Abstract: A fluid flushing device comprising a housing locatable in a fluid flow path and a gate pivotally supported on or in the housing and being movable between a closed position and an open position, the gate is biased towards the closed position to inhibit sewage flow and cause a build-up upstream of the device, the gate being movable to the open position to release a flushing pulse of fluid through the device when the fluid head height exceeds a required level, in which the device is provided with holding means for releasably holding the gate in the closed position whereby to increase the fluid head height required before it opens.
before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))
SURGE FLUSH GATE

The present invention relates generally to sealing systems and may alternatively or additionally relate to tipping gates, flusher gates and the like.

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The present invention may comprise one or more sealing petals for sealing between two surfaces, objects or the like. In some embodiments the petal/s are used as a sealing system for a movable gate, valve or the like, for example being provided on either or both of a fixed and/or moving part.

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In some aspects and embodiment the sealing system is applied to the water industry. However, the system may be applicable to other uses and industries than those described by way of example herein.

In some aspects and embodiments the present invention relates to a fluid-actuated tipping gate.

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In some aspects and embodiments the present invention relates to an improved sewer flusher.

An aspect of the present invention relates to a sealing member. In some embodiments the member is a "petal" like member and one or more such members are provided. The petal may be at least partly deformable. A plurality of such members may be provided and particular lay patterns of the members may be used.

The petal-based sealing system may be used in conjunction with one or more further sealing systems, such as a brush seal or a wiper seal.

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The principle of a fluid actuated tipping gate is well understood. This type of gate is often situated in a sewer to provide a flushing effect, this is designed to prevent FOG (fat, oil and grease) and silt build-up and for general fluid control, for example, flood water storage/controlled release. A fluid actuated tipping gate that exists in a sewer to control the movement of sewage, FOG and silt must operate in a hostile environment. One of the main problems associated with such a device operating in such an environment is providing adequate sealing to ensure a suitable fluid head is able to build behind the gate thus ensuring a successful, regular and reliable flushing function. This patent intends to address the issue of sealing.

General

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In some embodiments, the basic operational principle of the gate is as follows. A gate within a frame is positioned in a generally vertical orientation when no fluid is present. The gate is able to pivot approximately along its vertical length. The pivot point is below half way along the length of the gate, for example between one half and one sixth (towards the "bottom") of the way along the gate. The further down the gate the pivot point the greater the stored energy behind the gate is in use.
The gate may have additional mass attached below the pivot axis. Seals exist between the gate perimeter and housing. Fluid builds up behind the sealed gate; the lower one third of the gate cannot swing open (through) as it is constrained by pivot stops. As the fluid continues to build, it passes the gate's pivot axis and it continues to build. When fluid reaches a level such that the moment above the pivot axis is greater than the moment below the pivot axis, the gate becomes unstable. At this point there is nothing to stop the gate from rotating (opening). The gate opens rapidly, translating through, for example, 90° to a generally horizontal orientation; its rotational position again controlled by pivot stops and the mass of fluid. This action results in fluid flowing above and below the gate.

The gate is held in the open position as the mass of the fluid passing over it produces a greater moment on the two third side of the gate such that it overcomes the moment of the one third side of the gate and the additional mass contained on that side. Further, closure is also prevented by fluid passing under the gate. When the bulk of the fluid has dissipated, the gate again becomes unstable and the eccentric mass on the lower half of the gate causes the gate to rapidly rotate back a vertical position.

The Invention

The present invention may relate generally to devices and systems for fluid flushing systems (for example in an open or closed channel, conduit or the like). For example the present invention may relate to a flushing sewage system to prevent the build-up of deposits.

For example the present invention may provide a sewer flushing device located or locatable in a sewage system.

The device may comprise a housing, frame or the like adapted for location in a sewage flow path and a gate pivotally supported on or in the housing and movable between open and closed positions.

The gate may be biased towards a closed position so as to inhibit the flow of sewage and thereby cause a build-up of sewage; when the sewage upstream of the gate reaches a predetermined level the gate is urged to its open position such that a flushing pulse of sewage flows downstream.

In one aspect the present invention provides a fluid flushing device comprising a housing locatable in a fluid flow path and a gate pivotally supported on or in the housing and being movable between a closed position and an open position, the gate is biased towards the closed position to inhibit fluid flow and cause a build-up upstream of the device, the gate being movable to the open position to release a flushing pulse of fluid through the device when the fluid head height exceeds a required level, in which the device is provided with holding means for releasably holding the gate in the closed position whereby to increase the sewage head height required before it opens.

The holding means may comprise one or more magnets.
In one aspect the present invention relates to a new method of partially or fully sealing a gate, such as a sewage flusher gate, within a frame.

A further aspect provides a fluid flushing device comprising a housing locatable in a fluid flow path and a gate pivotally supported on or in the housing and being movable between a closed position and an open position, the gate is biased towards the closed position to inhibit fluid flow and cause a build-up upstream of the device, the gate being movable to the open position to release a flushing pulse of fluid through the device, in which the gate is provided with one or more sealing petals for sealing it against the frame.

