April 22, 1952 W. J. BOWTELL 2,593,969

SLUICE GATE

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FIG. 1.

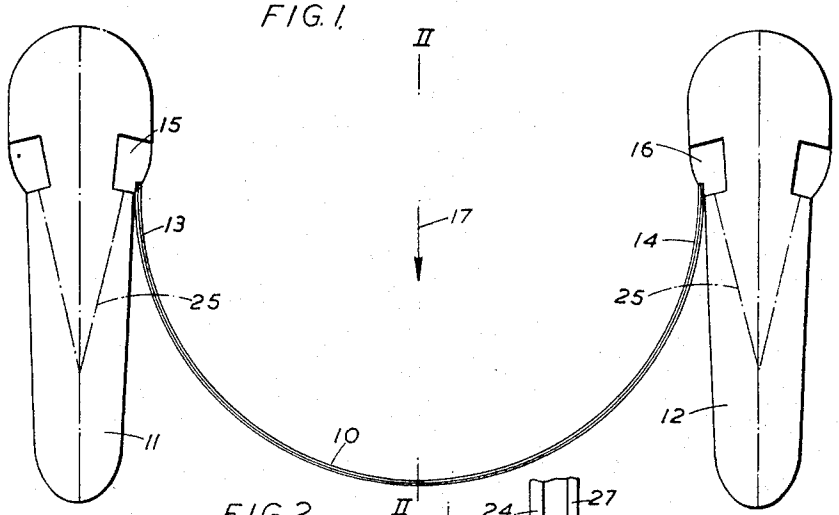

FIG. 2.

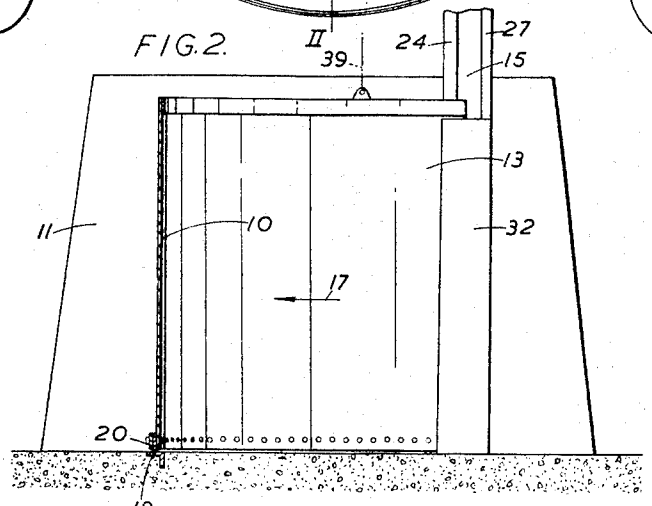

FIG. 3.

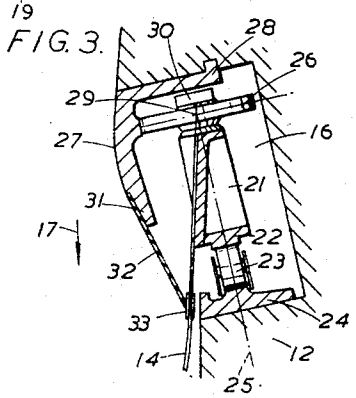

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FIG.4.

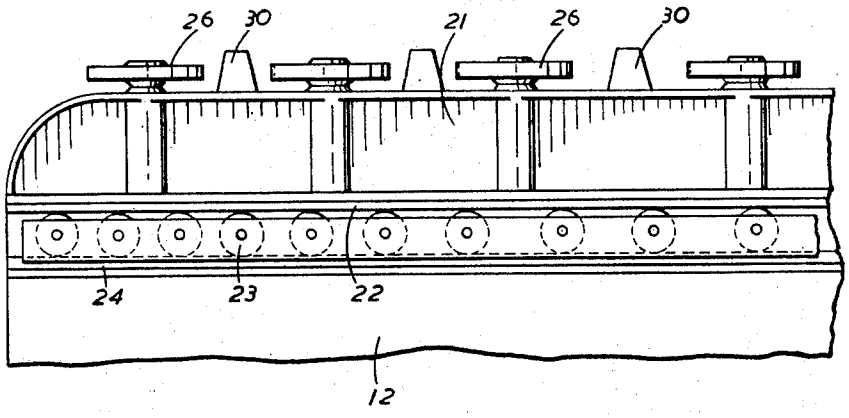
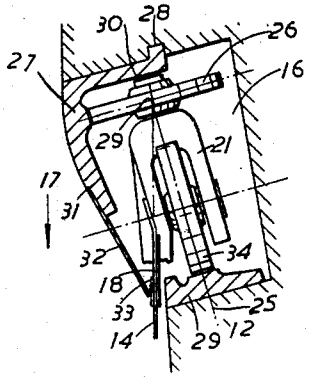


