which no trace can be found by scientific prospecting, no flume is built in the gulch, but the water allowed to take its own course. On its way down the mountain side, it cuts out a huge trough from 20 to 50 feet wide; and if the operation is prosecuted with vigor and plenty of cash, the bed rock is reached and swept clean from top to bottom, and a huge delta of mud, rocks and clay left in the valley below. The water is then shut off, and the owners of the boom examine the clean rock and claim all the veins exposed.

SANITARY NOTES—SEWERAGE AND SEWAGE.

It is no exaggeration to say that the problem of the conversion of the excremental waste of towns and people and the refuse of factories into useful materials is now engaging as much of the attention of intelligent minds throughout the world as any social question. The English press is burdened with publications on this general subject. Chemists, farmers, political economists, engineers, and physicians are all at work upon it. Costly experiments are being constantly made to test the worth of the various proposed plans. Stock companies are formed, whose business is first to make money for themselves at any rate, and, secondly, to benefit the rest of the world by their ventures. From all this excitement we ought to derive much useful information, and, from the experience gained in foreign countries, gather knowledge which may be turned to practical account in solving a problem which, in the natural course of the country's growth, must eventually be forced upon us. In briefly considering the subject, we draw for our facts upon the recent report of the State Board of Health of Massachusetts, and premise by explaining what is meant by the words

"SEWER," "SEWERAGE," AND "SEWAGE."

The last two are often confounded; but they signify quite different things. A *sewer* is an underground passage for the conveyance of water, filth and fluid, or half fluid, refuse emptied into it from the smaller drains from houses, factories, and streets. *Sewerage* is a system of sewers or subterranean conduits, and the word refers only to these works or constructions, while *sewage* is the material which is or may be conveyed in sewers. Public health requires that the foul fluids, half solids and solids, resulting from human excretion from the waste of food, from washing, and from the refuse of various manufactures, shall be either speedily removed from among the living, or that the character of these materials shall be so changed that they will not undergo decay. We have therefore to consider, first, the primary means of getting rid of this noxious waste; and second, how to utilize its valuable properties after we have provided for its removal. For merely disposing of human refuse, there are two principal systems to which we shall allude. The first is the

DRY EARTH SYSTEM.

Abundant experience has shown, and in these columns we have repeatedly explained the fact, that earth (not gravel or sand), when carefully dried so that it has lost all coherence or stickiness, and has become a powder, possesses the power of absorbing and reducing to an inodorous form the excretions of the human body, provided it be applied in quantities so as to completely cover and absorb all fluidity thereof. The mass may be removed at convenient times and seasons and used immediately as a fertilizer for land, or it may be dried and employed many times without giving off any offensive odor. Similarly, dry ash of hard coal or anthracite may be used instead of earth.

In densely populated cities and towns there are difficulties inherent in this system which will render its general use impracticable. If it is intended to absorb both the solid and fluid excretions of the human body (and the latter contain far more fertilizing material than the former), four or five pounds of dry earth must be supplied daily for each individual. Thus, in a city of 100,000 people, 250 tuns must be brought in every day from the surrounding country, and a somewhat larger amount carried out. And this must be divided among some 10,000 different houses, each of which must be carefully provided for. At the present high price of labor, it is evident that, financially, such operations are out of the question. The case, however, is altogether different with country houses with land from which the earth may be taken and to which it may be profitably returned. Here the wells will be protected from fouling, the stench of unsightly outhouses prevented, and the annoyance occasioned by frost obviated. In prisons and large establishments where labor is cheap, and possibly in boarding schools, the system may also be advantageously applied. Without proceeding further into a subject which we have already fully treated both in theory and practically, by illustrating and describing the many excellent inventions which have been introduced for its application, we proceed to the second systematic method of disposing of human excretion known as the.

WATER CARRIAGE SYSTEM.

This is by the underground drains and sewers which all compactly built towns are obliged to have in order to get rid of the surface water falling as rain, and also for drainage of the soil. With these sewers, by means of water closets, baths, etc., the interior of dwellings are brought into close connection. Consequently, whatever gases are contained in these underground passages seek to diffuse themselves through the buildings. These gases are dangerous to health, though what the specially noxious element in them is, no one can define.

