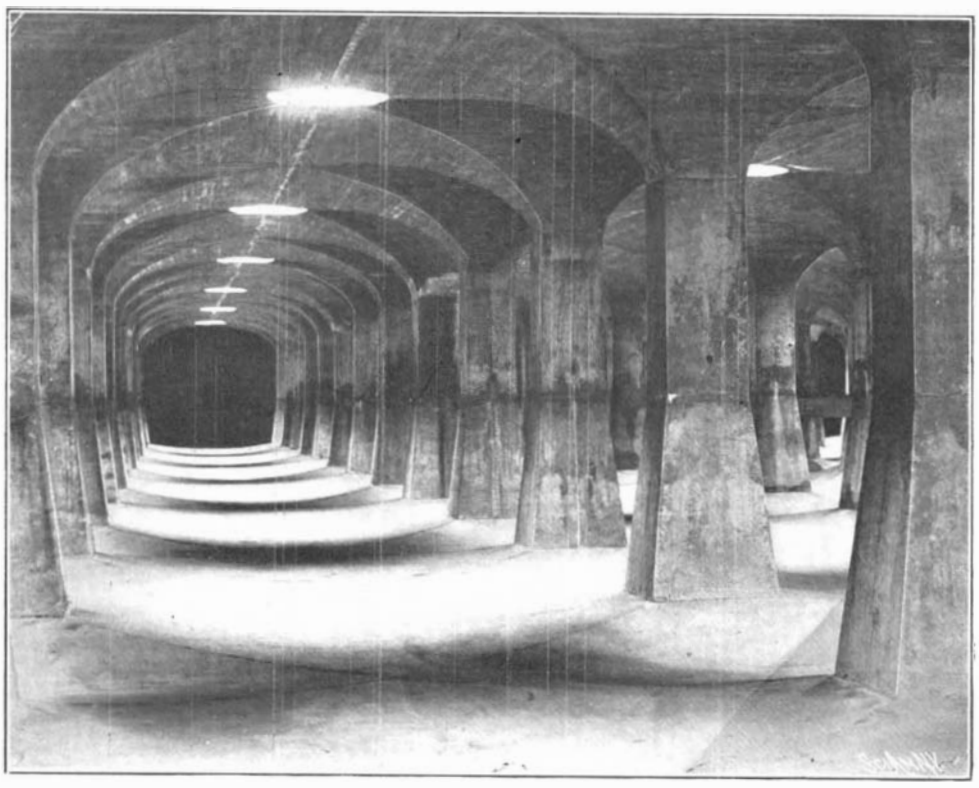
THE NEW PHILADELPHIA FILTRATION SYSTEM.

BY H. D. JONES.

In the words of Consulting Engineer John W. Hill, who is installing the new filtered water system with which Philadelphia will be provided with pure water in unlimited quantities, the improvement will be the "greatest municipal advance in the history of the world, and comparable only to the renovation of the entire sewerage system of London thirty years ago." To begin with, a conduit is being hewn, cut, drilled, and blasted out of the solid rock a hundred feet beneath the surface of the Delaware River bank, and only a few feet less beneath the surface of the stream, for a distance of more than 14,000 feet. This conduit is only a small part of the general plan, which includes five one-half acre filters at lower Roxborough, eight filters at upper Roxborough, eighteen filters at Belmont, and fifty-five filters at Torresdale. In round numbers the entire system when working will have a capacity of 300,000,000 gallons of filtered water a day, more than the entire consumption of the city. The Lower Roxborough plant is intended to supply the section of the city known by that name and Manayunk; Germantown will depend for its filtered water upon the supply from the filters at Upper Roxborough; West Philadelphia will be supplied from the Belmont plant, and the older parts of the city will be furnished with pure water from the enormous plant at Torresdale.

For an explanation of how the beds are made and how the filtering of the water is done, the Torresdale plant will serve as an illustration, that being the largest plant, and all the others being built practically in the same way. The amount of ground held by the city for the Torresdale plant is 384 acres, of which something in excess of 55 acres is now being built upon, the remainder being held for operations not immediately contemplated, but which will some day be necessary when the question of enlargement is forced upon the engineers.