FIG.5.



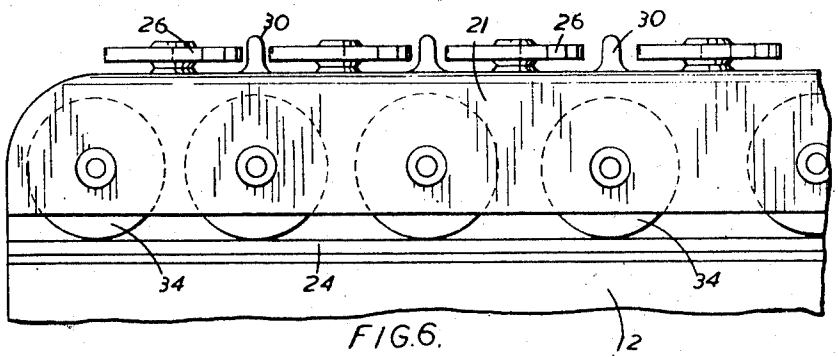


FIG.6.

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FIG. 7

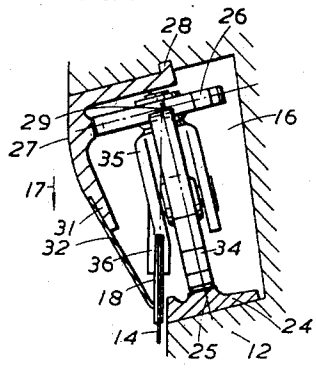


FIG. 8.

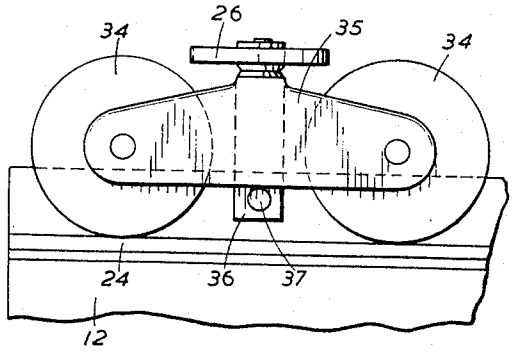
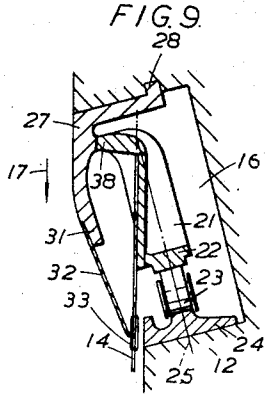


FIG. 9.



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UNITED STATES PATENT OFFICE

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SLUICE GATE

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Application January 6, 1948, Serial No. 695
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12 Claims. (Cl. 61—28)

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This invention relates to sluice gates of what may be termed the vertically sliding type in which a water retaining curtain extends across a channel between two piers of abutments, the curtain being movable up and down to open and close the channel and being mounted at its sides in guides in or on the piers.

It is an object of the present invention to provide an improved form of curtain and mounting for a sluice gate of this type, which is simple and cheap to manufacture.

According to the invention, in a sluice gate of the type specified the curtain is constituted by a relatively thin plate or sheet which is curved about a vertical axis in the form of part of a circular cylinder, with its convex surface in the downstream direction. It is desirable that the curved surface of the curtain should subtend an angle of between about 90° and about 180° at its vertical axis, and in a preferred form the curtain is substantially semi-cylindrical.

