THE

HOLLY SYSTEM

OF

WATER SUPPLY

AND

FIRE PROTECTION.

MANUFACTURED BY

THE HOLLY MANUFACTURING COMPANY,

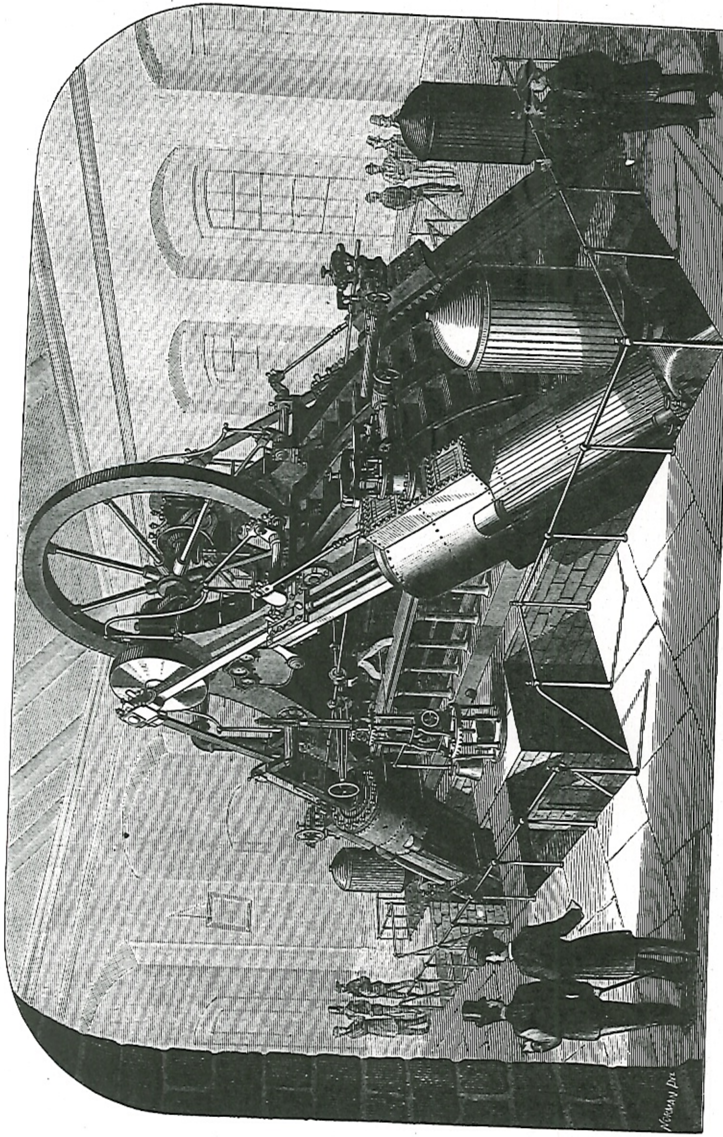
LOCKPORT, NEW YORK.

PARK BENJAMIN & BRO.,

General Agents,

49 & 50 ASTOR HOUSE,

NEW YORK CITY.



THE HOLLY ENGINES AT BUFFALO, N. Y.

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LOCKPORT, N. Y.

T. T. FLAGLER.................................PRESIDENT.
JAS. JACKSON.............................VICE-PRESIDENT.
C. G. HILDRETH...............................SECRETARY.
H. H. FLAGLER.................................TREASURER.
B. HOLLY..........................CONSULTING ENGINEER.
H. F. GASKILL..........................SUPERINTENDENT.

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THE HOLLY SYSTEM OF WATER SUPPLY FOR CITIES AND TOWNS.

The Holly system of waterworks consists in pumping engines of especial and superior construction, which force the water intended for the domestic supply and fire protection of the town directly into the mains and distributing pipes, *no reservoir or stand-pipe being interposed.* In order to maintain steady pressure, the operation of the machinery is continuous; but as the demand for water is subject to constant variation, means are provided for the automatic regulation and government of the pumps, so that the amount of water delivered is in exact accordance with the requirements of the moment.

Without such regulation, which is an essential feature of the Holly system, and which is fully covered by the patents of the Holly Company, direct pumping involves great waste of water.

It is impossible to adjust an engine adapted to supply water always under uniform pressures to meet a fluctuating demand. Water consumption varies with the day of the week, and actual experiment in Boston, Mass., has demonstrated that it is about four times greater between 9 and 10 o'clock A. M. than between midnight and 1 A. M. No provision, however, can adjust an ordinary engine to meet probable conditions of diminished demand, for the reason that unexpected drains are always likely to be made upon it by fires. A sufficient pressure must always be carried to meet not only the probable requirements, but a reasonable excess. That this involves the pumping of water which is not used is evident, and as the whole object of spending money for the construction and maintenance of waterworks is to pump water for useful purposes, it follows that every gallon not so applied represents a certain amount of unnecessary wear of machinery, of strain on pipes and fittings, and a certain sum of money lost.

The means of regulation which thus forms so important a feature in the Holly system is an exceedingly simple mechanical device depending for its operation upon the degree of pressure in the mains. If this pressure falls, owing to an unusual drain, the regulator instantly acts so as to admit steam for a longer period into the cylinders of the engines, and the pumps are thus at once caused to operate more rapidly and powerfully. When the pressure in the mains increases, owing to but small drafts being made on them, the reverse takes place, and less water is pumped. The normal pressure is adjusted by the engineer in accordance with average requirements.

The fire protection afforded by the Holly system is of the most efficient character. It is a fact not fully understood that *the introduction of the Holly works dispenses with the necessity for fire engines.* Water is not merely distributed to hydrants, but sent there under pressure, so that all that is required is to couple on the hose and turn on the stream. An idea of the capabilities of the system in this respect will be gathered from various extracts from reports, &c., given elsewhere in this pamphlet. It will suffice here, by way of example, to note, that at Rochester, N. Y., on the occasion of an official test, a four-inch horizontal stream, a solid column of water, was projected a distance of 465 feet, and thirty one-inch streams at one time were thrown to a height of 135 feet.

The adjustment of the engine to give a quick supply under heavy pressure, in response to a sudden alarm of fire, is the work of an instant. The mere opening of a hydrant causes sufficient diminution of pressure in the pipes to operate a valve, which in turn communicates with a whistle, the sounding of which is the alarm for the engineer to turn on the fire pressure.

To recapitulate, therefore, the essential features of the Holly system are:

1st.—Direct pumping into the mains, and consequent saving of the heavy cost of distributing reservoir or stand-pipe.

2d.—Self-regulation, to accommodate a fluctuating demand, thus saving fuel and wear of machinery and piping.

3d.—Prompt and efficient fire supply. Water delivered in powerful streams to the extent of corporate limits, and the expense and maintenance of a fire department saved, besides large reduction in insurance rates effected.

To these advantages is to be added the fact that the Holly engines have given, not only under elaborate engineering tests, but under conditions of actual experience, results which show them to be more economical in fuel and cost of maintenance than any other machines operating under conditions in anywise similar. These matters will be found more fully considered further on.

MODERN SYSTEMS OF WATERWORKS.

The Holly system is the newest system of waterworks, and involves more novel and ingenious improvements than any other. In its essential characteristics it has no competitor. No other system attains, or can attain, the same results. It is now in operation in nearly 100 cities and towns, a list of which is given on page 29.

