Civil and Mechanical Engineering.

JONVAL TURBINES, AND PLUNGER AND BUCKET PUMPS.

By EMILE GEYELIN.

Dynamometrical tests made on a Jonval Turbine, working under high pressure; also, measurements of actual delivery of water from two sets of pumps propelled by said Turbine, constructed for the city of Manchester, N. H., by the Geyelin department of the firm of R. D. Wood & Co., Philadelphia.

GENERAL DESCRIPTION.

These works are located at the mouth of Lake Massabesic, and comprise a fall of water of forty-five feet, which is led to a pumping station, from whence the water, to the extent of five hundred cubic feet per minute, is forced into a reservoir through an ascending main, twenty inches in diameter and seven thousand feet in length. The actual lift does not exceed, in ordinary condition, sixty-two pounds to the square inch; but all parts are constructed to resist a pressure of two hundred pounds to the square inch, the pumping works being so constructed as to force the water directly into the distributing main when desired. These works, including dam, water ways, and general design at the pumping station, were planned and directed by J. T. Fanning, H. E.; the Turbines and machinery proper were placed by E. Geyelin.

DESCRIPTION OF TURBINES AND PUMPS.

Two Turbines of one hundred and twenty-eight horse-power, each thirty-four and a half inches in diameter, receive the water from a chamber placed at the bottom of the fall, on top of which chamber is a stand pipe, that is to receive the recoil in case of a sudden closing of valves. The motions of these Turbines are independent of each other, and can be transmitted to either of two sets of pumps, by means of shifting gears.

TESTS MADE AT THE MANCHESTER WATER WORKS, JUNE, 1875, TABLE NO. 1.—WHEEL TESTS.

Number of Experiment.	Temperature of Water.	Time of commencing Test.	Time of closing Test.	Duration of Test in seconds.	Total number of revolutions of wheel during Test.	Number of Revolutions of wheel per second.	Number of Revolutions of wheel per minute.	Weight on scale in pounds.	Effect in feet pounds per second.	Head of water on wheel in feet and decimals of a foot.	Height of back water.	Acting head of water on wheel in feet and decimals of a foot.	Height of Waste Water going over a weir 8 ft. wide from both wheels.	Height of water going over a weir 8 feet wide from 1 wheel.	Cubic feet of water discharged per second less total waste.	Effect of same in feet pounds per second.	Ratio of effect of wheel.	Cubic feet discharged per second less $\frac{1}{2}$ of the waste.	Effect of same in feet pounds per second.	Ratio of effect of wheel.	Velocity of centre of bucket of wheel in feet per second.	Ratio of velocity of centre of bucket and theoretical velocity of water.	Horse power of wheel by Test, if increased to 45 feet head.	Cubic feet of Water discharged in a second under 45 feet head.
June 23, 1875.	H.M.S.	H.M.S.	H.M.S.																					
1	60	4 20 06	4 21 48	102	500	4.902	294	250	61.275	44.04	1.85	42.19	204	1.112	27.969	73.539	8333	29 190	76.697	.7689	37.54	.7206	126.75	31.134
2	60	10 34 03	10 35 13	70	300	4.2857	258.6	280	59.999	41.39	1.85	42.44	204	1.113	28.0097	74.035	8104	29.2357	77.259	.7766	32.82	.6282	122.65	30.983
3	60	10 51 26	10 54 40	194	500	2.5773	154.6	400	51.546	44.39	1.78	42.51	204	1.113	28.0097	74.157	.6897	29.2307	77.387	.6861	19.73	.3773	108.75	30.942
4	60	1 08 56	1 11 14	138	500	3.6292	217.89	330	59.7828	44.31	1.86	42.39	204	1.110	27.8802	73.579	.8125	29.1101	76.798	.7784	27.75	.5515	122.60	30.924
5	60	1 17 49	1 19 50	121	500	4.1322	248.	301	61.983	44.21	1.83	42.38	204	1.110	27.8802	73.613	.8420	29.1101	76.834	.8067	31.63	.6059	127.12	30.924
6	60	1 22 13	1 24 43	150	500	3.3383	200.	350	57.333	44.21	1.83	42.38	204	1.110	27.8802	73.613	.7788	29.1101	76.834	.7462	25.52	.4889	117.68	30.924
7	60	1 24 51	1 27 09	138	500	3.6292	217.39	330	59.783	44.21	1.83	42.38	204	1.110	27.8802	73.613	.8121	29.1101	76.834	.7781	27.74	.5814	122.61	30.924
8	99	1 55 17	1 56 50	102	500	4.9020	291.	250	61.275	44.21	1.83	42.38	204	1.110	27.8802	73.613	.8324	29 1101	76.834	.8057	37.62	.7206	125.67	30.924
9	69	1 57 20	1 59 05	105	500	4.7319	285.71	260	61.905	44.21	1.83	42.38	204	1.110	27.8802	73.613	.8109	29.1101	76.834	.8057	36.45	.6986	126.96	30.924
10	69	1 59 25	2 01 13	108	500	4.5936	277.8	270	62.499	44.21	1.83	42.38	204	1.110	27.8802	73.613	.8490	29.1101	76.834	.8134	35.45	.6791	128.17	30.924
11	69	2 01 23	2 03 15	112	500	4.4643	267.3	280	62.500	44.21	1.83	42.38	204	1.110	27.8802	73.613	.8100	29.1101	76.834	.8134	34.19	.6549	128.17	30.924

Friction Pulley = 42 inches Diameter, $10\frac{1}{2}$ inches Face.

