Rolling.

The use of a very heavy roller will much facilitate the consolidation of the road. A plan highly recommended is to have a roller made of a hollow cylinder of cast iron, or covered with iron bands seven feet in diameter, and five feet long. A strong axle passes through its length. Its ends are closed and two interior partitions perpendicular to the axles divided into three equal chambers. A longitudinal band of the surface a foot wide can be detached so as to give access to the interior spaces which are filled with gravel, one or all of them, according to the weight desired. The empty cylinder weighs 7000 pounds, each compartment filled with gravel adds 4000 pounds to the weight ; so that the entire weight may be made successively 7000 pounds, 11000 pounds, 15000 pounds and 19000 pounds. To compress a new road, four to six horses should be attached on a wet day in summer to empty roller and draw it several times over every part of the road till the materials have been so far compressed as not to form a ridge in front of the roller. Then the middle division is to be filled with gravel, moistened to give it solidity, and the rolling resumed till the draft is so much lessened that the end divisions can be filled, the middle one being emptied at first if necessary. There should be an excess of power in the horses so that they may do less injury by the violent pressures of their feet. Every part of the road should be passed over from 10 to 15 times. To increase the stability of the compression, an inch of gravel should be spread over the surface and passed over by the roller a few times. If the weather be dry the surface should be watered. The season should be summer, that the road-bed may be dry, and the day be wet to ensure a moist surface which facilitates the binding of the materials. When the roller has finished the compression the road is still very different from one which has borne the traffic for many years ; for although the materials are strongly pressed against one another and have taken a stable position they have not acquired the adhesion which takes place after a series of years. The new road therefore needs for some time careful attention. The travel must finish it by being forced to pass over every part of it uniformly, heaps of pebbles being placed very irregularly so as to direct the vehicles successively on all points of the road. Every rut and the slightest hollows and elevations must be promptly removed by a liberal supply of laborers, whose work will, however, have been greatly lessened by the previous rolling. They must rake over every inequality of surface the moment it is formed.

KEEPING UP A ROAD

This is a very different thing from repairing a road, though the two are often confounded. A due attention to the former will greatly lessen the necessity for the latter. The former keeps the road always in good condition ; the latter makes it so only occasionally after intervals of various length during which it is continually deteriorating in a geometrical ratio, so that the better the state in which the road is kept the less are the injuries to it and therefore the less the expense of keeping it in this excellent condition.

Keeping up the road requires the daily attention of a permanent corps of laborers. Supposing the road to be already in good condition, that is, in proper shape and free from holes, ruts, mud and dust, to keep it so requires two fundamental operations: 1. The conditional removal of the daily wear of the materials, whether in the shape of mud or dust: 2. The employment of materials to replace those removed.

The first operation requires hoes and brooms. The hoes should be three feet long and of wood, as iron ones would be most likely to loosen the stones. The lighter dust and more liquid mud must be swept off by birch brooms. The detritus between the little projections of the stones should not be removed by too thorough sweeping as it protects them from immediate crushing and preserves their stability. The broom is also necessary to remove every trace of wheels the moment they have passed so as to oppose that habit or instinct of horses which leads them to follow in the track of the preceding vehicle, and which would soon convert unremoved tracks into ruts. The broom and hoe have then a double end to be accomplished by the same operation, viz. : effacing tracks and removing detritus. Very effective machines have also been constructed for accomplishing these purposes.

The second operation of applying new materials demands several precautions. To prevent a weak place from being neglected because the materials are not at hand they should be kept in depots, never more than a quarter of a mile apart and carried thence in barrows. They should be applied after rain, as then they will more easily unite and no coat thicker that one inch should ever be applied at any one time. A cubic yard to a superficial rod will be quite enough at once. They will then soon become incorporated without having their angles worn out by motion and will be of such service as double the thickness applied at once. To avoid retarding the travel and increasing the draught too much a new coat should not be put on any continuous space larger than six or seven square yards.

Water.

In order to have a clear idea of the nature of water, we must take a view of its chemical construction.

Water was long considered as one of the natural elements and consequently was supposed to be simple, and incapable of being decomposed, or separated into other substances. The discoveries of chemistry however have proved that this fluid is in fact a chemical combination of two kinds of gases which of themselves are invisible.

The two gases of which water is composed are oxygen and hydrogen. But water is not a mere mechanical mixture of these two kinds of gas, for, if a portion of each be merely introduced into a vessel, water will not be the result. In order to produce water these gases must be united in what is termed a chemical mode, that is by a particular and intimate union very different from simple mixture. The fact of the composition of water was first shown by Mr. Cavendish, who demonstrated it by exploding oxygen and hydrogen gases in a dry glass vessel, by which a quantity of pure water was generated.

By ingenious experiments water can be separated to its elementry constitutents oxygen and hydrogen; and by another process these very constituents may be made to unite and form the same quantity of water as was decomposed.

There is therefore no opinion in natural philosophy better established than that water is a compound body, and consequently that it cannot be ranked among the elements.

When we speak of the general properties of water as a body we allude only to water which is absolutely pure, and unmixed with any other matter whatever. Although pure water is composed of two gaseous bodies, yet there is no variety in its composition ; that is, a given quantity of water has not at one time more hydrogen and at another more oxygen, but the proportion of these constituents is always precisely the same, namely, eight parts by weight of oxygen and one of hydrogen.

Neither is pure water in itself liable to any change whatever, when its elements have once fairly united to form a liquid they cannot be separated or altered in any manner without the liquid entirely loosing all its properties, and no longer existing as water. Why, then, it may be asked, do we hear of different kinds of water ? If water be unchangeable, what distinctions can be made or how can various specimens of water have different qualities, as hard, soft, and so on ? In answer to these questions we will first describe the properties of water as a body independently of any kind of mixture with any other substance, or contaminations of any kind.

Water is volatile, that is, it is capable of being converted into vapor. If a vessel containing water is exposed to the air, the water gradually lessens in quantity and at length disappears altogether into invisible vapor. This is called evaporation ; not a particle of the water is lost, but the whole has dissolved into air to return one day in the form of rain. Water boils, or is converted into steam, when it is heated to 212 deg. in the ordinary pressures of the atmosphere, that is, when the barometer stands at 30 inches ; water cannot be made any hotter in open vessels because the steam carries off the heat. If salt is added to the water it is capable of being heated