



(11) **EP 1 311 728 B9**

(12) **CORRECTED EUROPEAN PATENT SPECIFICATION**

Note: Bibliography reflects the latest situation

- (15) Correction information:  
**Corrected version no 1 (W1 B1)**  
**Corrections, see**  
**Claims DE**
- (48) Corrigendum issued on:  
**28.11.2007 Bulletin 2007/48**
- (45) Date of publication and mention of the grant of the patent:  
**30.05.2007 Bulletin 2007/22**
- (21) Application number: **01962462.6**
- (22) Date of filing: **21.08.2001**
- (51) Int Cl.:  
**E02B 13/02** <sup>(2006.01)</sup> **E02B 7/44** <sup>(2006.01)</sup>  
**E02B 7/54** <sup>(2006.01)</sup> **E02B 8/06** <sup>(2006.01)</sup>  
**G01F 1/00** <sup>(2006.01)</sup> **G01F 1/34** <sup>(2006.01)</sup>
- (86) International application number:  
**PCT/AU2001/001036**
- (87) International publication number:  
**WO 2002/016698 (28.02.2002 Gazette 2002/09)**

(54) **CONTROL GATES**

KONTROLLSCHIEBER

VANNES DE REGULATION

- (84) Designated Contracting States:  
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU**  
**MC NL PT SE TR**
- (30) Priority: **21.08.2000 AU PQ955400**  
**03.11.2000 AU PR121700**
- (43) Date of publication of application:  
**21.05.2003 Bulletin 2003/21**
- (60) Divisional application:  
**07108893.4 / 1 830 005**
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## Description

**[0001]** This invention relates to control gates for flow and level control of liquids and to lifting mechanisms for such gates.

**[0002]** Control gates are commonly for regulating the flow and level of water in water channels especially for irrigation. Control gates are typically of the vertical slide type eg US Patent No. 4726709; the radial control type eg US Patent No. 5516230; or the swing down type eg US Patent No. 4073147. Such gates have proved popular but require large motors or complex actuating devices to lift the gates against the weight of water, the flow of the water or the weight of the gate.

**[0003]** NL 1 010 851 C discloses a control gate adapted to be installed across a channel for liquids. The control gate has a barrier member that is pivotally mounted adjacent the base of the channel, and has two side members with circular arcuate sections. The gate comprises a drive means co-operating with the side members in the form of a rack whereby pinion gears mesh with these racks on the outer periphery of the side plates.

**[0004]** DE-B-1080934 discloses a further control gate that could be installed across a channel for liquids, said control gate having a barrier member that is pivotally mounted at a distance from the base of said flow channel. The barrier member has an arcuate barrier portion, and a drive means is co-operating with said barrier portion to allow raising and lowering of said barrier member to regulate flow of liquid through said control gate. The drive means include a winding spool which co-operates with one cable along or parallel to the arcuate barrier portion; said cable is connected close to a lower end of said arcuate barrier portion under tension, whereby the winding onto or off said spool of said cable will cause movement of said control gate.

**[0005]** DE-B-1103857 discloses a further example of a pivotally arranged control gate.

**[0006]** PATENT ABSTRACTS OF JAPAN, vol. 009, no. 231, related to JP-60-088711 discloses an arrangement for actuating a control gate by means of a wire and pulleys.

**[0007]** US-A-1544996 discloses a whirlpool filling and parrying plant designed to prevent damages caused by the whirlpool behind a constructions such as a weir, in the water.

**[0008]** PATENT ABSTRACTS OF JAPAN, vol. 1998, no. 12, related to JP-10-183585 discloses a control gate arrangement involving frame members.

**[0009]** DE-A-2935015 discloses a control gate arrangement involving sensors and processors for determining flow rates.

**[0010]** The present invention relates to a control gate as defined in claim 1. The use of a spool and cables arranged as defined in claim 1, with the spool located very close to the circular arcuate section and with the cable under tension, for example ensures that the cables do not lift from their peripheral contact with the arcuate

section, and maximize the mechanical advantage obtained from this positioning.

**[0011]** Preferred embodiments of the invention are defined in the dependent claims.

5 **[0012]** Thus, the primary object of the present invention is to provide a control gate which reduces the motor torque requirements to lift the control gate.

**[0013]** A further aspect of the invention is to provide a means of measuring the flow rate through the gate.

10 **[0014]** A further aspect of the invention is to provide a control gate with associated lifting mechanism which can be assembled as a self contained unit that can be retrofitted to existing regulating structures.

15 **[0015]** A further aspect of the invention is to provide a lifting mechanism for control gates which can be integrated into the construction of control gates or retrofitted to existing control gates.

20 **[0016]** With these objects in view the present invention provides a control gate adapted to be installed across a channel for liquids, said control gate having a barrier member that is pivotally mounted at or adjacent the base of said flow channel and two side members attached to said barrier member, a drive means co-operating with at least one side member to allow raising and lowering of said barrier member to regulate flow of liquid through said control gate.

25 **[0017]** Said side members have a circular arcuate section which co-operates with said drive means. Said drive means includes a winding spool which co-operates with two cables along or parallel to said circular arcuate section that are always kept under tension, whereby the winding onto or off said spool of said cables will cause movement of said control gate. In a preferred embodiment said two side members sealingly engage with a support frame within said flow channel. In a further embodiment said circular arcuate section may include a flange which projects into the flow of liquid to alter the flow characteristics through said control gate.

30 **[0018]** Said two cables are a pair of opposing cables secured to said at least one driving member in the form of a spool member from which said cables wind off and on from said spool member. In a practical embodiment said spool member can also move axially during rotation to allow the cables to wind directly onto and off said spool member at a substantially constant position on said spool member.

35 **[0019]** In yet a further aspect of the invention the control gate is provided with a flow stabilisation device for the regulation of liquid flow along a channel, said flow stabilisation device including a flow direction plate pivotally attached to said control gate, said flow direction plate adapted to allow liquid passing through said control gate to exit from said control gate substantially parallel with the floor of said channel.

40 **[0020]** Preferably said flow direction plate is pivotally attached to a pivotable plate over which said liquid flows and said flow direction plate retains a substantially parallel disposition with respect to the floor of said channel.

In a preferred embodiment said flow direction plate forms one side of a parallelogram with the opposing side being fixed in a position parallel to the floor of said channel.

**[0021]** In yet a further aspect of the invention the control gate is provided with means for measuring flow rate of a liquid through the gate in a channel, the method used including the steps of measuring the pressure of the liquid at a first position upstream of said gate, measuring the pressure of the liquid at a second position downstream of said gate, measuring the position of opening of said gate and calculating said flow rate using an algorithm based on said measurements. It is preferred that the measurements take place adjacent to the gate. Preferably said algorithm is determined using a system identification method.

