The discrepancy is more marked in the case of the nozzle ½″ diameter, where the two values are .909 and .976. It is suggested that this difference is due to the fact that the interior of this nozzle was covered with rust at the time of its being used in the water wheel, as it had been in place for some time. The coating of oxide on the interior would diminish the actual area of outlet, so that the co-efficient would appear to be smaller than it actually was. In addition to this there can be no doubt that the rough surface of the oxide would diminish the velocity of the outflowing water; this may be partly the reason why the trials with the ½″ nozzle show a smaller efficiency than those made with the ¾″ nozzle.

If this explanation is correct, it would point to the desirability of having the interior surfaces of the nozzle-tips clean and free from rust. To accomplish this, it would probably be worth while to have detachable nozzle-tips made of brass or some other metal not so liable to be acted upon as iron in the presence of moisture. It would also be advisable for the user to periodically take out and clean the nozzle tip, especially if made of cast or wrought iron.

With a dirty nozzle there is a direct loss of efficiency corresponding to whatever loss of velocity is caused by the rough surface of the nozzle. More than this, there is a diminution in the area of the outlet, and therefore in the discharge, with the result that the power developed by the motor falls off. This may become a serious consideration if the motor is not much more than equal to the demands usually made upon it.

The particular values will now be inserted in the expression for the efficiency.

Pressures = 75 and 100 lbs. per sq. in.

Corresponding heads = 175 and 235 ft.

$$v = 103.1 \text{ and } 119.6 \text{ ft. per sec.}$$
$$z = .666 \text{ ft.}$$
$$\delta = 170°$$
$$\cos\delta = -.9848$$

The value of c_w can be deduced, as mentioned previously, from an expression derived from a series of experiments on vanes of this description,

$$r = \frac{w}{v_0} = .0266\ \frac{A}{a}\ \frac{1}{v_0^{\ .3}}$$

where w is loss of velocity, v_0 the mean velocity of the water, a the sectional area of the jet and A the wetted area of the vane.

$$c_w = 1 - r \text{ approximately.}$$

The ratio $\frac{A}{a}$ is about 6.6

$$\text{whence } r = .176\ \frac{1}{v_0^{\ .3}}$$

The quantity expressed by v_0 here is the mean velocity with which the water passes over the surface of a bucket and may be taken as

$$\left(v - \frac{2\ \pi\ N z}{60}\right)$$

in expression (I).

Substituting values for the different conditions under which the wheel is run, the following table of values of c_w can be deduced :—

TABLE I.

N	h = 175 ft.	h = 235 ft.
300	.953	.955
400	.952	.954
500	.950	.953
600	.948	.952
700	.946	.951
800	.944	.949
900	.941	.947
1000	.937	.945