and speed of the cutting to be done. If the lines cannot be followed rapidly, it is useless to drive the saw faster than it can be fed.

Provision should be made for the expansion and contraction of the blade by elastic springs or weighted levers connected with the straining devices. The saws should be kept sharp, and should never be allowed to get sufficiently dull to require forced feeding, which of course falls on the back supports of the guides.

In joining the blades, brazing is the popular plan in England, and perhaps the best one, but not so convenient as silver solder, which makes a reliable joint, and one which can be made without a blow-pipe. The blade should be scarfed and then washed clean with acid, a sheet of the prepared solder placed in the lap, and the whole lapped with fine wire. By clasping the joint, when thus prepared, with a pair of tongs heated to a full red heat, the solder will melt and the surplus run off, leaving a neat, strong joint. To hold the blade during the operation, an iron clamp is necessary, which should be planed true, to insure that the saw is straight after joining. Many omit the wire lapping as unnecessary, but, as a rule, too much of the solder runs off if the tongs have to remain until the temperature is low enough to remove them, without risk of the joint opening.

(To be Continued)

EXPERIMENTS UPON THE SWAIN WHEEL NO. 3.

Made at Lowell, Mass., by **HIRAM F. MILLS, C. E.**

AFTER the experiments with the Swain Wheel, made in June, 1869, and recorded in the *Journal of the Franklin Institute*, Vol. LIX., No. 3, the patterns of the 42-inch wheel were changed by removing the upper two inches of the band *b b*, (Plate II. of the above report,) which surrounds the lower part of the buckets, thus increasing the depth of opening through which the water enters the wheel from 5.35 inches to 7.4 inches. The gate, guides and guide chamber were correspondingly increased in height, but buckets of the same form, stamped by the same dies were used, and the guides were put at the same angle, and the whole apparatus was evidently as near as could be reproduced the same as before, excepting the necessary changes in the vertical direction involved in the increased motion of the gate.

The crown of the wheel was thus raised four inches higher from

the floor of the pit, but the crest of the weir was raised about the same amount, hence their relative position was as before.

The wheel was of ordinary finish, the castings were well cleaned and the surfaces coated with red paint.

The following dimensions were measured after the wheel was removed from the pit:—

Mean vertical distance from the under side of the crown to the lower edge of the buckets.....	1.144 feet.
Mean vertical distance from the under side of crown to bottom of lower band.....	1.156 feet.
Mean vertical distance from the under side of crown to top of lower band.....	0.629 feet.
Mean shortest distance of the inner edge of one bucket from the adjacent bucket at 1 inch below the crown.....	0.065 feet.
Do. do. at 5 inches below the crown.....	0.079 "
Do. do. at 10½ inches below the crown.....	0.110 "
Do. do. at 1 inch from outside at the bottom.....	0.135 "
Mean shortest distance from the inner edge of one guide to the adjacent guide.....	0.219 feet.
Mean shortest distance from the outer edge of one guide to the adjacent guide.....	0.334 feet.
Mean area of outlets of wheel.....	18.87 sq. inches.
Total area of outlets of wheel.....	3.276 sq. feet.

The apparatus for weighing the power of this wheel was essentially the same as that used by Mr. Francis in experiments upon the Tremont Turbine, described in detail in his "Lowell Hydraulic Experiments." The scale pan, hydraulic regulator and bell crank, with their bearings, were the same as were used in those experiments; the brake and friction pulley were of similar form but somewhat reduced in size, the latter having a diameter of 42.03 inches, and a face 10.5 inches wide.

The large frictional surface allowed the use of water as a lubricator and substituting a worm gear and hand wheel in place of the levers by which the amount of friction was regulated, a very steady motion was maintained throughout the experiments.

The weight of the friction pulley and brake which was supported by the step of the wheel was 2,612 pounds. This weight being much more than would be imposed upon the step when in use in a factory, a portion of it was counterbalanced by ropes attached to the brake, and passing over pulleys about one foot in diameter and eight feet above the brake, so fixed that the ropes would draw vertically when the pointer on the bell-crank was at zero. Four of these ropes, attached to the brake symmetrically with respect to the

shaft, supported at the other end a little more than 400 pounds apiece. The fifth rope, attached near the point of attachment of the link connecting with the bell crank, supported at the other end, 152 pounds, making a total counterbalancing weight of 1,782 pounds, and leaving upon the shaft a weight of 830 pounds corresponding to that of an ordinary crown gear for this wheel.

The measuring weir was bordered by plates of cast iron having sharp and square up-stream edges. The length of the crest was 9.996 feet, and its height above the floor of canal approaching 3.51 feet.

The apparatus for measuring the depth of water upon the weir, for the suppression of whirls in the water approaching the weir, and that for measuring the fall acting upon the wheel were the same described in the report upon the first Swain Wheel previously cited.

The method of conducting the experiments was also the same as there described. The data and results of these experiments are arranged in the following table, in which the mode of computation previously described was followed.

The distance from centre of shaft to the point of application of the link, to the arm of the brake, measured at right angles to the direction of the draft was 8.164 feet. The length of the vertical arm of the bell-crank was 4.4955, and of the horizontal arm 5.0027, making the effective length of the lever 9.085 feet, and the circumference corresponding 57.083 feet.

From this table it will be seen that the mean maximum efficiency of the wheel is as follows, viz:—

With full gate.....	81 $\frac{7}{10}$	per cent. of the power of the water.
With seven-eighths gate.....	81 $\frac{7}{10}$	“ “ “ “
With three-quarters gate.....	80 $\frac{9}{10}$	“ “ “ “
With one-half gate.....	76 $\frac{7}{10}$	“ “ “ “
With one-quarter gate.....	61 $\frac{5}{10}$	“ “ “ “

Or, classifying the results with reference to the quantity of water the wheel can discharge; they may be stated thus:—With full quantity the efficiency of the wheel was 81 $\frac{7}{10}$ per cent. of the power of the water; with 90 per cent. of the full quantity of water, 81 per cent. of the power of the water used; with 80 per cent. of water, 79 $\frac{5}{10}$ per cent.; with 70 per cent. of water 76 $\frac{7}{10}$ per cent.; with 60 per cent. of water, 71 $\frac{7}{10}$ per cent.; and with 50 per cent. of water, 65 per cent.