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GATE VALVE

This invention relates to a valve and particularly, although not exclusively, relates to a valve type referred to as a "soft faced gate valve".

Soft faced gate valves are well known valves often used for controlling the flow of water in pipes. Components of such a valve are shown in figures 1 to 4 of the accompanying diagrammatic drawings, in which:

Figure 1 is a cross-section through a soft faced gate valve;

Figure 2 is a front elevation of a valve member of the valve;

Figure 3 is a view of the valve member in the direction of arrow III of figure 2; and

Figure 4 is a view of the valve member in the direction of arrow IV of figure 2.

The valve 2 comprises a valve body 4 which comprises a pipe section 6 and a housing 8. The body 4 is arranged to co-operate with a valve assembly 10 which includes a rotatably mounted valve stem 12 which carries a nut 14 and an obturator 16. The valve stem 12 is arranged to be rotated using a handle 18 for moving the obturator, within guides (not shown) defined in the pipe section 6, into and out of the pipe section for blocking or permitting the flow of fluid therealong.

The obturator 16 is generally wedge-shaped and includes first and second arcuate sealing regions 20, 22

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on opposing upstream and downstream faces thereof. The sealing regions extend from position M to position N via the nut end of the obturator as shown in figure 2 and are arranged to sealingly mate with respective upstream and downstream faces of the pipe section 6. The obturator also includes butt seal 24 which extends from position M to position N via an end of the obturator remote from the nut. The butt seal is arranged to sealingly engage inwardly facing inclined surfaces and a radially inwardly facing part of the pipe section 6. Shoulders 26 are defined between sealing regions 20, 22 and butt seal 24 which shoulders define a relatively abrupt transition between the regions 20, 22 and the butt seal 24. These shoulders add to complexities in manufacturing an obturator that can mate accurately with the pipe section. The sealing regions 20, 22 and butt seal 24 are made of a resilient synthetic rubber material.

It will be noted from figure 2 that regions 20, 22 extend through an angle of about 200° and occupy about 60% of the sealing periphery of the obturator, with the remainder being provided by the butt seal 24.

When the valve 2 is fully open, the obturator is positioned within housing 8 of the body 4. To close the valve, handle 18 is used to gradually move the obturator into the pipe section 6. During that part of the movement of the obturator when arcuate sealing regions 20, 22 are engaged with the respective upstream and downstream sealing faces of the pipe section, the upstream fluid pressure load (as represented by arrow 7 in figure 1) is heavily concentrated on the downstream face of the pipe section 6 at a position generally opposite shoulders 26. This is because parts of the obturator below the shoulders 26 are unsupported in the direction of the pipe axis

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and thereby act like a cantilever. The force due to this cantilever effect counter-balances a large part of the pressure force due to fluid acting on the obturator above the shoulders 26. Thus, the sealing force between the
5 obturator and the pipe section is substantially and disadvantageously reduced in the region near the nut and increased in the region near the shoulders.

Although the upstream pressure force seals the
10 region 22 against the downstream faces of the pipe section 6, the butt seal is not, however, sealed by this pressure force. Consequently, a force must be supplied via the valve stem 12 to urge the butt seal against the pipe
15 section and, in view of the relatively large area of the butt seal, a relatively large operating force must be supplied to fully close the valve, especially in larger sizes.

When fully closed, the respective sealing regions 20,
20 22 apply sealing forces in the direction of, for example, arrows 28 (figure 4) which forces have components parallel to the direction of the axis of the stem 12 and parallel to the direction of the axis 29 of the pipe section 6. The butt seal 24 applies resultant sealing forces as
25 represented by, for example, arrows 30 (figure 2) which forces have components both parallel and perpendicular to the stem axis 12, as viewed in figure 2. Thus, the obturator 16 is arranged to seal in three dimensions which necessitates a relatively long butt seal which suffers
30 from the cantilever effect described above.

It is an object of the present invention to address problems associated with known valves.

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According to the invention, there is provided a valve for controlling the passage of a fluid along a pipe section, the valve comprising an obturator which includes a butt seal region for forming a butt seal between the
5 obturator and the pipe section, the butt seal region having a curved surface the axis of curvature of which is arranged, in use, to extend transverse to the axis of the pipe section.

