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“High-Pressure Fire-Service, Alexandria, Egypt.”

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(Abridged.)

IN a previous Paper¹ the pumping and filtration plant installed by the Water Company for dealing with the supply to the City of Alexandria has been described in some detail. This service has proved fully adequate to all the purposes for which it was intended. The supply has been constant, the quality of the water excellent, and the pressure in the mains sufficient for all ordinary domestic and manufacturing requirements. More recently, however, there has arisen a demand (the outcome of circumstances hereinafter described) for a high-pressure fire-service, and the object of this Paper is to describe how that demand has been met.

As is well known, the City of Alexandria is the receiving and distributing centre for Egypt's greatest asset, its cotton crop, the annual value of which may be estimated at 30 to 40 millions sterling. The hydraulically-pressed bales are warehoused there in buildings known as “Choonahs,” and in due course are opened, sampled, graded, and re-packed. Unfortunately the cotton district of Alexandria has earned for itself during the last 20 years a somewhat unenviable notoriety in the matter of fires. The insurance companies 2 years ago felt themselves compelled to make a substantial increase in their rates, but an arrangement was made with the British Fire Offices' Committee and the “Syndicat” of French Insurance Companies to reduce their rates 30 per cent. on properties protected internally with automatic sprinklers and externally by means of drenchers or water curtains.

The official “Rules of the Fire Offices' Committee for Automatic Sprinkler Installations” stipulate that there must be “two separate

¹ Minutes of Proceedings Inst. C.E., vol. clxvi, p. 316.

and adequate sources of water-supply always available, one at least of such sources being practically unlimited and one automatic"—whilst another rule provides that the supply from the city mains, where utilized, must give "at all times during the day and night a running pressure at the level of the highest sprinkler of not less than 25 lbs. to the square inch." Whilst an unlimited supply could be obtained from the water-mains previously existing, the augmentation of pressure to the extent called for by the insurance companies was quite impossible. To comply with this, the Alexandria Water Company have recently completed a new system of high-pressure mains exclusively for fire service, in which a pressure of approximately 120 to 130 lbs. per square inch is maintained and from which 6-inch connections are taken to each of the sprinkler and drencher equipments in the city.

Before describing the new high-pressure service, it may be noted that an ordinary type of automatic sprinkler with a standard $\frac{1}{2}$ -inch orifice will, at a running pressure of 40 lbs. per square inch at the nozzle, discharge 30 gallons of water per minute, and as the number of sprinklers required for the protection of a cotton "choonah" ranges from 500 to 2,000, it is evident that the quantity of water necessary to supply the whole of the sprinkler-heads, assuming them all in action at the same time, would be beyond the capacity of any ordinary pipe-system. But experience has proved that only a very small proportion of the total number of sprinklers in a room or building are required to operate over actual fires. Records carefully compiled establish that between the years 1897-1908 in 6,062 fires under automatic sprinklers 78·09 per cent. were extinguished by less than ten sprinklers, and 93 per cent. by less than fifty sprinklers; and that in only 4·55 per cent. did more than 100 heads operate. The insurance companies have, therefore, never attempted, except for small sizes of pipes, to reconcile in actual practice their schedule of pipe-sizes with their theoretical capacity.

The Table on page 260 gives the number of sprinklers allowed to be taken off pipes of given diameter.

The site chosen for the pumping-station was on the banks of the Mahmoudieh Canal at Minet el Bassal, which is quite the most convenient position, being in the centre of the cotton district, whilst it provided for the pumps two distinct sources of supply, in that the suction-chamber could be supplied direct from the filtered-water mains, or in case of need from the canal. The particulars of the pumping installation are as follows:—

There are two horizontal steam-pumps, each capable of delivering 2,000 gallons per minute, and two vertical steam-pumps, each

Size of Pipe.	Theoretical Equivalent in Number of Sprinklers with Standard $\frac{1}{4}$ -Inch Orifice.	Maximum Number allowed by Insurance Companies' Rules.
Inches.		
1	4	3
2	16	18
3	36	46
4	64	115
5	100	150
6	144	Over 150