For purposes of comparison with other systems of water supply, brief reviews of these are subjoined:

The Gravity System.—This is the oldest mode of supply. It involves the impounding of the drainage from water sheds, or the water from natural springs in a large reservoir placed at a sufficient elevation to give ample head to allow the water to be distributed to the highest portions of the town. Where a copious natural water supply and a proper reservoir site exist in close proximity to the town, the gravity system has a preponderance of advantages. Under other circumstances it becomes exceedingly costly, for the following reasons:

Because of the large expense of building a reservoir sufficient to hold water both for ordinary needs and for a reserve. The best authorities state that a storage reservoir should hold four months' supply, which for a population of 25,000, at 40 gallons per head, daily amounts at 19.53 million gallons, requiring a drainage area of about two square miles. To the cost of the reservoir is to be added that of the aqueduct, and usually that of a fire department when the elevation of the reservoir—as is most frequently the case—is not enough to afford sufficient head for fire streams.

Where the reservoir is situated at some distance from the city, and is fed by a stream, the cost of extinguishing water rights is often excessive. In Troy, N. Y., where the gravity system was first contemplated, the aggregate amount found to be needed for this purpose was half a million dollars—more than double the total cost of the Holly works ultimately adopted for the supply of the city.

2. *The Gravity and Pumping System Combined.*—Under this system distributing reservoirs are fed by pumping engines. The reservoir serves as a settling basin when the water contains impurities, and as a means of enabling the pumping engine to operate at a uniform speed, doing its work for the day in a portion of the twenty-four hours, thus giving a higher duty and dispensing with night attendance, and as a safeguard, holding in store a supply in case of accident to the pumps or to the mains. It also equalizes the flow in the latter.

The cost of a distributing reservoir, while not so high necessarily as where the reservoir forms the sole source of a gravity supply, is nevertheless very large. The reservoir at Parker Hill, Boston, cost $250,000 and supplies daily 1,600,000 gallons. The Holly works at Bangor, Me., with an engine of a capacity of 3,000,000 gallons per day, at ordinary speed, a reserve rotary of 4,000,000 gallons for occasional use—boiler and engine-house, filtering cribs, 17 miles of pipes and 127 hydrants—cost $186,000, or $64,000 less than the Parker Hill reservoir and its mains.

At Lynn, Mass., the reservoir force, mains and land cost $156,000. The average daily supply is about 1,250,000 gallons. At Brookline, Mass., the reservoir and land cost about $75,000. At Salem, Mass., $150,000; at Lowell, Mass., $125,000. In most cases the reservoirs are not placed at such elevations as to furnish sufficient pressure for fire purposes in all parts, if any, of the districts supplied without the intervention of fire engines, yet the cost of the reservoirs and their necessary adjuncts amounts to far more than the expense of even triplicating the pumping machinery; and in most cases the interest alone on the cost of the structures amounts to far more than the extra cost of fuel and attendance under the direct Holly system.

It is frequently urged by the opponents of direct pumping that a failure of the machinery leaves the town with no reserve supply; and that in this respect the reservoir furnishes a sure support. It is obvious that the supply from the reservoir is limited to its contents at the time of the failure, and this is rarely more than sufficient for a few days; after which time, if the machinery is still inoperative, there is certainly no supply at all. The difference in favor of the Holly system is then at once apparent, and it takes no special discernment to discover which is preferable—dependence on what water may be in a reservoir, built to hold ordinarily from five to twenty days' supply, or on the powerful reserve machinery which forms a part of every Holly engine. This point is cogently presented in the report of the engineer of the Troy (N. Y.) Water-works, Prof. D. M. Greene, in which he considers (under date April 16, 1879) the merits of the various proposals submited to the Water Commission of that city. Comparing the Worthington engine, which pumps into a reservoir, with the Holly engine, he says:

"Even if the Worthington engine were capable of developing the same duty, it would be relatively objectionable, and for the following reasons:

"1. Its stroke is not positive and unvariable; rendering careful adjustment necessary to ensure safety in its operation. * *

"2. Its narrow range of capacity, while operating economically.

"3. When a *part* is disabled the *whole* is disabled. * *

"The Holly quadruplex engine, or a slight modification of it, is free from *all* these objections, while meeting all the requirements.

"Its four cylinders, connected at intervals of 45°, insuring *eight* charges and discharges of the pumps, at equal intervals of 45°, during each revolution of the crank discs, require the use of a small and comparatively light fly-wheel for equalizing the power and resistance and ensuring equable motion. The mode of connection adopted renders it easy to disconnect any *one*, *two*, or *three* of the pumps in a few minutes, and to reconnect them as easily and as readily; thus the machine can operate *one*, *two*, *three* or all its pumps at a time, and in that way, in connection with the large speed variation of which it is capable, its capacity may be varied to meet every possible contingency."

The question of the relative safety gained by reserve pumping machinery and by a reservoir, is also ably discussed in a report by Mr. N. H. Crafts, C. E., to the Committee on water supply of the town of Watertown, Mass. He says:

"If a reservoir should leak badly, so as to endanger its safety, it is evident a much longer time would be necessary to repair it than would be required in the most serious accident that could befall the machinery of a pumping engine, and in this case the risk depending upon a single means of supply would be correspondingly prolonged. * * It is well known that reservoir structures require large outlays and great care in construction, and that failures are quite as common, and usually far more disastrous, than failures in pumping machinery."

Mr. Crafts gives two striking illustrative instances; the first being that of the East Boston reservoir, of a capacity of some 6,000,000 gallons, and built in 1850, at a cost, including land, of about $70,000. The leakage in this reservoir, always great, in 1867 reached 50,000 gallons per day. Ultimately the cost of repairs amounted to $48,000, or $2,000 more than the original cost of the reservoir, exclusive of that of the land.

In 1871–72 Lynn, Mass., built a 20,000,000 gallon reservoir, at a cost of $70,000. On testing it it was found to leak so badly as to be unserviceable. The repairs occupied five months in 1873, and their cost was about $50,000.

"There are probably hundreds of reservoirs," he goes on to say, "now in a leaky or more or less dangerous condition, kept partly full and maintained in a constant state of semi-efficiency, on account of the great expense and long time involved in suitable repairs. I doubt if any such state of things can be shown as relating to the machinery of pumping works. I know of no instance on record where even the entire destruction of pumping works could possibly involve such serious consequences as followed the failures of reservoir dams at Mill River, at Worcester and at Clinton. * * Now, if I have shown that a second Worthington engine, pump, boiler, &c., is a more reliable safeguard, as an adjunct to the first, than the ordinary reservoir, it must be conceded by any one who has fully and impartially investigated the peculiar merits of the improved Holly machinery, that the entire arrangement is such that failure becomes even more remote, and we have in the quadruple set of double-acting piston engines and pumps, which can be run singly, by pairs, by threes, or all together, at a higher or lower rate of speed than any other pumps, a machine most perfectly adapted to every requirement of *safety, efficiency* and *economy*."

It is rarely that a distributing reservoir is built to hold twenty days supply, and furthermore it may be very possible that at the time of unexpected failure of the pumps the reservoir may be but partly full. The supply, therefore, normally limited, is still further reduced. Add to this the fact that the water becomes more and more foul, both from being left stagnant and from the impurities near the bottom of the reservoir being reached, and it will be obvious that such dependence is far from safe.

