are good, I think, for one more. The gearing on steam rollers should be of steel and cut and fitted as nicely as in any high-class automobile construction. Gears should be closed so as to exclude dust.

This paper might be extended indefinitely, going through all the different kinds of machinery required for the different kinds of road work, but I am going to conclude, as I have touched upon the equipment that is common to all road construction, whether it be water-bound macadam, bituminous macadam or concrete.

THE V-NOTCH WEIR METHOD OF MEASURING WATER.*

By Robert Yarnall.†

Attempts to measure accurately and to record automatically the flow of water through pipes or channels have been made from time to time with varying results as to accuracy and convenience. This paper will attempt to show results obtained by the simple and practical V-notch method of measurement, which though not new, seems now to be meeting with marked success, both abroad and in America, in power plant measuring problems. Tests of the accuracy of this method of measurement have recently been made in America and the data collected are here presented to show the degree of accuracy attainable.

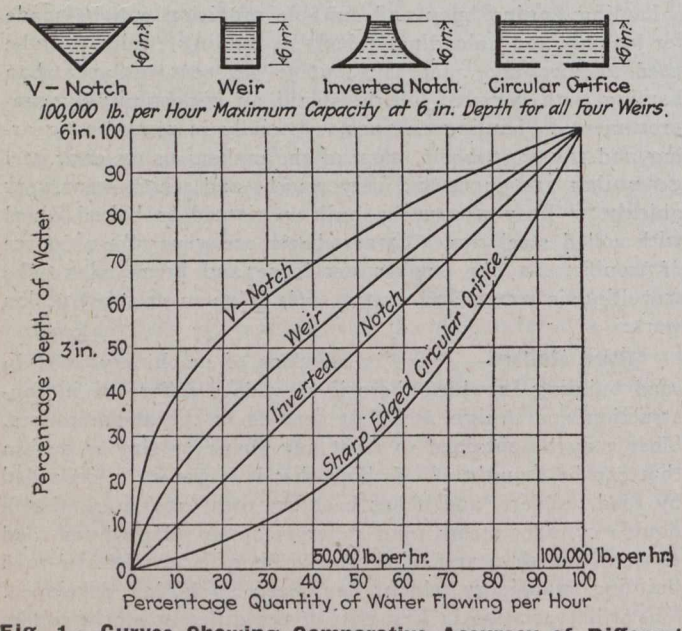

Fig. 1.—Curves Showing Comparative Accuracy of Different Types of Weirs Under Different Rates of Flow.

The instrument employed in the tests is the Lea V-notch recorder, an apparatus which depends on the laws governing the flow of water through weirs. These laws have been found to work with extraordinary accuracy, but it is only comparatively recently that they have been turned to account in measuring the widely varying rates of flow, both hot and cold, met with in power plants.

The most common forms of weir are the plain horizontal sill and the sharp edged rectangular notch. The former of these has the full width of the stream or channel and is without end contraction, the formula used in connection with it being that of Francis:

$$\text{cubic feet per second} = 3.33\ LH\sqrt{H}$$

where

L = The width of the weir in feet.

H = The head of water passing over it in feet.

The latter is a sharp edged rectangular notch of less width than the channel or stream and therefore has end contraction. The formula used in this case is

$$\text{cubic feet per second} = 3.33\ LH\sqrt{H \times C}$$

where

L and H are the same as before.

C = a constant which depends on the ratio of the width of the weir to the width of the channel.

Although these two formulas give a fair degree of accuracy, there is another in which the accuracy is very nearly 100 per cent. This is Prof. James Thomson's formula for the sharp edged V-notch weir:

$$\text{cubic feet per minute} = 0.305\ H^2\sqrt{H}$$

where

H = The height of the notch in inches, the angle of the notch being 90°.

Table I. gives the flow of water through 90° V-notches for each inch of head, up to and including 15 in., calculated by Thomson's formula.

Table I.—Flow Through 90° V-Notch Weirs.

Depth in notch, in.	Flow per hour, lb.	Depth in notch, in.	Flow per hour, lb.
1	1,140	9	277,900
2	6,480	10	361,740
3	17,830	11	459,030
4	36,610	12	568,720
5	63,940	13	694,710
6	100,860	14	836,110
7	148,290	15	993,510
8	207,060		

The section of the flow through the V-notch is at all times the same shape, though the area may vary, and this constancy of form tends to simplify the formula and make it accurate. This form of notch is also especially adapted for measuring smaller quantities of water than the rectangular weirs, as shown by the curves in Fig. 1, which give a comparison of the accuracy of the different types of weirs at different rates of flow. Another property of the notch is that its angle may be less than 90° without impairing its efficiency, which enables it to be used to measure very small quantities of water.

It was for these reasons, as well as for its accuracy, that the V-notch was adopted for use in connection with the Lea recorder, a sectional view of which is shown in Fig. 2. It will be seen that a float spindle, rigidly attached to a float which rides on the surface of the water flowing over the V-notch, passes up through the bottom of the instrument case. A rack on this spindle engages a small pinion upon the axis of a drum revolving between centres. Upon the body of the drum is a screw thread, the contour of which is the "curve of flow" for the V-notch in connection with which the recorder is used, and as the flow through the notch increases rapidly with the depth, the pitch of the screw increases in the same proportion. Above this drum is a horizontal slider bar, supported on small pivoted rollers and carrying an arm, at the upper end of which is a pen or pencil point in contact with a paper chart upon a clock-driven recording drum, which revolves once in 24 hours. As the float rises or falls the drum spiral is rotated, and its motion

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