10 Force applying means is preferably provided for urging said obturator against the pipe section for forming a butt seal therebetween. Said force applying means is preferably arranged to apply a force in a direction which extends diametrically across said obturator and suitably
15 bisects the butt seal region. Said force applying means is preferably arranged to apply a force in a direction transverse to the axis of curvature of said curved surface of the obturator. In a first embodiment, said force applying means is arranged to apply a force in a direction
20 substantially perpendicular to the axis of curvature of the curved surface. In a second embodiment, for example where the butt seal region includes two curved surfaces having respective axes of curvature which extend transversely to one another, said force applying means is
25 preferably arranged to apply a force in a direction which is transverse to the axes of curvature of said curved surfaces.

Support means is preferably provided for said
30 obturator. Said support means is preferably aligned with the direction in which said force applying means is arranged to apply a force to the obturator. Said support means preferably extends away, suitably in a radial direction, from said obturator. Said support means and

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said butt seal region are preferably provided on diametrically opposing sides of the obturator.

Said support means preferably comprises a stem which
5 is movable for urging the butt seal region against the pipe section. For example, said support may comprise a screwed stem and nut which is movable axially by rotation of the stem for urging the butt seal region against the pipe section. Handle means may be provided for manually
10 moving said support means, for example by manually rotating said stem.

Said butt seal region preferably has a convex sealing surface. Said butt seal region preferably includes an
15 arcuate sealing surface. Said butt seal region preferably includes a part-circular sealing surface. Preferably, said butt seal region traverses a surface with a circular cross-section. In said first embodiment referred to above, said surface preferably has a substantially
20 constant circular cross-section along its extent. In said second embodiment, however, said surface may taper along its extent.

In said second embodiment, the butt seal region
25 includes first and second curved surfaces each of which includes a respective axis of curvature which is arranged, in use, to extend transverse to the axis of the pipe section. Said first and second curved surfaces may be substantially identical, although they are suitably
30 symmetrically arranged about an axis which extends diametrically across the obturator. Said first and second curved surfaces are preferably tapered. Said curved surfaces preferably taper inwardly on moving towards an extreme end of the butt seal region. Preferably, said
35 first and second curved surfaces traverse respective

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conical surfaces. Said conical surfaces may have any suitable cross-section, including a circular or an elliptical cross-section. Preferably, however, the conical surfaces have a circular cross-section.

5 Preferably, an intermediate curved surface is arranged between said first and second curved surfaces.

Preferably, said obturator is arranged to co-operate with a pipe section having a curved, suitably non-angular cross-section. Preferably, the pipe section is generally

10 circular in cross-section and, therefore, preferably the obturator is generally circular in cross-section.

Said butt seal region preferably is arranged to apply

15 a sealing force in at least first and second directions which are mutually orthogonal to one another. Said first direction is preferably parallel to the pipe axis and said second direction is preferably parallel to the direction of application of a force by said force applying means.

20 In said first embodiment, said butt seal region may be arranged to apply substantially no sealing force in a direction perpendicular to both the axis of the pipe section and the direction of application of a force by said force applying means. However, in said second

25 embodiment, said butt seal region may be arranged to apply a sealing force in three mutually orthogonal directions.

Said butt seal region may traverse less than 50%, preferably less than 40%, more preferably less than 30% of

30 the periphery of the obturator.

Said butt seal region may subtend an angle of less than 120°, preferably less than 100°, more preferably less than 90° at the centre of the obturator.

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In preferred embodiments, said butt seal region comprises a single sealing surface. In other embodiments, said butt seal region may include first and second spaced apart sealing surfaces, wherein each surface may be
5 arranged as described in any statement herein. Said first and second sealing surfaces may allow the valve to provide a so-called "double-block and bleed function". In this event, the valve suitably includes bleed means for bleeding a gap between the first and second surfaces.

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Said obturator preferably includes a second sealing region which is suitably arranged to apply a sealing force in a direction substantially parallel to the axis of the pipe. Said second sealing region preferably blends into
15 said butt seal region. Preferably, said obturator defines a smooth curve, preferably a convex curve, on moving from said second sealing region to said butt seal region. Said second sealing region preferably extends from one end of the butt seal region to an opposing end thereof, via a
20 part of the obturator diametrically opposite said butt seal region.

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Said second sealing region may traverse greater than 50%, preferably greater than 60%, more preferably greater
25 than 70% of the periphery of the obturator.

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Said second sealing region is preferably substantially planar. Said second sealing region preferably defines one face of a wedge-shaped obturator.
30 An opposite face of the obturator is preferably provided by a third sealing region which may have any feature of the second sealing region described above. Preferably, said second and third sealing regions are substantially identical.

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Said valve is preferably arranged to be fixed to upstream and/or downstream pipe work.