**[0022]** In yet another aspect of the invention the gate is provided with a device for measuring flow rate of a liquid through the gate in a channel, said device having a first pressure sensor for measuring the pressure of the liquid at a first position upstream of said gate, a second pressure sensor for measuring the pressure of the liquid at a second position downstream of said gate, an opening sensor for measuring the position of opening of said gate and computation means for calculating said flow rate using an algorithm based on said measurements.

**[0023]** In a further preferred embodiment the control gate is adapted to be installed across a channel for liquids, said control gate having a first frame member adapted to be secured to said channel, a second frame member which slidably co-operates with said first frame member, said second frame member including a gate for controlling flow of liquid therethrough, and sealing means on said second frame member to provide sealing between said gate and said second frame member.

**[0024]** Preferably said sealing means is a continuous seal located on or within said second frame member. It is preferred that said continuous seal includes a plurality of parallel ribs which abut said gate to provide a positive sealing effect.

**[0025]** In yet a further aspect of the invention the gate is provided with means for measuring flow rate of a liquid through the gate in a channel, the method used including the steps of providing at least one sensor in or adjacent said gate, measuring the output from said at least one sensor, and calculating said flow rate through said gate using an algorithm based on said measurements. Preferably said algorithm is determined using a system identification method. Preferably said measurements may be made using pressure, magnetic inductive, sonar or other suitable types of sensors and/or a combination of different sensors. Preferably the position of opening of said gate is also measured and this measurement is also included in the determination of said algorithm.

**[0026]** In order that the invention may be more readily understood and put into practical effect, reference will now be made to the accompanying drawings, in which:-

Fig. 1 is a perspective view of a control gate not falling

within the scope of the invention, since the gate shown in figure 1 has a different type of drive means than the claimed drive means;

Fig. 2 is a plan view of the drive means of the claimed control gate;

Fig. 3 is a perspective view of the claimed control gate having the control gate mechanism as shown in Fig. 2;

Fig. 4 is a perspective view of the control gate shown in Fig. 1 having a flow stabilization device (the drive mechanism differs from that of the invention as claimed);

Fig. 5 is a side view of the control gate shown in Fig. 4 with the gate shown in a closed flow mode;

Fig. 6 is a side view of the control gate shown in Fig. 4 with the gate shown in an open flow mode;

Figs. 7 to 11 illustrate a variation of the control gate shown in Fig. 1 not falling under the scope of claim 1 showing the assembly sequence of the control gate (in these drawings, the drive means differ from the drive means of the invention claimed);

Fig. 7 is a perspective view showing the fitting of the sealing member to the support frame;

Fig. 8 is a perspective view showing the outer frame receiving the support frame with barrier member pivotally attached thereto (the drive means differs from the drive means of the invention as claimed);

Fig. 9 is a cross-sectional view along and in the direction of arrows 17-17 shown in Fig. 8 but including the outer frame;

Fig. 10 is a side view showing the sealing of the barrier member to the sealing member of the control gate shown in the direction of arrow 18-18 of Fig. 8; and

Fig. 11 is a similar view to that of Fig. 1 showing a further embodiment of the invention (also including a drive means different from the claimed one).

**[0027]** Throughout the description and drawings the same reference numerals have been used for similar integers to avoid repetition of description. In Fig. 1 of the drawings there is shown a control gate 10 for controlling the flow of water through a channel 12, this control gate 10 is not falling under the scope of protection since a different drive means as claimed is used. Channel 12 can be a drain, irrigation channel or other water course where flow must be regulated. The channel 12 has a pair of side walls 14,16 and a floor 17 in the form of a U-shaped channel. Although a U-shaped channel is shown the channel could be of any shape e.g. circular, trapezoidal or other shape. The channel 12 is preferably formed of concrete to provide ease of construction and a smooth flow of water. Preferably slots (not shown) are cut into opposing side walls 14,16 for reception of a support frame 18 of control gate 10. Support frame 18 is U-shaped and will slide into the slots for an easy installation. Support frame 18 interlocks with the slots or other frame to provide structural stability for the assembly. Barrier

member 22 is pivotally mounted to support frame 18. Barrier member 22 is formed from a bottom plate 24 and a pair of circular arcuate side plates 26,28. Barrier member 22 can pivot to a fully closed position where bottom plate 24 is substantially vertical to a fully open position where bottom plate 24 is substantially horizontal.

**[0028]** By positioning bottom plate 24 in a position between the fully open and close positions the rate of flow of water can be controlled. Side plates 26,28 have a right angular section with a circular arcuate section 30 along the hypotenuse. The right angular section can be substituted by more or less of an angle of 90°, if required. Bottom plate 24 is rectangular or square depending on the dimensions of channel 12. Seals 32 eg seal strips, run along the length of the support frame 18 to provide a water tight seal with barrier member 22 and prevent water bypassing flow through barrier member 22. In a practical embodiment a continuous seal strip is provided on either side of the pivot for barrier member 22 and are fixed within support frame 18 and extend the full length of support frame 18.

**[0029]** In order to control the flow rate accurately a motor 34 is used to lift barrier member 22. Motor 34 can be monitored by a circuit means (not shown) to determine the positioning of barrier member 22 or by a switch (not shown) for manual operation. Motor 34 is coupled to a reduction gear box 36 which has an output shaft 38 supported by bearings 40 on either side of channel 12. In the drive arrangement of figure 1, which differs from the claimed one, pinion gears 42 are secured to shaft 38 and mesh with a racks 44,46 on the outer periphery of respective side plates 26,28. The pinion gears 42 are directly located above the pivot point for barrier member 22. The arrangement of the racks 44,46 and pinion gears 42 provides a great mechanical advantage which allows smaller capacity motors 34 to be used in view of the lower torque requirement needed to lift barrier member 22.

**[0030]** In use, motor 34 is preferably monitored by a control panel (not shown) to which a plurality of control gates 10 may be connected. Motor 34 can be selected or deselected to control the angle of bottom plate 24 with respect to the floor 17 of channel 12. By having pressure sensors (not shown) in the channel, the flow of water through control gate can be measured and varied by the lifting of bottom plate 24 by the rack and pinion action of racks 44,46 and pinion gears 42 with rotation of shaft 38 by motor 34 under monitoring from the control panel. It is preferred that a pair of pressure sensors are used and that they are mounted on the support frame 18 upstream and downstream, respectively. These sensors can be placed anywhere on the support frame but preferably adjacent the bottom thereof on the side of support frame 18. With the measurements from the pair of pressure sensors together with the measurement of the gate opening, the flow rate can be calculated by a computational means within said control panel using the known technique of "system identification". The expression "system identification" used in this specification refers to the

known technique of deriving a system model from experimental data. It consists of suggesting a suitable mathematical representation for the model of the system of interest, followed by a tuning process in which the particular representation is optimised as to reproduce as closely as possible experimental timed observations from the system. The methodology provides a means of comparing different models and ranking them according to their ability of reproducing the system's behaviour. System identification is a particular sub-topic in mathematical system theory and also in statistics. The technique of system identification will allow development of a specific relationship for each gate in a multiple gate system. Water will flow in the direction indicated by arrow 48 and flow over bottom plate 24 in the position shown in Fig. 1. When bottom plate 24 is vertical all flow will be stopped as bottom plate 24 will block all flow. Seals 32 will ensure that there is no seepage between support frame 18 and barrier member 22.