In some embodiments, for example, a series of sealing petals are provided. Different types of petals are provided for by the present invention, along with different lay patterns. In one embodiment, for example, the petal/s taper along their length to provide flexibility.

The sealing means may comprise a plurality of polyurethane petals.

A further aspect provides a fluid flushing device comprising a housing locatable in a fluid flow path and a gate pivotally supported on or in the housing and being movable between a closed position and an open position, the gate is biased towards the closed position to inhibit sewage flow and cause a build-up upstream of the device, the gate being movable to the open position to release a flushing pulse of fluid through the device, in which the pivot point of the gate is spaced away from the gate centre line.

A further aspect provides a fluid flushing device comprising a housing locatable in a fluid flow path and a gate pivotally supported on or in the housing and being movable between a closed position and an open position, the gate is biased towards the closed position to inhibit fluid flow and cause a build-up upstream of the device, the gate being movable to the open position to release a flushing pulse of fluid through the device, in which an edge strip seal is provided for attachment to the periphery of the gate for sealing it against the housing.

A further aspect provides a fluid flushing device comprising a housing locatable in a fluid flow path and a gate pivotally supported on or in the housing and being movable between a closed position and an open position, the gate is biased towards the closed position to inhibit sewage flow and cause a build-up upstream of the device, the gate being movable to the open position to release a flushing pulse of fluid through the device, in which side walls are provided on the downstream side of the frame to restrain flow between the frame as the gate initially moves away from the closed position.

In some aspects and embodiments the present invention provides a sewage flushing device located or locatable in a sewage flow path. In other embodiments, for example, the device is located or locatable in a conduit or culvert such as a roadside drain and/or could be built into an irrigation system.
A further aspect relates to alternative considerations, for example for a flusher gate system.

The current state of the art flusher gate has a pivot which is near or very close to being in-line with the gates CoG (centre of gravity) when in a vertical orientation. The restoring moment, acting to close the gate, is at or near its maximum when the gate is horizontal, which decreases as it moves toward its vertical (closed) orientation.

In some aspects and embodiments the present invention relates to positioning the pivot away from the gate centreline, or CoG, so to produce a greater restoring moment (acting to close the gate) when the gate is near or at its vertical orientation. The additional restoring force acts to push the section of seal acting around the curved section into the gate, improving the effectiveness of and helping to close the seal. The restoring moment throughout the gate travel is also required to overcome rotational resistance, which for an embodiment having a seal in constant contact, may be required due to friction between the seal and gate housing (could prevent gate from fully closing).

Alternatively or additionally, the sweep of the gate may be modified so that as the gate moves toward its vertical orientation, there is a component of vertical translation rather than only horizontal (at curved section of gate), acting to push the seal down rather than only along its contacting surface. The redistribution of restoring force from having all at its horizontal and little to none when vertical, means that less weights would be required to alter the 'snap open' water height. By increasing the restoring moment when in a vertical orientation, the required water height before the gate snaps open is also increased, which is done by positioning pivot point away from CoG rather than having to add additional weights as in the current state of art.

Figure 53 shows a chart which shows the restoring force for a particular embodiment, where the gate closing or restoring moment is almost the same in both horizontal and vertical orientation, reaching a peak when at 45 degrees (it could be made to be whatever was required, could be exactly equal at each end of gate sweep).
The principles established here may be used to provide a gate valve, for example a sewage flusher gate. It may be used separately or in conjunction with the sealing system described herein.

In a further aspect a flusher gate is provided with a coating or layer which helps to prevent the build-up of FOG. This may be used in conjunction with other aspects, for example the sealing system, or may be used separately.

In some aspects and embodiments a flusher gate is formed from a metal; in other embodiments at least part of the gate may be formed from a plastics material. This feature may be used separately or in combination with other aspects and embodiments described herein.

In a further aspect the present invention provides a flushing gate in which magnet(s) are used to provide a force acting to hold the pivoting gate in its closed position, resulting in a greater fluid head height than would be achieved if they were not there; and which when the gate has begun to open, the force they provide to hold the gate closed will rapidly diminish or be completely removed.

A further aspect provides a flushing gate in which a catch mechanism is used to provide a force acting to hold the pivoting gate in its closed position, resulting in a greater fluid head height than would be achieved if the catch were not there; and which when the gate has begun to open, the force it provides to hold the gate closed will rapidly diminish or be completely removed.

A further aspect provides a flushing gate where side walls are used on the downstream side to restrain flow between the frame and pivoting gate during initial opening of at least 25 degrees (from fully closed position) or until fully open.

A further aspect provides a flushing gate which has its pivot point on the downstream side of the gate, and which is spaced away from the gate centre line by at least 25mm.

A further aspect provides a flusher gate where an edge strips seal is used to seal between the gate and its housing. The edge seal may be clipped on, and which no adhesive or fixings are used.

