2d. Cheapness. We mean cheapness in the true sense of the term. That is not always the cheapest which costs the least. If there is any matter in which a city may be "penny wise and pound foolish," it is just this matter of pavements. That is truly the cheapest where the purchaser gets the greatest possible return for the expenditure. Viewed with reference to durability alone, other things being considered as equal, that pavement is the cheapest with which it costs the least, interest and repairs included, to keep a street paved, and which exacts the least from teams and vehicles compelled to use it. To illustrate by an extreme: A pavement that would last forever—supposing such a thing possible—would be dear at sixteen dollars per square yard, as compared with an equally agreeable pavement, lasting eight years, at five dollars per square yard; for the interest on the difference of cost would more than renew the pavement every eight years. The pavement, no matter how good, should not exceed in cost our present improved pavements, say five or six, or at most, for the severest streets, like our Broadway, seven or eight dollars per square yard. This, of course, does not include bonuses to jobbing city officials, for a pavement possessing all the requisites would fight its own battles, and ultimately compel its own adoption, and not be under the necessity of buying its way into public favor.

3d. Permanent abundance of material. We say *permanent* abundance, for, no matter how good a pavement may be, constructed of a material the supply of which is limited, or must in a few years become so, such an one cannot be the pavement of the future.

4th. Evenness of surface. This essential hardly needs remark. The jolting, rattling, and rumbling, and wear and tear on horses and vehicles, of our present stone pavements, are nuisances no longer to be borne, and it is marvellous that they have been tolerated so long.

5th. Sure foot-hold for horses. Neither those who own horses nor those who have any sensitiveness to the sufferings of these much-abused and useful animals, will favor a pavement upon which horses are constantly slipping, straining, or falling.

6th. Noiselessness. This follows, of course, from evenness of surface, which must be combined with a certain degree of uniform roughness to meet the 5th requisite—sure foot-hold.

7th. Rapidity of construction, so that the street may be impeded for the shortest possible time. The pavement should be completed at the rate of a block, or nearly so, per day, and each block be thrown open to the public on the day following its construction.

8th. Facility of repairs. For the sake of an illustration, we have supposed a pavement lasting forever; but pavements do *not* last forever. It would seem that a pavement which could be laid with facility ought naturally to be repaired with facility; but this does not follow. Some of our improved pavements cannot be repaired without keeping the block, upon which the repairs are made, closed for days for the repaired portion to harden, and some cannot be *perfectly* repaired at all.

9th. Freedom from dust. That is, freedom from dust arising from the pavement itself, which follows naturally from durability; for dust of the pavement proper is caused by pulverization under attrition of hoofs and wheels, and if a pavement wears slowly it makes but little dust. Freedom from dust arising from droppings of animals, etc., is only attained by sweeping, and the surface should have such a kind of roughness as to be easily swept, possessing no deep crevices, or places for the permanent lodgment of filth.

10th. Dryness. There should be nothing of an absorbent nature in or about a pavement, because moisture absorbed into the pavement renders it subject to the action of frost, and, in a sanitary point of view, certain to become impregnated with impurities, making it both offensive and unhealthy.

We have purposely left out of our enumeration of requisites one frequently mentioned, and by some considered indispensable, viz: facility of taking up for the purpose of repairing or constructing sewers, gas pipes, water pipes, etc. Such facility at the present time is desirable, but for the future it is not indispensable. The subterranean work for cities will ere long conform to the pavements, and be so constructed as to be reached without disturbing them.

It would not be deemed wise to build houses with reference to digging and repairing cellars under them afterwards, and it is but a little better policy to construct streets with reference to tearing them up. We do not pretend to say what material, or combination of materials, or what device, or contrivance for using them, are to meet all the conditions which we have enumerated. The material most abundant, and thus far most extensively used, has been stone. Yet no form of stone pavement has, up to the present time, proved satisfactory. All have been either uneven and noisy, or, if smooth, so slippery as to be at times inconvenient. The most agreeable form of stone roadway extensively used is the form commonly known as the McAdam, or broken stone road. And yet a street paved with broken stone alone would not answer the purpose, for the reason that it is not impervious to water. Yet we venture to suggest—and inventors may take the suggestion for what it is worth—that if broken stone could be held together by some kind of cement of sufficient tenacity and durability to hold the stones in their places till worn out, and render the wood impervious to water, and if a pavement thus composed could be made to meet the requisites of cheapness and rapidity of construction, it would, perhaps, approach very nearly to the requirements of the coming pavement.