**[0031]** Fig. 2 shows a similar drive means to that used in the control gate shown in Fig. 1 but pinion gear 42 has been replaced by a spool 54 and rack 50 has been replaced by cables 56,58. This drive means shows the invention made: Cable 56 is guided along the peripheral edge of circular arcuate section 30 and is secured at one end of barrier member 22 and at the other end 60 to spool 54, after looping therearound. Similarly cable 58 is guided along the peripheral edge of circular arcuate section 30 and is secured at the opposite end of barrier member 22 and at the other end 62 to spool 54, after looping therearound. The positioning of cables 56,58 could be by the use of a channel on circular arcuate section 30 or a flange thereon. Rotation of spool 54 by shaft 38 will cause lifting of barrier member 22 by either cable 56 being unwrapped from spool 54 whilst cable 58 is wrapped onto spool 54 or vice versa. Spool 54 is located very close to circular arcuate section 30 and under tension to ensure that cables 56,58 do not lift from their peripheral contact therewith and maximize the mechanical advantage obtained from this positioning.

**[0032]** In one preferred embodiment of the drive means shown in Fig. 2 spool 54 may also be axially movable during rotation to allow the cables to be positioned on the spools at a substantially constant axial position along the spools. Such axial movement of spool 54 will provide a smooth laying on or laying off of the cables from the spool 54.

**[0033]** Fig. 3 illustrates how the lifting mechanisms shown in Figs. 1 and 2 is used for a standard radial gate 76. Radial gate 76 has a part cylindrical plate 78 which in its closed position will rest on the floor 17 of channel 12. Side frames 80,82 are joined along opposing peripheries of plate 78 to complete radial gate 76. Pivots 84,86 on side frames 80,82 co-operate with side walls 14,16, of channel 12 to allow radial gate 76 to pivot upwardly and allow water to flow thereunder. Seals (not shown) are provided on the lower edge of plate 78 and on both circular edges of plate 78 to ensure there is no seepage

through the gate. This figure shows the use of the lifting mechanism shown in Fig. 2. Cables 56,58 are secured at each end of plate 78 and extend along the outer surface of plate 78.

**[0034]** Figs. 4-6 show control gates not falling within the scope of claim 1 but comprising a flow stabilization device 96. The flow stabilization device 96 is a plate. 98 which extends the full width of the bottom plate 24. Plate 98 is pivotally mounted to bottom plate 24 by hinge 100. A pair of extension arms 102 (only one shown) extend parallel to the floor 17 of channel 12 and are the same width as the width of plate 98. A pair of rods or links 104 are pivotally attached at either end to a respective extension arm 102 and the free edge 106 of plate 98. Rods or links 104 will be the same length as the bottom plate 24.

**[0035]** Thus the side edge of bottom plate 24, the plate 98, a respective rod or link 104 and a respective extension arm 102 will form a movable parallelogram. As extension arms 102 are fixed in their parallel relationship with floor 17 of channel 12 then plate 98 will also be in a substantial parallel relationship with floor 17 when bottom plate 24 is lifted. Without plate 98 water will flow over bottom plate 24 and create turbulence where it leaves bottom plate 24 to exit the control gate. Plate 98 will maintain a horizontal flow path for the water as it exits the control gate. Figs. 5 and 6 show a closed flow rate and open flow rate respectively and it can be clearly seen that the horizontal flow path is maintained at any flow rate. Plate 98 will reduce the turbulence one would normally expect when water exits a flow control gate.

**[0036]** In the embodiment shown in Figs. 7 and 8 the assembly of the control gate 10 is illustrated. An outer frame 110 replaces the slots in channel 12 for reception of support frame 18. Outer frame 110 is a U-shaped structure with vertical sections 112,114 and a bottom section 116. Sections 112,114,116 have a U-shaped profile and are secured to the side walls 14,16 and bottom 17 of channel 12. The securement can be by fasteners, adhesive or any other suitable means. Outer frame 110 is grouted, sealed by silicone type sealers or other waterproofing agents to prevent seepage between channel 12 and outer frame 110. Support frame 18 as previously described has barrier member 22 pivotally attached thereto. Support frame 18 in this embodiment is formed as a hollow square or rectangular section and has side arms 118,120 which join with bottom arm 122. The shape of support frame 18 and outer frame 110 are not limited to the shapes shown in the figures as they can vary to suit requirements.

**[0037]** Interlocking extrusions, circular or triangular shapes may be used as examples. Seal 32 is mounted as a continuous strip to the inner facing surfaces of side arms 118,120 and bottom arm 122. Seal 32 preferably extends over the opposing edges of support frame as seen at 124 (Fig. 9). This overhang 124 will provide a seal between outer frame 110 and support frame 18 to prevent seepage therebetween. Seal 32 can be of any suitable profile but the preferred embodiment has a pair

of parallel ribs 126,128 which provide a very effective seal with barrier member 22. The double rib will provide an excellent double seal for the pivot point of barrier member 22 as shown in Fig. 18 and for the side plates 26,28.

**[0038]** In use, support frame 10 with barrier member 22 fitted thereto, will be guided into position into vertical sections 112,114 and into sealing engagement with bottom section 116. The overhangs 124 will ensure that there is no seepage between outer frame 110 and support frame 18. Support frame 18 will then be interlocked to outer frame 110. If barrier member 22 needs to be repaired, or a different type of barrier member fitted (e.g. a radial gate as shown in Fig. 3), it is any easy matter to withdraw support frame 110 with barrier member 22.

**[0039]** Pressure sensors 130,132 (Fig. 7) are located upstream and downstream of control gate 10 and preferably on support frame 18. These pressure sensors 130,132 are located at a point immediately upstream of seal 32 and a point immediately downstream of seal 32 i.e. either side of ribs 126,128. The type of sensors used can vary to suit the nature of the flow rate to be measured and the invention is not limited to the type of sensor used, its position or the number of sensors used.

**[0040]** The control gate shown in Fig. 11 again does not fall within the scope of claim 1 but is a variation of the control gate shown in Fig. 1. The addition of a curved flange plate 134,136 on the circular arcuate section 30 of each side plate 26,28 will alter the flow characteristics of the liquid passing through the control gate. Curved flange plates 134,136 are mounted perpendicular to the plane of side plates 26,28 and extend inwardly therefrom. The change in flow characteristics has been found to increase the sensitivity of pressure measurements by the pressure sensors.

