cases the explosive mixture in the second container was not ignited and the flame extinguisher thus prevented propagation of the explosion.

As the propane concentration decreased, the rate at which the pressure in the first container built up and the ultimate maximum pressure on the surface of the water proved to increase, but in all cases the connecting pipe proved to remain virtually entirely filled with water and the other container up to the bottom of the sewer pipe, and the burning gas mixture forced to the other container was effectively extinguished. Ignition of the explosive mixture immediately above the surface of the water proved to lead to a higher pressure build-up than ignition immediately beneath the cover. When the mixture is ignited beneath the cover, a portion of the mixture escapes uncombusted to the other container and then no longer takes part in the combustion.

With the lower water level the pressure build-up proved to be substantially smaller than with a maximally filled container, probably because the burning gas mixture could flow more easily to the other container owing to the smaller water column through which it had to travel. The water level of 250 mm in each container however proved sufficient to effectively extinguish the burning gas mixture.

<u>Example II</u>

The flame extinguisher of Example I was on the side blinded in that example fitted with a 20-metre-long sewer pipe with a diameter of 600 mm, which was entirely filled with a propane-air mixture, like the flame extinguisher itself. The concentrations in the various tests were as in Example I. The mixture was each time ignited at the end furthest removed from the container. It was found that when the propane concentration decreased, the propagation rate of the flame increased, even to 100 m/s. The flame extinguisher proved effective under all the tested conditions and it was found that no transfer of the combustion to the other container took place.

Claims

1. Flame extinguisher for a free-head sewer comprising two vertical containers, each having a connection to a sewer pipe, which are connected in a communicating manner by a connecting pipe, which in each of the containers has an outlet at a lower level than the connection to the sewer pipe in the container concerned, the area of a perpendicular cross-section of the connecting pipe being at most 50% of the area of a perpendicular cross-section of each

of the containers and the difference in height between the lowest point of the connection to the sewer pipe and the highest point of the connecting pipe's outlet being at least 0.3 m in each container.

2. Flame extinguisher according to Claim 1, with the difference in height being at least 0.5 m.

3. Flame extinguisher according to Claim 1 or Claim 2, with the container extending to below the bottom of the connecting pipe's outlet.