A further aspect provides a fluid flushing device comprising a housing locatable in a fluid flow path and a gate pivotally supported on or in the housing and being movable between a closed position and an open position, the gate is biased towards the closed position to inhibit fluid flow and cause a build-up upstream of the device, the gate being movable to the open position to release a flushing pulse of fluid through the device when the fluid head height exceeds a required level, in which the device is provided with helper means for helping the gate to move from its open to its closed position.

A further aspect provides a fluid flushing device comprising a housing locatable in a fluid flow path and a gate pivotally supported on or in the housing and being movable between a closed position and an open
position, the gate is biased towards the closed position to inhibit fluid flow and cause a build-up upstream of the device, the gate being movable to the open position to release a flushing pulse of fluid through the device when the fluid head height exceeds a required level, in which the upstream face of the gate is provided with means for inducing turbulent flow in the fluid pulse.

A further aspect provides a fluid flushing device comprising a housing locatable in a fluid flow path and a gate pivotally supported on or in the housing and being movable between a closed position and an open position, the gate is biased towards the closed position to inhibit fluid flow and cause a build-up upstream of the device, the gate being movable to the open position to release a flushing pulse of fluid through the device when the fluid head height exceeds a required level, in which the device is provided with means for monitoring the open/closed status of the gate.

Different aspects and embodiments of the invention may be used separately or together.

Further particular and preferred aspects of the present invention are set out in the accompanying independent and dependent claims. Features of the dependent claims may be combined with the features of the independent claims as appropriate, and in combination other than those explicitly set out in the claims.

Other aspects, objectives and advantages of the present invention will appear more clearly on reading the following description of several embodiments thereof, given by way of non-limiting examples and with reference to the appended drawings. The figures are not necessarily to scale for all the elements represented so as to improve the readability thereof. In the remainder of the description, for the sake of simplicity, identical, similar or equivalent elements of the various embodiments bear the same numerical references.

The present invention will now be more particularly described, by way of example, with reference to the accompanying drawings.

Example embodiments are described below in sufficient detail to enable those of ordinary skill in the art to embody and implement the systems and processes herein described. It is important to understand that embodiments can be provided in many alternate forms and should not be construed as limited to the examples set forth herein.

Accordingly, while embodiments can be modified in various ways and take on various alternative forms, specific embodiments thereof are shown in the drawings and described in detail below as examples. There is no intent to limit to the particular forms disclosed. On the contrary, all modifications, equivalents, and alternatives falling within the scope of the appended claims should be included. Elements of the example embodiments are consistently denoted by the same reference numerals throughout the drawings and detailed description where appropriate.
The terminology used herein to describe embodiments is not intended to limit the scope. The articles "a," "an," and "the" are singular in that they have a single referent, however the use of the singular form in the present document should not preclude the presence of more than one referent. In other words, elements referred to in the singular can number one or more, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises," "comprising," "includes," and/or "including," when used herein, specify the presence of stated features, items, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, items, steps, operations, elements, components, and/or groups thereof.

Unless otherwise defined, all terms (including technical and scientific terms) used herein are to be interpreted as is customary in the art. It will be further understood that terms in common usage should also be interpreted as is customary in the relevant art and not in an idealized or overly formal sense unless expressly so defined herein.

Figure 1 shows one example of the proposed flusher gate assembly formed according to an embodiment of the present invention. The downstream side of the assembly is shown - the gate is in the closed position. The assembly consists of a generally 'U' shaped frame that has two angled dam plates attached. The dam plates connect the frame to the manhole wall, they are used to collect the fluid and ensure it builds up against the gate and cannot escape around the sides of the gate housing. The radius of the frame has a radius just smaller than the radius of the sewer half pipe located in the bottom of the manhole - this enables relatively easy fitment - minimum civil enabling works - the frame is grouted and sealed into position. The frame has slots on each of its vertical, parallel sides. The slots are designed such that the gate can be fitted to the housing whilst the housing is in-situ by lowering the gate and rotating it through approximately 45°, slotting it between the housing walls and re-orientating it to engage with the slots - removal is the reverse procedure. The frame has a device (pivot stops) to stop the gate continuing to rotate when it is in the horizontal position and a device (pivot stops) to stop the gate continuing to rotate when it is the vertical position. The gate is shown fitted into the housing. Figure 2 shows the same downstream view but with gate in the open position.

Figures 3 shows a gate installed in a sewer half pipe with its dam walls located up against the manhole wall so as to capture all of the fluid and allow it build-up against the sewer gate. Figure 4 shows the gate at 45° with respect to vertical and Figure 5 shows the gate in its fully open position, that is, 90° to vertical (fluid flow is not depicted).

Seal Designs
This patent intends to describe a new method of partially or fully sealing the gate within its frame to ensure 'fit and forget' operation and reliability. It is considered that removing the type of seals that require compression to operate to be beneficial, for example, where a gate compresses a seal against a frame. This type of seal can fail if debris becomes lodged between the gate and the frame - this results in
leakage preventing a fluid head from being able to build - this prevents flushing, in turn, this prevents the removal of the trapped debris.