**[0041]** Although the control gate has been described with reference to the flow of water it will be apparent that the invention can be used for many different liquids and slurries. The preferred embodiments show the use of a pair of spools 54 the invention will work with one or more than two of such integers. The use of a pair of spools 54 provides a better balance for lifting the control gates. The flow measurement method has the pressure sensors on support frame 18 but they can be positioned to other suitable positions to suit computational requirements.

**[0042]** A further control gate not covered by the invention will now be described with particular reference to Fig. 8. The pressure sensors of Fig. 8 can be omitted and a substitute system of flow rate determination can be used. Electromagnetic or sonar devices can be included in such a system. For the electromagnetic system the concept is that any conductive liquid passing through a magnetic field will induce a voltage which can be measured. This method is based on Faraday's law of induction. The amplitude of the induced voltage is related to the velocity of the liquid. The flow rate through the gate can be derived from these measurements using system identification techniques. Bottom plate 24 and side plates 26,28 can include suitable devices to induce a magnetic field and

to measure the induced voltages. Sonar techniques may also be used using either the Doppler effect or the direct travel time method. In the Doppler effect method an acoustic signal is transmitted into the moving liquid and the change in the frequency of the signals reflected from the particles of the liquid is measured. The frequency distribution of the frequency shift of the reflected signals is related to the velocity of the liquid. In the direct travel time method pairs of transmit and receive acoustic sensors are located in opposite boundaries of the moving liquid. The sensors are oriented so that the direction of the acoustic path between them is aligned to transmit to the opposite sensor and to also receive a signal from the opposite sensor. The sensors are positioned such that the path between the sensors traverses the liquid flow direction at an angle other than perpendicular. The time of the signal to travel in either direction is measured. The difference in travel time is directly related to the velocity of the liquid between the two sensor points. Additional pairs of sensors may be used to build up a profile of the liquid velocities.

**[0043]** The measurements made and the use of system identification methods will determine whether additional sensors are used. A number of different sensors of the same type or different type can be used in combination which has the potential of improving the flow rate measurement algorithm. One type of sensor may measure high flow rates better than low flow rates and the different sensors may be weighted when deriving the relationship under system identification.

**[0044]** The invention will be understood to embrace many further modifications as will be readily apparent to persons skilled in the art and which will be deemed to reside within the scope of the invention, as defined by the appended claims.

## Claims

1. A control gate (10) adapted to be installed across a channel (12) for liquids, said control gate (10) having a barrier member (22), wherein said barrier member (22) is pivotally mounted at or adjacent the base (20) of said flow channel (12), and in that said control gate further has two side members (26, 28) having circular arcuate sections (30) attached to said barrier member (22), and a drive means co-operating with at least one of said side members (26, 28) to allow raising and lowering of said barrier member (22) to regulate flow of liquid through said control gate (10), **characterised in that** said drive means comprises, for at least one of said side members, a spool (54) and two cables (56, 58), wherein a first cable (56) of said two cables is guided along the peripheral edge of the respective circular arcuate section (30) and is secured at one end of the barrier member (22) and at the other end (60) to said spool (54), after looping around the spool, and wherein a second cable (58) of said two cables is guided along the peripheral edge of the circular arcuate section (30) and is secured at an opposite end of said barrier member (22) and at the other end (62) to the spool (54), after looping around the spool, whereby rotation of said at least one spool (54) by its shaft will cause lifting of the barrier member (22) by either the first cable (56) being unwrapped from the spool whilst the second cable (58) is wrapped onto the spool, or vice versa, said at least one spool (54) being located very close to said respective circular arcuate section (30) with the cables (56, 58) being maintained always under tension to ensure that the cables (56, 58) do not lift but are kept in peripheral contact with said respective circular arcuate section (30).
2. The control gate of claim 1, wherein said side members (26, 28) sealingly engage with a support frame (18) within said flow channel.
3. The control gate of claim 1, wherein said winding spool (54) is movable axially during rotation to allow the cables (56, 58, 64, 66) to wind directly onto and off said winding spool (54) at a substantially constant position on said winding spool (54).
4. The control gate of claim 1, wherein said circular arcuate section (30) includes a flange (134, 136) which projects into the flow of liquid to alter the flow characteristics through said control gate (10).
5. The control gate of any one of the preceding claims, further including a flow stabilisation device (96), said flow stabilisation device (96) including a flow direction plate (98) pivotally attached to said control gate (10), said flow direction plate (98) adapted to allow liquid passing through said control gate (10) to exit from said control gate (10) substantially parallel with the floor (17) of said channel (12).
6. The control gate of claim 5, wherein said flow direction plate (98) is pivotally attached to said barrier member (22) over which said liquid flows and said flow direction plate (98) retains a substantially parallel disposition with respect to the floor (17) of said channel (12).
7. The control gate of claim 5 or 6, wherein said flow direction plate (98) forms one side of a parallelogram with the opposing side (102) being fixed in a position parallel to the floor (17) of said channel (12).
8. The control gate of any one of the preceding claims, wherein said control gate (10) has a first frame member (110) adapted to be secured to said channel (12), a second frame member (18) which slidingly co-operates with said first frame member (110), said barrier member (22) being pivotally attached to said sec-

ond frame member (18), and sealing means (32) on said second frame member (18) to provide sealing between said side members (26, 28) and said second frame member (18).

9. The control gate of claim 8, wherein said sealing means (32) is a continuous seal located on or within said second frame member (18).
10. The control gate of claim 9, wherein said continuous seal (32) includes a plurality of parallel ribs (126, 128) which abut said barrier member (22) to provide a positive sealing effect.
11. The control gate of any one of the preceding claims, further including a first pressure sensor (130) for measuring the pressure of the liquid at a first position upstream of said barrier member (22), a second pressure sensor (132) for measuring the pressure of the liquid at a second position downstream of said barrier member (22), an opening sensor for measuring the position of opening of said barrier member (22) and computation means for calculating said flow rate using an algorithm based on said measurements.
12. The control gate of claim 11, wherein said algorithm is determined using a system identification method.
13. The control gate of claim 11 or 12, wherein said measurements are using pressure, magnetic inductive, sonar or other suitable types of sensors (130, 132) and/or a combination of different sensors (130, 132).
14. The control ate of any of the preceding claims, wherein said drive means cooperates with both of said side members (26, 28), wherein said drive means comprises, for each one of said side members, one of said spools (54) and two cables (56, 58) as defined in claim 1.