3. *Pumping Engines and Stand Pipes.*—Stand pipes and a reserve of machinery are substituted for reservoirs where the latter are impracticable on account of excessive cost. The stand pipe is either an air-tight receiver, acting as a gigantic air vessel to the pumps, or it may be open at the top and rise higher than the elevation due to the head of pressure. The use of a stand pipe admits of a variable pressure at certain hours of the day and night, thus making the average lift of the pumps less than when pumping into a reservoir, where all the water has to be raised to a maximum height. Stand pipes, however, are large and costly structures. At the waterworks of Erie, Pa., the stand pipe is 220 feet high and five feet in diameter. At West Philadelphia it is 130 feet high and of same diameter. The stand pipe has no advantage which is not obtained cheaper and in a better and more efficient manner by means of the Holly system, and it is open to the serious objection of freezing in winter.

CONSTRUCTION

OF

THE HOLLY PUMPING ENGINE.

The Holly Quadruplex Pumping Engine is represented in perspective in the frontispiece and in sectional elevation in Fig. 1. It has four steam cylinders inclined at an angle of forty-five degrees, and four pumps, one of which is in a direct line with each cylinder. The steam cylinders and their pumps are arranged in pairs on opposite sides of a heavy iron frame, the two cylinders of each pair being connected to a common crank-pin, and the crank for one pair of cylinders being set 135 degrees in advance of that on the opposite side. The engines are of the reciprocating piston form, with guides and connecting rods. A connecting rod attached to the back crank-pin actuates an air-pump beam, giving motion to two single-acting air pumps and two boiler feed pumps, one of which draws water from the hot well, and the other from the steam jackets which surround the sides of all the steam cylinders. The steam from the jackets passes through a feed water heater, so that the temperature of the feed can be raised to any desired point by increasing the amount of steam supplied to the jackets.

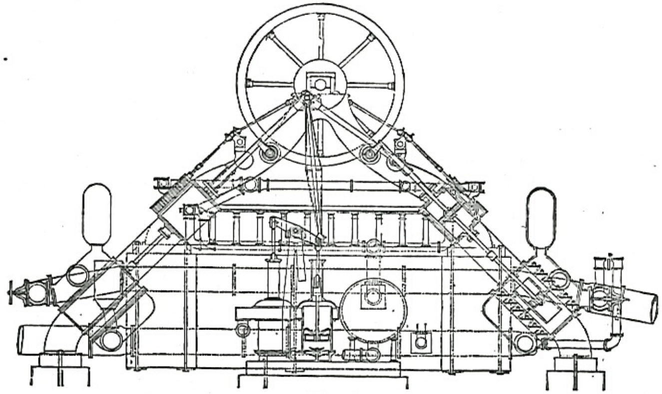

Fig. 1.

The connection of the pumps with the steam cylinders and the steam piston rods with the pumps, is by means of keys, so that any engine or pump can readily be thrown out of action.

The steam piston is packed by cast-iron rings set out by springs, the set screw of which projects beyond the face of the piston, and there are bonnets in the lower cylinder heads, so that the piston rings can be adjusted without opening the cylinder.

The pumps are of the piston variety, double-acting, the pump barrel being secured in a chamber containing the valves by a rib which forms a partition between valves on the opposite ends. The pump valves are flat discs of rubber, secured to iron discs having stems working in guides. These iron discs are of sufficient weight to bring the valves to their seats promptly, and no springs are used. The valves seat on metal gratings. The steam and exhaust pipe of the several steam cylinders are so arranged that steam from the boilers can be admitted directly into all the cylinders, and exhausted into the condenser, or live steam can be admitted to but one cylinder, and exhausted into the other three, then passing the condenser, forming a compound engine at pleasure. To change from direct to compound, it is only necessary to manipulate three stop valves, one connecting the steam pipe of three cylinders with the boilers, one connecting the exhaust pipe of the fourth cylinder with the condenser, and the third connecting the exhaust pipe of one cylinder with the steam pipes of the three.

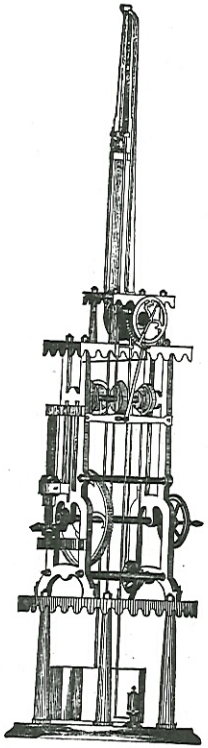

Fig. 2.

The valve gear of each steam cylinder consists of a slide valve moved by an eccentric in the usual manner, and admitting steam throughout the whole stroke. A double puppet valve in the steam chest regulates the point of cut-off, being actuated by a revolving spiral cam which can be moved in an axial direction, and thus vary the period of admission from zero to full stroke. The manner in which this cam is moved so as to regulate the speed and power exerted, constitutes the chief peculiarity of the Holly Pumping Engine.

The adjustment is effected by means of a regulator connected with the water main in such a manner that any change in water pressure is immediately corrected by an adjustment of the cut-off, resulting in a practically uniform water pressure, under the most varying conditions of supply. If the water pressure

tends to fall, owing to an unusual draft upon the main, the cut-off is immediately lengthened, and the engines exert a sufficient power to maintain the original pressure; if the consumption is suddenly lessened, so that there is a tendency for the water pressure to increase, the cut-off is at once shortened, diminishing the power of engine sufficiently to maintain the original pressure under the reduced supply, and if all consumption of water suddenly ceases the engine will immediately stop. The regulator is represented in Fig. 2.

It is evident from the foregoing description that the Holly regulator acts in an essentially different manner from the ordinary governor, which would increase the cut-off as the water pressure augmented, and shorten the cut-off as the same diminished. The details of the regulator are briefly as follows:

A small water cylinder, containing a solid piston, is connected directly with the main, and a weight is attached to the piston so as to counterbalance the water pressure. This is effected by suspending the weight from a strap which passes over a cam that rotates as the pressure changes, thus altering the lever arm of the counter-balance, and keeping it in equilibrium with the water pressure, however much the latter may vary. The cut-off cams of the steam cylinders are moved axially, either to shorten or lengthen the cut-off when the regulator throws a friction clutch into gear, which it does whenever the water pressure varies from a given amount. A weighted lever would maintain this friction clutch in gear, were it not for the action of the regulator.

The shaft on which the counter-balance cam rotates has an index wheel, and the index can be set at any desired water pressure. So long as the water pressure varies from the figure at which the index is set, the friction clutch is kept in gear by the weighted lever, and the cut-off is adjusted until the required pressure is reached. At this point the index engages with the weighted lever, and throws the friction clutch out of gear. Whenever the water pressure varies, the friction clutch is thrown into gear again, changing the cut-off so as to maintain the water pressure constant.

It will be seen that the cut-off is regulated by positive gear driven by the engine, and the only work required of the regulator is to connect or disconnect this gear. Should the pressure rise very suddenly, however, a piston in a safety cylinder raises a lever to which the cut-off gear is connected, and throws the cut-off to zero instantly, if this is requisite.

THE DUTY AND GENERAL EFFICIENCY OF HOLLY PUMPING ENGINES.