The present invention contemplates individual, flexible, membrane type elements (petals) that combine to form a near continuous but passive seal that provides an effective sealing system. Individual petals, as these elements can be described, can be, for example, side-by-side, overlapping, offset, staggered, interwoven or multi-layered in any combination, format, arrangement or configuration. The petals can be of any suitable shape, size, profile, section, material, strength or stiffness in any combination, format, arrangement or configuration.

Petals can be attached to the gate or the frame or a combination of such. Individual petals have the ability to deflect alone and independent of their neighbour(s). Where debris becomes trapped then an individual petal may not seat correctly or may partially deflect around it, however, its neighbouring petal(s) will maintain a full seal. Leakage may still occur but it should be minimal. This will still allow a head to build, albeit more slowly, the next flushing action should remove the trapped debris.

Figure 6. Shows an example of a basic petal. The gate and frame may use a combination of petal seals and strip seals or a combination of petal seals and large folding half cone membrane seals or all petal seals; examples will be given later. A high tear strength, high flexibility petal is desirable, an appropriate material may be Polyurethane, for example. Polyurethane is extremely stable and resistant to many chemicals often found in sewers. Further, cast Polyurethane can be very smooth and other substances find it difficult to adhere to. Although not exhaustive, other examples of materials that could be used for the petals include; Nitrile, EPDM, Neoprene, SBR, Silicone, Butyl, Polyacrylate, Hypalon, Viton and Flurosilicone.

Although far from exhaustive, Figures 7 through 19 show examples of other petal shapes, profiles and sections. The exact physical and chemical parameters of each petal will be bespoke to the application in question.

Figure 19 shows a gate that uses individual petal seals on the radius of the gate and strip or ‘P’ seals on the straights of the side walls (petal seals are not shown deflected rearwards). It is likely that any debris will become trapped around the bottom of the gate area, hence, this sealing arrangement may be acceptable with respect to function and reliability.

Figure 20 shows a gate that uses individual petal seals on the radius of the gate and a passive folding half cone membrane seal on the side walls (only one cone seal shown is shown and petal seals are not shown deflected rearwards). This type of seal due to its deformable shape can be considered as a passive seal, that is, it does not actually seal against any surface, in compression or otherwise. Generally, it is likely that any debris will become trapped around the bottom of the gate area, the radius area, hence, this sealing arrangement may be acceptable with respect to function and reliability.
Figure 2a shows a gate that uses individual petal seals around its full perimeter (petals are not shown deflected rearwards). To allow this system to be successful it is necessary to invert the gate mounting slots in the side wall (see Figure 1 for previous layout) and to provide additional side plates - both of these features are critical and are detailed in Figures 22 and 23 respectively. The additional side plates and moving the mounting slots prevent the individual petals inverting during the opening and closing sequence, instead they simply slide in plane. To enable a polymeric petal seal, for example, Polyurethane to slide and not invert due to friction effect, it is beneficial to coat the inner part of the frame with a low-friction coating. Shown is also a modification to the gate - lifting eyes - this allows the gate to be affixed to and removed from the housing by an operative external to the manhole, in turn, this allows the seals to be checked and or replaced above-ground. Further, by providing lifting eyes, the gate can be readily tested by operatives external to the manhole, however, an additional gate test eye can also be incorporated - see Figures 28 and 29. Figure 21b and Figure 21c show how the petal would deflect rearward when in operation and sealed against the frame radius or housing wall.

To further help eliminate the possibility of debris becoming trapped, the petal seal design allows for substantial clearance between the gate and the housing. Figure 24 shows this clearance - this is shown on a 12" gate. Further, operating in a sewer environment, where multi-phase flow is present, sealing bearings can be extremely difficult, especially when cost is critical. This design will accept either a sealed bearing or preferably, a high-play free running plain or bushed bearing as illustrated by Figure 25.

Another design of petal seal involves moulding a continuous 'U' shaped seal, for example, that extends around the complete sealing perimeter of the gate (hence 'U' shape). The continuous 'U' shaped seal is then partially slit such that individual petals are formed but a continuous element still remains - see Figure 26 - note; this shows only a small section of a straight element. Further, this type of seal or the separate petal seals themselves could be modified with a hinge to alter the bending/sealing properties of the petal for a given material stiffness - see Figure 27.

It is important to be able to test the gate whilst operatives remain external to the manhole - to allow this to occur a test eye can be incorporated into the gate - its position is important - it should be below the pivot axis. Figures 28 and 29 give an example of such a test eye point - such an eye could take any form and include a wire pull if deemed necessary.