Maximum size of pipe 6 inches.

capable of delivering 400 gallons per minute against a head of 130 lbs. per square inch, a total nominal capacity of 4,800 gallons per minute. There are two boilers, each of ample power to supply steam to the engines when delivering their full quantity of water against the above head. These are of the vertical type, fitted with inclined and crossing water-tubes, in which steam of 100 lbs. pressure can be raised in 10 to 12 minutes from the time of lighting the fire, cold water being used at starting. The boilers were tested under a hydraulic pressure of 250 lbs. and a steam pressure of 160 lbs. per square inch.

The larger units are of the horizontal type, each engine having two steam-cylinders and two water-cylinders connected by the engine-frames. The piston-rods are connected to the head-piece of the pump-rod; from a joint in this head-piece a connecting-rod returns to a double-throw crankshaft. On the crankshaft there are eccentrics for working the slide and expansion-valves and two balanced fly-wheels.

Diameter of the steam cylinders	14 $\frac{3}{4}$ inches.
" " pumps	9 $\frac{1}{4}$ "
Stroke	12 "
Capacity per revolution	11.24 gallons.

They are designed to deliver 2,000 gallons per minute at 190 revolutions per minute, allowing for slip. The steam-cylinders are of large area in proportion to the pump, allowing the engine to be worked with low-pressure steam if the fires are banked and the steam low. The pump-valves are of large area, readily accessible

for renewal or repair, and suction and delivery air-vessels of ample capacity are fitted.

On the delivery side of the pump a safety-valve is fitted, which relieves at any set pressure, and with a slight increase of pressure even for the full delivery of the pump. An arrangement is made for shutting off this valve should any accident occur to it. A by-pass, connecting the suction to the delivery from the town mains, and a waste-valve are fitted, to be used when starting against pressure in the mains.

Pilot-Pumps.—There are also two smaller units comprising two vertical sets of steam-engines with pumps, each capable of delivering 400 gallons of water per minute against a head of 130 lbs. per square inch at 178 revolutions per minute:—

Diameter of steam-cylinders	9 $\frac{3}{8}$ inches.
" pump "	5 $\frac{1}{8}$ "
Length of stroke	6 $\frac{1}{2}$ "

Each engine has two steam-cylinders and two double-acting pumps. They are fitted with pressure-regulators, consisting of equilibrium-valves governed by pistons controlled by springs and raised by water under pressure from the delivery-head of the pumps. The springs are set to suit the desired pressure in the pumps, and when this is exceeded the pistons rise and shut off the steam.

The purpose of these smaller pilot-pumps is to keep the new fire-mains constantly charged at the static pressure of 120 to 130 lbs. per square inch, and further, when there is any slight draught from these mains, such as the opening of a few sprinklers or a hydrant, to maintain automatically the supply and pressure until such time as the draught becomes too great for the smaller pumps, when the larger ones would be immediately started. One of these sets is actually kept moving slowly under steam day and night maintaining the pressure in the mains, and is regulated by the automatic regulator as described above.

In the event of the pressure in the mains falling, an alarm is given by a loud gong, which sounds automatically and warns the attendants, who in less than a minute can start one of the large engines which are always kept in readiness to work.

Suction Arrangements.—Immediately underneath the foundations of the pumps, there is a masonry reservoir containing about 22,000 gallons, supplied with the town's filtered water from 12-inch and 8-inch town mains, in which there is a pressure of about 90 feet, through an equilibrium-valve, which is controlled by the

level of the water in the reservoir. To provide against a serious conflagration—which may last for a considerable time—or of any failure of the filtered water-supply, a direct connection has been made between the suction-reservoir and the Mahmoudieh Canal, from which an unlimited supply of unfiltered water is always available in case of necessity. This arrangement provides, therefore, two distinct sources of supply to the high-pressure mains, as required by the insurance companies.

