## EXPERIMENTS WITH TURBINE WATER-WHEELS.

A very interesting series of experiments, with several different varieties of Turbine water-wheels was made at the Fairmount Water-Works, Philadelphia, during 1859–60. As this species of wheel is attracting much attention from water companies, manufacturers, &c., who depend upon water as a motive-power, we present a few extracts from the official report of the chief engineer, Mr. Birkinbine, accompanied with illustrations of the most effective wheels, and some remarks as to their working power.

It may be well to remark that these experiments were made by the direction of the water committee of the councils of Philadelphia, and were conducted under the immediate superintendence of Mr. Birkinbine.

We also give an illustration of the apparatus used for testing the models.

The large box C, forms a reservoir for supplying the models with water; it communicates with the penstock D, by way of the trunk P, and has a waste notch adapted to it, for preventing overflow of the box. The valve *p*, operated by the lever R, having its fulcrum in the post S, opens and closes the communication with the trunk and reservoir, at the pleasure of the operator.

The models to be tested were placed in the box F, which served as a wheel pit, with their inlet water-ways connected directly to the side of the penstock D. Those wheels which had no gates of their own, were provided with one at the opening of the penstock into the inlet of the wheel. After the water had performed its work in the wheels, it flowed into the box F, and escaped through the notch *f*, into the trough G, by which it was either conveyed from the apparatus into the river, or conducted into the measuring box L, through the spout K.

When the discharge valve J was open, any water passing down the trough fell into the measuring box; but when the valve was shut, the water passed over its back and was delivered outside. This valve was operated by the rod *j* extending through a slit in the top of the trough, the side of which is removed to show the arrangement.

The measuring box L is emptied through the opening M, by drawing the slide N, and has a graduated glass tube O fitted to its side, for exhibiting the exact depth of the water within.

To the top of the penstock D was fitted an overflow spout E, for carrying off any excess of head of water from the models, it being important to maintain an unvarying head over them. The perpendicular distance between the summit *e*, of the overflow E, and the notch *f*, was six feet.

The shaft of each model was connected by suitable gearing to the shaft of the drum T. Upon this drum was wound a rope, which, passing over the sheave B, revolving in bearings at the tops of the posts AA, lifted the weight-box H.

The posts AA, were held in position by guys, which extended back and were fastened on the upper level of the wall.

The whole apparatus was supported on and connected with the framing UU, VW, XY, and Z.

The box C received a constant supply of water, through pipes connected with one of the pump mains.

The measuring box was five feet every way inside.

The apparatus is Isometrically represented to a scale of one-eighth of an inch to the foot.

The height of the wall against which the apparatus stood is fifteen feet.

### OPERATION.

After the model to be tested was properly connected with the penstock D, and drum shaft T, the reservoir C was filled with water, and kept constantly supplied to the point of overflow.

The weight box H was then charged and carefully weighed, and the valve J thrown upon its seat, to pass the water outside the measuring box. This valve was operated by an assistant, whose business it was to open and close it promptly, when the signals were given.

An assistant was stationed at the lever R, to control the valve *p*, and keep the water in the penstock, during the experiment, just at the point of overflow.

The rope was well stretched before it was used, and during the course of the experiments two pieces of tape were fastened around it, at a convenient distance apart for observation (usually 25 ft.), which distance was measured when the whole weight of the loaded box was suspended. Before trial, the box was raised and lowered several times by running the wheel, to ascertain that all the machinery was properly adjusted and to give the rope every opportunity of becoming fully stretched for the trials. The distance between the tapes was again measured, and frequently also during the trial, to enable the operators to eliminate every possibility of error from the stretching or contracting of the rope.

When the wheel was fully under weigh, and at the moment the first tape was passing a fixed point, a signal was given to open the discharge valve and direct the tail water into the measuring box; when the second tape was passing the same point, another signal was given to close the valve, and conduct the tail water away from the apparatus; after which the wheel was stopped and the weight-box allowed to run back to the place of starting.

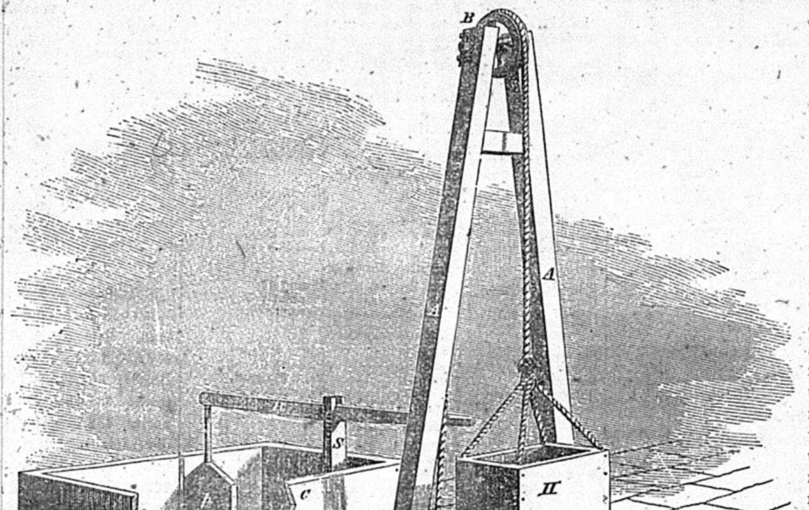
If the depth of overflow from the top of the penstock varied in any experiment, or in different experiments, the operator at the inlet valve noted the amount of variation from observations made at the summit of the spout, and allowed for it accordingly.