It is proposed that the dam plates will be made as extruded plates with socket and plug profiled ends - this will allow the plates to be brought together to make up a given length. Typical material would be polymeric, for example UPVC. The structure form will give it its strength. Alternatively, the dam plates could be made in a concertina arrangement. The object of this is to make the dam plates rapidly adjustable to allow the gate assembly to be rapidly installed in the manhole. An angled extrusion on the gate housing could allow rapid attachment of the dam plate to the housing. The angled extrusion could be adjustable with respect to angular positioning. Figures 30 and 31 show an example.
To ensure the sealing mechanism of the petals is as effective as possible bristle cleaning tufts can be included. As the gate closes the bristles/brushes sweep the radius and/or the walls of the housing clean, as such, the petals have a clean surface onto which to seal. An example of a single tuft is illustrated in Figures 32 and 33. As an example, Figures 32 and 33 show a single bristle tuft mounted radially onto the bottom edge of the lower part of the flusher gate. The bristles can be any stiffness, length, material, orientation, diameter, further they can be mounted in any position to yield best cleaning results.

Figure 34 illustrates a further embodiment in which a finger seal overlays a gap between two petal seals. The petal seals are formed from a polyurethane material with a Shore hardness of approximately A90. In this embodiment at least the surfaces of the (steel) housing across which the petals slide are coated with a low friction coating such as Apticote 450 (a nickel/PTFE composite coating). This can be used to reduce friction and to avoid an excessive dam plate opening/closing force.

In use the petals and the finger will deform. The silicon is softer and therefore gets pressed into the gap between the petals to form a good seal therebetween when the dam plate is closed.

Figure 35 shows a one-piece petal seal arrangement forming part of an embodiment of the present invention.

Figure 36 shows a one-piece finger seal arrangement suitable for use in conjunction with the petal seal arrangement of Figure 35.

Figure 37 shows the finger seal arrangement of Figure 36 overlaid onto the petal seal arrangement of Figure 35; with the combined sealing arrangement fitted onto a dam plate.

Figure 38 is a perspective view of a flusher gate dam plate formed according to the present invention.

This embodiment includes use of an encapsulated magnet, for example positioned at the top of the gate (out of the fluid) that would allow the fluid head to build past the point of normal gate instability, whilst still maintaining the gate in a vertical closed position. At a point where the instability due to the fluid head combined with the clamping force of the magnet is overcome the gate will open with a greater moment than with the instability moment alone.

Although previously in main text body - important points which may form part of embodiments of the present invention include:

- Seal Material
- Seal Shape
- Seal cross-section profile - wedge
- Overlap methods or single layer of seals
- Full gate seal in petals
• Lip seals on both sides of gate
• Flexible membrane seal
• Wiper Brush
• High-play (loose) bearings

High clearance under and around gate to allow debris to exist without affecting the closing operation of the gate
• Individual petals to deflect around debris without affecting sealing capabilities of gate
• Seal of non-compression type only / passive type.
• Seal - PU high strength/tear resistance/un-affected by chemicals or thin-film PTFE

Rapid fit side-extension panels to form seal between gate housing and sewer wall - UPVC type interconnection
• Magnet for a more ‘snappy’ opening.
• Low friction coating on walls to allow petals to slide and not invert
• In-situ mass movement to easily adjust gate tipping point

Upper stops and lower stops
• Gate installation from surface
• Gate inspection from surface
• Gate testing from surface
• One-piece petal seal arrangement with separate slits to form petals

Housing side panels to prevent petals inverting
• Position of gate loading slot and pivot point on downstream side of gate - thus upstream, where fluid head must build, fluid in unable to escape and the general principle of sealing is made easier and its low slung position and eccentric gate pivot point with respect to plane of the gate prevents the petal seals having to pass the opening and thus inverting

Easy removal of the gate (hooks at its top) from outside the manhole such that the seals can be easily checked and/or replaced above ground.
• Shoot bolt on hinge - to lock pivot and bush to prevent gate jumping out.
• Petal seal system will allow for a substantial clearance gap.

Figures 39 to 41 illustrate a further embodiment of a flushing gate, the technical features of which are described below. Figure 39 shows the rear (downstream) side with the gate in a closed position; Figure 40 shows a front (upstream) perspective view of the gate in an open position; Figure 41 shows a rear (downstream) view of the gate in an open position.

Magnets are housed on both the pivoting gate and its accompanying housing frame, which are used to provide a force acting to keep the gate in a closed position (which for this embodiment is upright at 90 degrees, although an embodiment having a closed position away from vertical is also possible). The purpose of the magnets is to produce an additional force acting to close the gate other than that provided by the head of fluid or self-weight, which can quickly be removed once the gate has started to open (in under 10 degrees from its closed position). Because the force provided by the magnets
diminishes rapidly as the gate starts to open, the gate tends to 'snap open' rather than to open slowly or fail to fully open due to loss in fluid head height.