The sensible properties of sewer air are quite remarkable. It is by no means fœtid, as many people suppose, neither is it pungent or ammoniacal. It is rather negative in character, faint in odor, mawkish, smelling perhaps, more like soap than any other familiar substance. This air frequently escapes into houses, diffusing a virulent poison and carrying with it the seeds of disease; it is subject to pressure from sudden influx of water in rainstorms, and in sea board towns by the action of the tide. It is also caused to rise from the difference of temperature of the house and sewer; and unless the joinings of the soil pipes are perfect, and have not become leaky through contraction and expansion, it is forced out and quickly spreads through the dwelling. Defective traps and similar imperfections in the plumbing also form free vents. For these reasons, it is best to give the whole drainage plan of the house the freest possible communication with the outer air at a point so elevated that the sewer gases cannot fail to be diffused and got rid of. This can readily be done, while building, by carrying the soil pipe, made of iron, at full size, through the roof, and leaving it open like a chimney. By this arrangement all stagnation is prevented; the contents of the house drains are constantly exposed to the oxidizing and purifying influence of currents of air; when rain conductors are filled with water, there is still free escape for the sewer gases; and the water traps throughout the house are relieved from pressure both of the pent up sewer air on the one side, and of suction or atmospheric pressure on the other. In the houses already built, a lead pipe may be readily carried from the highest point of the soil pipe directly through the roof; but the larger the pipe and the straighter its course, the better.

THE TREATMENT AND VALUE OF SEWAGE.

Experience having shown that the best method of getting rid of excretal and other matters is by the water carriage system, the question arises what shall be done with the sewage. As we have above intimated, many and various plans have been proposed, from which the conclusion may be justly reached that the purification of sewage is a possibility to an extent that it may be discharged into running streams without vitiating the water to any extent other than to unfit it for drinking purposes. The writer of the report before us qualifies this view, however, with the opinion that no process has yet been proposed which, unless in exceptional cases, renders the purification an operation of real profit, although it may be conducted so that there shall be some pecuniary return. Before entering upon the description of some of the principal plans, it may not be amiss to add a word as to the value of this waste material The value of the annual voidings of an average individual is, by competent authority, estimated at from $1.61 to $2.01. The value assigned to "average" sewage by the English Rivers Pollution Commission is per 100 tuns $4.10, or about 4 cents per tun. Then sewage of London, for example, is estimated to amount to 260,000,000 tuns annually, which, considered as worth only two cents a tun, aggregates $5,000,000; that of New York would be worth close upon $2,000,000.

THE LIME PROCESS

consists in mixing the sewage with a certain proportion of milk or cream of lime, agitating the mixture violently and then allowing it to subside. There settles from the mixture a copious precipitate of a highly putrescible mud, while the liquid flows off in a tolerably clear condition. As far as purifying the sewage is concerned, the process is a failure. The suspended matter; removed are also found to contain only about one tenth of the valuable constituents; so that, as a manure, the product is of no special merit. The drying of the mud is a very offensive operation. Practised in England, the manure only brought 1s. per tun, and sold sparingly. This sum was about one third its cost of production.

BLYTH'S PROCESS

consists in attempts to recover the ammonia from the sewage. Superphosphate of lime and a salt of magnesia are added, under the supposition that an insoluble phosphate of magnesia and ammonia will be thrown down. Unfortunately, however, this compound is only insoluble in the presence of an excess of ammonia; and, moreover, analyses show that a third part of the phosphoric acid added is left in the solution, proving absolute loss. The English Sewage Commission consider this the worst and most costly plan yet proposed.

HOLDEN'S PROCESS

is a patented operation, and consists in mixing the sewage with sulphate of iron, lime, and coal dust. It not only fails to remove the putrescible organic matters in solution, but actually augments their quantity. An analysis of the air dried mud showed the presence of only ·3 per cent phosphoric acid, ·004 per cent ammonia, and 0·555 per cent of organic nitrogen; so that, as a manure, it is practically worthless.

THE A B C PROCESS

we fully described in a recent issue of our journal. It derives its name from its essential ingredients, alum, blood, clay, and charcoal, which are mixed with water and run into the sewage in a continuous stream. The good results obtained by its use we have already fully detailed.

THE PHOSPHATE PROCESS

is founded on the fact that certain mineral phosphates, especially those containing alumina, when in a hydrated or freshly precipitated state, eagerly combine with the organic matter contained in the sewage, it being sufficient merely to agitate them in the most fœtid sewage to deprive it of all its odor and color, even if tinctorial substances of great intensity be present in the solution at the same time; while the phosphate of magnesia combines with the ammonia contained in the sewage, and precipitates it also in the state of the double phosphate of ammonia and magnesia. The process delays putrefaction in the effluent water, but the amount of ammonia carried down by the precipitate is found to be practically nothing. The manure is of course valuable on account of the proportion of the phosphate used in its manufacture; but it is hardly probable that it could be made the source of extended profit.