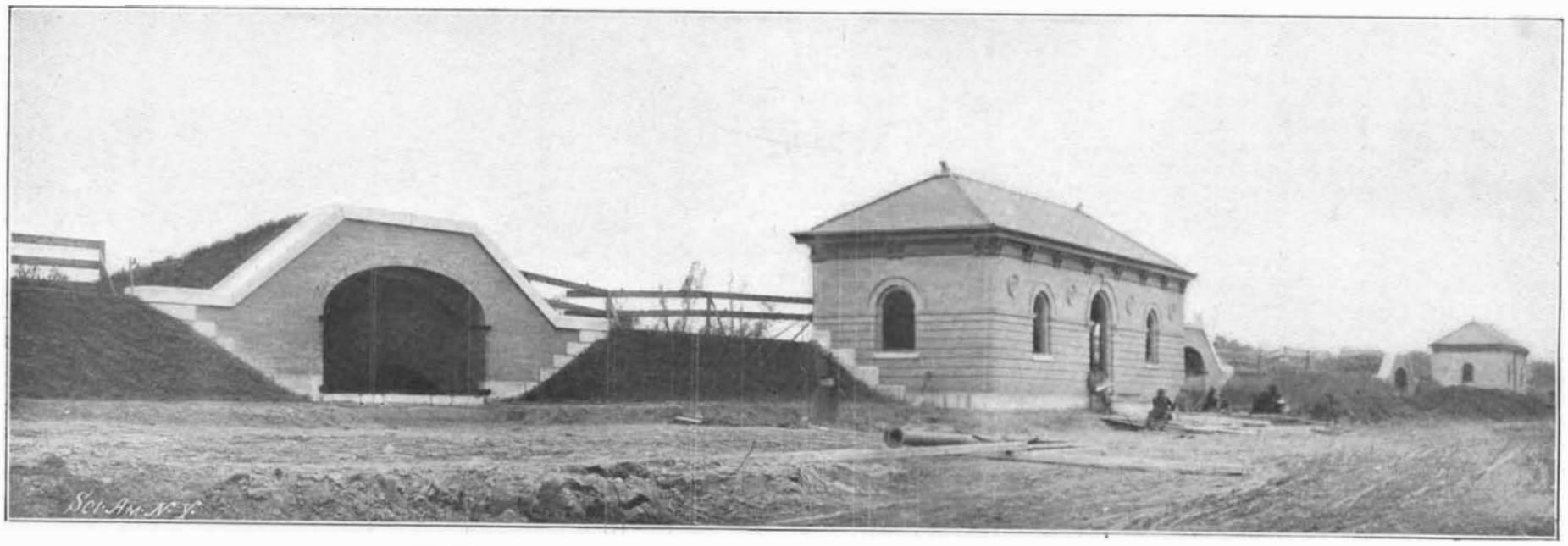


Perspective View of One of the Compartments of Filter Bed.