The effect of the magnets can be explained with reference to Figure 43, which shows the moments (forces) which act on the gate. The opening moment due static fluid pressure does not begin to build until the fluid level has reached the pivot point, and then increases as a square of the head height. The moment acting to close the gate begins to build from zero head height, and increases linearly after reaching the pivot point. The resultant moment from static fluid pressure acting on the upstream side of the gate is shown, which acts to keep the gate in its closed position until reaching an equilibrium point at a fluid head height of about 490mm (which is driven by gate area differences either side of the pivot) where the forces from static fluid pressure acting to close the gate are equal to those acting to open it. The lower line shows the resultant moment acting on the gate from fluid head, self-weight, and magnetic force. The self-weight of the gate, its CoG position relative to the pivot, and force required to part the magnets mean that a higher fluid head level is required before the moment acting to open the gate equals that acting to close it.

As the gate begins to open (even by a single degree) the force required to part the magnets rapidly drops off (due to exponential decay in magnetic field with separation), which produces a step change (an almost instantaneous change) in the resultant moment acting on the gate, with a significant increase in magnitude of moment acting to open the gate. The increase magnitude accelerates the gate toward its open position, as well as keeping the resultant moment acting to open the gate with drop in fluid head height. Had a magnet, or any other additional hold back force or latching mechanism which quickly dissipates when the gate begins to open, not been used, then it would be possible for the gate to slightly open and close again after losing head height (gate repeatedly part opens and closes, with minimal head loss at each occurrence rather than fully open and only close again once fluid head level has substantially dropped). For the described embodiment, the gate closes after flushing once the fluid head level has dropped below the gate in its horizontal open position.

While the flushing gate embodiment described uses a magnets mounted on both the gate and the gate housing to produce an additional holding force, it would be possible for an embodiment to use a magnet housed on one or the other which attracts to a piece of ferritic material. A further embodiment could encompasses an alternative mechanism or method which applies a force acting to keep the gate closed when the gate is at or very near its closed position, but which quickly dissipate as the gate begins to open in order to provide a step increase in magnitude of resultant moment acting to open the gate.

The "ears", or side walls, shown in Figures 39 to 41 are used to contain the fluid as the gate first opens. If the fluid is not restrained between the frame and gate as it has been done in the described embodiment, then it is possible that the gate will be unable to fully open, with even a partial opening (<20°) proving a large enough gap between the frame and gate for sufficient flow to prevent the gate from fully opening (flow though is below that of up stream flow, with a rapid falling head height causing
the gate to re-close before it has fully opened). Having the ears, or side walls, to contain the fluid as the
gate begins to open ensures a slug of fluid has to pass over the top of the gate, firmly slamming it into
the end of travel stop.

The embodiment illustrated in Figures 39 to 41 have ears which restrict flow between the flusher frame
and gate above the pivot for the first 45 degrees from opening, however alternative embodiments could
contain the fluid between the pivoting gate and supporting walls though any angle beyond 15 degrees up
to its fully open position.

The current state of the art flushing gates have a pivot which is near or very close to being in-line with
the gate assembly CoG when in a vertical (or closed) orientation. The restoring moment, acting to close
the gate, is at or near its maximum when the gate is in its fully open position (likely to be on, or near to
horizontal), which decreases as it moves toward its closed orientation (likely to be near or close to
vertical). In this embodiment the is positioned pivot away from the gate centreline, or CoG, so to
produce a greater restoring moment (acting to close the gate) when the gate is near or close to its
closed orientation (which is vertical for the described embodiment, but could be at an angle several
degrees away from this in an alternative embodiment). In addition, the sweep of the gate is modified so
that as the gate moves toward its closed position (or vertical orientation for the described
embodiment), there is a component of vertical translation rather than only horizontal at curved section
of gate, acting to push the seal down rather than only across its contacting surface. The redistribution of
restoring force from being at a peak when the gate is open, and at or near to its minimum when fully
closed, means that fewer weights are required to achieve the same equilibrium of moment fluid height.
By increasing the restoring moment when in its closed position (or vertical orientation for the described
embodiment), the required fluid height before the gate snaps open is increased, which is done by
positioning the pivot point away from the gate CoG rather than adding additional weights. In addition,
moving the pivot off centre allows for the added weights (hidden by the pivot fairing in Figures 39 to 41)
to be positioned on the downstream side (underside of gate when open), which helps to reduce
probability of rags being snatched. The bottom of the gate is provided with a weight stack to restore it
to the closed position after the flushing pulse. In this embodiments the weights are covered by a fairing
which stops rags and the like snagging and makes the gate more hydrodynamic.

The chart shown in Figure 44 shows the restoring force for this particular embodiment, where the gate
closing or restoring moment is almost the same in both its horizontal (open) and vertical (closed)
orientations, reaching a peak when at around 45 degrees (it could be made to be whatever was
required, could be exactly equal at each end of gate sweep).