The efficiency of a pumping engine is estimated by its "duty." By this term is meant the useful work exerted by the engine pumps, expressed in "foot-pounds" of work done for each 100 lbs. of coal consumed. A "foot-pound" is an expression indicating a weight of one pound lifted a distance of one foot. In the case of a pump, the weight is the water. Hence, when a pumping engine is said to have a duty of, for example, seventy million, the meaning is that the machine is competent to raise that number of pounds of water one foot high, through the expenditure of 100 lbs. of fuel under the boiler. We are thus given a convenient mode of comparison between engines, which applies equally well to every type and form; for it is evident that, all else being equal, that engine is the most economical which does the most work with the smallest expenditure of fuel.

The question of duty, therefore, is one of great importance in an economical sense, and committees charged with the selection of waterworks are generally called upon to give it their careful consideration. The point often arises as to whether it is better, with regard to two engines, both presumably capable of doing the required work, to pay a higher price for the one guaranteed to give the higher duty. Frequently the yearly saving in outlay for fuel amounts to considerably more than the interest at six per cent. of the difference in cost; so that there may be higher economy in buying the relatively more expensive machine.

In comparing the duty reached by the Holly pumping engines with that attained by the engines of other makers, the circumstances under which the machines work must be borne in mind. It is hardly necessary to point out that where an engine is working steadily and uniformly against an invariable pressure, and delivering water into a reservoir, the conditions are far more favorable toward its giving a high duty than when it is running against the constantly varying pressure in the supply mains. Despite this obvious disadvantage, the Holly engines have given extraordinary high duties.

At Binghamton, N. Y., on a twelve hours test trial, a duty of 85,000,000 foot-pounds was attained. For the entire year of 1878, the average duty was 53,318,146 foot-pounds, as shown by the report of the Water Commissioners. At Buffalo, N. Y., under an eighteen hours run, a duty of 86,176,315 foot-pounds was shown. The following is a comparison of

the yearly duty of the Holly engine with that of two pumping engines of other makers which deliver directly into the mains:

Holly, Binghamton (yearly duty)................	53,318,146
Worthington, Rahway, N. J., ordinary working..	16,922,910
Corliss, Providence, R. I., ordinary working......	8,487,370

The Buffalo test of the Holly engine made in 1879, was conducted by Park Benjamin's Scientific Expert Office of New York with the utmost accuracy, and totally without allowances. Fires were started fresh, and every ounce of coal was charged.

Under these conditions as stated, the duty shown was 86,176,315 foot-pounds. The best recorded duty of the Worthington engine was obtained at the Newark, N. J., waterworks, and amounted to 77,358,478 foot-pounds. This was the result of a trial of but six (!) hours—fires were *not* started fresh and coal consumed was consequently guessed at. Regarding this trial, Prof. D. M. Green, Chief-Engineer of the waterworks of Troy, N. Y., in the report already alluded to, states that its duration was "far too short for reliable determination. Short trials almost invariably give results higher than can be realized from longer trials, or for continuous running. This results from starting with fresh full fires and ending with fires nearly exhausted, and thus actually consuming more coal than is fed to the fires during the trial." Continuing his comparison between the Holly and Worthington systems, he adds: "I still entertain my early views as to the *absolute* merits of the Worthington engine; but think differently of its *relative* merits—as we all do with reference to the locomotive or steamship of to-day, as compared with the best of their respective kinds of twenty years ago."

THE PRACTICAL WORKING OF THE HOLLY SYSTEM REPORTED BY CITIES AND TOWNS USING IT.

Prior to the establishment of the Holly Waterworks in 1879, in Troy, N. Y., Mr. Jerome B. Parmenter, the editor and proprietor of the *Troy Press*, forwarded to a large number of towns a circular of inquiry containing the following questions:

"Will you have the goodness to inform me at your very earliest convenience, how the Holly water supply system (or machinery) works in your town, whether satisfactorily or not? Do you use the Holly system, or merely the Holly machinery? How long has it been in use? The cost per year of operating it? Is the gravity system practicable or possible for your town? What is the population of your town? Is your service 'high' or low'?"

The following abstracts are made from the replies received:

BINGHAMTON, N. Y.—The Holly system of water supply works well in this city, and has always given satisfaction; 2d, we use both the Holly system and machinery; 3d, it has been in use here about ten years; 4th, it costs per year to operate about $11,000; 5th, the gravity system is both possible and practical in this city, but attended with much greater expense; 6th, our populaton is about 16,500; 7th, we use the compound condensing engines.—CHARLES BUTLER, Mayor.

HYDE PARK AND LAKE, COOK CO., ILL.—We use the Holly system and Holly machinery, and the machinery is working fairly, doing an average duty, with anthracite coal, of about 55 millions; has been used four years; cost of operating is about $10,000 per year. The gravity system is hardly practicable; is possible. Population about 18,000. Service requires a pressure at work of 45 lbs.—J. J. FOSTER, Superintendent.

KANSAS CITY, MO.—The Holly system works well here, and is perfectly satisfactory. We use both the system and machinery; in use about three years. The gravity system is not practicable, but might be possible, as we think there is nothing, or nearly nothing, that is impossible. In any event, water would have to be pumped to stand pipe or reservoir on some high elevation, which would be hard to find near enough to supply by gravitation. Unless the source of supply and the elevation suited for reservoir are obtainable together, the Holly system is decidedly the most practicable. Our city is divided; part of the city on bluffs, high above the river bottom, where the railroads, packing-houses, elevators, most of the manufacturing and heavy business is carried on. Our works are built on the bottom and take suction from the Kansas river above the city limits. Water is pumped into a reservoir at the works and allowed to settle, after which it is forced up to the upper reservoir, situate in the up town or bluffs, from which it stands back to the pumps at the building (and by gravitation supplies the lower town, giving a pressure all over of about ninety pounds), and taken up by the pump is sent up town and distributed by direct pressure, giving a pressure of from thirty to ninety pounds, according to elevation, which is increased in case of fire from 60 to 120 pounds. Should the pumps stop from any cause, the upper town would be supplied by reservoir pressure, but would not reach some of the higher parts of the city, and in case of trouble with the upper reservoir could pump direct

into the lower town also. We have about 50,000 inhabitants.—B. F. JONES, Secretary and Superintendent.

PORT HURON, MICH.—We are using the Holly system of waterworks, and they are giving entire satisfaction. Have had them in operation for five (5) years. Cost of operating is about $6,000 per year. The gravity system could be used here, but the cost of maintaining the gravity system would be greater than the Holly. Population of city of Port Huron is 9,000. We are pumping about 500,000 gallons of water per day, and supplying 900 water takers. Revenue from takers about $7,000 per year.—WM. H. AVERY, Chief Engineer and Superintendent Waterworks.

BUFFALO, N. Y.—The Holly system is a success, and gives entire satisfaction, and performs its work as represented. The present engine has been in use 10 years, supplies 28 miles of pipe (the high service only), and furnishes 2,500,000 gallons (at a cost of $18) daily. We are now (1878) erecting a new Holly engine, which will increase the supply about six million gallons daily. Population 150,000.—GEO. TRUSCOTT, Secretary Board of Water Commissioners.