An adjustable slide was fitted to the notch *f*, to enable the operator to maintain a uniform overflow of the tail water from the wheels. Upon the surface of the water in the wheel-box F rested a float, from which projected a rod vertically to the top of the penstock; this rod exhibited to the operator above the level of the water in the wheel box, and served as a check to any neglect of duty on the part of the operator at the adjustable notch *f*. For wheels which vented water more rapidly than others, the adjustable notch and float indicator were necessary to ascertain the actual difference of level of the head and tail water, during every trial; which difference is the *true* head or fall, acting on any water wheel.

It will be noticed that the amount of water which escaped from the wheel during the experiment, into the measuring box, was only that which was used to raise a *known weight* a *measured height*, *after* the wheel had attained a uniform speed.

It is reasonable to assume that the amount of water required to start different wheels may vary very considerably; and it is possible that a wheel which gives a higher ratio of useful effect while in motion, may require more water to get it under weigh than one which gives a lower ratio. It is also certain that at the commencement of the trials the rope would be drawn to different tensions; perhaps, in some instances, it would hang loosely from the sheave, in which case the wheel would vent a great deal of water before the weight would be lifted at all. It was to avoid errors from these sources that the apparatus was constructed in the manner described; to ascertain the useful effect of each wheel, *only while in motion and during the performance of its work*; omitting altogether the uncertain conditions of starting and stopping.

The different parts of the apparatus were so disposed that the observer at the penstock overflow could see the level of the water in the wheel-box, as indicated by the float-rod; and the observer stationed to signal the passage of the tape over the measuring point could, by his ear, note the time of closing and opening the discharge valve, and make allowance, if necessary, for any fore or after movement which might unavoidably

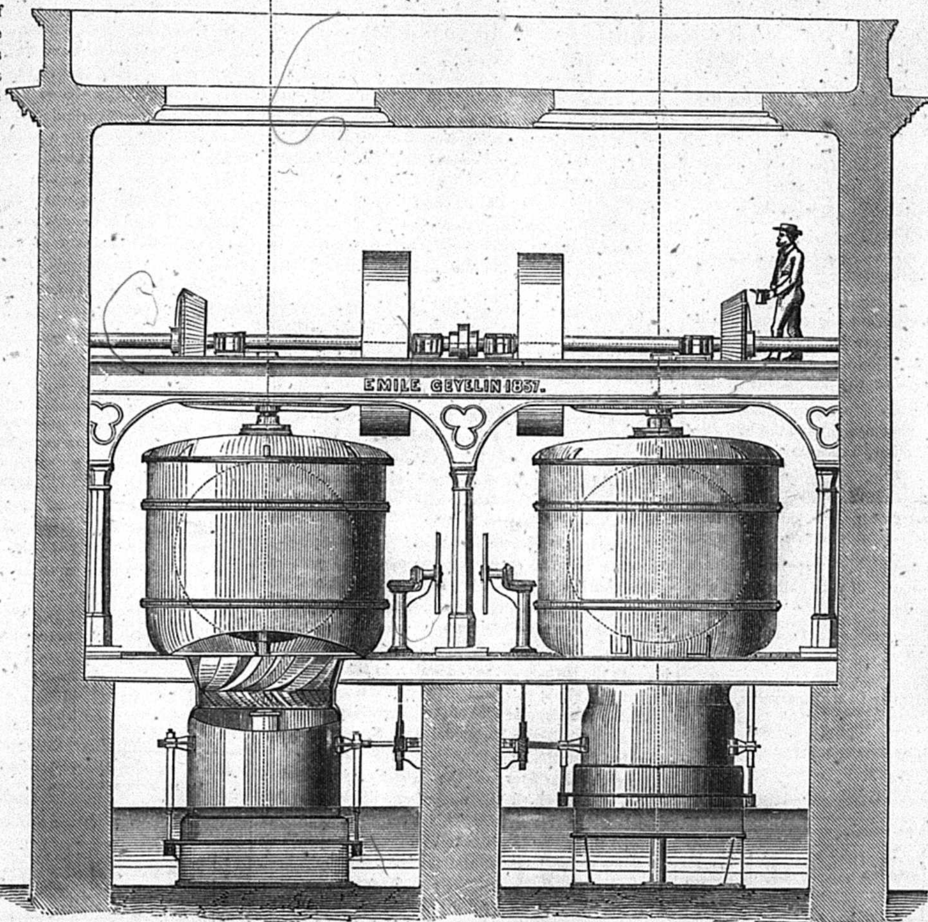


No. 1.—Apparatus for Testing the Model Turbine Wheels.

occur while closing it. This observer was at the same time within sight of the float rod and penstock overflow, and in the interim of tape transits, could detect, at a glance, the height of head under which the wheel was working. In this manner, one observer could watch the performances of the others, and act as a check to any neglect of duty on their part; and any person interested in the correct testing of the wheels, could see the ropes, water-levels, and discharge valve, from one station point, and thus observe for himself the faithfulness of the operators and the progress of the trials. The time required for each wheel to perform its work was taken by an observer, who stationed himself on the upper platform, at a point favorable for observing the exact moment of transit of the tapes.

