J. F. SIMMANCE & J. ABADY.

WATER METER.

APPLICATION FILED JULY 26, 1910.

1,067,491. Patented July 15, 1913.

Fig. 1.

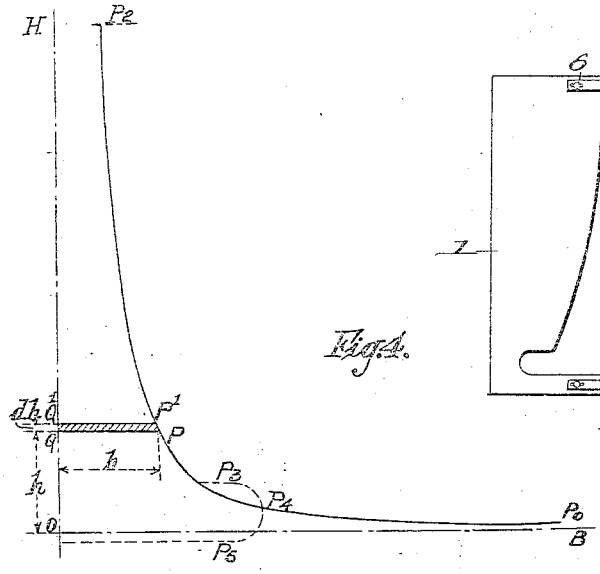
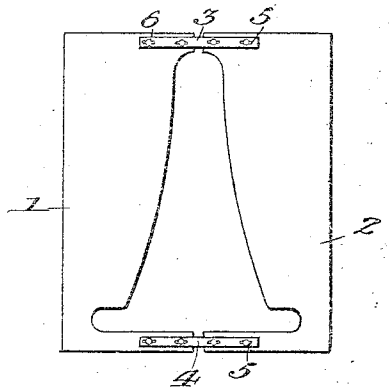


Fig. 4.



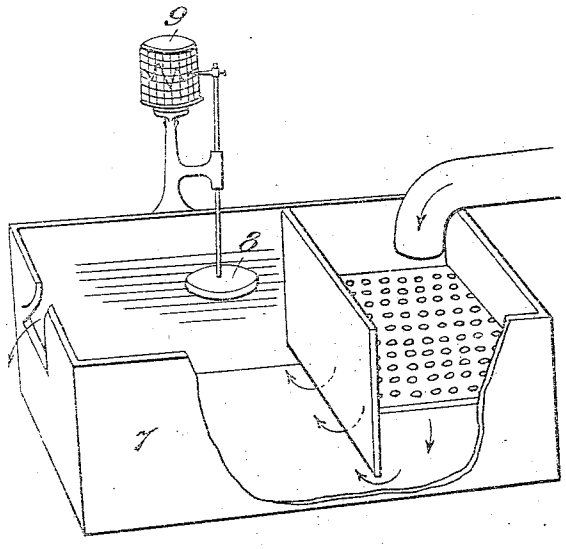


Fig. 3.

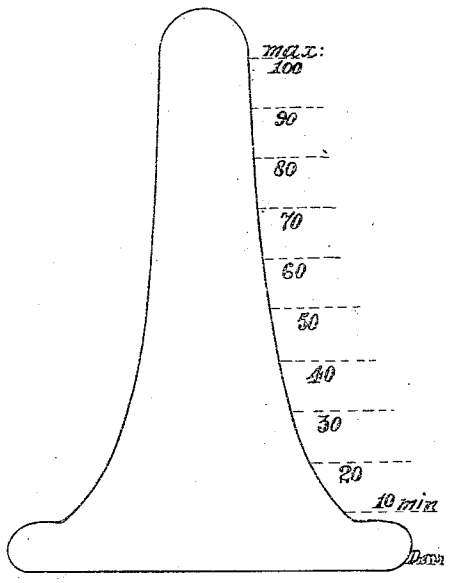


Fig. 2.

Witnesses:-
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and Jacques Abady
by their attorneys
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UNITED STATES PATENT OFFICE.

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WATER-METER.

1,067,402. Specification of Letters Patent. Patented July 15, 1913.

Application filed July 23, 1910. Serial No. 573,830.

To all whom it may concern:

Be it known that we, JOHN FREDERICK SIMMANCE and JACQUES ABADY, subjects of Great Britain, residing, respectively, at 1 Westminster Palace Gardens, London, S. W., and Fountain Court, Temple, London, W. C., England, have invented certain new and useful Improvements in Water-Meters, of which the following is a specification, reference being had therein to the accompanying drawings.

This invention relates to a weir for the measurement of water when the same is allowed to pass freely thereover.

The weir or weir notch is of such shape that the "quantity discharged per unit of time" (hereinafter termed the rate of discharge) is strictly proportional to the distance measured between a fixed datum level and the surface of the water; the said datum level would be theoretically the bottom edge of the weir, but in some cases another level may be taken as datum, as hereinafter described. The said distance between the datum level and the surface of the water is hereinafter called the "head." The ideal conception of such a weir is not novel, as it has already been proposed to set out a weir notch having the property of making the rate of discharge approximately proportional to the head above it, by forming the notch of a number of vertical sections or imaginarily separate vertical sections having flat or pointed stops, and we do not therefore make any general claim thereto. But, as far as we are aware however, the method of setting out the shape or the weir or notch as hereinafter described, so as to attain the desired result, is novel.

In the accompanying drawings, Figure 1 represents diagrammatically the mathematical theory of the shape of the weir. Fig. 2 represents a weir notch made symmetrical about a vertical axis; the outline corresponding to the outline P_2 P P_3 P_4 P_5 of Fig. 1, the datum line corresponding to the line O B of Fig. 1, and the graduations being from a minimum discharge of 10 units to a maximum discharge of 100 units. Fig. 3 represents the arrangement of the weir with a clock driven recorder by which the varying head is recorded on a chart, and Fig. 4 represents a modified construction of weir notch.

