THE CENTRIFUGAL PUMP, TURBINES, AND WATER MOTORS: INCLUDING THE THEORY AND PRACTICE OF HYDRAULICS. (SPECIALLY ADAPTED FOR ENGINEERS); PP.4-229

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105:47

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(SPECIALLY ADAPTED FOR ENGINEERS.)

BY

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PREFACE.

THE matter comprised in the second edition of this book may be divided into seven parts: the first deals with general principles; the second with pressure engines producing rotary motion; the third with turbines whose power is obtained by altering the direction of motion and the velocity of the water; and I have added a description of the Pelton wheel, with some remarks on its theory.

In Chapter XXI. will be found descriptions of the various forms of steam turbines designed by the Hon. C. A. Parsons, to whom I am indebted for the whole of the matter and illustrations. I have endeavoured in Chapter XXII. to show that, in water turbines, theory and experiment agree very closely. Chapters XXIII. to XXX. inclusive deal with the centrifugal pump, and Chapters XXXI. and XXXII. with the fan. Chapter XXXIII. is a description of the hydraulic works at Niagara, and the book concludes with a short description of the hydraulic buffer stop. Graphical methods have been used wherever possible, but the advantage of trigonometry is so great, that it has been introduced wherever necessary.

In the preparation of the book no effort has been spared to make the text clear, by means of copious illustrations, wherever they were deemed desirable, and the matter will, it is thought, be found of special value to those engineering students preparing for the Honours Stages of the Science and Art and Technological Examinations in Machine Construction and Mechanical Engineering.

Rutherford College,
December, 1898.

CHAS. H. INNES.

INDEX.

but $h - h^1 = \frac{v^2}{2g}$, because h^1 is absorbed by friction, and $h - h^1$ produces the kinetic energy.

$$\therefore \quad \frac{v^2}{2g\,C_v^2} - F\frac{v^2}{2g} = \frac{v^2}{2g}.$$

$$F = \left(\frac{1}{C_v^2} - 1\right)$$

CHAPTER II.

Measurement of the Power of a Stream.

The power of a stream may be used to drive machinery, and in order to know its magnitude we must measure the quantity of water flowing per second or per minute, and the

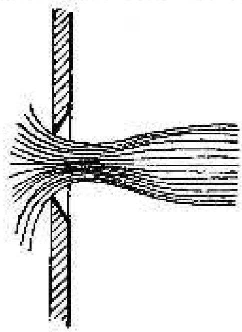

Fig 3.

distance it will fall—*i.e.*, the head. This latter is found by levelling, while the former may be calculated by the above formulæ if the stream is small, the water being made to flow through a number of completely immersed round or square sharp-edged orifices. It is, however, generally most convenient to form a notch in a temporary weir. The notch is generally rectangular or triangular in section; in the latter case the vertex being downwards (figs. 5, 6, 7), the sides and bottoms being chamfered; or, better, edged all round with thin sheet iron, in order that contraction may not be suppressed, and the following formula may be applied :

For a rectangular notch—

$$Q = \frac{2}{3} c \,.\, b\,h \,.\, \sqrt{2\,g\,h},$$
$$= 5{\cdot}35\, c\, b\, h\, \sqrt{h},$$

where Q = cubic feet per second ;
b = breadth of notch ;
h = height of surface of still water above the bottom of the notch ;
c = a coefficient of discharge.

If b is one-fourth the width of weir, the least width advisable, $c = {\cdot}595$.

FIG. 4.

If b is the whole width of weir, $c = {\cdot}667$.

For any intermediate proportions—

$$c = {\cdot}57 + \frac{b}{10\,B},$$

where B = breadth of weir.

For the method of obtaining such a formula the reader is referred to Prof. Cotteril's "Applied Mechanics," page 450, section 236.

In consequence of variations in the coefficient of contraction already stated, which depend on the ratio $\frac{b}{B}$, and other variations which have been reduced to no general law, Prof. Thomson adopted a triangular notch, so that the issuing jet is always a similar figure—a triangle, with apex downwards. Here—

$$Q = \frac{8}{15}\, c\, \frac{b\,h}{2}\, \sqrt{2\,g\,h}.$$

When $b = 2\,h, c = {\cdot}595, Q = 2{\cdot}54\, h^{\frac{5}{2}}$.
" $b = 4\,h, c = {\cdot}620, Q = 5{\cdot}3\;\; h^{\frac{5}{2}}$.

In order to measure h, a scale must be driven in the ground in the pond above the notch, at a point where the water is sensibly still, or has a very slow motion. As the height h is liable to vary, it should be noted as often as possible.

When the stream is large, the area of the cross-section must be found, and the velocity must be measured at as many points as possible. The area should be divided into several parts, and the velocity in each part having been noted, the total quantity Q per second will be $A_1 v_1 + A_2 v_2$, &c., where A_1, A_2, &c., are the areas of the several parts,

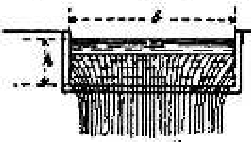

FIG 5.

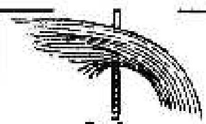

FIG 6

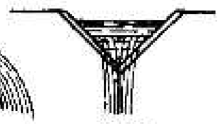

FIG 7

and v_1, v_2, &c., the velocities therein. It will be less trouble, but not so accurate, to multiply the total area by the mean velocity. There are several instruments for measuring the velocity. The principle of all is as follows: A small revolving fan drives a spindle, on which is a screw which gives motion to a train of wheelwork, which, by means of pointers, records the number of revolutions. To graduate the instrument it must be drawn through still water at known velocities. It is fixed at the end of a pole, so that it can be placed at different depths in the stream whose velocity is to be measured.

CHAPTER III.

Form Assumed by the Energy of Rising or Falling Water.

If a stream of water flows continually without meeting any cause of loss of energy, such as friction of piping or sudden enlargements and contractions, a simple law may be used connecting the pressure, velocity, and head producing the flow. In fig. 8 a tank is shown, the surface of water being at a height H above a certain level, and the water is flowing through a pipe to work some machine or machines, let us suppose, the flow being unbroken. Then, neglecting