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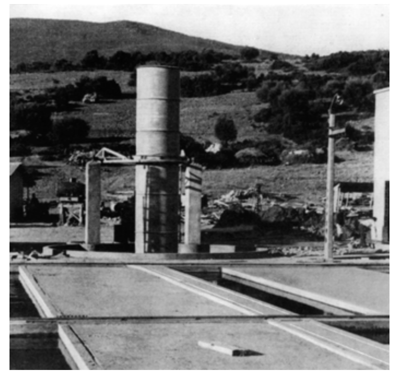
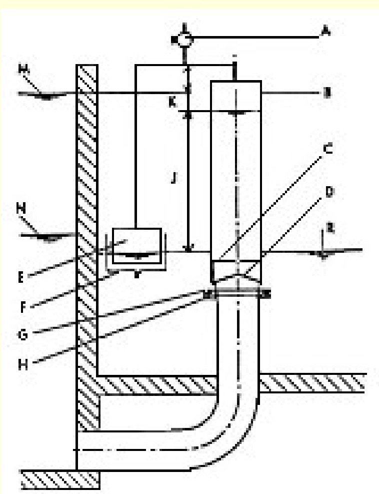
CYLINDER® GATE

Downstream level control



The Cylinder® Gate is one of a number of original solutions provided by our Group to meet the problems of downstream water level control. It is used to equip short ducts, operating under a low head and return its discharge into a basin where the water level has to be kept constant.

One feature of this equipment lies in its closing system formed by a vertical tube (SLEEVE) that covers the delivery pipe outlet (DUCT); the water goes up the sleeve to the same lever as the upstream level, or slightly lower due to duct head losses.



- A - Compensating counterweight
- B - Sleeve
- C - Diaphragm plate
- D - Deflector
- E - Float
- F - Float chamber
- G - Sill
- H - Flange
- J - Head loss
- K - Pipe head loss
- M - Maximum upstream level
- N - Minimum upstream level
- R - Controlled downstream level

Cylinder® Gates are trademark

The cylindrical gate sleeve is raised or lowered, as required, by means of float and rocker arm so that the discharge into the lower basin is adjusted to the demanded discharge.

As there is no vertical thrust on the cylindrical sleeve, the upstream level don´t have any influence on its equilibrium.

Construction

A shaped circular sill, fastened with screws to a built-in flange, which is welded to a convergent elbow, forms the pipe end. The sill dimensions and shape are designed to reduce the gate head losses. Depending on the gate size, the sleeve seat onto the sill may be in metal or fitted with rubber lining.

A cone shaped deflector reflects the jet back on the sill, preventing any flow separation and also limits any lateral sleeve movements.

A rocker arm mounted on bearings supports on its ends the sleeve and the float.

The cylinder sleeve, which is hydraulically centered on the water jet, forms the closing off element. Inside it there is usually an orifice acting as a damper.

A float links the sleeve movements with the downstream level by means of the rocker arm.

The float is fitted inside a chamber to protect it against possible eddies.

Function

The gate operation is easily understood: with the water demand discharged from downstream side, the water level lowers, i.e. the float is also drawn downwards. Using the rocker arm, the sleeve raises to admit the required flow. Conversely, if the downstream demand falls off or ceases all together, the float is drawn upwards causing the sleeve to lower until it eventually seats down on the sill to close off the gate completely.

Level control quality

Precision – Compensating counterweight

The Cylinder® Gates, as described above, will have a decrement (variation of the downstream level as the gate is moved from fully closed to fully open position), equal to the float travel as: (a) the gate equilibrium is independent of upstream pressure, (b) the rocker arm center of gravity coincides with the rotation axis so that its weight plays no impact in the assembly equilibrium. Consequently, the apparent weight of the float and its degree of immersion are constant.

For standard gates with the sill orifice diameter equal to or smaller than 0,5m, the travel of the sleeve and the float is equal to 0,2 ∅ (where ∅= the sill orifice diameter). For larger gates, the float travel and decrement are reduced to 0,1 ∅.

The natural gate decrement may be reduced by placing, a compensating counterweight on the rocker arm, to unbalance the assembly by raising its center of gravity. Therefore, the degree of immersion of the float is no longer constant since the moment due to the weight of the rocker arm alters with the rotation angle.

If this variation in the immersion level remains equal and opposite to the vertical float displacement, regardless of the gate opening, then the gate will maintain an absolutely constant downstream level.