Many existing flushing gates use multiple seals and seal types to seal between the gate and its frame. The
embodiment illustrated in Figures 39 to 41 uses a single piece clip on edge seal, with an end on view of
the pivoting gate and seal shown in Figure 42. The simplicity of the seal attachment, combined with it
being of a single piece cut to length from a continuous roll, mean that it can be quickly replaced during
maintenance. The particular edge seal shown in Figure 42 is simply push fitted onto a 2mm-4mm thick plate edge, without need to use (although could be used to compliment) fixings or adhesive. The material from which the seal is formed may be, for example, rubber, Nitrile, EPDM, Neoprene, SBR, Silicone, Butyl, Polyacrylate, Hypalon, Viton and Flurosilicone.

Figures 45 and 46 show front and rear views of an embodiment which is almost identical to that illustrated in Figures 39 to 41, with the exception of the end of travel stop being located in a position to prevent the gate from opening further than 45 degrees from vertical (which could be a greater or smaller angle when in a fully open position in an alternative embodiment), with fluid still contained between the gate and frame above the pivot point when fully open. This has been done to concentrate any flow through the gate during flushing to being below the pivot point, as this has a greater pressure head, and would reduce the head loss between flushes. This will give a greater number of flushes for same volume of fluid passing through the gate, as well as the fluid that did passing though doing so with a greater average velocity, which may be more productive in scouring.

Figure 47 and 48 shows an embodiment of the flusher gate installation in a sewer. A slit is cut into the channel, filled with grout or other filler, and then the flusher frame edge is slotted in until the underside is tangential with the channel surface. Side plates made to suite are installed in a similar manner, being bolted to both the frame edge and side walls of confinement (in this case the sides of the man hole). Fluid, or sewerage, is then able to build up on the upstream side of the flusher until the critical head level required for the gate to open is reached. The shape of the device and parts thereof are complimentary with the sewage conduit. For example, the bottom of the gate may be rounded or square-bottom to match a conduit. The device may be scalable to fit conduits of any size based on the principles established and defined herein.

In Figure 49 there is shown plan, perspective, side and front views of a helper spring arrangement. The spring can be fitted to the rear (downstream) face of a gate. When the gate opens the spring is deformed and energised and then helps the gate to return to the closed position. In other embodiments (not shown) a spring or other energisable closing feature could be provided on the floor of the conduit.

In Figure 50 there is shown various views of the fluid head side of a gate formed according to an aspect of the present invention. The gate face is provided with a plurality of fins, which in this embodiment are curved. In use when the gate opens fluid rides over the top of the fins, which promote turbulent flow to improve the cleaning effect of the fluid pulse.

Figures 51 and 52 show a gate formed according to a further aspect of the present invention and in a closed and open position. The gate is provided with means for determining opening and closing events. In this embodiment a sealed reed switch is provided on the gate and a magnet is provided on the housing. When the switch is near the magnet (for example within about 10mm) it is open and when the
A switch or the like may be connected to a data logger. The logger may then be linked (for example wirelessly) to a receiving station which processes/displays the data.

Data relating to opening and closing of the gate can be used for a variety of purposes. For example an opening and/or closing signal could inform that the gate is functioning correctly.

This system could also, for example, be used to provide basic flow rate data. For example it would be possible to calculate the volume of fluid which passes through the gate with each pulse; then the frequency of pulses could be used to determine fluid volume passing through over time. This could be used to determine flow rate in that section of conduit and this in turn could, for example, give an indication of a blockage.

Although illustrative embodiments of the invention have been disclosed in detail herein, with reference to the accompanying drawings, it is understood that the invention is not limited to the precise embodiments shown and that various changes and modifications can be effected therein by one skilled in the art without departing from the scope of the invention as defined by the appended claims and their equivalents.
CLAIMS

1. A fluid flushing device comprising a housing locatable in a fluid flow path and a gate pivotally supported on or in the housing and being movable between a closed position and an open position, the gate is biased towards the closed position to inhibit fluid flow and cause a build-up upstream of the device, the gate being movable to the open position to release a flushing pulse of fluid through the device when the sewage head height exceeds a required level, in which the device is provided with holding means for releasably holding the gate in the closed position whereby to increase the sewage head height required before it opens.

2. A device as claimed in claim 1, in which the holding means comprise one or more magnets.

3. A fluid flushing device comprising a housing locatable in a fluid flow path and a gate pivotally supported on or in the housing and being movable between a closed position and an open position, the gate is biased towards the closed position to inhibit fluid flow and cause a build-up upstream of the device, the gate being movable to the open position to release a flushing pulse of fluid through the device, in which the gate is provided with one or more sealing petals for sealing it against the frame.

4. A device as claimed in claim 3, in which the sealing means comprises a plurality of polyurethane petals.

5. A fluid flushing device comprising a housing locatable in a fluid flow path and a gate pivotally supported on or in the housing and being movable between a closed position and an open position, the gate is biased towards the closed position to inhibit sewage flow and cause a build-up upstream of the device, the gate being movable to the open position to release a flushing pulse of fluid through the device, in which the pivot point of the gate is spaced away from the gate centre line.