The curtain may be likened to a section of a vertical boiler shell or tank, and it will be appreciated that when it is retaining water it will be subjected mainly to tensile stresses. Thus the present invention is not to be confused with known sluice gates in which a curved curtain is employed, the curvature being convex in the upstream direction. Such curtains are subjected mainly to compressive stresses, and must be rigid and robustly made. In contradistinction to such known gates, with a sluice gate according to the present invention the pressure of the water will tend to force the curtain into and retain it in the desired curved form. Thus transverse bracing or stiffening will usually be unnecessary although some light transverse bracing or stiffening members may be used in some instances without departing from this invention. The absence of bracing or stiffening members facilitates periodical attentions such as scraping and painting, and provides a light and simple structure for which extreme accuracy of manufacture is not essential. It also reduces or eliminates places in which silt and the like can lodge.

Above water level it may be desirable to install some form of transverse member, for example to provide a footway across the channel. This member may conveniently coincide with the points of suspension of the curtain, by which the curtain is raised and lowered, and which may be located vertically above or slightly downstream or upstream of the centre of gravity of the curtain.

The bottom edge of the curtain may rest on

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a suitable sill, and stanching means, for example an adjustable rubber strip, may be provided around this bottom edge.

The sides of the curtain may be supported in the guides in any suitable manner, for instance in one class of support each side of the curtain is attached to or is integral with a mounting which is adapted to be supported by the guide at a position outwardly spaced from the side of the curtain against movement in a downstream direction either substantially parallel to the general direction of flow through the channel or diverging therefrom by an angle of up to about 30°; and also so as to resist the turning effect on the mounting of the thrust on the curtain. The part of the mounting supported by the guide which takes the main downstream load is preferably spaced from another part which takes the turning load.

An effect of inclining the main downstream support so that the mounting is supported against movement in a direction diverging from the general direction of flow in the channel is to transmit the main thrust on the mounting due to the pressure of water on the curtain towards the interior of the pier.

It is desirable that the line of action of the thrust imparted to the mounting by the curtain should pass through or near to the intersection of the lines of action of the forces through the parts of the mounting supported by the guide, so that side thrusts at the points of support between the mounting and the guide will be as small as possible.

It will be understood that the mounting may be supported in the guide in a number of different ways; by corresponding sliding surfaces on the mounting and on the guide, by wheels carried by axles on either the mounting or the guide and running on tracks or rails on the other member, by rollers running between tracks or rails on the mounting and on the guide, or by a combination of these devices.

When a wheel is referred to herein it is intended to indicate that the load which it supports is taken by or transmitted through an axle, while a roller is intended to mean that the load which it supports is transmitted across a diameter thereof.

Where a wheeled mounting is employed it may be convenient to arrange it in the form of two or more bogies, each bogie comprising a frame connected to the side of the curtain and carrying at least two main wheels arranged in tandem with their axes horizontal, which axes are trans-

verse to the general direction of flow through the channel, and at least one auxiliary wheel arranged with its axis horizontal and transverse to the axes of the main wheels. A simple form of bogie has two main wheels and a single auxiliary wheel lying equidistantly from the axes of the main wheels.

Terms such as "horizontal," "parallel," and "transverse" used herein are intended to be interpreted in a general sense rather than strictly geometrically. For example, if the guides are slightly forwardly or backwardly inclined to the vertical it will be desirable also to incline the axes of the auxiliary wheels to the horizontal so that they run in the direction of the guides.

A bogie with only three wheels makes a three point contact with the guides, which avoids the necessity for extreme accuracy in manufacture. To the same end, the connection between the curtain and a bogie may be a pin or similar non-rigid joint, which may be equidistant from the axes of the main wheels. Some form of stop is preferably incorporated so as to limit the permissible pivotal movement of the bogie with respect to the side part of the curtain. If the side of the curtain is connected to only two bogies, one bogie is preferably mounted at or below the level of the centre of pressure on the curtain at normal high water level, and the other bogie is arranged higher up on the curtain. More than two bogies at each side may be provided if desired, and more than two main wheels and one auxiliary wheel may also be provided on each bogie.

As an alternative to the bogie type the mounting may comprise one or more members or frames secured to the side of the curtain, which may extend over substantially the full depth of the curtain, main and auxiliary wheels being carried by the frame or frames and being spaced apart at intervals. The intervals may be selected as desired, and need not necessarily be uniform; for example it may be preferred to space the wheels more closely near the lower part of the curtain.