#### Patentansprüche

1. Steuerungstor (10), das geeignet ist, quer zu einem Kanal (12) für Flüssigkeiten installiert zu werden, wobei das Steuerungstor (10) ein Barriereelement (22) umfaßt, wobei das Barriereelement (22) schwenkbar am Boden (20) des Flußkanals (12) oder an den Boden angrenzend befestigt ist, wobei das Steuerungstor ferner zwei Seitenelemente (26, 28) mit kreisförmig-bogenförmigen Abschnitten (30) umfaßt, die an dem Barriereelement (22) befestigt sind, und Antriebsmittel, die mit mindestens einem der Seitenelemente (26, 28) so zusammenwirken, daß sie das Anheben und Absenken des Barriereelements (22) gestatten, um den Fluß der Flüssigkeit durch das

Steuerungstor (10) einzustellen, **dadurch gekennzeichnet, daß** die Antriebsmittel für mindestens eines der Seitenelemente eine Spule (54) und zwei Kabel (56, 58) umfassen, wobei ein erstes Kabel (56) von den zwei Kabeln entlang des Umfangsrandes des jeweiligen kreisförmig-bogenförmigen Abschnitts (30) geführt ist und an einem Ende des Barriereelements (22) und an dem anderen Ende (60) an der Spule (54) befestigt ist, nachdem es um die Spule gewickelt wurde, und wobei ein zweites Kabel (58) von den zwei Kabeln entlang des Umfangsrandes des kreisförmig-bogenförmigen Abschnitts (30) geführt ist und an einem gegenüberliegenden Ende des Barriereelements (22) und an dem anderen Ende (62) an der Spule (54) befestigt ist, nachdem es um die Spule gewickelt wurde, wobei die Drehung der mindestens einen Spule (54) durch deren Welle verursacht, daß das Barriereelement (22) entweder **dadurch, daß** das erste Kabel (56) von der Spule abgewickelt wird, während das zweite Kabel (58) auf die Spule gewickelt wird, oder umgekehrt, angehoben wird, wobei die mindestens eine Spule (54) sehr nahe an dem zugehörigen kreisförmig-bogenförmigen Abschnitt (30) angeordnet ist, wobei die Kabel (56, 58) stets unter Spannung gehalten werden, um sicherzustellen, daß die Kabel (56, 58) nicht abgehoben werden, sondern in Umfangskontakt mit dem zugehörigen kreisförmig-bogenförmigen Abschnitt (30) gehalten werden.

2. Steuerungstor nach Anspruch 1, bei dem die Seitenelemente (26, 28) abdichtend mit einem Halterahmen (18) innerhalb des Flußkanals in Eingriff stehen.
3. Steuerungstor nach Anspruch 1, bei dem die Wickelspule (54) während der Drehung axial beweglich ist, um es den Kabeln (56, 58, 64, 66) zu ermöglichen, sich bei einer im wesentlichen konstanten Position auf der Wickelspule (54) direkt auf die Wickelspule (54) zu wickeln bzw. von dieser abzuwickeln.
4. Steuerungstor nach Anspruch 1, bei dem der kreisförmig-bogenförmige Abschnitt (30) einen Flansch (134, 136) umfaßt, welcher in den Fluß der Flüssigkeit ragt, um die Fließeigenschaften durch das Steuerungstor (10) zu ändern.
5. Steuerungstor nach einem der vorhergehenden Ansprüche, das ferner eine Flußstabilisierungsvorrichtung (96) umfaßt, wobei die Flußstabilisierungsvorrichtung (96) eine Flußrichtungsplatte (98) umfaßt, die schwenkbar an dem Steuerungstor (10) befestigt ist, wobei die Flußrichtungsplatte (98) geeignet ist, es der Flüssigkeit, welche das Steuerungstor (10) passiert, zu gestatten, im wesentlichen parallel zum Boden (17) des Kanals (12) aus dem Steuerungstor (10) auszutreten.

6. Steuerungstor nach Anspruch 5, bei dem die Flußrichtungsplatte (98) schwenkbar an dem Barriereelement (22), über welches die Flüssigkeit fließt, angebracht ist, und die Flußrichtungsplatte (98) eine im wesentlichen parallele Ausrichtung bezüglich des Bodens (17) des Kanals (12) beibehält.
7. Steuerungstor nach Anspruch 5 oder 6, bei dem die Flußrichtungsplatte (98) eine Seite eines Parallelogramms bildet, bei welchem die gegenüberliegende Seite (102) in einer Position parallel zum Boden (17) des Kanals (12) festgelegt ist.
8. Steuerungstor nach einem der vorhergehenden Ansprüche, bei dem das Steuerungstor (10) ein erstes Rahmenelement (110) umfaßt, welches geeignet ist, am Kanal (12) befestigt zu werden, ein zweites Rahmenelement (18), welches gleitend mit dem ersten Rahmenelement (110) zusammenwirkt, wobei das Barriereelement (22) schwenkbar am zweiten Rahmenelement (18) befestigt ist, und Dichtungsmittel (32) an dem zweiten Rahmenelement (18) umfaßt, um eine Abdichtung zwischen den Seitenelementen (26, 28) und dem zweiten Rahmenelement (18) bereitzustellen.
9. Steuerungstor nach Anspruch 8, bei dem die Abdichtungsmittel (32) durch eine zusammenhängende Abdichtung gebildet werden, die auf oder innerhalb des zweiten Rahmenelements (18) angeordnet ist.
10. Steuerungstor nach Anspruch 9, bei dem die kontinuierliche Abdichtung (32) eine Mehrzahl von parallelen Rippen (126, 128) umfaßt, die an dem Barriereelement (22) anstoßen, um einen positiven Abdichtungseffekt bereitzustellen.
11. Steuerungstor nach einem der vorhergehenden Ansprüche, das ferner einen ersten Drucksensor (130) zum Messen des Drucks der Flüssigkeit an einer ersten Position stromaufwärts des Barriereelements (22) umfaßt, einen zweiten Drucksensor (132) zum Messen des Drucks der Flüssigkeit an einer zweiten Position stromabwärts des Barriereelements (22), einen Öffnungssensor zum Messen der Öffnungsposition des Barriereelements (22) und Berechnungsmittel zum Berechnen der Flußrate unter Verwendung eines Algorithmus basierend auf den genannten Messungen.
12. Steuerungstor nach Anspruch 11, bei dem der Algorithmus unter Verwendung eines Systemidentifikationsverfahrens ermittelt wird.
13. Steuerungstor nach Anspruch 11 oder 12, bei dem die Messungen Drucksensoren, magnetische Induktionssensoren, Sonarsensoren oder andere geeignete Arten von Sensoren (130, 132) und/oder eine