Weight = 1503 pounds, about equal to usual shaft and gear.

Weight of Brake = 1023 pounds, balanced off.

SAMUEL WEBBER.

TESTS MADE AT THE MANCHESTER WATER WORKS, JUNE, 1876, EFFECT OF PUMPS, TABLE NO. 2.—WATER DELIVERED AT RESERVOIR.

Number of Experiment.	Number of wheels used.	Experiment commenced.	Experiment ended.	Duration of experiment expressed in minutes.	Number of Revolutions of wheel per minute.	Number of strokes of pump per minute.	Actual head of water on wheel in feet.	Height of flow of water over a weir 8 feet wide.	Height of flow of water over a weir 8 feet wide, while one of the wheels was running.	Cubic feet of water discharged through wheel per minute, less $\frac{1}{2}$ waste.	Effect of same expressed in foot pounds per minute	Height to which the water was pumped.	Height of flow over a weir 5 feet wide, stationed at delivery in reservoir.	Cubic feet delivered per second.	Number of gallons delivered in 24 hours.	Weight lifted, expressed in foot pounds.	Weight due friction in pipe.	Total effect expressed in foot pounds.	Ratio of effect to power used.	Velocity of water in main, in feet per second.	Water used, to water delivered in reservoir.
1	1	H. Min. June 25, 10 52	H. Min. June 26, 11 06	14	107.16	15	42.33	203	1-1280	29.794	78,547	110.55	0.391	4.007	2,593,004	25,528	12.07	28735	.3658	1.8368	7.448
2	1	10 01	10 20	19	135.74	19	42.80	203	1-1660	31.466	83,873	110.50	0.453	4.0845	3,221,573	34,303	23.12	36615	.4385	2.2847	6.313
3	2	10 49	11 03	14	178.60	25	42.98	203	1-5740	50.536	133,380	110.62	0.502	6.8573	4,431,989	47,191	54.48	42649	.3917	3.1431	7.369
4	2	11 11	11 34	23	214.32	30	42.28	203	1-6590	54.564	143,684	110.66	0.629	8.007	5,233,228	55,793	80.61	63784	.4439	3.7113	6.241
5	1	12 40	4 40	240	142.88	20	44.853	203	out	31.466	87,960	110.58	0.475	5.3469	3,453,817	33,731	25.28	39259	.4466	2.4508	6.

Water used to lubricate steps = 10.8088 cubic feet per minute = 4800.34 gallons per hour.
 Water pumped by calculation = 648242 gallons.
 Revolutions of wheel to 1 stroke of pump = 7.144.
 Water pumped by weir and lubricator = 595,529.86 gallons.
 Number of strokes of pump attained by 1 wheel = 20.66.
 Water pumped by measure reservoir = 508,336.65 gallons.
 Water as shown by weir in reservoir = 576,969.50 gallons.

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The gears are bevel and spur (mortise) and so proportioned as to give twenty-eight strokes to the pumps a minute, while the Turbine makes two hundred and twenty revolutions per minute. The pumps are four in number and are placed in a vertical position. Diameter of plunger, eleven and a quarter inches; length of stroke, forty inches. The receiving valves are in each of the four pumps of the kind known as "Double Beat Cornish" and are seven in number in each set. The air vessels, placed at the junction of two pumps, are supplied with air by means of automatic pumps.

DESCRIPTION OF THE TESTS.

Two tests were made and conducted by Samuel Webber, H. E., of Manchester, who used the dynamometer and water gauge, that served in the experiments made at Lowell, by J. Francis. The table No. 1, gives the results under different velocities, varying from 294 to 217 revolutions per minute, wherein the percentage of useful effect, varied only from 0.7989 to 0.7781. As shown, the best results were obtained at velocities of 270 to 280 revolutions per minute, amounting to 0.8134.

The duty of the pumps is given in table No. 2, the results therein stated were obtained by the measurement of the depth of water flowing over a weir, put up at the reservoir; width of weir, sixty inches. From the data obtained, the actual duty of the pumps is at thirty strokes, equal to eighty-eight per cent. of the theoretical capacity of the pumps. When the length of the ascending main (7000 feet) is taken into consideration and a probable leakage, these results are fair, though with a short and tight main, the duty should not be less than ninety-four per cent.

Export of the manufactures of Iron from Philadelphia.— During the fiscal year ending June 30th, proximo, Philadelphia exported to foreign countries the following iron products, aggregating \$1,001,387. Railroad bars, \$9,977; car-wheels, \$64,900; machinery, \$767,560; nails, \$15,030; other manufactures of iron, \$143,920.

The total exports of the city during the same time were \$28,588,019.