March 16, 1937. P. F. DANEL 2,073,610

CONTROLLING FLUME

Filed Sept. 29, 1934

Fig. 1.

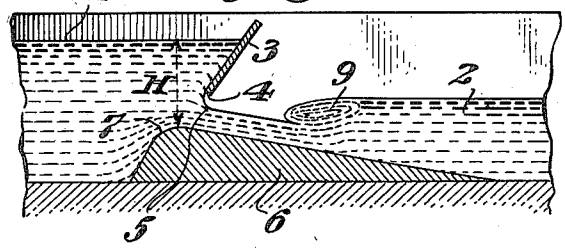


Fig. 2.

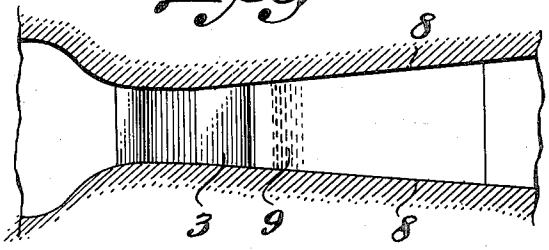


Fig. 3.

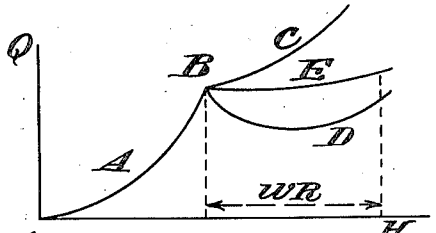


Fig. 4.

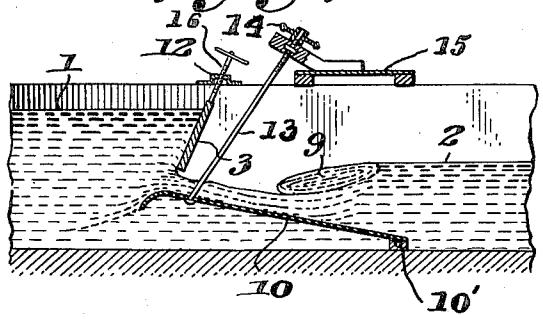
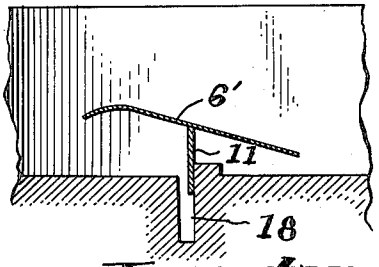


Fig. 5.



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Patented Mar. 16, 1937 2,073,610

UNITED STATES PATENT OFFICE

2,073,610

CONTROLLING FLUME

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Application September 29, 1934, Serial No. 746,173
In France September 30, 1933

7 Claims. (Cl. 61—14)

This invention concerns a device for controlling to a practically constant but adjustable value the flow in an open flume or channel within a certain working range of upstream and downstream levels.

The device consists of a special type of orifice set in a controlling flume.

The water enters the controlling flume by a more or less converging head race, the width of the head race channel being greater than that of the controlling flume. The controlling flume proper has its side walls parallel or gently flaring downstream. The bottom of the controlling flume proper contains a sill, the rear floor of which slightly slopes downstream.

The orifice is bounded by the flume sides, the sill floor, and the lower edge of a partition having a negative slope of nearly 1/1, extending from one side wall to the other.

The bottom edge of the partition, that is the top edge of the orifice, is located slightly below the lowest upstream level in the useful working range, so that the orifice discharges always at full bore. The top edge of the orifice is located downstream of the sill vertex.

In the accompanying drawing:

Fig. 1 is a longitudinal section of a controlling flume according to the present invention.

Fig. 2 is a plan view of the same.

Fig. 3 shows diagrammatically the working of the device.

Fig. 4 is a view similar to Fig. 1 showing a pivoted sill with a sliding partition for adjusting purposes.

Fig. 5 is a longitudinal section view of a device with a sliding adjustable sill.

As shown in Figs. 1 and 2, the flume contains a sill 6 having its front surface sloping downwards to the floor of the head race and its rear surface or floor sloping downwards at a lesser angle to the floor of the tail race. The front and rear floors of the sill are joined by a rounded apex 7. Above the rear floor and somewhat to the downstream side of the apex is a partition 3 sloping negatively to the direction of stream flow, that is, downwardly and in the upstream direction. The lower edge 4 of this partition forms the top edge of the flume orifice 5, the other boundaries of which are formed by the rear floor of the sill and the side walls of the flume.

The device so constructed provides means to obtain a practically constant flow within a certain working range between upstream and downstream levels 1 and 2.

When the upstream level 1 is below the lowest working range, the controlling flume no longer acts as an orifice but as a broadcrested weir. Curve A of Fig. 3 represents the variation of the discharge Q with the head H. When the upstream level 1 rises gently, there comes a moment when the flow passes flush with the top edge 4 of orifice. This corresponds to point B of the discharge curve (Fig. 3). When upstream level goes on rising, the orifice discharges at full bore, but a contraction of the jet at the top occurs. This contraction tends to lessen the discharge while the increase in the velocity of flow through the orifice, with increasing head, tends to increase the discharge. With the device, according to the invention, these two effects can be made to so nearly compensate each other that the flow is nearly constant within the working range.

When the top edge 4 of the orifice is too near the vertex 7 of the sill 6 the effect of increase of velocity with increasing head preponderates over the effect of the increased contraction, and a curve similar to BC in Fig. 3 results. If the top edge 4 is too far downstream of the sill vertex 7 the variation of contraction is the most important effect, and a curve like BD results. With the top edge 4 of the orifice set in the proper position, which is a distance downstream of the vertex about equal to the vertical depth of the orifice, a curve like BE is obtained.

