

liquids, but facilitate their prompt discharge into the side gutter catch basin, it should also be of such material and construction that it can readily be taken up in places and quickly and firmly relaid, so as to give easy access to water and gas pipes. Facility to repairs at all seasons of the year is another important requisite, economy of maintenance and repair require that the material at the surface shall be durable. All the road coverings heretofore described are wanting in one or more of the most important of the qualities while they possess, beyond doubt some of those that are at least essential in even a greater degree than the best street covering. Road surfaces of broken stone or gravel produce less noise and give a more secure footing for horse than blocks of stone and wood or a construction surface of asphalt or other material, but they require such constant supervision to arrest the formation of ruts and are so infested with either dust or mud as to render them greatly inferior to a good stone or asphalt pavement, for streets subjected to heavy traffic. An exception may perhaps be made in their favor upon suburban streets so exclusively devoted to light travel or pleasure driving as to justify the expense of frequent sprinkling by day and sweeping by night, these kind of road coverings are also conceded to be excellent for drives in public parks and there are cases where the principle of throughfare leading thereto should be constructed after the same method and maintained with the same care, as, the park drives especially if the bulk of the travel and traffic over it be of a light character. They should be swept every night and in dry weather sprinkled repeatedly every day. It must be admitted, however, that there appears to be no trust worthy record of any urban street of this kind in a thickly settled district which has been maintained in such manner that the inconvenience and annoyance inflicted by dust and mud upon the residents or people doing business on either side but did not really amount to a most serious public nuisance. The object of a pavement being to secure a hard even and durable surface and not to any considerable extent nor necessarily to support the weight of heavy loads, it is evident that the surface will soon subside unequally forming ruts and depressions unless it rests upon a firm and solid foundation. A good foundation is as necessary for the stability of a pavement as for that of any other construction. Among the foundations I would recommend, provided the thickness be adapted to the character of the subsoil and the nature of the traffic are: First, Hydraulic concrete six to eight inches in thickness. Second, Rubble stone set on edge but not in contact with the interstices filled in with concrete. Third, Cobble set in a form of sand or gravel. Fourth, A layer of broken stone laid in the manner of a macadamized road.

## Water Supply.

### IV.

The question of conducting a supply of water to, and delivering the same under pressure in, a city from a distant source, by gravity alone, or by erecting a pumping station, and lifting water by power from a nearer source, is sometimes a complicated one. In such a case all the items of cost and annual maintenance should be carefully considered, as well as the elements of safety, which are not to be sacrificed for a moderate difference of first cost. Long lines of conduits and mains are expensive, and their putting down may absorb more in capital and interest than would pay for pumps, power, and attendance for lifting from the nearest supply. As regards safety and reliability of operation, the gravitation system comes first and second in the method of delivery, as when the supply is elevated by hydraulic power, and third, when it is elevated by steam power to a liberal sized reservoir, holding in store from six to ten days reserve of water, from whence the supply flows by gravity into the distributing pipes.

If in such case there are duplicate first-class pumping machines, whose combined capacity is equal to the whole daily supply in twenty hours, then this method is scarcely inferior in safety to the gravitation method.

The elements of safety may be equally secured in the low and high service method, when the physical features of the town or city may make such division desirable. The records of nearly all the water departments of the largest cities having duplicate pumping machines, show how valuable and indispensable have been their reserve stores of water, and refer to the risks that would have been incurred had such reservoir storages been lacking. Fourth, as regards safety and reliability, comes the direct pressure delivery by hydraulic power; the fifth by steam power with either stand-pipe or air vessel cushions and safety relief valves. The mechanical arrangements that admit of this method of delivery are simple, and several builders of pumping machinery have adapted their manufacturies to its special requirements, but in point of continuous reliability the method still remains inferior to gravity flow. Even when the most substantial and most simple steam pumping machinery is adopted, if not supplemented by an elevated small reserve of water, this method of delivery is accompanied with risks of hot bearings, sudden strains, unexpected fracture of connection, shaft, cylinder, valve chest or pipe, and occasional necessary stoppages.

The best pumping combinations are so certainly liable to such contingencies that cities may judiciously hesitate to rely entirely upon the infallibility of their boilers, engines and pumps, even when so fortunate as to secure attendants upon whom they can place implicit confidence.

The direct pressure method alone necessitates incessant firing of the boiler and motion of the pumping engine, and consequently double or triple sets of hands, to whose integrity and faithfulness, night and day, and at all times, the works are committed.

The direct forcing method does not provide for the deposition or removal of impurities after they have passed the engines, but the sediments that reach the pumps are passed forward to the consumers in all sections of the pipe distribution.

In combination with a reservoir sufficient for all the ordinary purposes, and equaling the ordinary work and the ordinary pressure at the taps, and also in combination with a very small reservoir, the direct pressure facilities may prove a most valuable auxiliary in times of emergency, and they are then well worth the insignificant difference in first cost of pumping machinery. In the smaller works, the entire machinery, and in the larger works one half of the machinery, may with advantage be capable of and adapted for direct pressure action.

If instead of substantial and simple machinery, built especially for long and reliable service, some one of the intricate and fragile machines freely offered in the market for direct pumping is substituted, and is not supplemented by an ample reservoir reserve, then a risk is assumed which no city can knowingly afford to suffer; and if true principles of economy of working are applied it will generally be found that no city can upon, well established business theories, afford to purchase and operate such machinery.

Well designed and substantially constructed pumping machines, such as are now offered by a number of reliable builders, are most economical in operation and most economical in maintenance, and infinitely superior in reliability for long continuous work.

The quantity of water required in cities has been found to increase much faster than the population. From 30 to 40 gallons *per capita* per day in non-manufacturing towns, and from 60 to 70 gallons per day in large commercial cities, ought to be sufficient; but statistics show that many cities consume largely over this amount.

With economy to prevent wastage, about 60 gallons per day would be a fair allowance; but inasmuch as cleanliness, comfort, and health are dependent upon its free use, as few restrictions as possible should be placed on it.

\* \* \*

The subject of country roads is just now receiving extraordinary attention, an illustrated article in the *April Century* being the latest notable contribution. All that is said goes to show that no other civilized land has such poor country roads. But then, no other land has legislative bodies which habitually put politics above public interests.