Title: WATER CONTROL GATE

Abstract: A water control gate pivotable about a horizontal axis. Control may be by a combination of inflatable actuators and ballast chambers in combination with means for preventing over-rotation. Sealing between gate panels and between gate panels and abutments may be by means of seals inflated hydrostatically. The present invention is bottom hinged water control gate actuated by a combination of ballast chambers and inflatable actuators. The invention further includes an inflatable sealing means. The invention is particularly suited for use as a navigation lock gate system or as a flood control gate in a watercourse such as a navigation canal.
WATER CONTROL GATE

This application is the International Phase of and claims priority to US Provisional Application Number 62/298,815 February 23, 2016. Said application is incorporated herein by reference.

Field of the Invention
The present invention relates to large scale water control gates particularly suited for use as flood barriers in ship canals and for use as lock gates for facilitation navigation between pools of differing surface elevations.

Summary of the Invention
The present invention is comprised of one or more bottom hinged water barrier gates in conjunction with restraining means to prevent overturning of the gates in response to differential water pressure. The gate panels preferably incorporate controllable ballast chambers used to eliminate or minimize the actuating force required to raise the gates.

Background of the Invention
This disclosure relates to water control gates that may be used to block the flow of water against differential head. Conventional miter type lock gates utilize gate panels swung about vertical axes and are limited in width by the weight of the gate. Floating gates with vertical pivot axes have been built. But these require large and precise, and therefore expensive, foundations. Gates actuated by inflatable bladders have been built to heights of approximately 8 meters. Greater heights require very large inflatable bladders. Radial gates, hydraulic flap gates, pelican gates, slide gates and roller gates all require intermediate piers which may be unacceptable in the case of a shipping channel, for example.

The present invention utilizes gate panels comprised of a horizontal edge pivotally attached to the bottom of the channel in combination with one or more ballast chambers that may be controllably filled with either water or air in further combination with restraining means to prevent over rotation of the gate panels in response to the force of the water. The ballast chambers may be utilized to facilitate water transport of the gate panels from the fabrication
facility to the installation site, i.e., the gate panels may be simply floated, and then sunk, into position. The hinge means is preferably a reinforced elastomeric hinge that serves as both hinge and seal. Seals between gate panels are preferably inflatatable. The inflatatable seals disclosed herein allow generous clearances between gate panels consistent with the dimensional tolerances and long term dimensional stability achievable with large scale earth and concrete structures while also providing a desirably tight seal against water leakage. Hydrostatic inflation provides a uniform sealing force throughout the vertical extent of the seal. Heating of rubber seals in accordance with prior art is difficult. This invention provides convenient and effective seal heating as well as a sealing force with a hydrostatic pressure gradient that closely matches the hydrostatic pressure gradient of the controlled water.

**Brief Description of the Drawings**

Figures 1 and 4 are views of the gates in the raised position viewed from the high water side.

Figures 2 and 3 are views of the gates in the raised position viewed from the low water side.

Figure 5 is a view of the gates in the lowered position.

Figure 6 is a schematic of a gate fitted with a hydrostatically inflated and fluid heated inflatatable seal.

Figures 7, 8, and 9 show gate panel cross sections with inflatatable seals.

**Description of the preferred embodiments**

The accompanying drawings illustrate the general features of the gate in Figures 1 through 9.