During the whole course of the experiments the same persons gave the same signals and operated the same parts of the apparatus, and no pains were spared in securing the greatest degree of exactness in every manipulation of the machine.

The amount of weight to which the box was loaded was varied in different experiments; these weights, together with all the essential data of the trials, appear in the tables which are given under the head of each wheel. A correct platform scale for weighing the box was kept at the apparatus during the whole time of the experiments, and any person who wished to be satisfied of its correctness before trying his wheel, could have it tested upon making that wish known.




Jonval Turbine by E. Geyelin.

EXPERIMENTS.

GEYELIN'S DOUBLE JONVAL WHEEL ON A HORIZONTAL SHAFT.

Geyelin's first series of trials was made with two wheels, secured on a horizontal shaft. The head-water was admitted between the fixed wheels, and escaped horizontally outwards through the movable wheels into discharge tubes, which were submerged in the tail water in the same manner, and for the same purpose as in the case of the single wheels hereafter described. The arrangement and general design of the wheels and cylinders, and the curvature of the guides and buckets, were similar to those of the single wheel on a vertical shaft.

Table No. 1 exhibits the results with this arrangement.

A high percentage was not claimed for the double Jonval wheel; the trials with it were regarded altogether as experimental in their nature, with a view to ascertain the comparative merits of the two systems, when wheels, in every way similar to each other, were used under similar circumstances; that is, two wheels on a horizontal shaft compared with one wheel, of about the same power, on a vertical shaft, and under the same head.

JONVAL TURBINE BY GEYELIN.

In the official report of these experiments diagrams are given showing various sections of this wheel, drawn to a scale, and exhibiting the several parts disconnected. We have no space for the publication of the large plate, and consequently were obliged to omit it in our abstract. The buckets were fastened in the movable wheel, to the central part, or hub, and were bound around their outer edges by a wrought iron band.

The wheel thus constructed was secured to the shaft turned off truly on its upper face and outer edge, and fitted to run freely under the fixed wheel, and within the cylindrical part of the casing. The guides were firmly secured to the outer face of the fixed wheel, and fitted closely against the conical sides of the upper part of the casing. The shaft revolved freely through the top plate of the fixed wheel. The part of the casing in which the fixed wheel rested, and the cylindrical part in which the movable wheel turned, were bored out truly, and the under edge of the hub where it meets the corresponding rim of the movable wheel, was faced off, so that the movable wheel could run nearly in contact with it.

No. 1.

GEYELIN'S FIRST SERIES OF TRIALS.

NOTES OF TRIALS OF JONVAL TURBINE (DOUBLE VERTICAL) BY E. GEYELIN, NOV. 9, 1859. HEIGHT 25 FT. HEAD 6.04 FT.

| No. | Weight raised. | Water in box. | Time in seconds. | Ratio of useful effect. |
|---|---|---|---|---|
| 1 | 700 lbs. | 3.31 feet. | 20 | .5633 |
| 2 | 800 " | 3.52 " | 22 | .6054 |
| 3 | 900 " | 3.76 " | 24 | .6376 |
| 4 | 1,000 " | 4.02 " | 25¼ | .6626 |
| 5 | 1,100 " | 4.31 " | 28 | .6799 |
| 6 | 1,200 " | 4.72 " | 30 | .6772 |
| 7 | 700 " | 3.283 " | 21 | .5680 |
| 8 | 600 " | 3.126 " | 20 | .5112 |
| 9 | 500 " | 2.966 " | 19 | .4490 |
| 10 | wheel held fast, | 3.42 " | 20 | |
| 11 | " running free, | 3.835 " | 20 | |

Ratio of gearing,
Bevel 50 to 144 } 25 to 288.
Spur 6 " 24 }

Area of orifices in both fixed wheels, 42.6 sq. in.
Area of orifices in both movable wheels, 42 sq. in.
Number of buckets in each fixed wheel, 9.
Number of buckets in each movable wheel, 28.
Note.—In trial No. 11, the drum made 13½ revolutions.

No. 2.

GEYELIN'S SECOND SERIES OF TRIALS.