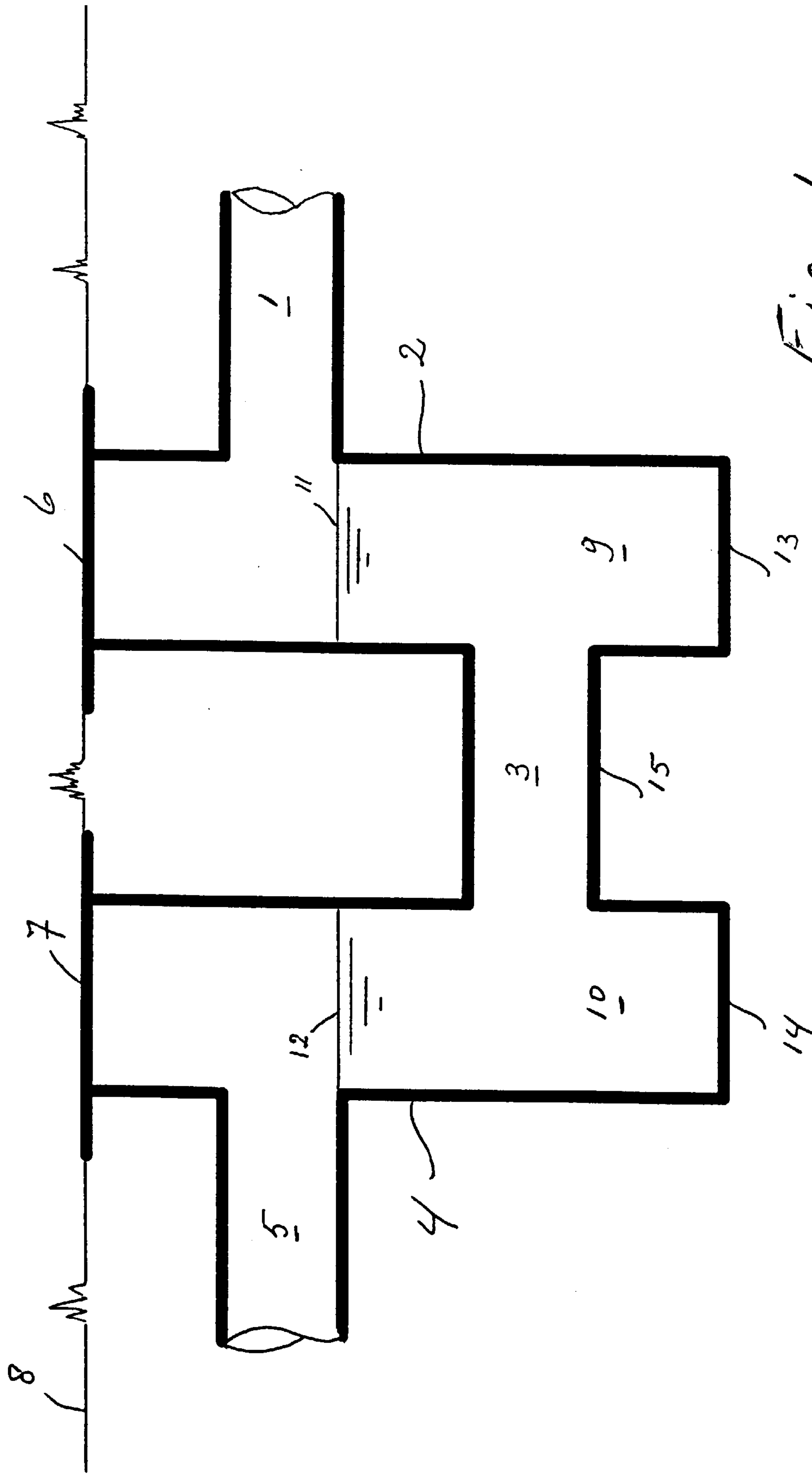

Fig. 1

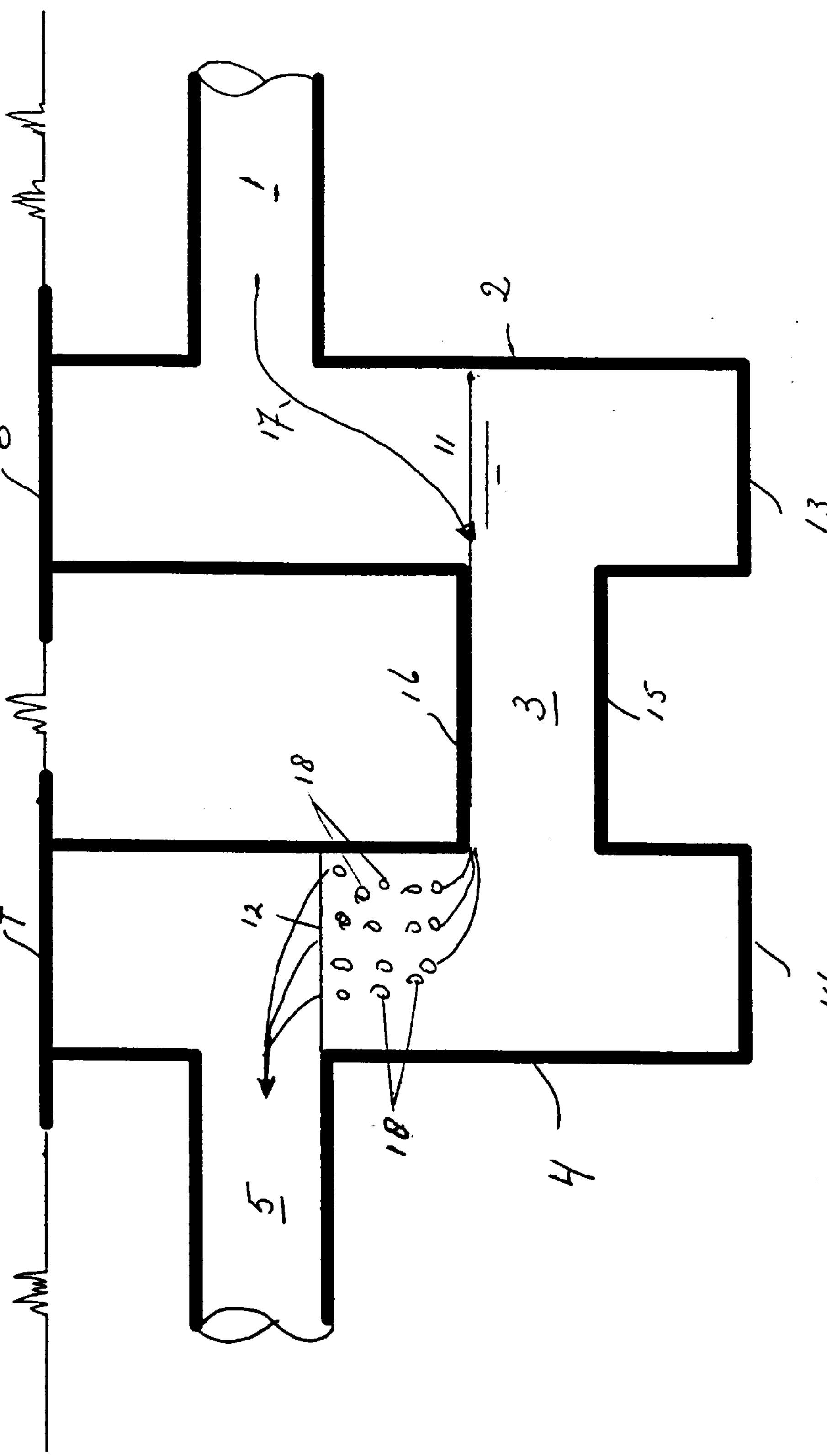

Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 97 20 1805

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	FR 752 552 A (MERLIN) 26 September 1933 * page 2, line 12 - line 53; figures * ---	1	E03F5/24 E03F5/20
A	DE 27 10 478 A (STAHN) 14 September 1978 ---		
A	DE 12 09 514 B (BETEILIGUNGS-UND PATENTVERWALTUNGSGESELLSCHAFT) 20 January 1966 -----		
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			E03F E02D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	6 October 1997	Vijverman, W

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