A VEIN of block coal, forty-seven feet in thickness, was recently discovered near Alamo, Ind. A company of Pennsylvania capitalists have, it is said, offered one million dollars for it, but have been refused.

AIR LIGHT.

What has become of the air light about which so much was said a few years ago? This light belonged to the class where an oxide is rendered incandescent, and hence powerfully luminous by the heat of a burning jet of mixed gases. Instead of using oxygen and hydrogen, it was proposed to compress illuminating gas into cylinders and to employ atmospheric air also under pressure, but previously superheated. The air contains one part, or 20 per cent, of oxygen, and four parts, or 80 per cent, of nitrogen; hence it would require four or five parts of air to give the requisite quantity of oxygen; that is, to obtain one foot of oxygen, five feet of air would be needed, as four of them would be nitrogen.

It has been proposed to remedy this difficulty by passing the air through water under pressure, and freeing it of a large part of its nitrogen, as that gas is not so soluble in water as oxygen. But this would involve expensive apparatus. If the nitrogen could be prevented from carrying away the heat from the jet at the point of ignition, the air would give us all the heat and light required when burnt in combination with illuminating gas. To prevent the nitrogen from conducting away the heat the air must be previously superheated in furnaces and fed hot to the burner. Some of the locomotives on the New York Central Railroad were at one time supplied with head-lights composed of four compound jets, encircling a small pencil of lime. A current of air and of gas was conveyed to each jet, and by a simple device the air was heated before reaching the jet. The flow of gas was controled by simple regulators and stop-cocks within the lamp. Two gas holders, placed under the engine, communicating with the lamp by a small pipe for each, were constructed to carry two or three times the requirements of a trip. The air was superheated by being passed through the fire-boxes under the boilers without additional cost. The engineer who explained it to us pronounced it a perfect success, but that was several years ago; since then we have heard nothing of it, and so repeat the question: What has become of the air light?

WASTE LIQUORS OF PAPER MILLS.

The American Wood Paper Company at Manayunk, Penn., have introduced an important feature into their works in saving the waste alkali solutions. It is said that eighty-five per cent of the original alkali employed is recovered. The spent liquor is conducted from the pulp boiler into a suitable reservoir, where it is pumped up into evaporating furnaces. These furnaces are constructed according to a patent granted to Messrs. Keen & Burgess in 1865. They are of great length and radiate from the center of a building resembling a locomotive shed, and all communicate with one central chimney. A powerful draft carries the hot gases of combustion over and under the evaporating pans, and the water is thus rapidly carried off. The alkali is finally transferred to the calcining furnaces, where it is brought to a condition suitable for mixing with a fresh portion, preparatory to being used again. In the manufacture of paper from straw the stock is also boiled in caustic soda lye under pressure, and in most establishments the impure black liquor is thrown away. The soda extracts silica and gluten from the straw, and thus forms a very weak and impure soluble glass. It has been proposed by some manufacturers to evaporate the solution and economize the soluble glass and the extra alkali, but the expense of the evaporation has deterred most of the larger establishments from attempting to make the saving. It would be well for such paper manufacturers as deal in large quantities of alkali, to try the Manayunk process described above. If soda were a substance that could be thrown down from a solution by precipitation, it would be an easy matter to save it, but unfortunately there is no reagent with which it can be combined for this purpose, and we are compelled to have recourse to evaporation. The use of the spent alkali for agricultural purposes has been tried, and if potash had been employed instead of soda the results would be favorable where the expense of transportation did not destroy all the profit, but as soda is now considered by many authorities as actually deleterious to the growth of plants, this application of the spent alkali of the paper mills cannot be recommended. The soluble silica would be of great value in agriculture if it could be separated from the alkali, but this separation is not feasible. There is no reason why the lime used in the vats to render the soda ash caustic should not be put upon land, and such a disposition of it is made at many country mills.

If any of our readers can give us additional information on this subject we shall be glad to make room for their communications.

SPIRITUALISM AND SCIENCE.

Two of our correspondents exhibit a commendable desire for information in reference to the movements of tables by invisible spirits, and as one of them appears to have been severely handled by some of the evil kind, we do not wonder that he seeks for an explanation of the phenomenon.

If there is anything established in nature, it is the invariableness of her laws. The laws which regulate the material world are beyond all reach, and the Creator never permits the management of the universe to pass out of his own hands, or to be interfered with by any of his creatures. The moment we deny this, that moment science becomes impossible. For ages the belief obtained that angels and demons were able to control or influence physical laws. As long as such superstition prevailed, scientific progress was impossible. It was only when it was discovered that the laws of the physical universe were fixed and sure that men were encouraged to carry on scientific research, for they then knew for the first time that if they asked for bread they would not receive a stone.