NOTES OF TRIAL OF JONVAL TURBINE (HORIZONTAL) BY E. GEYELIN, FEB. 29, 1860. HEIGHT RAISED 25 FT. HEAD AND FALL, 6 FT.

| No. | Weight raised. | Water in measuring box. | | | Average. | Time in sec'nds | | | Ratio of useful effect. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 900 lbs | 2.96 ft. | 3.02 ft. | 2.96 ft. | 2.98 ft. | 22 | 25 | 21 | .8099 |
| 2 | 950 " | 3.18 " | 3.06 " | 3.10 " | 3.113 " | 25 | 24 | 25 | .8183 |
| 3 | 1,000 " | 3.25 " | 3.32 " | 3.23 " | 3.266 " | | 26 | 26' | .8210 |
| 4 | 1,050 " | 3.54 " | 3.46 " | 3.46 " | 3.486 " | 27 | 28 | 27 | .8077 |
| 5 | 1,100 " | 3.67 " | 3.60 " | 3.63 " | 3.633 " | 26 | 27 | 28 | .8119 |
| 6 | 1,150 " | 3.84 " | 3.73 " | 3.82 " | 3.80 " | 30 | 29 | 30 | .8124 |
| 7 | 1,200 " | 4.02 " | 4.05 " | 4.01 " | 4.03 " | 31 | 31 | 31 | .7993 |
| 8 | 1,250 " | 4.25 " | 4.32 " | 4.21 " | 4.26 " | 32 | 33 | 33 | .7868 |
| 9 | 1,300 " | 4.51 " | 4.39 " | 4.56 " | 4.49 " | 34 | 33 | 34 | .7771 |
| 10 | 1,000 " | 3.87 " | | | | 30 | | | .6928 |
| 11 | Wheel held fast, | | | | 4.52 " | 30 | | | |
| 12 | " running free, | | | | 3.98 " | 30 | | | |

Ratio of gearing,
Bevel, 1 to 2½ } 7 to 60.
Spur, 7 to 24 }

Area of orifices thro' guides, 44.6 square inches.

Area of orifices thro' wheel, 37.7 square inches.

Number of buckets in fixed wheel, 10.

Number of buckets in movable wheel 26.

Notes.—In trial 12, the wheel made 20 revolutions.

In trial 10, the gate was only partly raised.

The head water flowed freely into the chamber over the fixed wheel, whence it passed into the chutes formed by the guides, and acted upon the buckets of the movable wheel, the curves of which being in reverse order, received the most effective blow and pressure of the discharging water. After the water had performed its work in the wheel, it escaped downwards through the discharged tube, which was a continuation of the cylinder. This tube was enlarged immediately below the wheel, to give the escaping water an unobstructed flow, and was submerged in the tail water, to secure the power of the suspended column of water below the wheel, forming a draft tube.

This wheel, in common with all wheels where the draft tube is used, occupies a mid-position between the head and tail water; when the former was shut off, the suspended column of water sunk to a level with the latter, and left the wheel in a favorable position for examination and repairs.

Should any solid body pass between the buckets and guides, which would endanger the breakage of either, while the wheel is in motion, the guide wheel being fitted loosely into the conical part of the casing, would be raised and let the obstruction pass out without doing injury. This peculiarity also permits the raising of the movable wheel, when the step, or any of its parts, needs repairing, and obviates the necessity of taking the wheel apart.

In the diagram published in the report the dimensions are given of the template, which was fitted to the guides of the the model, against the outer circumference of the hub, and the ordinates to the curve at every tenth part of the whole space occupied by the curve, equal to 8.55 inches.

In the lower part of the diagram are given the ordinates of the bucket curve of the movable wheel for every tenth part of the whole curve space. The template from which the bucket curve was taken was formed to suit the curve of the bucket against the inner surface of the ring which encircles the whole wheel. The guides and buckets project radially from the hubs of the wheels.

The model was very nicely and truly fitted up. The cylinder, gate, base-plate and wheel centres were made of cast iron; the shaft, of two-inch wrought iron, running on a steel step, about five-eighths of an inch in diameter; the guides and buckets were made of sheet brass, correctly and uniformly shaped to the proper curves; the former were about one-eighth, and the latter one-sixteenth of an inch in thickness. Its proportions and finish were well designed and executed, and leave nothing to be desired to make it a perfect model of this type of turbines.

Table No. 2 exhibits the results of trials with this model. The average useful effect given by this series of trials is .8049.

The contract for the new wheels for the Fairmount Water-Works was awarded to Mr. Geyelin. The following letter from Mr. Birkinbine explains the reasons for this action of the department:

DEPARTMENT FOR SUPPLYING THE CITY WITH WATER,
Philadelphia, April 5th, 1861.

EMILE GEYELIN, Esq.:

Dear Sir,—The following are the reasons that influenced the department in awarding you the contract for furnishing the Jonval Turbine water-wheels for working the new pumps at the Fairmount Water-Works:

*First.*—The fact that your model gave the best average percentage over all others brought into competition.

*Second.*—The durability and continued satisfactory operation of your Jonval Turbine, erected at the Fairmount in 1851.

*Third.*—The general and highly competent evidence brought before the Committee of your ability as a constructor of Turbine wheels.

*Fourth.*—The fact of your estimate of cost being considerably lower than that of any other party.

Yours, respectfully,
HENRY P. M. BIRKINBINE,
*Chief Engineer.*

### JONVAL BY STEVENSON.*

No. 3.

STEVENSON'S FIRST SERIES OF TRIALS.