The variation in the contraction of the issuing jet with rising upstream level depends on the shape and slope of partition 3.

The best results obtain with a flat partition with a negative slope of 1/1 and a sharp edge. But the results will not differ materially if a slight departure is made from those proportions.

Downstream of the orifice, owing to the almost parallel sides 8 of flume, a "gradually varied flow" prevails that is a flow without considerable curvature of the water filaments. What is termed in the art as "critical velocity" prevails, that is the water flows at the velocity of propagation of surface waves. Under these conditions a permanent hydraulic jump 9 is formed downstream of the orifice, if high downstream level prevails, as shown in Fig. 1, or the water goes on accelerating if very low water level exists.

Owing to these features the discharge of the orifice is independent of the downstream level in the working range of the device, that is with downstream level varying from the very lowest up to only a few inches of upstream level, owing to regain in height due to the hydraulic jump

9. With a downstream level too high, the hydraulic jump 9 works its way up to the orifice and reduces the discharge.

The main dimensions of the flume in a given case are designed so that an efficient hydraulic jump 9 can form itself within the chosen working range. This calculation does not differ materially from that effected in designing so called "Venturi flumes" known to the art.

The device providing a discharge independent of upstream and downstream levels acts as an automatic control without working parts.

To provide for adjustment of the control, the sill 6 is made vertically adjustable as shown in Fig. 4, constructing it in the form of a shell 10 and mounting it for pivotal movement about the axis 10'. The sill can then be raised and lowered by means of the threaded rod 13, which is actuated by the hand wheel 14 carried by the support 15, which is mounted on the walls of the flume.

As shown in Fig. 4, the partition 3 is also vertically adjustable and is raised and lowered by means of a threaded rod 16 threaded in a support 12 carried by the walls of the flume. A hand wheel 17 is provided for rotating the rod 16.

A modified sill construction is shown in Fig. 5, in which the sill 6' is provided with a sealing member 11 vertically slidably mounted in a slot 18.

The apparatus can also be divided by longitudinal vertical partitions, of the length of the control flume, and adjustment can be made by shutting down one or several of the partial flumes thus made.

The apparatus according to the invention can be used to limit the discharge of a channel to a given maximum value, in setting the partition 3 far enough downstream, so as to have a characteristic curve such as BD Fig. 3. In that case, if the apparatus is set and locked so as to obtain the condition of point B Fig. 3, the only effect of any interference with upstream or downstream will be to reduce the discharge.

I claim:

1. A control flume comprising side and bottom walls, a sill of substantially triangular form in vertical cross-section extending across the bottom of said flume between the side walls, said sill having one inclined surface facing upstream and another inclined surface facing downstream, and a partition extending between said side walls and inclined to the vertical with its upper edge further downstream than the lower edge, said partition having its lower edge spaced above and slightly downstream of the apex of the sill to form a flow orifice therebetween.

2. A control flume comprising side and bottom walls, a sill of substantially triangular form in vertical cross-section extending across the bottom of said flume between the side walls, said sill having one inclined surface facing upstream and another inclined surface facing downstream, and a partition extending between said side walls and inclined at an angle of substantially 45° to the vertical with its upper edge further downstream than its lower edge, said partition having its lower edge spaced above and slightly downstream of the apex of the sill to form a flow orifice therebetween.

3. A control flume comprising side and bottom walls, a vertically adjustable sill extending across the bottom of said flume between the side walls, said sill having one inclined surface facing upstream and another inclined surface facing downstream, a partition extending between said side walls and inclined to the vertical with its upper edge further downstream than the lower edge, said partition having its lower edge spaced above and slightly downstream of the apex of the sill to form a flow orifice therebetween, and means carried by a wall of the flume and having an operative connection with the sill for raising and lowering the sill to vary the distance between the lower edge of the partition and the sill.

4. A control flume comprising side and bottom walls, a sill of substantially triangular form in vertical cross-section extending across the bottom of said flume between the side walls, said sill having one inclined surface facing upstream and another inclined surface facing downstream, a vertically adjustable partition extending between said side walls and inclined to the vertical with its upper edge further downstream than the lower edge, said partition having its lower edge spaced above the apex of the sill to form a flow orifice therebetween and also slightly downstream of the apex of the sill, and means mounted on one of said side walls and connected with the partition for raising and lowering the same to vary the distance between the lower edge of the partition and the sill.

5. A control flume comprising side and bottom walls, a vertically adjustable sill extending across the bottom of said flume between the side walls, said sill having one inclined surface facing upstream and another inclined surface facing downstream, a vertically adjustable partition extending between said side walls and inclined to the vertical with its upper edge further downstream than the lower edge, said partition having its lower edge spaced above and slightly downstream of the apex of the sill to form a flow orifice therebetween, and means mounted on the walls of the flume and connected to the sill and partition for raising and lowering both the sill and the partition to vary the distance between the lower edge of the partition and the sill.

6. A flume according to claim 1, in which the lower edge of the partition is located at a distance downstream from the apex of the sill substantially equal to the vertical distance between the lower edge of the partition and the sill.

7. An open control flume for controlling the flow from an upstream channel, comprising side and bottom walls, said side walls converging to form a contracted zone, the cross-section of which is sufficiently less than that of the upstream channel to produce a flow through said contracted zone substantially equal to critical velocity and a hydraulic jump, a sill of substantially triangular form in vertical cross-section extending across the bottom of said flume between the side walls in said contracted zone, said sill having one inclined surface facing upstream and another inclined surface facing downstream, and a partition extending between said side walls in said contracted zone and inclined to the vertical with its upper edge further downstream than the lower edge, said partition having its lower edge spaced above and slightly downstream of the apex of the sill to form a flow orifice therebetween.

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