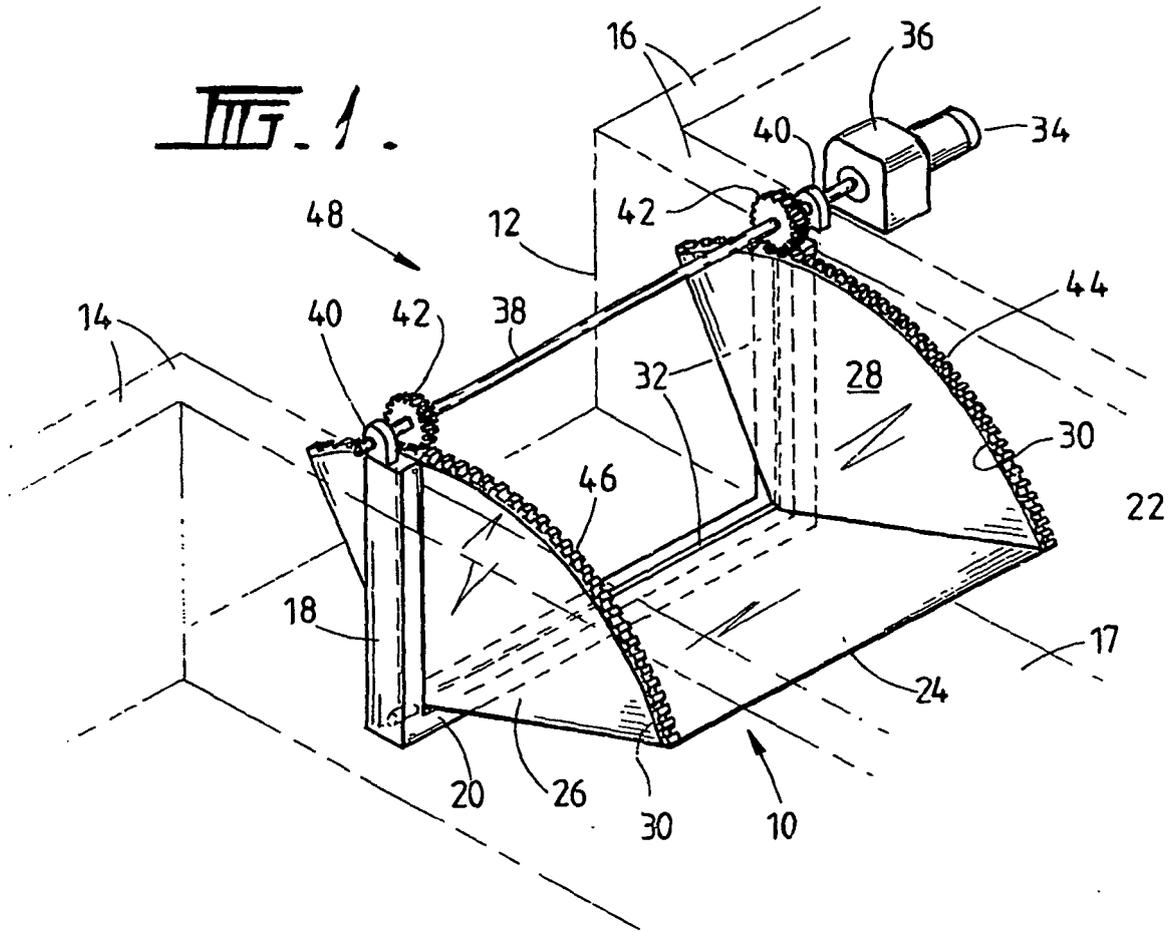
Kombination von verschiedenen Sensoren (130, 132) verwenden.

14. Steuerungstor nach einem der vorhergehenden Ansprüche, bei dem die Antriebsmittel mit beiden Seitenelementen (26, 28) zusammenwirken, wobei die Antriebsmittel für ein jedes der Seitenelemente eine der Spulen (54) und zwei Kabel (56, 58) umfassen, wie sie in Anspruch 1 definiert sind.

#### Revendications

1. Vanne de régulation (10) adaptée pour être installée à travers un canal (12) pour liquides, ladite vanne de régulation (10) ayant un élément barrière (22), dans laquelle ledit élément barrière (22) est fixé de manière pivotante sur ou de manière adjacente à la base (20) dudit canal d'écoulement (12), et ladite vanne de régulation a en outre deux éléments latéraux (26, 28) ayant des sections arquées circulaires (30) montées sur ledit élément barrière (22), et un moyen d'entraînement coopérant avec au moins l'un desdits éléments latéraux (26, 28) pour permettre l'élévation et l'abaissement dudit élément barrière (22) de manière à réguler l'écoulement de liquide à travers ladite vanne de régulation (10), **caractérisée en ce que** ledit moyen d'entraînement comprend, pour au moins l'un desdits éléments latéraux, une bobine (54) et deux câbles (56, 58), dans laquelle un premier câble (56) desdits deux câbles est guidé le long du bord périphérique de la section arquée circulaire respective (30) et est fixé à une extrémité de l'élément barrière (22) et à l'autre extrémité (60) à ladite bobine (54), après avoir été enroulé en boucle autour de la bobine, et dans laquelle un second câble (58) desdits deux câbles est guidé le long du bord périphérique de la section arquée circulaire (30) et est fixé à une extrémité opposée dudit élément barrière (22) et à l'autre extrémité (62) à la bobine (54), après avoir été enroulé en boucle autour de la bobine, moyennant quoi la rotation de ladite au moins une bobine (54) par son arbre va entraîner le soulèvement de l'élément barrière (22) soit par le premier câble (56) qui est retiré de la bobine sur laquelle il était enroulé tandis que le second câble (58) est enroulé sur la bobine, ou inversement, ladite au moins une bobine (54) étant située très proche de ladite section arquée circulaire respective (30), avec les câbles (56, 58) toujours maintenus sous tension pour assurer que les câbles (56, 58) ne se soulèvent pas mais soient maintenus en contact périphérique avec ladite section arquée circulaire respective (30).
2. Vanne de régulation selon la revendication 1, dans laquelle lesdits éléments latéraux (26, 28) viennent en prise de manière étanche avec un cadre de support (18) à l'intérieur dudit canal d'écoulement.