The physicist now knows that to move a table without the aid of muscular or mechanical force requires a suspension of the law of gravitation, and he also knows that the momentary suspension of this law would reduce the whole universe to chaos and destroy the equilibrium of matter. To suppose that any spirits have such power as this is impious and irreverent in the extreme. None but the Divine Spirit can act on matter except through the medium of matter, and to ascribe such power to any of God's creatures, whether in the flesh or out of the flesh, overthrows all that religion and science have taught us. Hence the scientific man never believes in any apparent infraction of the laws of the universe. He knows that the phenomenon observed is due to natural causes, and goes to work to search out the mystery. There are plenty of known causes which have always been in operation, that are quite sufficient to produce all of the genuine results of spiritual manifestation without the necessity of appealing to the supernatural for an explanation, and Dr. Hammond has shown us that there are other causes which explain why honest people may conscientiously believe in the genuineness of all these manifestations.

We have recently given a series of articles on the history of attempts to invent a perpetual motion. The physicist is absolutely certain that a perpetual motion *accomplishing work* is an impossibility according to the known laws of mechanics, yet the attempt to construct such a machine has been made for centuries, and no doubt will continue to be made as long as the world stands.

If a party of true believers in spiritualistic manifestations could seat themselves by the side of a stream of water and make it run up hill, they would accomplish a much more clever trick than to chase a table up stairs or out of the window, as your genuine spiritualist will not hesitate to do for you at any time; but as it is difficult to take hold of the particles of a liquid, this particular form of exhibition is never attempted, and making water run up hill is chiefly confined to a vulgar force pump.

Many of our readers have no doubt witnessed the performances of necromancers, and have gone home greatly puzzled and wholly unable to explain what they had seen. We recollect to have seen a cane set upright on a floor and a lad balanced horizontally upon it. There was nothing particularly wonderful about this, but when the cane was taken away, without the lad's falling, and it was passed over, and under, and all about him, so as to show that he was not supported by wires from the ceiling or by rods from the floor, we had no ready way for accounting for it, but were absolutely certain, from our knowledge of the fixity of all physical laws, that there was some trick by which it was done, not visible to the senses. Aristotle believed that the heavenly bodies were suspended by invisible cords, otherwise they would fall upon the earth and crush it. He was evidently no spiritualist, but a believer in the necessity of something tangible to hold up the stars.

Some of our correspondents complain that scientific men will not examine into the phenomena of table-turning and give us an explanation upon a physical basis. They forget that this has been done by the highest authorities in this country and Europe.

In 1859, in the city of Boston, a reward of five hundred dollars was offered, through the columns of the *Courier*, for a satisfactory exhibition of some of the ordinary manifestations which mediums of every degree were constantly pretending to produce and which were fully believed in by the faithful as of spiritual origin. The challenge was accepted by a spiritual corps consisting of Dr. H. F. Gardner, Mr. Allen Putnam, Mr. Alvin Adams, Major Raines, Miss Kate Fox, and others, and Professors Peirce, Agassiz, Horsford, and Dr. B. A. Gould, were appointed a committee to give them a fair trial. It is hardly necessary to say that the whole thing was an utter and complete failure, although the distinguished professors displayed the utmost candor and patience in their search for the truth, just as they would have done in any other scientific investigation.

In England the late lamented Professor Faraday subjected the phenomena of table-turning to a most searching investigation. The report of his experiments has been extensively published and ought to be regarded as conclusive by the most skeptical inquirer. Our readers will find it in *The Athenæum*, page 801, for the year 1853.

Professor Faraday by an ingenious device found a way of measuring the direction of the force by which the table was moved and showed that the movement of the muscles was involuntary. Whenever an index was attached to the table which made the least motion visible to all, there was no effect, because the involuntary feature was destroyed and the parties to the transaction could not exert the force required for lifting it excepting in the ordinary way, and such table lifting would be like moving furniture about the room in the most humdrum style. The experiments were a perfect demonstration of the muscular origin of the table moving, and must be admitted as such by any one possessed of sufficient capacity to understand them.

There is no doubt that rappings and tippings were known to the Romans, and they were re-discovered, so far as this country was concerned, at Rochester, in 1846. Since that date we have had a surfeit of them, and it has now become a regular business, as much so as selling groceries or giving exhibitions with the magic lantern. The tricks of the trade have been exposed over and over again, but the world will be deceived by them in spite of all the warnings that we or the daily papers can give. We must look to our schools to correct the evil by the dissemination of accurate scientific information among the people.

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