This condition is perfectly feadible, though it is more convenient to use a compensating counterweight strongly fitted to the arm. In this case, the immersion level variation follows a slightly different law. The decrement is not zero, but it has a minimum value that may be defined for any case of application, by means of the formula given below:

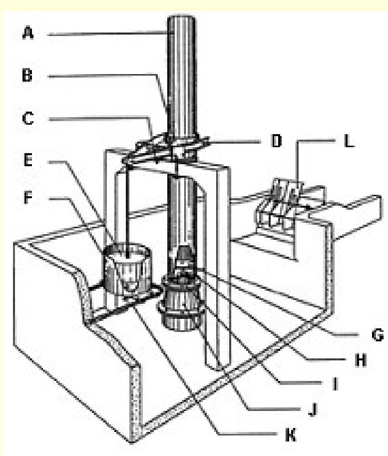
$$\Delta = 2 \times b \times \sin^3 \alpha_0$$

Where:

Δ = Decrement value

b = Lever arm until the float fixation point

α_0 = Maximum angle of the rocker arm with the horizontal.



- A - Sleeve
- B - Cardan or fork suspension
- C - Adjustable screw stop
- D - Rocker arm
- E - Float
- F - Float chamber
- G - Gate sleeve diaphragm plate
- H - Fixed deflector
- I - Sill
- J - Converging section
- K - Chamber bracket
- L - Baffle Distributors

For standard Cylinder® Gates, the decrement is approximately equal to b/500.

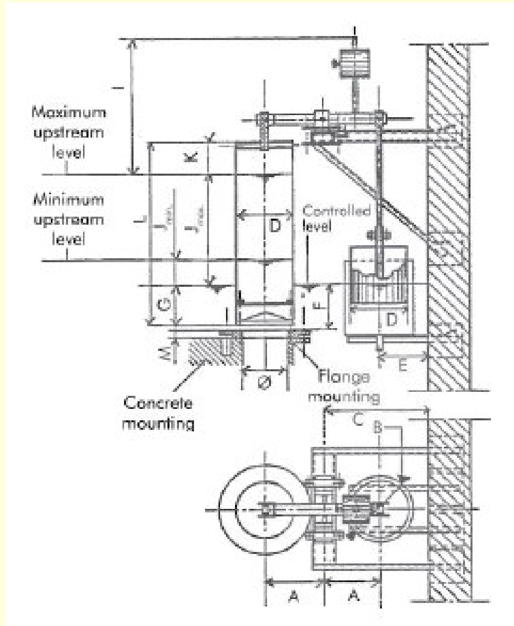
Increasing the counterweight mass and its fitting height allows one to reduce the decrement by sacrificing its operational stability.

If the counterweight mass and its fitting height are decreased the result will be an opposite effect, i.e. greater stability, but with greater decrement.

Stability

In order to assure a sufficiently rapid damping for the Cylinder® Gates fluctuations and in case of changes of the flow conditions, these gates are equipped with a damper system. It is formed by a diaphragm plate installed strongly inside the sleeve, whose small orifice is responsible for the hydraulic damper operation.

The diaphragm plate has no impact on the gate operation during steady flow coniditions. On the other hand, during the operation, it limits the water flow to be evacuated when the gate is opened or the incoming water flow when the gate is closed, because it tends to act opposite to the vertical sleeve displacement. On the other hand, the float itself that displaces inside a fixed tank with a small radial span constitutes an efficient hydraulic damper.



Characteristics and dimensions

The Cylinder® Gate is characterized by the sleeve diameter (1,25∅) followed by the sill orifice diameter (∅)expressed in millimiters.

The Cylinder® Gates are standardized in nine dimensions. Gates in larger dimensions or for a certain application may be constructed upon request.

Depending on the sleeve height and the fitting feasibilities, this gate may be suspended from the top (short sleeve) or fitted in the middle by a cardan or fork rocker arm (long sleeve). These fitting alternatives, coupled combined with whether a compensation weight is required or not, establish 4 types of standard gates (A, B, C and D) :

- Gate fitted with a top suspended sleeve:
  . Typo A: without counterweight;
  . Type B: with counterweight.
- Gate fitted with cardan suspesion:
  . Tipo C: without counterweight;
  . Tipo D: with counterweight.