The gate panels 1 are preferably fitted with internal pipes 30 for emptying either water or air from the ballast chambers 31. Inflatatable actuators 2, which may be filled with air or water, for example, may be used in conjunction with buoyancy effects to raise gate panels 1. Restraining means, such as restraining straps 3 may be used to prevent over-rotation of the gate panels and to resist hydrostatic loads resulting from water on the restraining strap 3 side of gate panels 1. Gate panels 1 are preferably sealed to each other with interpanel seal assembly 7 and sealed to the abutments with abutment seal assemblies 8. Clamps 25 may be used to secure inflatatable actuators 2 and hinge flaps 22 to foundation 4. With gate panels 1 lowered, barges 31 may pass between abutments 5. Referring to Figure 6, gate panel 1 is held up by inflatatable actuator 2 and
positioned at its pivot edge 32 by hinge flap 22. Hinge flap 22 is in turn secured by clamp 25. Clamp 25 is in turn secured by anchor bolt 23 in conjunction with nut 24. Inflatable seal assembly 8 is provided, during freezing conditions, with circulating heated fluid through supply line 29. Return line 28 returns fluid to tank 33. Pump 26 circulates the fluid. Pressure control means 28 provides a controllable gas pressure above the fluid in tank 33. The pressure on the seal varies with elevation and is usefully highest at the bottom of the gate 1 where differential pressure against the gate is greatest.

Due to the large scale of the gates and the large relative motions of the foundations, inflatable seals may be used to provide a tight seal under varying clearance conditions.

The inflatable seals may use circulated heated fluid to prevent ice problems.

Strong restraining straps may be used to prevent overturning of the gates. Shield plates with stops may be used for this purpose instead.
Claims:

What I claim is:

1. A water control gate comprised of at least one gate panel with an edge pivotably connected to the channel bottom, at least one ballast chamber, and restraining means to prevent over-rotation of the gate panel(s) against the force of the water.

2. The apparatus of Claim 1 further comprising an inflatable actuator.

3. The apparatus of Claim 1 further comprising at least one inflatable seal along at least one gate panel edge adjacent the gate panel pivot edge.

4. The apparatus of Claim 2 further comprising at least one inflatable seal along at least one gate panel edge adjacent the gate panel pivot edge.

5. A water control gate including at least one inflatable seal positioned to seal the clearance between at least one moving and at least one stationary portion of said water control gate.

6. The apparatus of claim 5 wherein said inflatable seal is inflated with a fluid so as to provide a hydrostatic pressure distribution within the seal.

7. The apparatus of Claim 6 wherein said inflatable seal is configured to resist leakage in either direction.

8. An apparatus for blocking flow of water in a watercourse comprising one or more gate panels with ballast chambers and rotation limiting means for each gate panel.

9. The apparatus of claim 8 further including inflatable actuators for assisting rotation of the gates about their horizontal pivot axis.

10. The apparatus of claim 8 wherein the rotation limiting means includes one or more tensile retraining elements.

11. The apparatus of claim 8 further comprising a reinforced elastomeric hinge.

12. The apparatus of claim 8 further comprising at least one inflatable seal at at least one marginal edge of at least one gate panel.

13. A bottom hinged water control gate including an inflatable seal along at least one marginal edge.

14. The water control gate of claim 13 wherein the inflatable seal in inflated with a liquid.
15. The apparatus of claim 13 further comprising a fluid filled stand pipe for maintaining seal pressure.

16. The apparatus of claim 13 wherein the inflatable seal includes a hinged portion.
INTERNATIONAL SEARCH REPORT

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8): - E02B 7/42; E02B 7/00; E02B 7/20; E02B 7/40; E02B 7/44; E02B 7/46; E02B 7/50 (201 7.01)
CPC: - E02B 7/42; E02B 7/00; E02B 7/005; E02B 7/20; E02B 7/40; E02B 7/44; E02B 7/46; E02B 7/50; E02B 7/54 (201 7.02)

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)
See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 405/86; 405/87; 405/94; 405/100; 405/102; 405/110; 405/115 (keyword delimited)
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<td>X</td>
<td>WO 2008/038221 A1 (EURO INTERCONNECTIONS LTD) 03 April 2008 (03.04.2008) entire document</td>
<td>1, 3, 5-8, 12-14, 16</td>
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<tr>
<td>Y</td>
<td>US 201 101 16871 A1 (OBERMEYER et al) 19 May 2011 (19.05.2011) entire document</td>
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Further documents are listed in the continuation of Box C. See patent family annex.

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