As a further alternative the main wheels may be replaced by a roller track or rail, the adjacent part of the guide being similarly formed, and a row of rollers being provided between the mounting and the guide. The auxiliary wheels may remain unchanged or may be replaced by roller tracks and rollers, or by sliding surfaces.

A desirable feature of the invention concerns a stanching plate which serves to reduce leakage past the side of the curtain and which may be adapted to close the opening in the guide when the curtain is raised. The stanching plate may be secured by one edge to and extend from the upstream side of the guide opening, the opposite edge of the stanching plate being adapted to make contact with the upstream surface of the curtain or a member attached thereto when the curtain is lowered. Preferably the stanching plate has a degree of resilience so that when the curtain is raised the stanching plate makes contact with the pier or with the guide at the downstream side of the opening, and closes this opening. The upper part of the downstream edge of the stanching plate may be formed to provide a lead for the entry of the curtain between the stanching plate and the pier or guide when the curtain is lowered from its raised position, should it lie clear of the stanching plate in this raised position.

The invention may be carried into effect in various ways, but one general form of sluice gate embodying the invention, with various alternative forms of guides and mountings, will be described by way of example with reference to the accompanying drawings, in which

Figure 1 is a diagrammatic plan of the sluice gate and piers.

Figure 2 is a diagrammatic sectional side elevation, taken on the line 11—11 in Figure 1.

Figure 3 is a horizontal cross-section, and

Figure 4 is an elevation of a form of guide and mounting using main rollers and auxiliary wheels.

Figure 5 is a horizontal cross-section, and

Figure 6 is an elevation of a form of guide and mounting using main wheels and auxiliary wheels.

Figure 7 is a horizontal cross-section, and

Figure 8 is an elevation of a form of guide and bogie mounting using main wheels and auxiliary wheels.

Figure 9 is a horizontal cross-section of a form of guide and mounting using main rollers and an auxiliary sliding surface.

In the various figures, parts which are generally equivalent have been given the same reference letters, even though they may not be identical with one another.

The curtain 10 of the sluice gate shown in Figures 1 and 2 is built up from relatively thin plates and lies on a substantially semi-circular arc between the piers 11 and 12 with its convex surface downstream; the curtain 10 may be likened to half a vertical cylindrical boiler shell or tank. The sides 13 and 14 of the curtain lie vertically adjacent to guide grooves 15 and 16 in the piers, in planes parallel to the direction of flow through the channel, indicated by the arrow 17. The extreme edges of the sides of the curtain are in some cases reinforced by vertical plates 18 (Figures 5 and 7). The bottom edge of the curtain is adapted to rest on a suitable semicircular sill 19 (Figure 2), and stanching means, for example an adjustable rubber strip 20 is provided around this bottom edge.

The curtain may be raised and lowered in any convenient manner, for instance by cables or by racks and pinions. The raising and lowering devices are preferably attached to the upper edge of the curtain directly above the centre of gravity of the curtain and its apendages as indicated at 39 in Figure 2.

The sides 13 and 14 of the curtain 10 may be supported in the guide grooves 15 and 16 respectively in several different ways. One form of mounting is shown in Figures 3 and 4. These figures show only the side 14 of the curtain, supported by the pier 12, but it will be understood that the other side 13 will be supported by the pier 11 in a similar manner.

The side 14 of the curtain is secured to a frame member 21 which extends for the full depth of the curtain 10. The frame 21 carries a straight roller track 22 offset from the side 14 of the curtain 10. The frame can run over a row of rollers 23 which in turn bear against a guide rail 24 secured to the downstream wall of the groove 16 in the pier. The line of thrust through the rollers 23 is indicated by the line 25 (see also in Figure 1), which diverges from the direction of flow indicated by the arrow 17, and from the side 14 of the curtain, by an angle of about 15°. The main thrust due to the pressure of the water retained by the curtain is thus taken through the frame 21, the roller track 22, the rollers 23

and the guide rail 24, and is directed towards the interior of the pier. Owing to the offset of the roller track 22 from the side 14 of the curtain, a turning moment will be exerted on the frame 21 in an anticlockwise direction as shown in Figure 3. This turning moment is resisted by providing auxiliary wheels 26 on the frame 21 substantially perpendicular to the plane of the rollers 23, bearing against an L-shaped guide member 27 secured to the upstream edge of the groove 16. The guide member 27 carries a lip 28 projecting into the masonry of the pier 12 to assist in holding it in position.