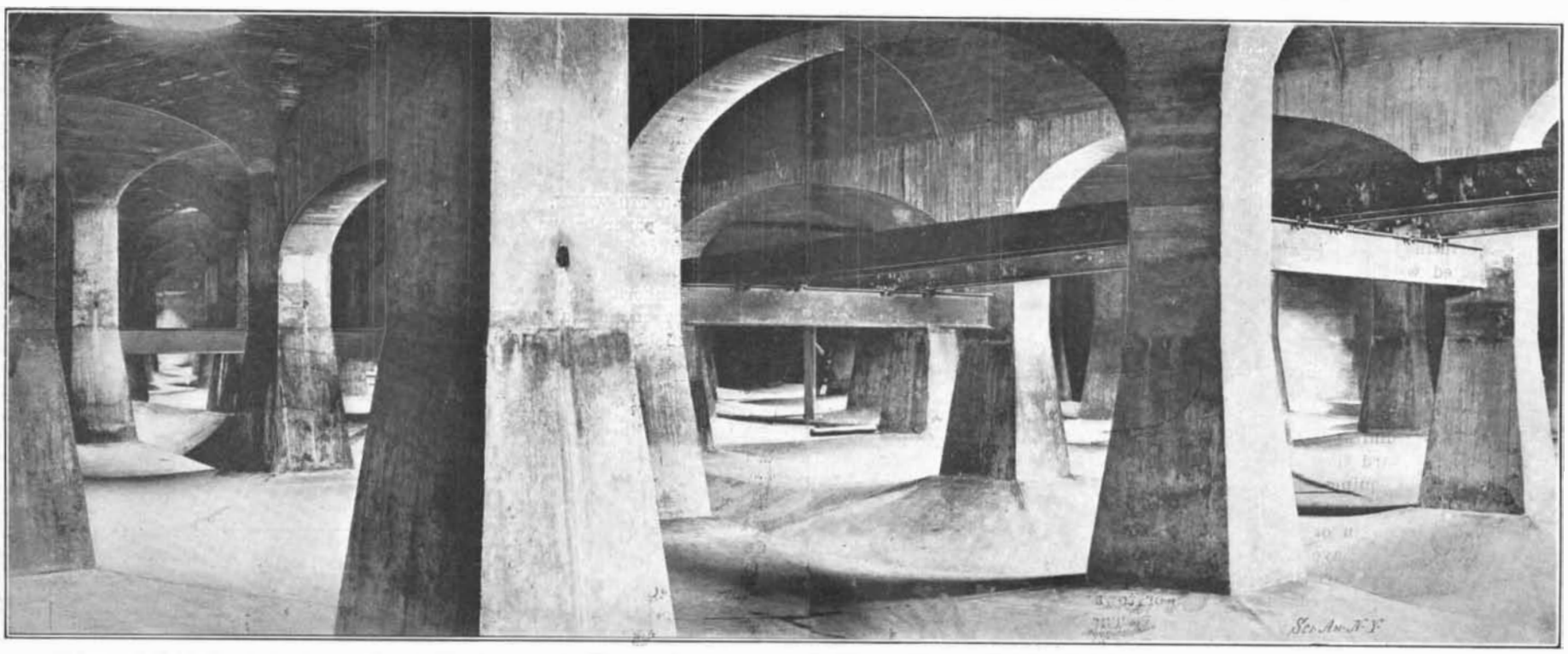
In this plant alone there are 4,450 feet of main sewers, from three and a half to eight and a half feet in diameter. These of course are for drainage, and not for the handling of sewage. There are two miles of 20, 24, and 30-inch terra-cotta pipe; 8,000 tons of cast-iron pipe from 16 to 60 inches; a million yards of excavation; 4,000 lineal feet of concrete conduit from 7½ to 10 feet in diameter; 170,000 cubic yards of concrete work; 118,000 yards of clay puddle work. Everything used in the construction except the piping is made on the spot, as is all of the temporary material, such as the wooden forms in and around which the concrete work is molded, and this in itself necessitates a manufactory that is by no means a small affair.

Each filter bed covers an area of three-quarters of an acre, net, that is exclusive of the walls and the pillars inside which hold up the roof. There are fifty-five of these filter beds at Torresdale, which, as before stated, make the plant the largest in the world. Each bed has a capacity of four and a half million gallons in a day of twenty-four hours under a "six million rate." The six million rate is the amount of water that will run through an acre of sand in twenty-four hours.

The process of filtration is of course exactly the same. Each basin is covered with a roof, the filtering material being placed in the bottom of the basin. The roof of the filter bed is 12 feet 9 inches in the clear above the floor and is supported by concrete walls which are three feet wide at the bottom and taper to 22 inches, and by piers, also of concrete, with bases 22 inches square placed at regular intervals, so that their centers are 15 feet 10 inches apart. The roof supported by these piers consists of a series of arches. The floor of the bed is made by putting down 12 inches of puddle (clay mixed with gravel in



Entrance to Filter Bed. House in which Ingoing and Outgoing Flow is Regulated.



Interior of One of the Filter Beds.—Parallel Lines Running Through Compartments on Right are the Tracks of Railroad Used to Transport Sand into the Filter Bed.

THE NEW PHILADELPHIA FILTRATION SYSTEM.

equal parts) and over this the concrete. The walls and piers are made by ramming the concrete into wooden forms, due allowance being made for contraction and expansion, while the concrete forming the roof is also put on over wooden forms in such a way that each pier is actually, and the whole chamber practically, a monolith, or single stone, the leakage through which, either in or out, may be disregarded. On the floors of the bed, in parallel lines between every two rows of piers, are laid perforated terra-cotta pipes 8 inches in diameter. These pipes, running to the center of the floor of the bed, meet there a pipe running at right angles to them, and this pipe conducts the filtered water out of the chamber.