Steam is always under pressure in one of the boilers, ready at any moment to supply one or more of the pumping-sets, and full pressure can be raised in the second boiler from cold water in less than 20 minutes. Boiler feed-pumps, air-vessel and charging-pump, recording-gauges and feed-water heaters are provided.

At the date of this Paper, about 6 miles of high-pressure mains had been laid in the principal streets and thoroughfares where the cotton stores and presses are situated, the sizes of the mains being 12 inches, 8 inches and 6 inches, according to the importance of the branch connections required.

As already explained, the insurance regulations call for an additional supply to the sprinklers beyond the connection with the high-pressure main. The second source adopted in Alexandria is an elevated tank with a capacity of 7,500 to 10,000 gallons, according to the size of the installation, one for each block of protected buildings. The height of these tanks is such that there will be a minimum static pressure of 6·5 lbs. per square inch on the highest sprinkler.

A check-valve is fixed on both the supply-pipe from the high-pressure main and on the delivery-pipe from the tank. In the event of the high-pressure service being temporarily interrupted, the tank will thus automatically supply the installation. Both supply-pipes are coupled together into a combined or “trunk” main before reaching the installation controlling-valves. In large buildings it is usual to subdivide the plant into two or more separate installations, each controlled by its own set of valves. This, among other advantages, serves to reduce the number of sprinklers rendered inoperative in the event of repairs or alterations being necessary.

The water-supply to each installation is controlled by a main stop-valve, immediately above which an alarm-valve is fixed. As soon as there is a continuous flow of water into the installation, even if only sufficient to feed one open sprinkler, a by-pass in the alarm-valve allows sufficient water to escape to actuate a small water-motor with revolving hammers which sounds a loud alarm on a gong fixed on the outside of the building. This continues so long as any

water is flowing into the pipes. Provision is made for dealing with any slight increase in pressure in the mains and false alarms are thereby avoided.

Although a building in which sprinklers have been installed can be considered as efficiently protected internally, there still exists a danger from the outside, owing to the congested nature of the Minet el Bassal quarter. Many of the sprinkler-protected buildings are separated from unprotected property by streets less than 20 feet in width, and even in this space considerable quantities of cotton are frequently lying. The drencher system was, therefore, adopted to overcome the danger from external fires. Each window, door, roof-skylight or other opening, in fact any portion of the building to or through which fire could spread from the outside, is fitted with drenchers which when in operation will concentrate on the vulnerable points a curtain of water through which it is impossible for fire or heat to penetrate. It should be noted that the drencher system is not automatic, but as the installation is divided into sections, each controlled by its own stop-valve, the whole supply and pressure of the water can be directed to that part of the building which is threatened. Hitherto in many of the conflagrations the fire brigade's first thought has been to save the adjoining properties. In future the drencher system will relieve them to a large extent of this duty and enable them to concentrate their attack on the actual seat of the fire.

As with sprinklers, so with drenchers the pipes are carefully graduated in diameter. Although the orifice of a drencher is never more than $\frac{3}{8}$ inch in diameter and in some cases is only $\frac{1}{4}$ inch, the fact that all the heads on any one section will be in operation at the same time renders necessary a relatively larger pipe system than in the case of sprinklers, so as to ensure a full supply of water at points farthest from the source.

The following Table gives the number of drenchers allowed to be taken off pipes of given diameter :—

Size of Pipe.	Maximum Number of Drenchers allowed by Insurance Companies' Regulations.	Size of Pipe.	Maximum Number of Drenchers allowed by Insurance Companies' Regulations.
Inches. 1	2	Inches. 4	72
2	10	5	100
3	36	6	Over 100

An attachment is provided so that in the event of a very large demand on the high-pressure system a fire-engine, drawing water from the low-pressure mains or from the canal, can be coupled to the drencher system and thus supplement the pressure.

The whole arrangement of this high-pressure installation of pumping-station and mains was designed and carried out by Mr. H. R. C. Blagden, Manager of the Alexandria Water Company, Messrs. Mather and Platt, Ltd., being responsible for the sprinkler, drencher and tank installations.