NOTES OF TRIALS OF JONVAL TURBINE, BY J. E. STEVENSON.

| No. | Weight raised | Height. | Water in meas. box. | Time in sec'ds. | Head and fall. | Ratio of useful effect. |
|---|---|---|---|---|---|---|
| 1 | 900 lbs. | 25 ft. | 3.520 ft. | 26 | 6 02 ft. | .6838 |
| 2 | 1,000 " | " | 3.816 " | 29 | " | .7004 |
| 3 | 1,050 " | " | 3.926 " | 29 | " | .7148 |
| 4 | 1.100 " | " | 4.053 " | 30 | " | .7254 |
| 5 | 1,150 " | " | 4.190 " | 31 | " | .7385 |
| 6 | 1,200 " | " | 4.420 " | 33 | " | .7256 |
| 7 | 1,250 " | 22 " | 4.075 " | 30 | " | .7218 |
| 8 | 1,300 " | 22 " | 4.346 " | 32 | " | .7085 |
| 9 | 1,350 " | 20 " | 4.166 " | 31 | " | .6929 |
| 10 | Wheel held fast, | | 4.58 " | 30 | " | |
| 11 | " running free, | | 4.39 " | 30 | " | |
| | | | | | Average, | .7112 |

Ratio of gearing.
Bevel, 17 to 69, } 187 to 1406.
Spur, 44 " 96, }

Area of orifices through guides, 41.25 square inches.
" " " wheel, 30.9 " "
Outside diameter of wheel, 21 inches.
Inside " " 15.5 "
Number of buckets in movable wheel, 18.
" " fixed wheel, 12.
Depth of movable wheel, 5.25 inches.
" " fixed " 5 "
In trial 11, the drum made 18 revolutions.

*The Messrs. W. G. & J. Watson, of Paterson, N. J. claim to be the designers, constructors, and owners of the wheels designated by Stevenson's name, and also claim that their name should be inserted throughout the report in place of that of Stevenson.

(*First Model.*)

In Stevenson's first model, the guides were not bent down at their lower ends, as shown in the description of the second, but the lower edge of the band of the movable wheel was flared; and the water-ways in the fixed wheel narrowed to the point of discharge. The movable wheel had eighteen buckets, the fixed wheel twelve guides, and the forebay had a partition projecting from one side to near the shaft, to prevent gyration of the head-water, which entered the forebay in a radial direction towards the centre of the wheel-shaft.

The results of the trials are shown in table No. 3.

(*Second Model.*)

This Jonval model, by Stevenson, was similar to Geyelin's in principle, but different in the arrangement of its details. In the diagram referred to is a vertical section of the movable and stationary wheels, as arranged when it gave the second series of trials, in which is shown the relative positions of the fixed and movable wheels, and the shaft to which the latter is secured. The buckets were bound to the hub by a thin wrought iron band, as in Geyelin's, and were additionally secured by two small square bands outside. A flange projected from the movable wheel, within the rim of the fixed wheel, and formed against it a water-tight joint.

The guides were doubly bound to the hub of the fixed wheel, in the same manner as the buckets of the movable wheel. The fixed wheel was secured in a groove turned in the floor of the forebay, into which it projected.

The step-box was adjusted laterally by radial screws, which passed through lugs on the centre-plate of the spider beam, and rested on a ring which was fitted into the central aperture of the latter. This ring was adjusted vertically by a large taper key, which extended under it and across the central aperture. If the radial screws were slackened and the key withdrawn, the ring and step-box could be lowered through the central aperture, and repaired, without raising or disturbing the wheel, after which it could be replaced with little trouble.

A circular chamber bolted fast to the centre-plate of the spider beam surrounded the step-box and extended above the bearing; a spout led from the side of the discharge tube into this chamber, for the purpose of keeping the chamber constantly filled with water.

This wheel had a discharge or draft-tube extending beneath the surface of the tail water, in the same manner as Geyelin's, and was fitted with a gate, which consisted of a circular disc of the same diameter as the tube, supported on a horizontal axis, by which it was operated from the outside.

Beneath the floor, of the forebay, projected a flange, within which the upper band of the movable wheel freely revolved. This flange and another allowed the movable wheel to be lowered without loss of water at the joints of the flanges with the wheel. This arrangement permitted experiments to be made with the wheel at different distances from the guides.

The head-water entered the forebay in the direction of a tangent, thus favoring gyration in its motion over the chutes or guide curves, which, in the first model, was prevented by a partition in the forebay.

In the diagram are shown the guide and bucket curves of the model, drawn to a scale of one-tenth the full size. The dimensions were taken from templates fitted to the guides and buckets on the inner surfaces of the bands which encircle them.

In the fixed wheel there were twelve guides, and in the movable wheel nineteen buckets. The top edges of the guides were radial lines, and the lower edges were tangent to a circle 6 inches in diameter, concentric with the wheel, as shown by the lines I, fig. 1. The top edges of the buckets were tangent to a circle with a diameter equal to one and a half inches, and the bottom edges were radial lines; all the tangents were on the same side of the axis.