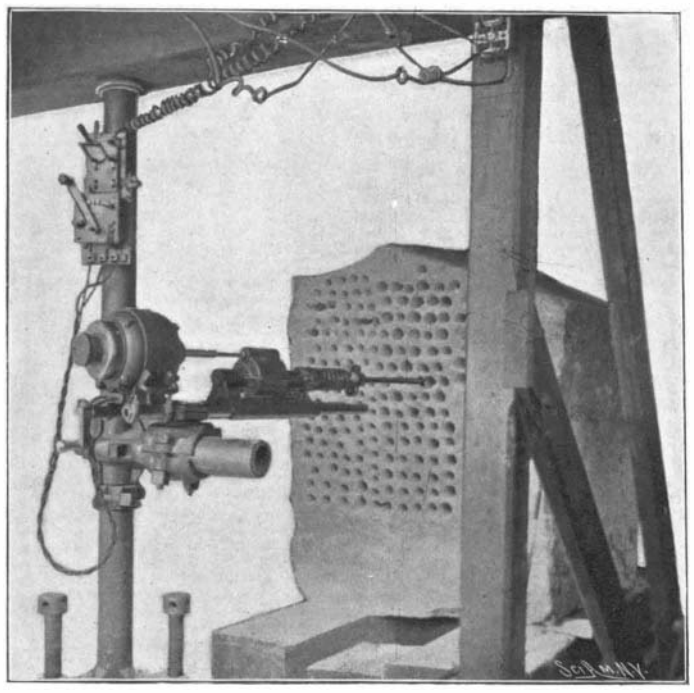
Over the perforated pipe is put broken stone or coarse gravel, the first layer being of stones the size of a walnut, to a depth of a foot. Over this is put from three to three feet and a half of sand. It is this sand which does the work of filtering. Over the roof is about two feet of earth, and such surface water as may fall on this and find its way to the concrete roof is taken up by a two-inch drain pipe.

The water to be filtered is let into the bed directly from the river through a twenty-four inch pipe; there is only one outlet for each bed. The water filters through the sand and into the perforated pipe, and thence into the pipe, which carries it out of the bed. Just outside of the bed it goes to the regulating chamber, whereby the flow of water, and consequently the rate at which it is filtered, is automatically controlled. The filtered water flowing into this chamber fills it to a point where it may flow out by passing over and into the upper end or mouth of a pipe which stands vertically in the chamber, and which is so supported on a float that its mouth is always at a given distance below the surface of the water. If the mouth is raised above the surface, as it can be of course, no water flows out; the lower it is sunk below the surface the faster the water will flow. From the regulating chamber the water flows by gravity into pipes which run along the alleys—or courts as they are called—between the batteries or sets of filter beds, and thence it finds its way to the conduit running along the west side of the plant. This conduit is practically one solid stone pipe made out of concrete, beginning with a diameter of 7½ feet and increasing to 10. It empties into the filtered water basin, which covers an area of 10½ acres and has a capacity of 50,000,000 gallons. The basin is made entirely of concrete. Its inside height in the clear is 18 feet, and its roof is supported by piers similar to those in the filter beds. The roof is covered with earth, as are those of the beds, but since the water is now filtered, no surface water is allowed to get into it, but is carried away by drainage pipes.

From the filtered water basin another solid concrete conduit 10 feet in diameter runs for a distance of 900 feet, carrying the water to a shaft that connects with a tunnel that runs to what is called Lardner's Point, three and a half miles away.

The water supplied to the filters is pumped to the preliminary filters, through which it will pass and flow by gravity to the plain sand filters. The preliminary filters contain a bed of granulated material, which may be broken trap rock or slag, varying in size from ⅜ to 3-16 of an inch and in depth about 30 inches, above which is placed a mattress of compressible material, through which the raw water flows from the bottom to the top.