5 The diameter of the pipe section may be at least 40 mm. In some embodiments, the diameter may be greater than 200 mm and even greater than 300 mm. It is believed that valves having pipe sections of up to 600 mm or more may be made as described herein.

10 The invention extends to a method of controlling the passage of fluid along a pipe section, the method comprising using a valve as described above.

15 The invention extends to an obturator for a valve for controlling the passage of fluid along a pipe section having an axis, the obturator including a butt seal region having a curved surface, the axis of curvature of which is arranged, in use, to extend transverse to the axis of the pipe section.

20 Any feature of any aspect of any invention described herein may be combined with any feature of any other aspect of any invention described herein.

25 Specific embodiments of the invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings, in which:

30 Figure 5 is a front elevation of a valve member of a valve;

Figure 6 is a view of the valve member in the direction of arrow VI of figure 5;

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Figure 7 is a view of the valve member in the direction of arrow VII of figure 5;

Figure 8 is a view of a part of an alternative valve member in a view corresponding to the figure 7 view;

Figure 9 is a view of a part of a further alternative valve member in a view corresponding to the figure 7 view;

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Figure 10 is a view in the direction of arrow X of figure 8 or 9 to a reduced scale;

Figure 11(a) is a view of part of the obturator of the valve of figures 1 to 4;

Figure 11(b) is a view of part of the obturator of the valve of figures 5 to 6;

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Figure 12 is a front elevation of an alternative valve member of a valve; and

Figure 13 is a view of the valve member of figure 12 in the direction of arrow VII in figure 12.

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In the figures herein, the same or similar parts are annotated with the same reference numerals.

A valve member 40 is provided for co-operation with a valve body (not shown). The valve member includes a rotatably mounted valve stem 12 which carries a nut 14 and obturator 42. The obturator 42 comprises two inclined planes 43, 44 arranged to define a wedge shape. The planes 43, 44 extend above lines $A_1 - A_1$ and $A_2 - A_2$ and are faced with respective arcuate first and second sealing

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regions 46, 48 made out of a resilient synthetic rubber material, shown shaded in figures 5 and 6.

It will be noted from figure 5 that respective
5 sealing regions 46, 48 (above line $A_1 - A_1/A_2 - A_2$) extend through an angle of about 300° and thereby occupy over 80% of the sealing periphery of the obturator.

The inclined planes 43, 44 converge towards a line
10 which extends through a point B and which extends perpendicularly to and intersects the axis of the stem 12. In other embodiments, the inclined planes may converge towards a line which is not aligned with and/or does not intersect the axis of the stem 12.

15 Below dashed lines $A_1 - A_1/A_2 - A_2$, the obturator comprises a part-circular-cylindrical outer surface with the axis of the cylinder extending perpendicularly to the stem 12 (when viewed in the direction represented in
20 figure 5) and being coincident with point X in figure 7. Also, the inclined planes 43, 44 are tangential to the outer surface.

A butt seal region 50 of the obturator (shown shaded
25 between lines $A_1 - A_1/A_2 - A_2$ in figure 6) includes a central region 52 which extends parallel to the axis of the cylindrical surface. Joining regions 54, 56, 58, 60 extend from the region 52 across the cylindrical surface, obliquely to the axis thereof, so as to meet the sealing
30 regions 46, 48.

Thus, it should be appreciated that the inclined
planes 43, 44 of the obturator above lines $A_1 - A_1/A_2 - A_2$
blend into the cylindrical surface below the lines so that
35 there is a smooth transition between sealing regions 46,

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48 and the butt seal region 50. It should be noted that there is no angular shoulder at the point of transition between the two regions as in the known obturator of figures 1 to 4.

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The obturator shown in figures 5 to 7 is arranged to co-operate with a suitably adapted cylindrical pipe section having an internal radius G which corresponds to the projected distance (as seen in figure 5) from the
10 centre of the obturator to the inner edges of the sealing regions 46, 48 and butt seal region 50. Referring to figure 5, it should be noted that the outer edge of the sealing surface of the obturator has a projected radius H except that the projected outer edge of butt seal region
15 50 is defined by a line C - C which is arranged at right angles to the axis of the stem 12 and tangential to the circle defined by radius G - that is, tangential to the bore of the pipe section.

20 The obturator 42 is arranged to be moved into its open and closed positions in the same way as for valve 2 described above.