3. Vanne de régulation selon la revendication 1, dans laquelle ladite bobine d'enroulement (54) est mobile axialement pendant la rotation pour permettre aux câbles (56, 58, 64, 66) de s'enrouler directement sur ladite bobine d'enroulement (54) et de se dérouler de cette dernière en une position sensiblement constante sur ladite bobine d'enroulement (54). 5
4. Vanne de régulation selon la revendication 1, dans laquelle ladite section arquée circulaire (30) comprend une bride (134, 136) qui saille dans l'écoulement de liquide de manière à modifier les caractéristiques d'écoulement à travers ladite vanne de régulation (10). 10
5. Vanne de régulation selon l'une quelconque des revendications précédentes, comprenant en outre un dispositif de stabilisation d'écoulement (96), ledit dispositif de stabilisation d'écoulement (96) comprenant une plaque de direction d'écoulement (98) fixée de manière pivotante à ladite vanne de régulation (10), ladite plaque de direction d'écoulement (98) étant adaptée pour permettre au liquide de passer à travers ladite vanne de régulation (10) et de sortir de ladite vanne de régulation (10) de manière sensiblement parallèle au sol (17) dudit canal (12). 15
6. Vanne de régulation selon la revendication 5, dans laquelle ladite plaque de direction d'écoulement (98) est fixée de manière pivotante audit élément barrière (22) sur lequel ledit liquide s'écoule et ladite plaque de direction d'écoulement (98) conserve une disposition sensiblement parallèle par rapport au sol (17) dudit canal (12). 20
7. Vanne de régulation selon la revendication 5 ou 6, dans laquelle ladite plaque de direction d'écoulement (98) forme un côté d'un parallélogramme avec le côté opposé (102) fixé dans une position parallèle au sol (17) dudit canal (12). 25
8. Vanne de régulation selon l'une quelconque des revendications précédentes, dans laquelle ladite vanne de régulation (10) a un premier élément de cadre (110) adapté pour être fixé audit canal (12), un second élément de cadre (18) qui coopère de manière coulissante avec ledit premier élément de cadre (110), ledit élément barrière (22) étant fixé de manière pivotante audit second élément de cadre (18), et un moyen d'étanchéité (32) sur ledit second élément de cadre (18) pour assurer une étanchéité entre lesdits éléments latéraux (26, 28) et ledit second élément de cadre (18). 30
9. Vanne de régulation selon la revendication 8, dans laquelle ledit moyen d'étanchéité (32) est un dispositif d'étanchéité continu situé sur ou dans le second élément de cadre (18). 35
10. Vanne de régulation selon la revendication 9, dans laquelle ledit dispositif d'étanchéité continu (32) comprend une pluralité de nervures parallèles (126, 128) qui viennent en butée contre ledit élément barrière (22) de manière à fournir un effet d'étanchéité positif. 40
11. Vanne de régulation selon l'une quelconque des revendications précédentes, comprenant en outre un premier capteur de pression (130) pour mesurer la pression du liquide en une première position en amont dudit élément barrière (22), un second capteur de pression (132) pour mesurer la pression du liquide en une seconde position en aval dudit élément barrière (22), un capteur d'ouverture pour mesurer la position d'ouverture dudit élément barrière (22) et un moyen de calcul pour calculer ledit débit à l'aide d'un algorithme basé sur lesdites mesures. 45
12. Vanne de régulation selon la revendication 11, dans laquelle ledit algorithme est déterminé à l'aide d'un procédé d'identification de système. 50
13. Vanne de régulation selon la revendication 11 ou 12, dans laquelle lesdites mesures utilisent des capteurs de pression, des capteurs magnétiques inductifs, des capteurs sonars ou d'autres types appropriés de capteurs (130, 132) et/ou une combinaison de différents capteurs (130, 132). 55
14. Vanne de régulation selon l'une quelconque des revendications précédentes, dans laquelle le moyen d'entraînement coopère avec les deux éléments latéraux (26, 28), dans laquelle le moyen d'entraînement comprend, pour chacun desdits éléments latéraux, une desdites bobines (54) et deux câbles (56, 58) selon la revendication 1.