The lines of action of the forces exerted by the curtain 14, the roller track 22 and the auxiliary wheel 26 all intersect at the point 29, so that there will be no heavy side thrusts on the auxiliary wheels 26 and on the rollers 23.

In order to prevent undue play between the mounting and the guides when the thrust on the curtain is relieved, for instance when the curtain is in the raised position, pads 30 are provided which limit the movement of the assembly in the upstream direction. When the curtain is lowered and is retaining water, the pads 30 will lie slightly clear of the guide member 27.

The guide member 27 carries an extension 31 extending in the downstream direction. Thus the guide groove 16 is closed except for a relatively narrow opening bounded by the extension 31 and by the outer edge of the guide rail 24. The side 14 of the curtain passes through this opening close to the outer edge of the guide rail 24. In order to prevent leakage of water through the opening and past the side 14 of the curtain, and to present a smooth surface to the flow of water when the curtain is raised, a stanching plate 32, which is slightly springy, is secured by its upstream edge to the extension 31. This stanching plate extends across the opening in the guide groove and makes contact at its downstream edge with the upstream surface of the curtain approximately opposite to the outer edge of the guide rail 24. The curtain has vertical reinforcing plates 33 arranged along the line of contact with the standing plate 32.

As stated above, the curtain may be made of relatively thin material, and lies close to the downstream edge of the opening in the guide groove. Thus when the curtain is raised it is only necessary for the downstream edge of the stanching plate 32 to move a short distance in order to close the opening. The pressure of water against the stanching plate will tend to keep it in engagement with the outside edge of the guide rail 24 when the curtain is raised and water is passing through the channel, and with the curtain when the latter is lowered. The downstream edge of the stanching plate may be provided with a rubber or similar sealing strip if desired.

It is believed that a stanching plate arranged in this manner will permit a smoother flow of water through the channel than would be the case with a guide having a wide opening facing across the channel, and that in addition the tendency for eddies to form and for silt and the like to accumulate in the guide will be reduced.

The stanching plate need not extend much higher than the normal high water level, and if the curtain is to be raised above this level the upper part of the downstream edge of the stanching plate may be formed to provide a lead for the curtain when it is lowered so that it can readily pass between the stanching plate and the pier or guide.

Another form of mounting for the curtain is shown in Figures 5 and 6. In this case the rollers 23 are replaced by a row of main wheels 34, which are mounted on axles carried by the frame 21, and the side of the curtain 14 is reinforced by a vertical plate 18 where it joins the frame 21, but otherwise the arrangement is similar to that shown in Figures 3 and 4.

A further form of mounting, using wheeled bogies is shown in Figures 7 and 8.

Two bogies are provided at each side of the curtain, one at or slightly below the level of the centre of pressure on the curtain at normal high water level, and the other near to the upper part of the curtain.

As shown in the drawing, each bogie comprises a bogie frame 35 supporting at its ends two main wheels 34 arranged in tandem. In elevation the frame is of shallow triangular form, the axles of the main wheels 34 lying at the bottom corners of the triangle. At the apex of the triangle is mounted an auxiliary wheel 26 which is transverse to the plane containing the main wheels 34, the axis of the auxiliary wheel lying in this plane. On one side of the frame and extending therefrom at a convenient angle (say 15°) is a lug or yoke 36 by which the bogie is connected to the side 14 of the curtain, a pin 37 passing through holes formed in the yoke and through the reinforcement 18 of the side of the curtain. Alternatively the bogies may be fastened to lugs attached to the side of the curtain. Stops (not shown) are provided to limit the pivotal movement of the bogies in relation to the side of the curtain.

In another form of mounting shown in Figure 9, the main thrust of the frame 21 is taken by rollers 23 as in the construction shown in Figures 3 and 4, but the auxiliary wheels 26 are replaced by a sliding surface 38 formed on the frame 21. This sliding surface co-operates with a similar sliding surface on the guide member 27. This construction is intended for use only with small gates and low heads of water, where the forces involved are small. It will be understood that in any case the force to be taken by the auxiliary wheel 26 or the sliding surface 38 will be considerably less than that taken by the rollers 23 or the main wheels 34.