6. A fluid flushing device comprising a housing locatable in a fluid flow path and a gate pivotally supported on or in the housing and being movable between a closed position and an open position, the gate is biased towards the closed position to inhibit fluid flow and cause a build-up upstream of the device, the gate being movable to the open position to release a flushing pulse of fluid through the device, in which an edge strip seal is provided for attachment to the periphery of the gate for sealing it against the housing.

7. A fluid flushing device comprising a housing locatable in a fluid flow path and a gate pivotally supported on or in the housing and being movable between a closed position and an open position, the gate is biased towards the closed position to inhibit sewage flow and cause a build-up upstream of the device, the gate being movable to the open position to release a flushing pulse of fluid through the device, in which side walls are provided on the downstream side of the frame to restrain flow between the frame as the gate initially moves away from the closed position.
8. A fluid flushing device comprising a housing locatable in a fluid flow path and a gate pivotally supported on or in the housing and being movable between a closed position and an open position, the gate is biased towards the closed position to inhibit fluid flow and cause a build-up upstream of the device, the gate being movable to the open position to release a flushing pulse of fluid through the device when the fluid head height exceeds a required level, in which the device is provided with helper means for helping the gate to move from its open to its closed position.

9. A fluid flushing device comprising a housing locatable in a fluid flow path and a gate pivotally supported on or in the housing and being movable between a closed position and an open position, the gate is biased towards the closed position to inhibit fluid flow and cause a build-up upstream of the device, the gate being movable to the open position to release a flushing pulse of fluid through the device when the fluid head height exceeds a required level, in which the upstream face of the gate is provided with means for inducing turbulent flow in the fluid pulse.

10. A fluid flushing device comprising a housing locatable in a fluid flow path and a gate pivotally supported on or in the housing and being movable between a closed position and an open position, the gate is biased towards the closed position to inhibit fluid flow and cause a build-up upstream of the device, the gate being movable to the open position to release a flushing pulse of fluid through the device when the fluid head height exceeds a required level, in which the device is provided with means for monitoring the open/closed status of the gate.

11. A fluid flushing device substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

12. A sewer flusher gate comprising a device as claimed in any preceding claim.

13. A fluid conduit fitted with one or more devices or gates as claimed in any preceding claim.

14. A sewage conduit fitted with one more devices according to any of claims 1 to 12.

15. A sewage network fitted with one or more devices as claimed in any of claims 1 to 12.
Figure 19

Figure 20

Figure 21a
Figure 46
An embodiment of a flushing gate allowing for restricted (throttled) flow.

Figure 45
End of Travel Stop
An embodiment of flush gate installation in a channel
Curved Fins

Figure 50

SUBSTITUTE SHEET (RULE 26)
Figure 51
Figure 53
A. CLASSIFICATION OF SUBJECT MATTER
INV. E02B7/40 E03F9/00
ADD.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
E02B E03F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<tr>
<th>Category</th>
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<th>Relevant to claim No.</th>
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<td>X</td>
<td>WO 2006/105983 A2 (GIEHL KLAUS ULRICH [DE]) 12 October 2006 (2006-10-12) figures 1-4</td>
<td>1,2, 12-15</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"A" document member of the same patent family

Date of the actual completion of the international search: 4 July 2016
Date of mailing of the international search report: 05/09/2016

Name and mailing address of the ISA:
European Patent Office, P.B. 5818 Patentlaan 2
NL-2280 HV Rijswijk
Tel: (+31-70) 340-2040
Fax: (+31-70) 340-3016

Authorized officer:
Flygare, Esa
INTERNATIONAL SEARCH REPORT

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

   see FURTHER INFORMATION sheet PCT/ISA/210

3. ☐ Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

   1, 2 (completely); 12-15 (partially)

Remark on Protest

☐ The additional search fees were accompanied by the applicant’s protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant’s protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.
This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1, 2 (completely); 12-15 (partially)
   Fluid flushing device with holding means

2. claims: 3, 4 (completely); 12-15 (partially)
   Fluid flushing device with sealing petals

3. claims: 5 (completely); 12-15 (partially)
   Fluid flushing device wherein the gate has eccentric pivot point

4. claims: 6 (completely); 12-15 (partially)
   Fluid flushing device having a edge strip seal

5. claims: 7 (completely); 12-15 (partially)
   Fluid flushing device having side walls downstream side of the frame(?) / the housing (?)

6. claims: 8 (completely); 12-15 (partially)
   Fluid flushing device having bias / helical means

7. claims: incompletely); 12-15 (partially)
   Fluid flushing device having the gate provided means for inducing turbulent flow

8. claims: lO (completely); 12-15 (partially)
   Fluid flushing device having means for monitoring open/closed status
Subject matter of claim 11 is unclear (Article 6 PCT) to such an extent that no meaningful search is possible. Moreover, this claim refers unnecessarily to drawings, contrary to Rule 6.2(a) PCT.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examination Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the applicant proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guidelines C-IV, 7.2), should the problems which led to the Article 17(2) declaration be overcome.
<table>
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