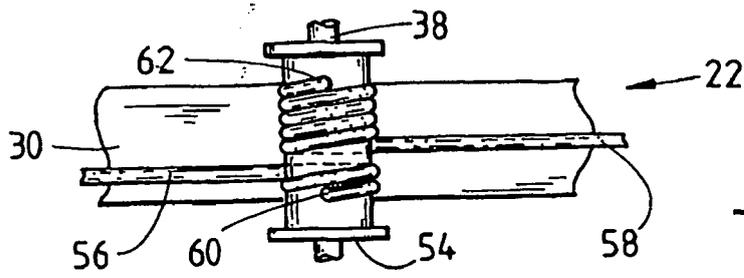
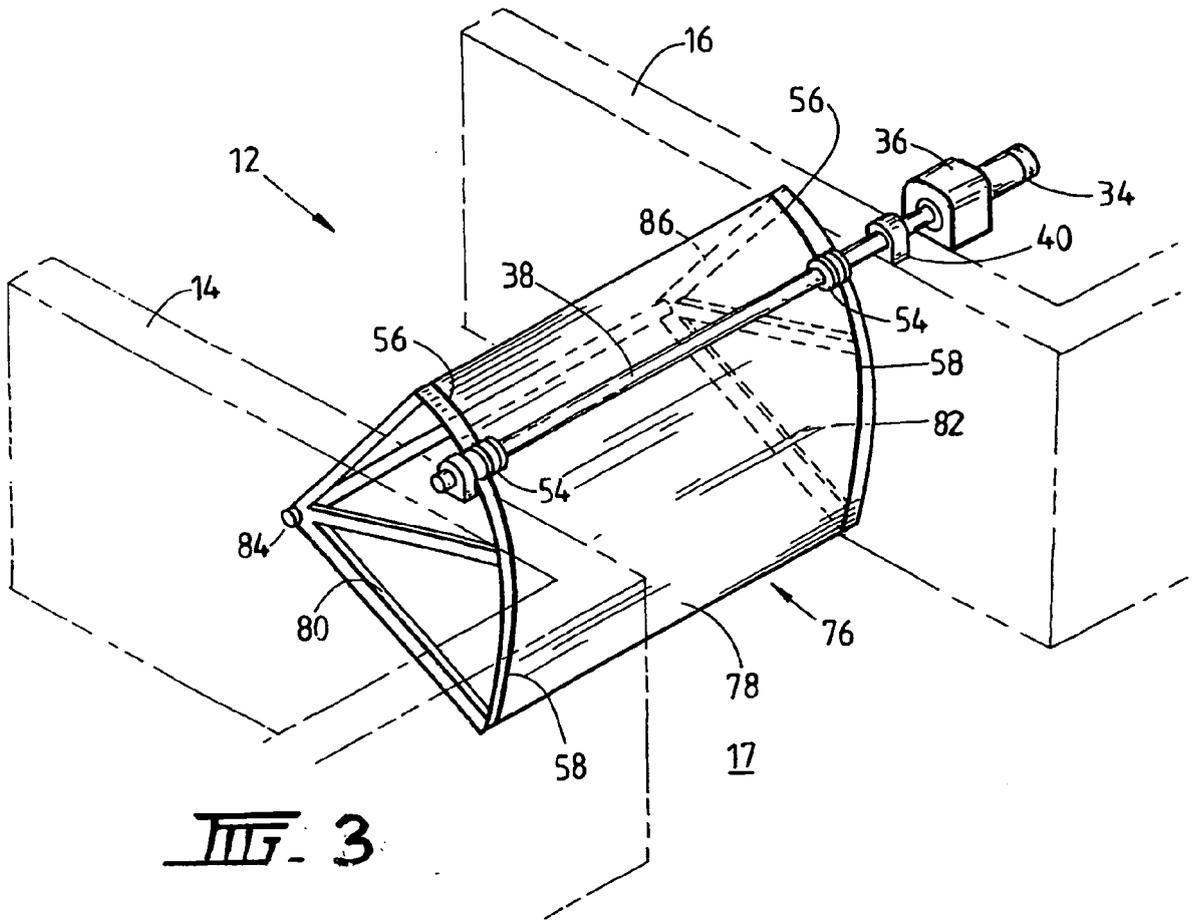
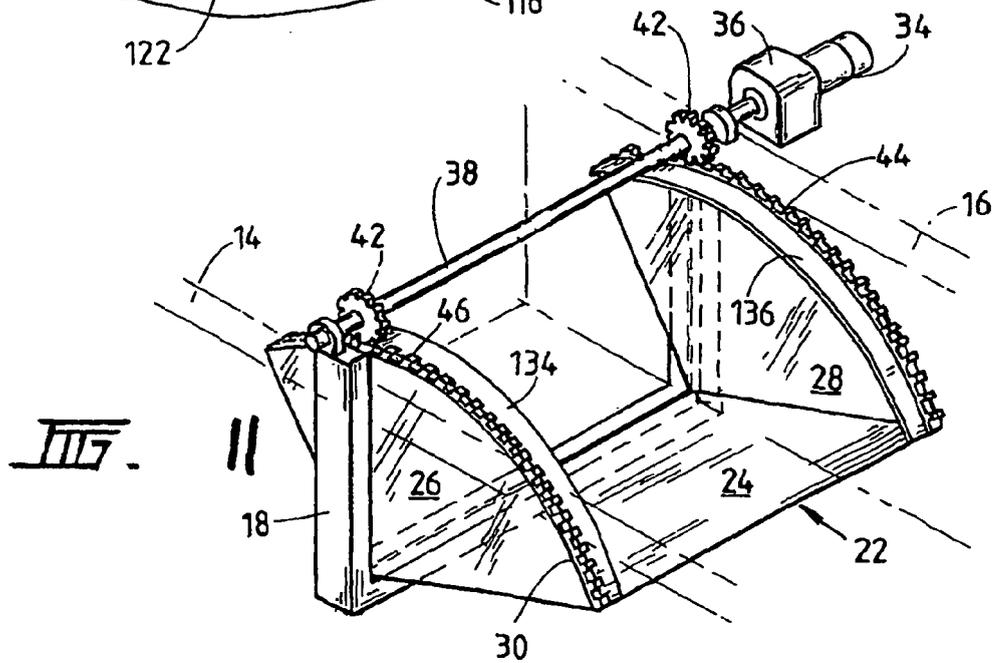
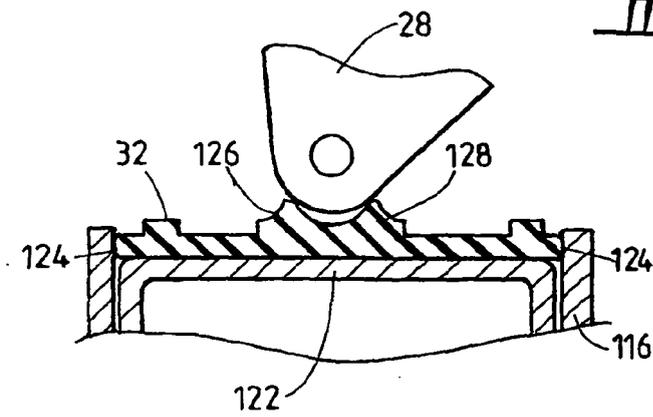
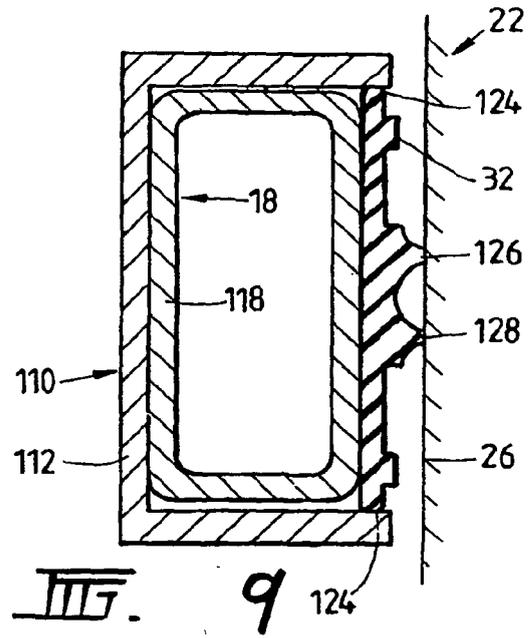
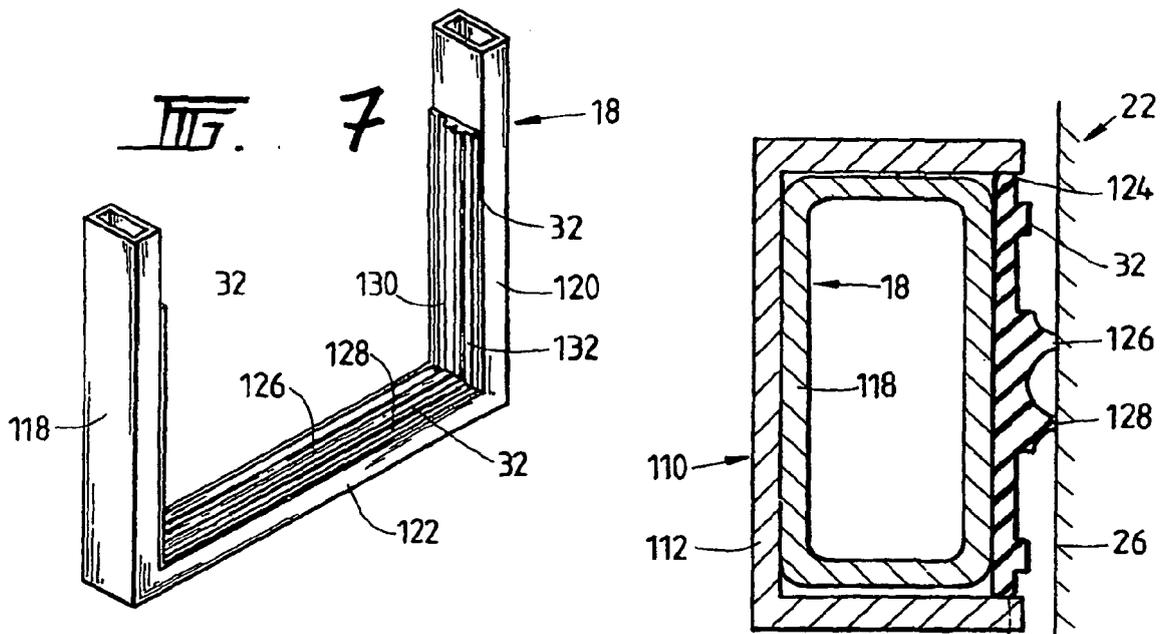


FIG. 2









## EP 1 311 728 B9 (W1B1)

### REFERENCES CITED IN THE DESCRIPTION

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