DAYTON, O.—The Holly machinery in use here has proved very acceptable to our citizens. There is scarcely a trace of opposition to the system remaining. Its mission is being well fulfilled, and merits the approbation of all who have bestowed on it any attention, or whose opinion is of any value. 2. We use the Holly system as it is popularly known. 3. Water is had from wells sunk near the bank of Mud river, and comes by natural filtration. 4. The works were established here in the Spring of 1870. 5. The gravity system could have been introduced here, but not to good advantage; besides, the first cost of this plan would have been very large and defeated the project of building waterworks on the popular vote. 6. Dayton, O., has a population now of about 38,000. 7. To this date we have 32 miles of pipe laid and 277 fine hydrants set. The average cost per annum of running the works (exclusive of the interest on the bonded debt) is about $16,000. We have about 1,500 consumers. The works are owned by the city and have cost about $900,000.—A. J. HILLER, Secretary.

LA PORTE, IND.—The Holly works and system works satisfactorily in our city, very satisfactorily, in fact. It has been in use since 1871. The cost per year for operating it, including wages of employés, fuel, repairs to pipes, hydrants and connections, oil, etc., is about $5,500. The gravity system, by means of a stand-pipe, is probably possible and practicable, but we regard it as useless under our system. The population of our town is about 9,000. Our service—meaning water rates, I presume—is reasonable. Our losses by fire in the last twelve months have been less than $1,000.—DAVID J. WILE, City Attorney.

FLUSHING, N. Y.—We use the Holly system and machinery here with satisfactory results. They have been in use about four years. The yearly cost, not counting interest or repairs, is $5,000. The gravity system is not practical. Population about 8,000.—W. H. MURRAY, President Board of Trustees.

BATAVIA, N. Y.—We use the Holly system, as I understand it. It has been in use since 1869. The gravity system is possible, but on account of distance was thought too expensive. The population of this place is about 6,000. Our domestic service is low and our fire service is high, varying from thirty to one hundred pounds. The cost while we used the Holly engine was about $2,000 per year, all told.—MYRON H. PECK, JR., Clerk.

SCHENECTADY, N. Y.—The city hires the water for fire purposes at $62.50 per year for each hydrant (124), and we are more than well pleased and satisfied with its working, doing all that has ever been promised to us.—WM. HOWES SMITH, Mayor.

TITUSVILLE, PA.—We use the Holly system and machinery and are well satisfied. The machinery had been in constant use for five years; cost of operating per year is $7,000. Population of our city is eleven thousand (11,000). For domestic use we run our engines compound, and for fire purposes we have two rotary pumps ready for use, with enough steam always up to start them in ten seconds' notice, consequently it is impossible to have a large fire. For five years a fire has never left the building in which it originated, in so that the city saves every year the full cost of the waterworks on insurance alone. We pump our water from dug wells, twenty-two feet deep, eight feet square. At present it is very dry, but the wells will yield nearly 2,000,600 gallons for twenty-four hours.—H. W. POTTER, Superintendent.

MINNEAPOLIS, MINN.—We have the Holly supply system and it works well, been in use ten years, cost last year to operate $6,785.98. Gravity system is both possible and practicable. Population estimated 50,000. We operate our pumps by water power. Have now two wheels of 180 horse power each, and shall probably put in a 600 H. P. wheel this fall. We shall have about 16 miles of pipe this fall, and last year we pumped 665,217,362 gallons of water, and this year we will pump as much more. —JOHN W. POMEROY, Superintendent.

MARTINSBURG, W. VA.—Our works are the Holly system and Holly machinery, and have given entire satisfaction ever since they have been in operation. They have been running near five years constantly. The gravity system is not practicable with us. The springs we take our water from are in the lowest part of the town. For domestic supply we keep the pressure at 60 lbs. per square inch at works, and for fire purposes from 90 to 100. The highest part of the town is about one hundred feet above the works. The cost of running the works will not exceed $1,000 this year, including everything. The works are driven by water power. We have steam power for low water and fire purposes, but up to the present time we have had but little use for it. The population of our town is 6,000.—J. M. SHAFFER, Engineer.

SIDNEY, O.—Works in Sidney are on the Holly system, and Holly machinery is in use, and perfectly satisfactory in every respect. In operation since 1873. Cost of operating per year, including secretary, $1,000. Gravity system practicable, as we have very high hills and yet water can be brought so as to afford water by reservoir. Population 4,500. Works cost in 1873 $47,000, additional pipes since about $2,000. Very efficient in time of fire, and satisfactory for domestic purposes. Service pipes and hydrants 55 feet above main part of town. Pressure 40 to 50 lbs. for domestic use.—F. E. HOOVER, one of the Trustees during construction.

KALAMAZOO, MICH.—The Holly system is in use here and it works satisfactory. Water was introduced in 1870. Population 12,000. Have both high and low service.—SUPERINTENDENT.

DUNKIRK, N. Y.—In answer to your inquiry about the Holly water system in this city, I answer briefly, that it works perfectly, and our people are entirely satisfied with it. It has been in operation over six years, and is growing more and more in favor. We use both the Holly machinery and what is known as the "Holly system." The cost per year for fuel, incidentals and salaries is about $5,000. The gravity system is possible but not very practicable. Our population is about 9,000. For every day use we have on hand at the works near the lake about 45 lbs. to the square inch; when used for fires the water pressure is run at about 125 lbs. to the square inch. The machinery seems to be perfect as possible, and is kept in excellent order. Fires are quickly and easily controlled. We can want nothing better in the way of machinery or system than we have.—J. T. WILLIAMS, President.

PORTSMOUTH, O.—Use Holly waterworks; machinery works "well"—satisfaction. Have used Holly "system." six years. Annual cost is ten thousand dollars. Population fourteen thousand. Have high pressure (and low pressure both). Have 83 fire-plugs and 32 public cisterns. —JAMES P. JACK, Secretary.

ROCKFORD, ILL.—We use the Holly system of waterworks, which has given perfect satisfaction. Been in operation over three years. I send pamphlets containing cost of construction and cost of operating for past year. Our population is about 15,000. The gravity system is unpracticable here for fire service. Our service pressure for domestic use is about 50 lbs. to the inch.—ALFRED P. WELLS, City Clerk.

DENVER, COL.—Holly system and machinery operates satisfactorily. They have been used six years. The cost equals 33 per cent. of the receipts to pump. At its first introduction the cost was about 100 per cent., but as the demand increases the per cent. of cost decreases. Population, 25,000. High service.—H. P. PARMLEE, City Clerk.

ATLANTA, GA.—We consider the Holy system in our town an eminent success. As you will observe from the reports, we do a very heavy duty. The machinery is in about as good order as when it was put in, and will last for many years to come.—WM. G. RICHARDS.

BURLINGTON, IOWA.—Burlington uses the Holly system of waterworks and machinery. Has been in use (1878) only a few months. The gravity system can be used here if desired. Population 25,000. The modern improvements of the Holy machinery are applied. Capacity of works 3,000,000 gallons daily; twelve miles of pipe down.—J. W. BURDETTE, Clerk.

LOCKPORT, N. Y.—The Holly water supply system works with entire satisfaction. We use both the Holly system and machinery. It has been in use over thirteen years and has never failed to afford a full and satisfactory supply of water for all purposes. The cost of operating is $1,800 to $2,000 per year, including everything pertaining to that department. The gravity or reservoir system could be used here, but only at greater cost. The population of our town is 15,000. I suppose this would be called high service, as the pumps work under a constant pressure of ninety-five pounds each, which gives us seventy pounds in the principal business part of the city and about thirty pounds in the highest portions. In case of fire service the water pressure is increased some forty to sixty pounds, according to location of fire.—B. B. HOAG, Mayor.

