WATER-WORKS AT BROOKLYN, N. Y.

The largest pumping-engine in this country, and probably in the world, has been recently put in operation in Brooklyn, and, after a satisfactory test, has been accepted by the city. The next largest is the Leighwater engine, for draining the Harlem Meer. In actual working power the Brooklyn engine exceeds it by 16 4-10 per cent. In the Brooklyn Water Works the reservoir is in two apartments, having a joint water area of 26 acres. Its capacity is 160,000,000 gallons. It is connected with the city distribution by a three-feet main, five miles long. The engine is of the Cornish class, but different in most of its details from previous examples of the class. It is *double-acting*, and works two single-acting pumps, and has a new valve-movement and other novel features.

The steam cylinder is 90 inches in diameter, with ten feet stroke; its pumps 36 inches by 10 feet stroke; its framing of cast-iron, 26 feet high from the floor; its beam cast-iron, 30 feet long, weighing 26 tons. The condenser is of the ordinary kind; the air-pump is double-acting. One pump is below the steam cylinder; its piston is worked by the steam piston-rod, descending, and connecting to a heavy cross-head, which serves as counter-weight and bumper, and is fitted with slides to work an equalizing weight of 20 tons, and consists of two quadrants or quarters of wheels, on a rock-shaft that vibrates 90 degrees, throwing the centre of gravity of the mass 45 degrees to either side. In the first half of the stroke this weight is raised so that its centre of gravity is over the rock-shaft; in the last half of the stroke it descends on the other side, giving to the latest portion of the stroke the power that it had taken from the earliest portion, thus compensating for the effect of expansion of the steam. Diagrams of the pressure in the pump show a nearly equal pressure for the whole stroke. The other end of the beam works the other pump. On the rod is a counter-weight of 20 tons, which balances the steam piston, rod, links, cross-head, &c. An air-band, 8 feet diameter and 20 feet high, stands at this end of the frame; and braces from it sustain the end of the gallery. The parallel motions are on Watts' plan. The links are long, and there is no perceptible inaccuracy in the movement of the piston-rods.

The air-pump rod is on the side next the pump. On the side next the cylinder is a rod which works a frame, in slides, traveling about 5 feet. Inside this frame are cams, which give half its movement to the valve rock-shaft, the other half being given by a water-cylinder and piston, whose valves are worked from the cams. The steam piston, through the bearer, thus closes the exhaust, and opens the water-valve, which determines the admission of steam for the next stroke. On the nice adjustment of the flow of water, from the main, into the cylinder, which completes the throw of the steam valve rock-shaft, depends the accuracy of the travel of the main piston, which is such that the bumper approaches within a quarter of an inch of its seat, yet very seldom touches. The valves are balanced puppet, dropped by withdrawing a bolt; cut off at $\frac{1}{4}$ to $\frac{1}{2}$ stroke. The time of cutting off is determined by a right-and-left screw, easily adjusted while at work. The steam and exhaust pipes are 20 inches and the valves 18 inches in diameter. Ten double strokes per minute is the usual speed. At this rate the motion is very accurate; no jar is produced that can be perceived by one standing in the gallery on a level with the beam. The steam pressure on the boiler is 15 to 20 pounds. The height of lift of the water is 163 feet; the pulsation in the air-barrel is about 4 pounds. The discharge-pipe is 3 feet diameter and 3,400 feet long—to the reservoir. The total weight of the engine, pumps, and all connected, is 450 tons.

The building is designed to hold four such engines. Another engine will soon be put in. It has two wings for boiler-rooms, each to accommodate six boilers, and below, one room for coal. Three boilers are now set and at work. They are cylindrical, 30 feet long and 8 feet diameter. Each has two furnaces, and each furnace two flues 20 inches diameter and 20 feet long. Each boiler has 16 return flues, 8 inches diameter, below the furnace flues; and the smoke, after traversing these return flues, descends, and passes under the shell, on its way to the chimney. The boilers are covered with felt, over which is cotton duck. Very little heat escapes—not enough to keep the room comfortable in winter. The workmanship is *good*—there being no sensible leakage of steam, either from boilers, pipes or engine. The action of the engine is almost theoretically perfect. There is no jar in stopping these ponderous masses; and the noise is merely that of the drop of the steam-valves. We often see steam-pumps of five-horse power that make more noise and jarring than are made by this enormous engine and its pumps.

As the peculiar principles of the Cornish engine are well illustrated in this example, it may be proper to mention them briefly, for the benefit of those who have occasion to use or design pumping engines.