Referring to Fig. 1, the theory of the weir is as follows. By the well known laws of the science of hydraulics, the rate of discharge through or over an orifice, notch or weir of continuous shape can be expressed by the formula

$$Q = CA\sqrt{h}$$

where

Q=rate of discharge.

A=submerged area of the weir, notch or orifice.

h=head.

C=a constant, which involves the "co-efficient of discharge."

In our invention the weir is so designed that the area of that part submerged by the issuing water is proportional to the square root of the head. Therefore,

$$Q = \sqrt{h} \times \sqrt{h} \times \text{a constant},$$

that is, $Q = h \times$ a constant.

The shape of the weir is determined as follows. Let b be the width of the opening of the weir at the water level corresponding to any head h. In Fig. 1, O B and O H are respectively horizontal and vertical axes, and P_0 P P_2 is a curve graphically representing the variation of the breadth b corresponding to the variation of the head h. Let P be a point on the curve corresponding to any head h, and let b be the corresponding width of the weir. If the horizontal axis O B represents the bottom edge of the weir, then the submerged area of the weir is the area B O Q P P_0 inclosed between the axes, the ordinate Q P and the curve P P_0. Then, as above described

$$A = K\sqrt{h}$$

where K is a constant.

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Suppose now that the water level rises to the level $P^1 Q^1$, slightly above the level P Q, then, using the usual mathematical notation, let d A be the small increase P P^1 Q^1 Q of the submerged area, and let d h be the small increase Q Q^1 of the head. Then, by a formula well known in the differential calculas, from the above equation is immediately deduced

$$\frac{dA}{dh}=\frac{K}{2\sqrt{h}}$$

But

$$b\times dh=dA$$

or

$$\frac{dA}{dh}=b$$

Therefore,

$$b=\frac{K}{2\sqrt{h}}$$

That is, the breadth of the weir is inversely proportional to the square root of the corresponding head. The curve P_0 P P_2 is the graphic representation of the above equation. It will be seen that the curve is asymptotic to the axes O B, and O H. That is, if the bottom of the weir were a horizontal straight line O B, theoretically, its width at the bottom would be infinite. But in practice a weir is never required to measure a zero rate of discharge, but the capacity of the weir may be specified to be from its maximum rate of discharge to a minimum rate of discharge, which may be 10, 20, 40, 50 per cent. of the maximum, as the conditions may determine. Thus, if the capacity of the weir is specified to be from its maximum rate of discharge to a minimum of 10 per cent. of the maximum, the water level may vary from the maximum P_2 to the minimum P_3, Fig. 1. The portion of the curve P_3 P_0 may therefore be replaced by a curve P_3 P_4 P_5 so chosen that the discharge is the same as given by the theoretical curve.

The outline of the weir as described above and illustrated in Fig. 1, would be mathematically correct if the co-efficients of discharge were absolutely invariable. In practice however, it is found that the co-efficient of discharge varies slightly if the shape of the issuing jet of water varies. It may therefore, be necessary to alter in a very slight degree the outline of the weir as above described to counteract the effect of the variation of the co-efficient of discharge. Any necessary correction would be determined experimentally. Thus, if for values of the head greater than the minimum, the co-efficient of discharge (and therefore also the constant K) is found to increase slightly, the corresponding width at the surface level may be slightly decreased as compared with that determined by the above formula. If for still greater values of the head the co-efficient of discharge is found to decrease, the corresponding width may be increased. But it is to be observed that for a weir whose minimum discharge is 0.20 times the maximum, and whose shape is exactly that determined by the formula, the greatest error may be less than one per cent.

The weir may be made symmetrical about a vertical axis as shown in Fig. 2, or may have one side a straight line, or again, one side may be made to any convenient outline and the other side to an outline determined by cutting off the widths corresponding to the heads as above described. Also the weir may be made from two plates secured together by suitable fastenings. The said fastenings may be made so that the two plates are capable of slight adjustment relative to each other, the said adjustment providing means for the final calibration of the weir. Such a construction is represented in Fig. 4, in which the two plates composing the weir are denoted by 1 and 2; the said plates being adjustably secured together by bars 3, 4, provided with slots 5, fitted to receive cap screws 6, threaded into the plates 1 and 2.

If the weir be formed in or fixed to the side of a suitable tank 7, and a float 8 be placed on the liquid in the upstream side of the weir as shown in Fig. 3 of the drawings, and the vertical movements of the float be recorded on a suitable chart or recorder 9, driven at a uniform rate by clockwork, the horizontal divisions will represent units of time, and the vertical divisions, rates of discharge. The area of the diagram inclosed by the datum line of the chart and the line drawn thereon by the float pen and the two extreme vertical ordinates will, during any period of time, be strictly proportional to the quantity of water discharged during that time although the head may vary considerably during that period of time.

It is to be clearly understood that a recording apparatus of the character described is well known and has been proposed for use with weirs of the class referred to above, and therefore we make no claim to such recording apparatus apart from its use in conjunction with the form of weir which is the subject of the present invention.

What we claim is:

A water meter provided with a weir notch having its width at the bearing surface level of the liquid between the maximum and

minimum heads inversely proportional to the square root of the corresponding head, its bottom edge below the datum level and its lower part below the minimum level, whereby the rates of discharge within the maximum and minimum capacities of the notch are proportional to the head.

In testimony whereof we affix our signatures in presence of two witnesses.

JNO. F. SIMMANCE.
JACQUES ABADY.

Witnesses:
CECIL ARTHUR GOODWIN,
JAMES FOREMAN.