BEAVER FALLS, PA.—The Holly water supply system or machinery—we use the machinery and run it by water power—has been in use four years.

The cost of operating is fifty cents per day. We do not use the gravity system. Our service high. The population of the city of Beaver Falls is 5,000. The Holy machinery has given good satisfaction here and has not needed any repairs since started, and we can recommend it as the best water machinery in use.—T. H. BRACKEN, Mayor.

ALLEGAN, MICH.—This village is supplied with water for culinary and fire purposes by the Holly waterworks system and machinery, which works admirably. The village has been so supplied for seven years past. The whole expense of the works, three miles of pipe, machinery, village lots, etc., has been $50,000. The cost of operating these works per year averages $1,000. The population when taken in 1874 was 3,718. The gravity system would be practicable in this village, but the water would not be of so pure a quality. Our village is furnished with water from two wells. The waterworks are operated by water power. The expense last year was $943.44. We Alleganians can cheerfully recommend the introduction of the Holly waterworks system of works into any city possessing the natural facilities for their use, such as quality of water or adjacency to river, stream or lake, or other good source of water supply.—D. C. HENDERSON, President of the Village.

COLUMBUS, O.—Holly machinery and system works entirely satisfactorily. We use Holly system and machinery. They have been in use seven years. Gravity is possible. We have 50,000 population. The domestic pressure is 60 lbs., and fire pressure 115 lbs.—S. P. AXTELL, Secretary.

EVANSVILLE, IND.—First, the Holly system gives good satisfaction; second, we use Holly machinery and system; third, commenced to supply water in 1871; fourth, cost of operating about $12,000 per annum; fifth, gravity system not practicable but possible; sixth, population about 40,000; seventh, service high.—W. G. WHITTLESEY, Secretary.

BAY CITY, MICH.—Our Holly water supply works very satisfactorily. We use the Holly system and the Holly machinery. Our works have been in use since December, 1872. The cost of operating, including all expenses of superintendence, repairs of pipes and collection of water rates, is about $9,000 per annum, of which about $6,000 is for cost of operating machinery. Gravity system is not practicable here. Population about 20,000.—GEO. LORD, Mayor.

POTSDAM, N. Y.—In reply to your inquiry as to the working of the Holly waterworks system and machinery, which we have had in constant use in our village since 1871, I would say it worked to our entire satisfaction, and been run at an average annual expense of $550, which includes services of superintendent and necessary repairs; and to all appearances the machinery is in as perfect condition as when started seven years ago. The gravity system is not practicable here, yet it is possible, but if it were practicable we would much prefer the Holly system, as under the gravity system the full pressure is continually in the water pipes, while under the Holly system we have only a small pressure on for service, whose highest point is forty-six feet above the machinery, and never subject the water pipes to severe test except in case of fire or firemen practice, when we can easily throw four streams at once one hundred feet high through an inch nozzle. The population of our village is about four thousand, and we have nearly five miles of water pipe, and shall undoubtedly be obliged to extend further to supply the demand.—GEO. B. SWAN, President Board of Water Commissioners.

ROCHESTER, N. Y.—We have a double system of water supply and two sets of pipes laid side by side. In the business portion of the city the Holly system is used for suppression of fires, for flushing sewers, sprinkling streets, and light power, such as elevators, printing presses, cloth cutters, meat cutters, power for blowing church organs, pumping beer, &c., &c. Under this system the river water is pumped from Brown's race by water power, two turbine wheels of twenty-five inches in diameter under 100 feet head being used, with about eight miles of pipe mains and 141 hydrants. It has worked to our utmost satisfaction, has been in use since January 1st, 1874. The cost is about $3,000 per year, including repairs. We have a steam reserve set for running the same works in case of accident to the water power. We use the Holly system and machinery for this part of our works. Our main works are by gravity from Hemlock lake, about thirty miles distant, with a head of 388 feet. The latter we designate as our domestic system, the water from which is used, as would be indicated by the term domestic, for all culinary and other domestic purposes, and this is also used for suppression of fires in outside districts, with nearly 600 fire hydrants. The population of our city is about 85,000. We regard the Holly system as unsurpassed for the extinguishment of fires, as the maximum of pressure is under control of the engineer, while the maximum pressure of a gravitating system is a constantly decreasing quantity, dependent upon the capacity of the supply, the conduit and the draft upon the mains.—J. R. PARSONS, Mayor.

SUSPENSION BRIDGE, N. Y.—As far as the Holly works and system is concerned, they work excellently. We use the Holly system in this respect, viz.: The water is forced by the pumps directly through mains and

distributing pipes, one and a half miles from the works, to and through our town, with a rise of about sixty feet in the distance. We pump into the reservoir, but take direct from the mains, hence you perceive that we do not, and cannot, very well use the gravity system, neither could we get the power that we now have, in case of fire, by the gravity system. One hundred and fifty pounds pressure has been used in cases of fires where one, two or three hydrants have been open at once, giving more pressure and volume of water, and throwing higher than three times the number of the best hand engines could do. It has been in use about three years, and the cost per year has been about $1,200. Our population is about 3,500, and Niagara Falls village also supplied about the same. Last year (1877) the works had severe trial, fire having broken out during a fierce gale of wind, which would have swept the whole town had they not had the water system. They had twenty-three hydrants open at once, and saved the town, although considerable damage was done.—W. H. WALLACE, President Board Water Commissioners.

GOUVERNEUR, N. Y.—The Holly works were put in at this place in 1868, for "the Gouverneur Waterworks Company," and have been extended since at a cost, in the whole, of about $25,000. The company rent the hydrants to the corporation at $50 per hydrant. The motive power is supplied by the Oswegatchie river. The works are indispensable to us, as we have no facilities to create a reservoir. We can, therefore, say that they operate successfully, and perform substantially what was promised. We cannot give details of supply and costs.—CHARLES ANTHONY, Treasurer of Gouverneur Waterworks Company.

LONG ISLAND CITY, N. Y.—The Holly water system has been a complete success. It performs all that was promised.—HENRY S. DEBEVOISE, Mayor.

AUBURN, N. Y.—Use Holly system. Been in use twelve years. The works are private, belonging to a company. Gravity is possible, but not practicable. Population 20,000. The pressure is from one to one hundred and fifty pounds.—M. L. WALLEY.

URBANA, O.—We are using the Holly system of waterworks with entire satisfaction, having been in operation since the 1st of February, 1878. We pay the Waterworks Company about $6,000 per year for fire protection. After full investigation, we deem direct pressure the most economical. Population between 7,000 and 8,000. Reservoir low.—J. DEUEL, Mayor.

As a complete record of work of the Holly system for one year, we append the following:

Interesting statements taken from the last annual report of the Board of Water Commissioners of the City of Binghampton, N. Y., as showing the results of the waterworks (which are on the Holly system of direct pumping) for the year ending December 31, 1879:

The receipts from water and frontage tax have been $26,623.04, and the running expenses $8,275,96, leaving a balance of $18,347.08, which shows the largest receipts and the smallest running expenses of any year since the waterworks have been in operation.