As the obturator 42 is moved from within the housing
25 in the valve body towards its closed position, it does not suffer, to any appreciable extent, from the disadvantageous cantilever effect described above. This is because, when the first and second sealing regions 46, 48 are engaged with respective upstream and downstream
30 sealing faces of the pipe section, the upstream fluid pressure force is incident on the relatively large area of the upstream inclined plane 46 leaving only a small area of the obturator below line A₁ - A₁ unsupported and being capable of acting in the manner of a cantilever. Thus,
35 the sealing force is relatively evenly distributed over

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the sealing area of the obturator and is not significantly affected by any cantilever effect.

In order to fully close the valve, an operator must provide a force via valve stem 12 to urge the butt seal region 50 of the obturator against the wall of the pipe section. In view of the relatively small area of the butt seal region 50 compared to the area of the butt seal 24 of the figures 1 to 4 embodiment, the force needed to be applied by an operator to urge the obturator 42 to its fully closed position will be less than the comparable obturator 20 of figures 1 to 4. This may allow a substantial reduction in operating forces with potential economic advantages especially in larger sizes of valves.

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A lower force may be required to open the valve compared to the valve of figures 1 to 4. In this respect, when the valve of figures 1 to 4 is in the fully closed position, an area defined by points abcdea in figure 11(a) represents the projected area of half the obturator when viewed along the axis of the stem. This area is referred to as the "unbalanced area". The unbalanced fluid pressure exerts a resultant force on the obturator in the closed direction thereof which is proportional to the unbalanced area and, it will be appreciated, that the greater the unbalanced area, the greater the force in the closed direction, and that the greater the force in the closed direction, then the greater the force required to open the valve. The unbalanced area of the valve of figures 5 to 7 is defined by points fbcdfg in figure 11(b) and, since this area is less than area abcdea, the force required to open the valve of figures 5 to 7 will, advantageously, be less than in the embodiment of figures 1 to 4.

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When the valve is fully closed, the respective sealing regions 46, 48 apply resultant sealing forces in the direction of, for example, arrows 28 (figure 7) as for the known obturator of figures 1 to 4. In contrast, however, the butt seal 50 applies resultant sealing forces as represented by, for example, arrows 70 (figure 7) which forces have components parallel to the pipe axis 29 and parallel to the axis of the stem 12, but have no other component forces. Thus, the obturator is, effectively, arranged to seal in two dimensions.

Alternative obturators are shown in figures 8 to 10. It should be noted that the views in the directions of arrow V in figures 8 and 9 generally correspond to the view of figure 5 and that the views in the direction of arrow X are, in both cases, generally as shown in figure 10. In the figure 8 embodiment, inclined planes 43, 44 blend into respective spaced apart cylindrical surfaces 74, 76, the axes of the respective cylinders passing through respective points P and Q. A flat area 78 extends between cylindrical surfaces 74, 76. In the figure 9 embodiment, inclined planes 43, 44 blend into respective spaced apart cylindrical surfaces 80, 82, the axes of the respective cylinders passing through respective points R and S. The surfaces 80, 82 are arranged so that a concave region 83 is defined therebetween.

The obturators of figures 8 and 9 include spaced apart sealing members 84, 86, as shown in figure 10. Each sealing member 84, 86 is arranged to define a respective butt seal region 88, 90 which blend into respective sealing regions 46, 48. Thus, the obturators effectively define a double seal.

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The obturators of figures 8 and 9 may be used as a so-called "double-block and bleed" valve for separating two components in a pipeline. Such a valve can block off an upstream pipeline by means of, for example, sealing member 84 and a downstream pipeline by means of sealing member 86. The space 78 or 83 between the members is arranged to be depressurised and vented to remove any material leaking into the regions 78/83 or between the sealing members 84, 86, whilst preventing any movement of fluid from the upstream pipeline to the downstream pipeline and vice versa.

In the embodiment of figures 12 and 13, a valve member 140 includes an obturator 142 which comprises two inclined planes, 143, 144 arranged to define a wedge shape. The planes 143, 144 extend above the lines AB, BC and CD and are faced with respective arcuate first and second sealing regions 146, 148 made out of a resilient synthetic rubber material and shown shaded in figures 12 and 13.

Below and to the left of line AB and below and to the right of line CD, the obturator comprises two part-circular-conical outer surfaces with the axis of the right hand cone extending along the line IJ. (To aid understanding, the full right hand cone is represented by the triangle IMN in figure 12). The axis of the left hand cone is a mirror image of that of the right hand cone when mirrored in the vertical axis KL. In figure 13 the axes of the cones are in line with the stem axis. The inclined planes 143, 144 are tangential to the cones along the lines AB and CD.