The lower edge of the band which encircled the buckets of the movable wheel was flared outwards, to give the water (in the opinion of the maker) "a free discharge from the wheel, and at the same time diminish friction, secure the action of centrifugal force upon the incline of the band, and give thereby additional power to the wheel."

In this wheel the guide curve is bent downwards at its lower end, causing the space between the curve and the dotted line (which latter is a guide curve advanced on the wheel) to widen towards the point of discharge.

This change of curvature deflects the direction of the discharge at a greater angle with the plane of the wheel.

These were strong, practical working models, 22 inches in diameter, with brass buckets, well finished. Every part was well and truly fitted; the "toe" of the shafts revolved upon *lignum-vitæ* steps about two inches in diameter, the same as that of their shafts; all of the machine work was done in the best manner.

It will be noticed in table No. 4, that the model gave its highest result in the twelfth trial, the first one made after the wheel was lowered from the guides; but in the next two trials it shows a decided *loss* when compared with the third and fourth trials, which were made under like circumstances, or nearly so, before the wheel was lowered from the guides.

It further appears, that on the next day, when three trials were made, the second of which was under circumstances precisely similar to those of the twelfth trial on the day previous, a falling off of 3.4 per cent. occurred, and the third trial failed by 1.6 per cent. to equal the fifth, with the same weight to lift as on the previous day, when the wheel ran close to the guides.

Reference to Stevenson's first series of trials, table No. 3, will show an average ratio of useful effect of .7112, which is considerably below .8485, the average of the second series. The average of both series taken together is .7798.

No. 4.

STEVENSON'S SECOND SERIES OF TRIALS.

NOTES OF TRIALS OF JONVAL TURBINE, MARCH 9, 1860. THE WEIGHTS WERE ALL RAISED 25 FEET.

| No. | Weight raised. | Water in measuring box. | | | Average | Time in seconds. | | | Head and fall. | Ratio of useful effect. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 750 lbs. | 2.36 ft. | 2.40 ft. | 2.36 ft. | 2.373 ft. | 20 | 20 | | 6 ft. | .8475 |
| 2 | 800 " | 2.57 " | 2.53 " | 2.46 " | 2.52 " | 20 | 20½ | 20 | " | .8512 |
| 3 | 850 " | 2.72 " | 2.64 " | 2.61 " | 2.656 " | 22 | 22 | 21 | " | .8582 |
| 4 | 900 " | 2.83 " | 2.78 " | 2.78 " | 2.796 " | 23 | 23 | 23 | " | .8632 |
| 5 | 950 " | 2.97 " | 2.90 " | 2.98 " | 2.95 " | 25 | 25 | 25 | " | .8635 |
| 6 | 1,000 " | 3.17 " | 3.12 " | 3.10 " | 3.13 " | 26 | 26 | 26 | " | .8567 |
| 7 | 1,050 " | 3.50 " | 3.34 " | 3.58 " | 3.456 " | 27 | 28 | 28 | " | .8147 |
| 8 | 1,100 " | 3.79 " | 3.77 " | 3.71 " | 3.756 " | 30 | 30 | 30 | " | .7853 |
| 9 | 1,050 " | 3.31 " | 3.28 " | 3.26 " | 3.283 " | 26 | 27 | 27 | " | .8372 |
| 10 | 1,000 " | 4.81 " | | | 4.81 " | 40 | | | " | .5575 |
| 11 | 975 " | 3.15 " | 3.05 " | 2.98 " | 3.06 " | 26 | 25 | 25 | " | .8544 |
| 12 | 925 " | 2.78 " | 2.83 " | 2.87 " | 2.826 " | 23 | 24 | 24 | " | .8777 |
| 13 | 900 " | 2.88 " | 2.79 " | | 2.835 " | 23 | 23 | | " | .8513 |
| 14 | 875 " | 2.78 " | | | 2.78 " | 22 | | | " | .8593 |
| 15 | wh'l h'ld | 4.29 " | | | 4.29 " | 30 | | | " | |
| 16 | " free. | 4.51 " | | | 4.51 " | 30 | | | " | |

NOTE.—IN THE LAST FIVE EXPERIMENTS THE WHEEL WAS LOWERED 1⅛ IN. FROM THE GUIDES.

MARCH 10th, 1860.