In cleaning the beds it is necessary to take great care not to disturb the layers of sand. Filtered water is at first put in very gently from the under side, taking just the reverse course it has when being filtered. Once the surface of the sand is sufficiently covered with water, the rest may be again put in through the regular supply pipe. These "refill pipes" are as numerous and complete in their system as the supply pipes. They are each 16 inches in diameter. Each bed has a sand incline, by which the sand is taken out or new sand put in. This sand incline is built upon iron channel beams, which are set into the two middle rows of piers. At the apex of every other one of the arches of which the roof is formed is a manhole, which serves for light and ventilation while the bed is being cleaned. Each filter bed has to be cleaned once a month, which requires a day's work on the part of thirteen or fourteen men. For the entire system there will be needed about 400 permanent employes working as filter-bed cleaners. It is expected that the work will be finished this fall.



THE LOCKE ELECTRIC PERCUSSION ROCK DRILL.

THE LOCKE ELECTRIC ROCK DRILL.

This drill is one of the percussion type, the drilling tool having a combined reciprocating and rotary motion. In this it resembles the usual form of air drills, but being driven by electricity it has, instead of the somewhat unmanageable air tubes, simply flexible wire connections. It is essentially a ball bearing machine, is made dust and water proof, and only requires a few drops of oil at intervals of an hour or more to keep it in perfect working order. Any overheating can be readily felt, and at once reduced with a little oil. The shank or base of the drill (see figure) is made to fit the clamp or saddle generally used upon the ordinary 4½-inch column or 4½-inch arm.

The motor, which is inclosed in a spheroidal shell (at the left of figure) is directly connected by means of a hollow extension shaft, thus doing away with the usual flexible shaft of other drills. It is readily detached, and as it only weighs 95 pounds one man can carry it about, or two men can handle the whole drill without disconnecting it. The motor is a shunt wound ¾ horse power making 2,500 revolutions per minute and using 220 volts of direct current. The drill strikes the rock 300 to 350 blows per minute, and the spring which gives the forward motion of the piston has a final compression at the end of the back stroke of 720 pounds, thus giving a very high forward velocity to the piston. The drill will rarely if ever stick in the rock when crossing seams or soft spots, as the mechanism is so constructed as to have much greater power to pull the drill back than the spring has to drive it forward.

The Locke Drill Company makes specially favorable arrangements to supply duplicate parts. A number of extra parts are supplied with each drill.

The weights of the different parts of the drill are as follows: Motor, 95 pounds; drill bore, side bar, and feed screw, 53 pounds; front and back cylinders and interior mechanism, 91 pounds; total weight, 239 pounds.

Among the advantages of this drill may be mentioned that the insulated wire connections of the drill are much more easily handled and much cheaper than the air pipes of pneumatic drills. Many mining districts are now well supplied with electric power, and it is only necessary to put in rotary transformers where the current is alternating or the voltage unsuitable. Many mines however have their own electric light plant, usually furnishing direct current, and a few drills using less than one horse power each would not overload the dynamo.

THE GORTER WATER TOWER.

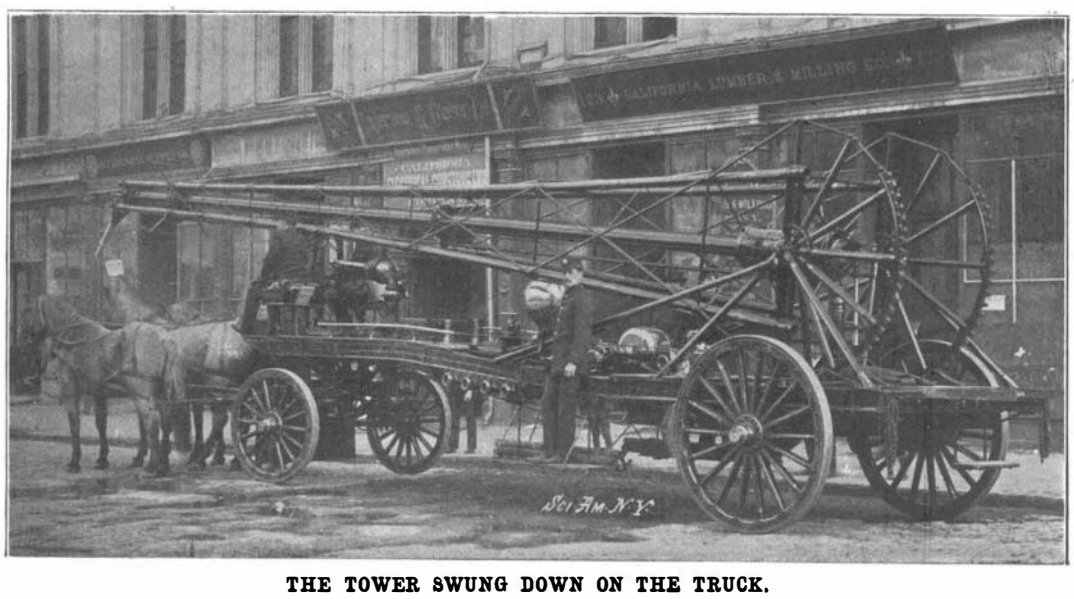
BY H. J. BENNET.