In the construction shown in Figure 9 a degree of self-stanching is obtainable, enabling the extension 31 of guide member 27 and the stanching plate 32 to be dispensed with if desired. This self-stanching occurs in this way. The thrust due to the pressure of the water on the concave surface of the curtain 10 downstream of the rollers 23 exerts a turning moment about the line of contact betwen the rollers and the guide rail 24 which tends to force the sliding surface 38 into firm contact with the guide member 27. There is an opposing turning moment due to the pressure of water on the side 14 of the curtain upstream of the rollers 23, but owing to the relatively small area of this part the opposing moment will not balance the stanching pressure, provided that the line of contact between the rollers 23 and the guide rail 24 is offset by a reasonable distance from the side 14 of the curtain.

It will be appreciated that many modifications may be made to the constructions described without departing from the invention. Thus for instance each side of the curtain may be supported between two parallel rows of wheels or rollers

lying in a guide groove, the outer row running on a guide rail mounted on the downstream side of groove in the pier, while the inner row runs on an overhung guide rail extending from the upstream side of the groove. Again, the auxiliary wheel need not be at right angles to the main wheels or rollers. Thus if the main wheels or rollers are inclined by 15° to the direction of flow it may be convenient to arrange the auxiliary wheel at right angles to the direction of flow, that is at an angle of about 105° with respect to the plane of the main wheels or rollers.

As an alternative to the limiting pads 30 shown in Figures 3–6, additional limiting wheels or rollers may be provided which are adapted to engage one of the guides, or one or more of the wheels, rollers, or sliding surfaces may be flanged.

Above the normal high water level it is desirable that the back of the guide groove should be open, or covered by a removable closure, to provide access to the mounting when the curtain is in a raised position.

It is preferred that the curtain should be semi-cylindrical, as in this case the tensile loading on the curtain for a given channel width is a minimum, and the thrust is applied to the mountings in a direction generally parallel with or slightly diverging from the direction of flow. However, if desired a curtain subtending a smaller angle may be employed. In this case for a given channel the length of the curtain will be less than with a semi-cylindrical curtain, but the tensile loading will be greater, and the thrust on the mountings will be in a direction inclined towards the direction of flow. On the other hand it may be possible in certain instances to provide a curtain which subtends an angle of rather more than 180°, and the present invention does not exclude such an embodiment.

It will be appreciated that by providing suitable stanching means for the upper edge of the curtain, the invention can be applied to sluice gates of the culvert type.

What I claim as my invention and desire to secure by Letters Patent is:

1. A sluice gate comprising two piers bounding a channel, a guide in each of said piers, a water-retaining curtain in the form of a relatively thin plate which is curved about a vertical axis in the form of part of a circular cylinder with its convex surface facing downstream extending across the channel between the guides, means for moving said curtain up and down to open and close said channel comprising mounting members attached to each side of said curtain, main supporting means in said guides located beyond the lateral limits of said curtain and downstream of said mounting members to support said mounting members against movement in a general downstream direction, and ancillary supporting means in said guides disposed on the streamward side of said mounting members to support said mounting members against movement in a direction transverse to the general downstream direction.

2. A sluice gate comprising two piers bounding a channel, a guide in each of said piers, a water-retaining curtain in the form of a relatively thin plate which is curved about a vertical axis in the form of part of a circular cylinder with its convex surface facing downstream extending across the channel between the guides, means for moving said curtain up and down to open and close said channel comprising mounting members attached to each side of said curtain, main supporting means for said mounting members located in said guides beyond the lateral limits of said curtain, downstream of said mounting members, and disposed in a direction which is divergently inclined from the general direction of flow through the channel by an angle of up to 30 degrees, and ancillary supporting means in said guides disposed on the streamward side of said mounting members to support said mounting members against movement in a direction transverse to the general downstream direction.

3. A sluice gate as claimed in claim 2, in which the said main supporting means and ancillary supporting means are both angularly disposed in the guide with respect to the edge of the curtain whereby the lines of action of the forces which the mounting member exerts on said main supporting means and ancillary supporting means intersect in proximity to the line of action of the force exerted on the mounting member by the curtain.