Office and superintendence	$2,535 52
Pumping service	4,330 56
Maintenance account	1,409 88
	$8,275 96

The maintenance account is made up of labor on streets, repairs on mains, pipes and hydrants, use of horse, attorneys and witness fees, a tapping machine, freight, cartage, supplies, &c.

Mr. D. Felter, Superintendent, to whom too much praise cannot be given for efficient and economical management, reports, among other items of interest, the following:

"The pumping machinery is in good repair, and has run constantly, with the exception of short stoppages for packing and other slight repairs. The whole amount of time it has stood still during the year is fifteen hours and forty minutes, and at any one time, two hours and forty-five minutes. The amount expended for repairs during the year was $3.26.

"The present machinery has run nearly ten years, counting the time as most other machinery is run, at the rate of ten hours a day.

"Whole amount of dust consumed during the year is 494 tons, 1,270 lbs.; of bituminous coal, 40 tons, 1,680 lbs. Daily average of dust, 2,710 lbs. Daily average of bituminous coal, 224 lbs. Daily average of the two together, 2,934 lbs. Daily average cost for fuel during the year is $2.41.

"The engineers and firemen at the pumping works are deserving the praise of all who are interested in the waterworks, for their strict attention to their duties, and in trying to reduce the expenses of running the pumping department of the waterworks."

Record of Work performed by the Engines and Pumps for the year ending December 31, 1879.

Months—1879.	Average quantity pumped monthly.	Average quantity pumped daily.	Average height of water in well at noon.	Domestic pressure, average.	Coal dust consumed monthly.	Coal consumed monthly.	Fuel consumed monthly.	Fuel consumed daily.	Number of fires.	Fire pressure.	Duration of fire pressure.	Quantity of water pumped at domestic pressure.	Domestic head pumped against plus one pound for friction in suction.	Quantity of water pumped at fire pressure.	Total fire head pumped against plus one pound friction in suction pipe.	Duty in lbs. water raised one foot per 100 lbs. of fuel — no allowance for cinders and ashes.
	Gallons.	*Gallons.*	*Ft. In.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*		*Lbs.*	*H. M.*	*Gallons.*	*Feet.*	*Gallons.*	*Feet.*	
January ..	51,054,500	1,646,919	5 4	40	85,390	6,000	91,390	2,949	4	60	4 20	50,621,167	117.481	433,333	163.481	52,512,876
February..	46,658,500	1,666,375	4 2	40	81,850	6,330	88,180	3,149	7	60	6 20	46,025,167	118.647	633,334	164.647	52,729,613
March....	48,548,500	1,566,081	4 10	40	77,625	8,650	86,275	2,786	6	60	8 25	47,706,834	117.981	841,667	163.970	55,847,720
April.....	43,382,000	1,446,067	4 4	40	80,900	8,340	89,240	2,975	3	60	3 30	43,032,000	118.481	350,000	164.143	48,274,988
May......	48,863,000	1,576,226	4	40	75,690	7,540	83,230	2,685	5	60	4 40	48,396,334	118.814	466,666	164.814	58,751,593
June	46,944,000	1,564,800	4	40	82,820	8,590	91,410	3,047	1	60	1 5	46,856,667	118.814	108,332	164.814	51,275,194
July......	53,709,000	1,732,548	3 1	40	86,330	6,990	93,320	3,011	0	....	....	53,709,000	119.731	....	....	57,378,000
August....	51,456,500	1,659,888	3 4	40	92,430	7,230	99,660	3,215	1	55	1 30	51,306,500	119.481	150,000	153.981	51,589,489
September	48,203,000	1,606,767	4 3	40	77,930	6,140	84,070	2,779	3	60	2 15	47,938,000	118.564	225,000	164.564	56,857,705
October ..	45,560,000	1,469,677	4 4	40	84,875	6,040	90,915	2,933	3	60	9 5	44,651,667	118.481	908,333	164.481	49,994,637
November	43,848,500	1,461,616	5 3	40	73,750	4,990	78,740	2,624	2	60	1 50	43,665,167	117.564	183,333	163.564	54,791,177
December.	47,113,600	1,519,974	4	40	89,680	4,840	94,520	3,049	4	60	1 5	47,004,667	118.814	108,333	164.814	49,754,764
Totals.....	575,340,500	....	....	....	989,270	81,680	1,070,950	....	39	....	44 21	570,932,170	....	4,408,330	....	....
Averages..	....	....	....	....	....	....	....	...	....	....	....	....	118.06	....	163.343	53,318,146

Center of gauge above bottom of suction pipe, 28.514 feet.

Cost of pumping service, $4,330.56.

Cost of raising 1,000,000 gallons one foot, 6.42 cents.

Cost of raising 1,000,000 gallons one foot in 1877, 7.6 cents.
" " " " 1878, 7.0 " (about).
" " " " 1879, 6.42 "

The pumping machinery used at these works is a Holly quadruplex, compound, condensing engine of the nominal capacity of 2,000,000 gallons daily.

FIRE PROTECTION IN PARTICULAR.

The following replies, sent in answer to questions proposed by the Water Committee of Taunton, Mass., where Holly works were subsequently introduced, relate more especially to fire protection under the Holly system:

DUNKIRK, N. Y.—The damage at fires is greater from water than from the flames. Stocks are completely drowned out. The alarm to the engineer at the works is automatic, and the opening of a hydrant (we have sixty-six) notifies him that a fire is in progress, and he increases the steam forthwith. The fact is that the Holly system is an immense steam fire-engine, constantly ready, and adapted for domestic uses as well.

SIDNEY, OHIO.—We use water power to propel our machinery and can have a fire stream or streams in two or three minutes, or even sooner. Using water power, our expenses for running the works are very small. Neither machinery nor pumps have required any repairs since they were started.

TITUSVILLE, PENN.—Several of our council are from your vicinity, and feel an interest in every improvement you make. As we are in the midst of inflammable material, we are compelled to have a good fire department. We had three steamers and two hand-engines, which are now dispensed with, unless a fire occurs where the water-mains do not extend. Now, a fire is confined to the building in which it originates. Have used some two-inch pipes on account of the scarcity of money. Do not advise its use, except for service-pipes.

ROCHESTER, N. Y.—A considerable number of fires occurred within the district covered by the water-mains. In almost every case the building on fire has been saved from entire destruction, and in every case confined to the building in which it originated. On no occasion have the works failed to respond to every demand made upon them. Streams of great power have been thrown upon fires one thousand six hundred to one thousand seven hundred feet from the hydrants.

Some of our own citizens, even after the great test exhibition, expressed the opinion that effective fire-streams would not be obtained in the outskirts of the city, at great distances from the pump-house. Experience and test, however, have demonstrated the utter fallacy of these notions, even when applied to our smallest mains. At distances over two miles from the pumps, with ordinary fire-pressure, streams of sufficient power

have been obtained to force shingles from the roof of a nearly new building, which was in flames.

No steamer of the fire department has played upon a fire in the districts covered by the waterworks for months; nor, in the past year, has a fire occurred within the range of hydrants of the waterworks, when hydrant streams have not played first upon it, and had it well under control before the steamers have been ready to play their streams upon it. *The Holly system has, perhaps, already saved property enough in one year to pay all it has cost.*

At the test display, for acceptance of the works, made February 18, 1874, thirty one-inch streams, at one time, were thrown a height of one hundred and thirty-five feet. A two-inch vertical stream, two hundred and thirty-five feet; a three-inch vertical stream, two hundred and eighty-five feet; a four-inch vertical stream, two hundred and ninety-seven feet; a four-inch horizontal stream, spray not measured, four hundred and sixty-five feet; a five-inch vertical stream, two hundred and fifty feet.