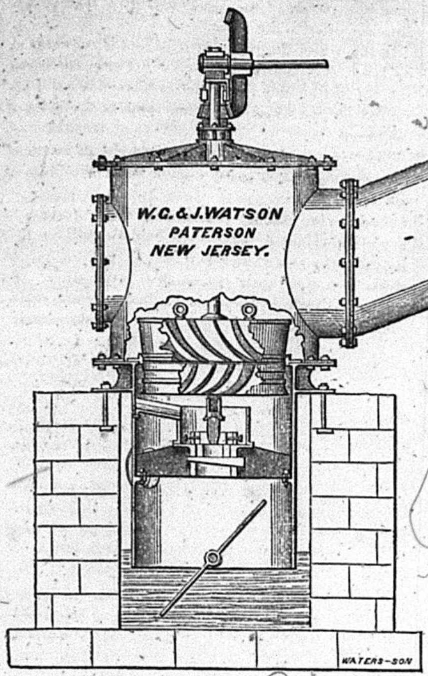
| No. | Weight raised. | Water in measuring box. | | | Average | Time in seconds. | | | Head and fall. | Ratio of useful effect. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 900 lbs. | 2.76 ft. | 2.82 ft. | 2.79 ft. | 2.79 ft. | 23 | 23 | 24 | 6 ft. | .8650 |
| 2 | 925 " | 3.01 " | 2.91 " | 2.90 " | 2.94 " | 24 | 24 | | " | .8437 |
| 3 | 950 " | 3.04 " | 3.00 " | 2.98 " | 3.006 " | 24 | 24 | 24 | " | .8475 |
| 4 | wh'l h'ld | 4.20 " | | | | 30 | | | " | |
| 5 | " free, | 4.22 " | | | | 30 | | | " | |

Omitting the 10th trial, the average is .8485

Ratio of gearing, { Bevel, 17 to 69, } 85 to 552.
{ Spur, 60 " 96, }

Area of orifices through guides, 42 square inches.
" " " " wheels, 32 " "
Number of buckets in movable wheel, 19.
" " fixed " 12.
Depth of movable wheel, 5.125 inches.
" fixed " 5.75 "
Depth of buckets in movable wheel, 4.937 inches.
" " fixed wheel, 5.75 "
Mean diameter of movable wheel at lower edge, 18⅝ inches.
Top edges of buckets of movable wheel are tangent to *a*; circle, 1½ inches diameter.
Bottom edges of buckets in movable wheel are radial lines.
Top edges of buckets in fixed wheel are radial lines.
Bottom " " " " tangent to a circle 6 inches diameter.
In trial No. 10, the gate was partly closed.

A cut of this wheel as made by Messrs. W. G. & J. Watson, of Paterson, N. J., is here inserted.




Jonval Turbine by W. G. & J. Watson.

The description of Stevenson's models given above apply to this cut, it being a representation of the wheel experimented upon. A letter from the Messrs. Watson is here inserted :—

Paterson, N. J., February 4, 1861.

To H. P. M. Birkinbine,

Chief Engineer, Water Department, Philadelphia:

Dear Sir,—Reverting to the experiments on turbine water-wheels, made at your Works at Fairmount, we beg to assure you that the models exhibited by J. E. Stevenson were constructed by us at our expense and upon our own plans; they were also erected at our own cost, and that he acted in the matter only as our agent. * * * * * * *

We are anxious to be fairly represented in your forthcoming report, and also to have the merit of our model certified to by you, as was your original intention, but which, unfortunately, a faithless agent perverted and appropriated to his own uses, by securing the testimonial in his own name.

We are, most respectfully, yours,
W. G. & J. Watson.

The following diagram shows the relative efficiency of several wheels by different makers, in which a marked variation is apparent:

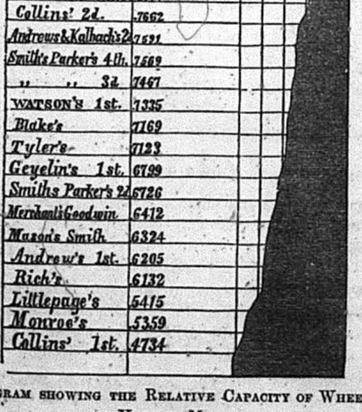



Diagram showing the Relative Capacity of Wheels by Various Makers.

Enameling Iron Pipes.—Among the important uses to which the enameling process has yet been applied, is that for securing both the internal and external surfaces of iron pipes from the corroding action of fluids. The principle involved in this improvement would seem to be of considerable importance to hydraulic engineers; for it has been found in practice, where pipes so prepared have been laid down, that the water delivered has retained its original purity, nor does it even deteriorate by long standing; the pipes are also found to last much longer than they otherwise would.—*Railway Review.*

The New Patent Law.—The new Patent Law is working very satisfactorily. The change comes quite opportunely, as only $15 is now required to be paid on presenting an application. The abolition of the excessive fees heretofore required of foreigners will do much to stimulate the introduction of many valuable inventions into this country, and protect them against unscrupulous pirates who lay violent hands upon everything within their reach.—*Ibid.*

Percussive Action of Gases.—It is stated that if fulminating mercury be laid on a block of iron and exploded, it will indent the iron. If this be a fact, it demonstrates, in a striking manner, the instantaneous or percussive action of gases.

Loss of Theoretical Effect of Pumps.—Pumps do not lift an amount of water equal for each stroke to that which would fill the pump barrel. Moderately good pumps lose 50 per cent. of the theoretical effect, and bad pumps as much as 80 per cent.