San Francisco has in service among its fire apparatus a "water tower" embodying in its design and construction some very novel features and radical departures from any other tower heretofore constructed.

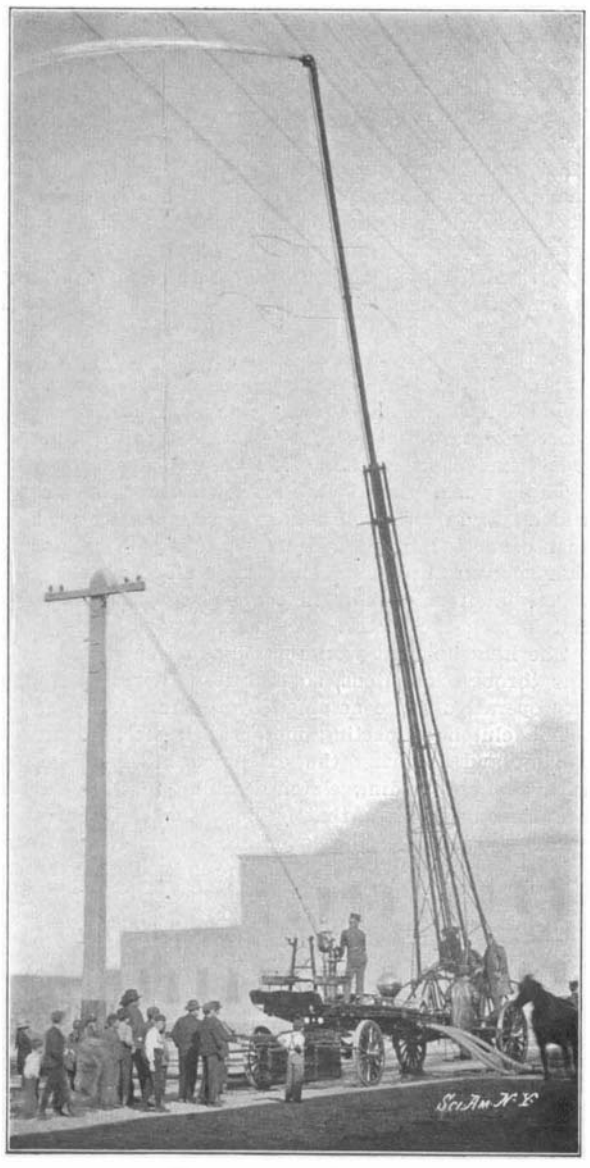
It was invented and designed by Henry H. Gorter, a mechanical engineer in the fire department of that city. This tower has fully demonstrated its superior efficiency, during its few months of service under rigid tests and at large fires, in a manner such as to attract wide attention from fire officials of various cities throughout the United States and Europe. Its construction and general features are as follows: The body frame or truck proper is of 5-inch channel steel, built on the truss principle, the rigidity being obtained by various hog braces and truss rods. The main mast is 3-inch light steel tubing, properly braced and reinforced, forming a very rigid, yet light pyramidal frame so arranged as to swing on trunnions at its lower end; said trunnions being carried on two tripod frames resting on truck proper.

The extension of mast which slides up and down through center of mast proper is of 5-inch light steel boiler tubing, reinforced by two feathers on the outside, to take up excess of spring under back pressure strain from nozzle.

The full extension of this tower is 76 feet to center of nozzle ball joint, the nozzle itself reaching 2½ feet beyond that, making this, by far, the highest water tower in service, in either the United States or the world. This tower is metallic telescopic, no hose at



THE TOWER SWUNG DOWN ON THE TRUCK.



THE TOWER IN ACTION.