4. A sluice gate as claimed in claim 1 in which each mounting has at least one sliding surface extending over the full depth of the curtain below normal high water level, adapted to engage a corresponding sliding surface in the guide to prevent leakage through the guide, said sliding surfaces being adapted to take part of the load applied to the mounting.

5. A sluice gate as claimed in claim 4, in which the corresponding sliding surfaces of the mounting and the guide transmit a load from the mounting to the guide in the direction transverse to the general direction of flow through the channel.

6. A sluice gate comprising two piers bounding a channel, a guide in each of said piers, a water-retaining curtain in the form of a relatively thin plate which is curved about a vertical axis in the form of part of a circular cylinder with its convex surface facing downstream extending across the channel between the guides, means for moving said curtain up and down to open and close said channel comprising a mounting attached to each side of said curtain in the form of a wheeled bogie, each bogie comprising a frame connected to the side of the curtain and carrying at least two main wheels arranged in tandem with their axes horizontal, which axes are transverse to the general direction of flow through the channel, and at least one auxiliary wheel arranged with its axis horizontal and transverse to the axes of the main wheels.

7. A sluice gate comprising two piers bounding a channel, a guide in each of said piers, a water-retaining curtain in the form of a relatively thin plate which is curved about a vertical axis in the form of part of a circular cylinder with its convex surface facing downstream extending across the channel between th guides, means for moving said curtain up and down to open and close said channel, and a mounting attached to each side of said curtain which is in the form of a wheeled bogie, each bogie comprising a frame connected to the side of the curtain and carrying at least two main wheels arranged in tandem with their axes horizontal, which axes are transverse to the general direction of flow through the channel, and at least one auxiliary wheel arranged with its axis horizontal and transverse to the axes of the main wheels, there being a bogie below the level of the centre of pressure on the curtain at normal high water level, and another bogie higher up on the curtain.

8. A sluice gate comprising two piers bounding

a channel, a guide in each of said piers, a water-retaining curtain in the form of a relatively thin plate which is curved about a vertical axis in the form of part of a circular cylinder with its convex surface facing downstream extending across the channel between the guides, means for moving said curtain up and down to open and close said channel, and a mounting attached to each side of said curtain which is in the form of at least one member fixed to the side of the curtain and carrying at least two main wheels arranged in tandem and spaced apart with their axes horizontal, which axes are transverse to the general direction of flow through the channel, and at least one auxiliary wheel arranged with its axis horizontal and transverse to the axes of the main wheels.

9. A sluice gate comprising two piers bounding a channel, a guide groove in each of said piers, a water-retaining curtain in the form of a relatively thin plate which is curved about a vertical axis in the form of part of a circular cylinder with its convex surface facing downstream extending across the channel between the guide grooves, means for moving said curtain up and down to open and close said channel, mountings attached to each side of said curtain and supported by the guide grooves, and a vertical closure member for each of said guide grooves, at least below high water level, said closure member co-operating with the guide groove to define a chamber which encloses the mounting supported by this guide groove except for a relatively narrow slot facing downstream and through which the side of said curtain can pass.

10. A sluice gate comprising two piers bounding a channel, a guide in each of said piers, a water-retaining curtain in the form of a relatively thin plate which is curved about a vertical axis in the form of part of a circular cylinder with its convex surface facing downstream extending across the channel between the guides, means for moving said curtain up and down to open and close said channel, and mountings attached to each side of said curtain and supported by the guides, each of said guides being in the form of a groove in the pier and having an opening through which the side of the curtain can pass, while a stanching plate is secured by one edge to and extends in the downstream direction from the upstream side of the opening in each guide, the opposite edge of the stanching plate being in contact with the upstream surface of the curtain when the curtain is in its lowered position.

11. A sluice gate as claimed in claim 10, in which the stanching plate has a degree of resilience, so that when the curtain is raised the stanching plate makes contact with the pier at the downstream side of the opening in the guide, and closes this opening.

12. A sluice gate as claimed in claim 10, in which the stanching plate has a degree of resilience, so that when the curtain is raised the stanching plate makes contact with the pier at the downstream side of the opening in the guide, and closes this opening, and there is a lead at the upper part of the downstream edge of the stanching plate to facilitate entry of the curtain when it is lowered from a raised position in which it lies clear of the stanching plate.

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