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The Elegant Gas-Lamps and Fountain at King's Lynn, Norfolk, England.—Mr. John Malam, the enterprising proprietor of the gas-works, at King's Lynn, has presented to that town a superb column, supporting a cluster of gas-lamps, combined with a free drinking fountain, the description of which is extracted from the Lynn *Advertiser* of February 16, 1861. The gift was promised by Mr. Malam so long ago as the mayoralty of Mr. Smetham, in 1858, and the delay has been occasioned by the determination of Mr. Malam, and of his resident manager, Mr. Almond, (on whom the arrangements have mainly devolved,) that the column should be at once as original and as handsome as could possibly be obtained. It might perhaps have been completed in a quarter of the time and at a quarter of the expense if any existing model had been adopted, either wholly or in part; but the design is entirely new, and we are informed that there is not its like nor its equal in the United Kingdom. Whilst its cost to Mr. Malam will no doubt exceed 300*l.* sterling, the proprietors of the Thorncliffe Iron Works (where it was executed) will probably reap no immediate profit, but quite the contrary. They, in fact, regard it as a specimen work, to which they may refer as an instance of what they can accomplish; and they will look for remuneration to the orders which it may bring them from other towns. The modelling (which was executed under the care of Mr. Depledge, the designer at the Thorncliffe Works) cost 130*l.* in wages alone, irrespective of material; but the model once made, of course any future castings from it after the first, could be made at a comparatively small expense. The design consists of a tall and handsome column supporting a cluster of four elegant gas-lamps, viz., one central elevated lamp and three others on arms at a lower elevation. The height from the ground level to the bottom of the upper and centre lamp is 26 feet 6 inches. The upper and principal portion of the column is a fluted pillar or shaft, tapering gracefully upwards, and terminating in a foliated capital. Above this is the ornamental support for the centre lamp, and from it extend the branches or arms of flowing scroll-work to support the other three lamps. The lower extremity of the shaft is embedded in foilage similar to that of the capital, and stands on a large and handsome square base which forms a very striking feature of the design. It is most elaborately ornamented with foliage and scroll work, in the centre of which on each face is a large escutcheon. Three of these escutcheons bear the arms of the town, and the fourth the following inscription: "Presented to the town of King's Lynn by John Malam, Esq., in the mayoralty of John O. Smetham, Esq., 1858." The corners of the base are splayed off, and attached to each of the minor faces of the base thus formed is a very elegantly, yet boldly, designed figure of a pelican (the familiar crest of the town arms), about 16 inches in height. These are a great addition not only to the appearance but to the use of the column, as from the bill of each pelican flows a stream of water into an enamelled basin beneath. This combination of lamp, pillar, and fountain in one design is a beautiful and original idea, and one that will be appreciated, especially on market days. The overflow from the basins passes away invisibly through the interior of the column into the drain beneath. The base stands on a substantial platform of stone-work, 15 feet wide, 18 inches above the roadway, and approached by two steps 12 inches broad. As the weight of iron in the casting amounts altogether to about five tons, adequate provision has been made for its support by a solid foundation of brick-work, sunk a considerable depth in the ground. The coloring of the iron work is green bronze throughout. The form of the lamps was the topic of much discussion; but it was Mr. Malam's determination not to spoil the column by any mean or common-place termination; and globular ground glass lamps were therefore decided upon. They are 20 inches in diameter, and are, it is believed, the first of their kind on such a scale. Considerable inquiry was necessary in order to find a glass factory possessing the necessary appliances for turning out globes of this size; but this was at length accomplished, and there will now be no difficulty in obtaining duplicates to any extent in case of accident to the lamps. We cannot conclude this notice without expressing our sense of the great obligation of the town to Mr. Malam for so handsome and liberal a gift, and to Mr. Sampson Almond for the great expenditure of time and anxiety on his part in order to bring the business to a worthy and successful issue; nor without stating our belief that in conception and execution the work is an admirable one, and redounds greatly to the credit of all parties concerned in it. The name of this beautiful and costly work is The Tuesday Market Lamp and Fountan, of which Mr. Almond has favored these rooms with a drawing, and also a photogram of the Market Place and Column.

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Charge of Stealing Gas in England.—At the last Durham Easter Sessions, Thomas Helsop, a butcher, of Bishopwearmouth, was charged with having stolen a quantity of gas from the Sunderland Gas Company. The prisoner had been for some time a customer of the Company, but not having paid up his arrears of gas, the pipe was cut off in June of last year. On the 3d of April the collector of the Gas Company found gas burning on the prisoner's premises, and it was discovered that the prisoner had connected a feed-pipe with the Company's service-pipe, and had for some time past been burning gas from nine lights in the prisoner's shop and a public house which he occupies. The defendant admitted the charge made against him of stealing the gas, but said the Company were to blame for not having allowed him to pay what he owed them by instalments. The prisoner was found guilty and sentenced to six months' imprisonment.

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Glass Gauges for Oil Lamps.—In filling a metal lamp, the oil is liable to be spilled by running over the top, because it is so difficult to judge of the exact rise of the fluid by looking downward into the small opening. A remedy could easily be provided for this evil in the use of a small glass gauge, fitted into a recess in the side of the lamp, so as to indicate the exact height of the oil. Metal lamps are not liable to be broken like those made of glass, but the latter are preferred by many who would otherwise choose the former, for the simple reason that, in filling them, they can witness the rise of the fluid, always preventing its overflow.—*Scientific American.*