SELLING STEAM AND HAND FIRE-ENGINES.

The fact that in nearly all of the sixty cities and villages having Holly waterworks, the authorities have, since their introduction, sold or offered for sale their steam and hand fire-engines, because they had no further use for them, except in some cases where a part were retained to protect the buildings not within reach of the hydrants, is a strong recommendation for the Holly works.

The following are given as samples.

LOCKPORT, N. Y.—One hand-engine sold; two hand-engines reserved.

AUBURN, N. Y.—Two hand-engines sold, leaving one on hand, which "is stored in the second story of a building."

PEORIA, ILL.—Two steamers and two hand-engines sold, leaving one hand-engine.

SARATOGA SPRINGS, N. Y.—Three hand-engines and one steamer sold. Chief engineer says the remaining one "is for sale cheap."

NORWALK, OHIO.—One hand-engine sold. The other never used since waterworks were started.

ALLEGAN, MICH.—Has one hand-engine on hand, never used within reach of hydrants. Superintendent A. J. Kellogg says: "The Holly has saved the whole business part of the village from destruction, on three different occasions."

ROCHESTER, N. Y.—Three steamers out of service. After some further extension of mains, will dispense with two others.

SCHENECTADY, N. Y.—Sold two steamers; reserved one.

OGDENSBURG, N. Y.—Sold two steamers; reserving one.

LA PORTE, IND.—Ordered steamer sold; have but one.

ROCK ISLAND, ILL.—Sold her two steam fire-engines.

DES MOINES, IOWA.—Engineer recommends to the council the sale of steamer.

DUNKIRK, N. Y.—Sold one hand-engine. Offers the others for sale.

TITUSVILLE, PENN.—Sold one steamer, and is trying to sell another, and two hand-engines.

COLUMBUS, OHIO.—Wants to sell three steamers.

CITIES AND TOWNS USING THE HOLLY SYSTEM OF WATERWORKS.

STATE.	CITY OR TOWN.	AGGREGATE CAPACITY OF ENGINES PER 24 HOURS.	
		Domestic Supply *in million gallons.*	Fire Service. *in million gallons.*
California	Sacramento	3	6
Colorado	Denver	8	11
	Pueblo	1	2½
	Golden	1	1½
Georgia	Atlanta	2	5
Illinois	Decatur	1	1
	Evanston	2	3
	Hyde Park and Lake	3	5
	Litchfield	¾	1
	Peoria	2	3½
	Rock Island	2	4
	Rockford	2	5
Indiana	Columbus	1	2
	Connersville	1	2
	*Fort Wayne	5	6
	Evansville	10	15
	Indianapolis	9	15
	Do. Insane Asylum	1	1
	Laporte	2	2
Iowa	Burlington	3	4
	Des Moines	3	6
	Keokuk	1½	2
	Oskaloosa	1	2
Kansas	Emporia	1	1½
Kentucky	Covington	3	4½
	Owensboro	1	2
Maine	Bangor	3	4½
	*Rockland	1	1
Maryland	Cumberland	1½	3
Massachusetts	Taunton	3	5
Michigan	Allegan	1	1½
	Alpina	1	2
	Bay City	2	4
	Big Rapids	1	1½
	East Saginaw	2	4
	Jackson	2	5
	Kalamazoo	1	3
	Marquette	1	2
	Plainwell	½	1

* Reservoir Works.

STATE.	CITY OR TOWN.	Aggregate Capacity of Engines Per 24 Hours.	
		Domestic Supply *in million gallons.*	Fire Service. *in million gallons.*
Michigan	Port Huron	2	3
	Saginaw City	2	4
Minnesota	Minneapolis	1	2
Missouri	Sedalia	1	3
	Kansas City	8	10
New York	Auburn	6½	9½
	Batavia	1	1
	Binghamton	4	6
	Do. Asylum	¾	¾
	Buffalo	9	12
	Dunkirk	2	4
	Flushing	1½	3
	Garden City	2	3
	Gouverneur	1	1½
	Lockport	2	4
	Long Island City	3	5
	*Middletown	1	1½
	Ogdensburg	2	3
	Potsdam	1	1½
	Rochester	6	10
	Rockaway Beach	1	1½
	Saratoga Springs	3	5
	Schenectady	2	4
	Suspension Bridge and Niagara Falls	1	1½
	Troy	12	16
Ohio	Canton	1	2
	Columbus	7	10
	Dayton	6	8
	Ironton	2	3
	Mansfield	2	3
	Middletown	1	2
	Norwalk	1	2
	Portsmouth	2	3
	Sidney	1	1½
	Youngstown	1½	3
	Urbana	1½	2½
Pennsylvania	Beaver Falls	1	1½
	Danville	2	3
	Titusville	1½	3
Tennessee	Memphis	3	5
Vermont	Vergennes	1	2
Virginia	Norfolk	1½	3
W. Virginia	Martinsburg	1	2
Canada	St. Cunegonde	1	1½

* Reservoir Works.

HYDRANTS.

The attention of Waterworks managers and contractors is respectfully called to Holly's Patent Fire Hydrants, which are offered at reduced prices for the purpose of securing their still more general introduction. Nearly 7,000 have been sold within the last six years to more than 75 cities and villages throughout the United States, and have always given entire satisfaction when properly set. Following are some of the principal claims we make for the *Holly Hydrant*, and applicable to all the various patterns:

Being made of extra strength, and for durability and service, they will stand extreme water pressures.

The valves may be readily replaced without digging up the hydrant.

Having an extra frost jacket, and a drip-valve, they are anti-freezing.

The main valve closes with the current, and when firmly closed will not leak a drop.

Waste of water, and tampering with hydrants by unauthorized persons, is effectually prevented by a guard at the top, thus requiring the use of a special wrench to operate the valve.

We are prepared to sell these hydrants at a lower price than any other reliable hydrant now manufactured.

The drip-valve is without springs, and positive in its action. It is held open by the main valve when the latter is closed, and closes itself immediately when the main valve is opened.

The main valve seat is a leather gasket (costing but a few cents to replace), which serves also as a packing for the lower joint of the inner pipe.

The screw and nut of the main valve stem are placed immediately above the valve itself, and so secured as to prevent any vibration or rattling of the stem and valve when open and under heavy water pressure.

Hydrants with special valves are made with a gate at the base (as shown by cut), if desired, which is a great advantage in case of replacing a hydrant or taking one up for any purpose.

We also make this hydrant with independent brass-faced slide valves before each hose take-off—an advantage which will be at once appreciated by Chiefs of Fire Departments. By this arrangement, should it become necessary from any cause, such as the bursting of one line of hose, or its being abandoned by the pipemen, it can be shut off without stopping the remaining stream.

Should it be desired to repair any of the working parts without digging up the ground, it may be effected by simply taking out four bolts at the surface of the ground and withdrawing the inner pipe, together with the main valve, valve-seat and drip-valve, all of which can as easily be replaced and made secure again by tightening the four bolts first removed.

Descriptive illustrated circulars of the hydrants made by the Holly Manufacturing Company will be promptly forwarded upon application.