

first be graded to the shape of the proposed roadway, and then firmly compacted with a roller. When the material which is to constitute the foundation is found to be too soft to roll, gravel should be put on until it is found that the roller works properly. If loose sand or gravel is found which will not compact under the roller, then hard pan loam or other suitable material is to be laid to the depth of about an inch to serve as a binder.

To make a macadam roadway, broken stone from one to two and a half inches in diameter should be placed on the compact bottom to a depth of three or four inches, and a roller passed over it four or five times. Then more broken stones of the same size should be laid to a depth of three or four inches in the centre of the roadway and two or three inches at the sides. This should be rolled with a roller until smooth. When the rolling of the top layer of stone is about half completed, it is the custom of some road makers to strew sand over the metal as the roller passes back and forth. This sand should be applied until all the interstices are filled. Others use an inch screening from the crusher, carrying in size from dust to half an inch. These should be thoroughly watered and rolled until the dust and stones have worked into the interstices, and bound the larger stones firmly together. The surface of a road should be curved transversely so as to allow the water to flow quickly to the gutter. If the rise is great, the travel is kept along the centre, which will soon be worn down to such an extent that water will collect. Moreover the water will make gullies in the surface at the sides, which will at all times be a discomfort. The crowning allowed by the best road-makers is a half to one inch to the foot on level ground and much more on a hill, so that storm water will reach the gutters before it has acquired a velocity which will be harmful.

Waterworks.

Whoever considers carefully and broadly the duties of the builders and managers of our public water supplies, whether he be city official or private citizen, will be deeply impressed with the responsibilities that accompany those duties. In building the works, the smallest part and each part of the various details, even to the complete whole, must be planned and executed with precaution, thoughtfulness and skilful workmanship, and afterwards, in their management, there must be no relaxation from eternal vigilance. It is of momentous consequence that every part of the construction be not only adapted, but that each part shall always be ready to fulfil its functions in perfect manner. A stoppage of pressure in the public fire hydrants causes consternation in a city, but a shutting off of the water from a kitchen, the steam boilers, and the sanitary apparatus, paralyzes the activity of the community.

All of those who have the care of a public water supply are not alike capable of being impressed with the importance of faithfulness, care and caution in their duties, and when on rare occasions there are conspicuous neglects or oversights, such may with profit be made the basis of object lessons for the information or the warning thereby suggested. A few selected instances, briefly cited, will suffice for the present purpose.

On inspection of a small steam pumping plant, the gauge on its only boiler was found not indicating the pressure within the boiler, and on trying the safety valve of the boiler, it was found stuck so fast that only with considerable difficulty was it pried loose, so it could act as a relief if the steam pressure became dangerous. The station attendant depended on the way his pumps worked for his information of the pressure within the boiler, and was thus satisfied in protecting his own life from the danger of a boiler explosion, and the village from the loss of its water supply.

In another case, a large, single-cylinder condensing engine, with fly wheel, was unable to do the work required, and it was supposed that a new engine must replace it at once. The engine appeared, on inspection, to be of good workmanship and of capacity to do the work required. On applying an indicator, it was found that its cut-off steam valves were so adjusted that three-fourths of its work was being done in one end of its cylinder. The valves were re-set in their proper positions, and although this was five years ago, no further complaint has been heard.

In another instance, some waterworks bonds were offered for sale. The prospectus scheduled an admirable plant. Included in this, were three pumps—one a duplex, direct-acting compound condensing engine, and the remaining two were single-acting high pressure pumps. At the time of the examination of the works in the interests of the proposed investors, the duplex pump was at work smoothly, and the other pumps were said to be reserved for fire purposes. The fire pressure was given direct from the pumps. When the attendant was asked to start up the two single-acting pumps he hesitated, and then explained that one of them was out of order and had not been used since he came to the station, four months previously. On being pressed to start the other pump, he procured a valve key and disappeared through a trap door to the basement. Soon he was heard laboring to start a valve in the force main that was shut and stuck fast, and cutting the pump off from the distributing pipes. In time he came up with bruised hands and turned on steam to start this one pump, said to be in order. It resisted, then jerked two inches and resisted again, then jumped to about three-quarter strokes, and afterwards would not move in either direction. He apologized that he had not had time to clean her up since he came,

yet his plant was trusted by the citizens as a guardian angel to save them from a conflagration.

In another instance, a pair of coupled condensing engines were working a pump unsatisfactorily. These engine cylinders had never been tapped for indicators. On enquiring of the attendant how he was guided in setting the engine valves, he said he could tell by the appearance of the exhaust puffs from the two exhaust pipes that extended above the roof of the pump house. His engines were then in good condition, in accordance with more precise information, their efficiency was greater, and regulation more satisfactory, and the attendant was happy in his added wisdom.

Although such lack of intelligent care and supervision sometimes escapes being very serious, it is often found to be one of a series of defects in the same works, and the efficiency of the whole works is greatly impaired by the lack of knowledge and thoroughness of attention by its supervisor.

Municipal councils and boards of water commissioners should see to it that the superintendent is a man of knowledge and experience, capable of judging of the fitness of the men in the various positions of trust under him, and also to see that they are diligent in closely watching all parts of the machinery, and at all times know that additional apparatus is in perfect working order, ready at a moment's notice to perform the work for which it is intended. It is also necessary that the superintendent should carefully test all fuel and other material consumed in the works, in order to know that value is received for the money expended. A coal company in asking for contracts will show that the analysis made of their coal places the fixed carbon at a high percentage, while that of others is much less, and thus they expect that it will be concluded that their coal is superior. A contract is awarded and an inferior article is shipped. The analysis in this matter is of very little use unless the superintendent sees that the material shipped is of an equal grade with the sample analyzed. First class coal consists of from seventy to eighty per cent. of pure carbon with varying quantities of oxygen and hydrogen and a small quantity of earthy or mineral matter; this last constitutes the ash of the coal when burned and in some cases it is excessive and weighty. Coal occurs in laminated form, that is in beds, in other stratified rocks and there are innumerable gradations from pure coal into earth and carbonaceous shale until ultimately ordinary shale is reached, and consequently it is not like a mineral with a definite form and a definite chemical composition without losing the name of coal, and unless those in charge are very careful, the municipality will be the loser of hundreds of dollars in this one item on account of accepting a tender slightly lower than that of a reliable firm, believing that all tenders are for the same grade of coal.