First—The motion is slow—ten strokes per minute; the chief object is to seat the pump-valves gently; but the other moving parts are likewise benefited. The slow motion requires a large engine to do a given amount of work; and, as the momentum of the moving parts and the water equalize the motion, so as to admit of expansion to a great extent, and to avoid concussion, it is necessary that these parts should be heavy. It is for this reason that the counterweights, which might appropriately be called momentum-weights, are added to the weight of the beam, pistons, etc. And, to complete the effect, we have the equalizing weight, which resists during the first half, and helps during the last half of the the stroke. Such ponderous masses, which, in the early engines, were not easily avoidable, were until WATT's time, detrimental to the action of the engine. They caused the bumper to strike with violence at the end of the stroke, wasting the power that had been expended to generate the motion, and damaging the machine by the concussion. To relieve the engine from these evils WATT cut off the power before the end of the stroke, leaving the motion to subside so that it would cease at the proper point without concussion. He found that when the steam, instead of being admitted during the whole stroke, as had been the practice, was cut off at the first quarter, the usual work was done and three-quarters of the steam was saved. In later engines, working at higher pressure, the steam is cut off at one-sixth; and the moving masses are purposely made heavy, so that the strong steam may exert its power upon them without producing too much speed, and so that the speed produced may not too soon diminish in consequence of the weakness of the expanded steam. Thus the heavy masses serve the purpose which the heavy fly-wheel serves in the common engine—they equalize the speed, and prevent jerks and collisions. In the Brooklyn engine this is effected so fully that the bumper seldom touches, and seldom falls a quarter of an inch short, so that very little power is lost either by pounding the guard-block, or by loss of steam in the clearance between the piston and cylinder-head.

Second—The air-chamber of this engine has a very useful effect. The delivery-pipe being 3,400 feet long and 3 feet diameter, the weight of the mass of water flowing in it is 1,500,000 pounds, at the speed of $3\frac{1}{2}$ feet per second. To stop this mass would require a power sufficient to lift 2,600.000 pounds, 1 foot high; it would not stop, but would continue to flow, drawing after it the water in the pump below the bucket, so that the valves would not drop into their seats at the proper time, but would strike violently after the commencement of the stroke. The elasticity of the air in the chamber reduces this evil, so that the beat is harmless. It has been still further reduced by placing in the air-chamber a diaphragm, having valves to allow a free upward movement of the air, but to throttle its return. This refinement eased the valves by retarding their descent; and by diminishing the pressure in the water-engine, which completes the throw of the steam valves, it caused a greater pause at the end of the stroke. But it wasted the power accumulated in the air by compression, and partially restrained by the throttling, to such extent that the mean pressure of steam had to be increased from 11,875 to 13,075 pounds per inch.

Third—There is an important distinction between the action of the Cornish engine and the crank and fly-wheel engine—which was among the plans proposed for these works. The crank gives to the piston a motion that does not accord with the easiest motion of the water, but the Cornish engine has its motion controlled by the flow, and the momentum of its parts, and thus it follows the water, without too much straining at one time and too little pressure at another. A long experience, in mines and other places, has established the Cornish principle as most favorable to the unrestrained flow of the water, on which economy of power depends, and to the smoothness of action, on which durability of the machinery depends.

Fourth—In this engine there is a novel arrangement of the pumps, which, the builders believe, contributes to the result they have attained. Each pump, 36 inches in diameter, is placed within a cylinder 54 inches in diameter. The buckets of the working-barrel are fitted with double-heat covers working on the pump-rods; and double-heat covers or valves are also fitted on the annular spaces between the working-barrel and the external cylinder. The lower 36-inch bucket delivers through the barrel above it, and also through the 54-inch barrel; and the upper bucket draws its charge through both a 36-inch and a 54-inch barrel. It is considered that this arrangement involves less friction than the ordinary arrangements.

A trial was made on the 12th to 14th January, which lasted 26 hours and 3 minutes, during which time 34,753 pounds of coal were burned, and 1,943,802 cubic feet of water were pumped to a height of 160 feet. The friction, leakage, &c., in the pumps and delivery pipe were computed to raise the work to 1,999,349 cubic feet, lifted 170 feet high, which is equal to 21,243,083,040 pounds lifted one foot by 34,763 pounds of coal, or 611,083 pounds lifted one foot by one pound of coal.

The average duty of one of the Cornwall engines for three months was, 1,494,000 pounds of water lifted one foot by a pound of coal. The tests, however, had been made on a somewhat different basis—favorable to the Cornwall engine. The Brooklyn engine does more than the required duty, under less advantageous circumstances, and in many particulars is a decided improvement upon the old plans.

A subsequent capacity test showed the engine capable of delivering 15,532,066 gallons in twenty-four hours. The average speed was 10.29 strokes per minute. When the four engines are completed, the city may receive 62,000,000 gallons per day.

The Chief-Engineer of the Water Works, is James P. Kirkwood. Samuel McElroy, is principal Assistant-Engineer of engine-house, pumping machinery, and reservoir. William Wright, a mechanical engineer of well-known ingenuity, superintended the construction of the engine at the works of the builders, Messrs. Woodruff & Beach, of Hartford, Conn.

THE AMERICAN PUMP.—Mr. J. M. Edney advertises his great American Pump, in to-day's issue. It is like a two-edged sword; it works both ways, and the amount of water it drives up is surprising. The certificates in its favor are too numerous to mention.