Dimensions in mm

Designação	∅	A	B	C	D	E	F	G	I	K	L	M	J_{min}	J_{max}
∅ 100/80	80	200	120	350	100	150	80	8	360	108	$L = J_{max} + F + k - G$	18	According to Q_{max} calculation. See the following page.	Value, which governs the sleeve height
∅ 125/100	100	200	150	350	125	150	100	10	380	110		20		
∅ 160/125	125	200	200	350	160	150	125	13	430	113		23		
∅ 200/160	160	200	240	400	200	200	160	16	480	116		25		
∅ 250/200	200	200	300	400	250	200	200	20	530	120		28		
∅ 315/250	250	250	380	490	315	240	250	25	640	125		30		
∅ 400/315	315	315	480	605	400	290	315	32	850	132		35		
∅ 500/400	400	400	600	750	500	350	400	40	1000	140		40		
∅ 630/500	500	500	750	930	630	430	500	50	1120	150		45		

The arrangement shown in the figure above is for a top suspended sleeve. If a cardan suspension arrangement is used (suspension half-way up the sleeve), the dimension not be considered.

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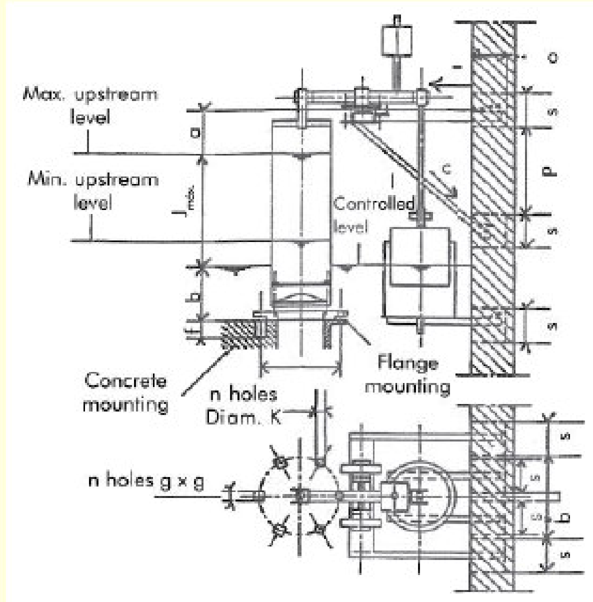
Selecting the size



The sill orifice diameter is dependent only from the maximum flow (Q_{max}) that must pass under the minimum upstream head (J_{min}); this flow is established by the following formula:

$$Q_{max} = 0{,}8\frac{\pi \times \phi^2}{4}\sqrt{2 \times g \times J_{min}}$$

with Q in m³/s, ϕ and J in m.

The upstream maximum head defines the sleeve length.

Once the sill orifice diameter ϕ and the sleeve length (L) are defined, the construction type A, B, C or D and the method of fitting the sill shall also be defined.

For the Cylinder® Gates, a prior consultation is necessary for the elaboration of the best project operational conditions.

Installation

The dimensions and shape of the basin in which the gate is to be installed shall be properly designed to assure good energy dissipation, avoid flow turbulence and to ensure that the gate discharge coefficient is not hindered.

In most cases, the minimum volume of the basin shall be equal to:
$V = 7 \,.\, Q_{max} \,.\, J_{max}$
With: V in m³, Q_{max} in m³/s, J_{max} in cm.

The water depth below the controlled level shall be at least equal to 2ϕ and not less than 50cm.

For large gates of 315/250 and above, the gate axis shall be at a distance of at least C +A from the walls of the basin, (see the table on previous page)

Dimensions in mm - forces in Kgf

Désignation	a	b	c	d	f	g	k	n	o	p	q	s	u	T	C
∅ 100/80	109	98	170	160	100	50	12	4	100	130	160	120	0	100	100
∅ 125/100	115	120	180	180	100	50	12	4	100	130	160	120	0	100	100
∅ 160/125	121	148	190	210	120	50	12	8	100	130	160	120	0	100	100
∅ 200/160	128	185	200	270	120	75	14	8	120	170	330	120	70	100	150
∅ 250/200	136	228	212	295	130	75	14	8	120	170	330	120	110	150	200
∅ 315/250	145	280	224	350	130	80	16	6	120	220	480	120	130	200	300
∅ 400/315	155	350	236	460	140	80	16	8	120	270	480	150	160	300	400
∅ 500/400	165	440	250	515	140	80	16	8	200	600	580	200	180	400	600
∅ 630/500	175	545	265	620	150	80	18	10	200	710	690	200	300	700	800

Forces T and C are calculated for a sleeve with L = 2m.