The part-circular-conical outer surfaces are joined by an arcuate curved surface QS.

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In figure 13, the shaded area above the chain dotted line F1-F2 represents the sealing area as it extends across one of the part-circular-conical outer surfaces, obliquely to the axis thereof, blending smoothly into the inclined plane surfaces 143, 144.

In figure 13, the shaded area below the chain dotted line F1-F2 represents part of the sealing area as it extends around that curved surface which has its axis of curvature substantially coincident with the pipe axis. In figure 12 this curved surface is represented by the arcuate line QS. The sealing surfaces above the line F1-F2 blend smoothly into the sealing surface below line F1-F2. It should, therefore, be noted that in this embodiment of the invention, as in the previous embodiment, each part of the total sealing surface blends smoothly into each adjacent part so that there is no angular shoulder at any point on the sealing surface.

Referring to figure 12, it should be noted that the outer edge of the sealing surface of the obturator has a projected radius H, except that the projected outer edge of the butt seal region is defined by lines RQ and ST on the part-circular-conical surfaces and the arcuate line QS which has its centre of curvature substantially coincident with the pipe axis when the valve is fully closed.

In use, as the obturator 142 is moved from within the housing in the valve body towards its closed position, any cantilever effect will be much reduced when compared with conventional valves as described above with reference to figures 2, 3 and 4. This is because the unsupported area subject to pressure in the direction of the pipe axis is relatively small.

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It should be noted that, although the figures 12 and 13 embodiment has been described with reference to the use of two part-circular-conical surfaces, any tapered curved surface may be used provided it affords a smooth
5 transitional sealing surface with no relatively sharp corners or shoulders. Thus, the surfaces may be based on elliptical "cones" or other non-circular cross-section cones.

10 The figure 12 and 13 embodiment can easily be arranged to incorporate the "block and bleed" feature described with reference to figures 8 to 10. In addition, the principles illustrated in figures 11(a) and (b) will also apply to the new embodiment of figures 12 and 13.
15 One advantage of the figure 12 and 13 embodiment, is that it enables the pockets where the obturator fits into the body to be inclined to the horizontal so as to discourage the settling of solid particles in the pockets, in use.

20 The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and
25 documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or
30 process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification
35 (including any accompanying claims, abstract and

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drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of
5 a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features
10 disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

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CLAIMS

1. A valve for controlling the passage of a fluid along a pipe section, the valve comprising an obturator which includes a butt seal region for forming a butt seal between the obturator and the pipe section, the butt seal region having a curved surface, the axis of curvature of which is arranged, in use, to extend transverse to the axis of the pipe section.
2. A valve according to claim 1, which includes a force applying means arranged to apply a force in a direction transverse to the axis of curvature of said curved surface of the obturator.
3. A valve according to claim 1 or claim 2, wherein said butt seal region has a convex sealing surface.
4. A valve according to any preceding claim, wherein said butt seal region includes an arcuate sealing surface.
5. A valve according to any preceding claim, wherein said butt seal region traverses a surface with a circular cross-section.
6. A valve according to any preceding claim, wherein said curved surface has a substantially constant cross-section along its extent.
7. A valve according to any of claims 1 to 5, wherein said curved surface tapers along its extent.
8. A valve according to claim 7, wherein the butt seal region includes first and second curved surfaces each of which includes a respective axis of curvature which is



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arranged, in use, to extend transverse to the axis of the pipe section.

9. A valve according to claim 8, wherein said first and second curved surfaces are tapered.

10. A valve according to claim 8 or 9, wherein said first and second curved surfaces traverse respective conical surfaces.

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11. A valve according to any preceding claim, wherein said butt seal region is arranged to apply a sealing force in at least first and second directions which are mutually orthogonal to one another.

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12. A valve according to any preceding claim, wherein said butt seal region traverses less than 50% of the periphery of the obturator.

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13. A valve according to any preceding claim, wherein said butt seal region subtends an angle of less than 120° at the centre of the obturator.

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14. A valve according to any preceding claim, wherein said obturator includes a second sealing region which is arranged to apply a sealing force in a direction substantially parallel to the axis of the pipe.

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15. A method of controlling the passage of fluid along a pipe section, the method comprising using a valve according to claims 1 to 14.

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16. An obturator for a valve for controlling the passage of fluid along a pipe section having an axis, the obturator including a butt seal region having a curved



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surface, the axis of curvature of which is arranged, in use, to extend transverse to the axis of the pipe section.