MORFIT'S PROCESS

replaces the natural phosphate of alumina by a new artificial material, which is in fact a waste product at present, being the "mother water" as eliminated by the processes of the inventor for the precipitation of pure phosphates of lime from hydrochloric solutions of mineral phosphates of lime. In his recent work on chemical fertilizers, Dr. Morfit says that the precipitate forms a superior special manure for clay soils, and devotes an entire chapter to detailed descriptions of methods for its utilization.

The Largest Railroad Shops in the World.

Located in Cheshire, one of the midland counties of England, and situated on the London and North Western Railway, some five sixths of the distance between the metropolis and Liverpool, is Crewe, a small and insignificant town by itself, but a city of no mean importance when considered in connection with the vast works which it contains. The establishment which supports, and, in fact, forms the town, the population and extent of which is about half that of Worcester, Mass., was originally laid down by George and Robert Stephenson, and is known as the Crewe Works, or, as it would be termed in this country, the shops, of the London and North Western Railway. Here no less than six thousand hands are employed, building or rebuilding the two thousand locomotives used upon th s longest of English railways, or working upon the two hundred and twenty engines which, it is calculated, are always at the works for repairs.

A correspondent of the Boston *Journal of Commerce* has recently visited this great factory, and, from the graphic letter which he writes, we extract the following interesting particulars: He says that a most extraordinary variety of especial tools is employed, among others several testing machines for trying the strength of materials used. Samples of every variety of material, and especially the boiler iron and steel, are submitted to these machines. For the proving of the iron for axles, there was a little machine in which a sample was submitted to a rapid series of torsional strains till it broke, the number of these, registered by a counter, being an index of the character of the iron. As an illustration of the attention to the smaller details of expense, a cleaning machine was running in the brass shops, consisting of an endless belt studded with small magnets, which, passing through the mass of filings in an inclined trough, thoroughly cleaned them of all fragments of iron. A large number of milling machines were in use for smaller work, especially such as finishing the heads of nuts and bolts, and many small bench shaping and slotting machines were running as many as 160 strokes per minute; engaged in a similar work, by using cheap labor (boys of twelve), the latter could compete with the former. Among other larger machines was one for grinding large plane surfaces, such as base and frame plates and side plates of tenders, instead of planing them, the work moving in a trough containing water, and the whole arrangement being quite on the plan of a Daniells planer. Much smaller flat work was finished by grinding in machines arranged to produce a level surface by self-operating attachments.

Perhaps the most remarkable thing in this part of the works was the huge lathe room, more than two hundred feet long, and filled with a double row of driving wheel lathes. Many of these were of eight feet swing, and of the heaviest description, carrying four cutters at once. A remarkable machine, near these, was a milling tool for milling out the inside cranks. All the engines have inside connections, the axles are forged solid and milled, instead of being turned out. The cutter of this machine was four feet in diameter and about five inches fall. There were here many other peculiar tools, such as a machine milling two key ways, exactly at right angles, at once, in the two ends of a locomotive axle. Also a wheel rimming machine, and another for slotting out in a proper curved form, the inside rims of locomotive wheels between the spokes.

A new process for making steel tires is here employed. The steel is cast in the form of truncated cones, the smaller end to form the outside of the tire. While still hot it is introduced to the horizontal steam hammers. These consist of a couple of enormous masses of iron, each running on a little track, and moved back and forth, by means of piston and rod, by a large steam cylinder behind each, the steam valves of each of which cylinders are operated by a common lever. By passing through two sets of these hammers, the steel is thoroughly worked up, and leaves them in the form of a thick disk. Carried from these, it passes to an upright hammer, with a sharp conical end to the striking part. This soon forces a hole through the disk, which, being turned round and round, and over and over. becomes a thick ring. Again heated, it goes to another hammer. This hammer has a very heavy anvil, with a peculiar slope to one side, from which projects a stiff horn. Upon this horn the ring is hung. The face of the striking part is formed to the slope of the rim and flange of the wheel, and as the workmen manipulate the wheel under its blows, slipping one portion after another of the rim up to receive the stroke, the whole tire gradually expands to the requisite diameter, and is ready to be turned on the inside and driven on to its wheel.

These details were noticed in but a small portion of the vast factory, but serve to give an idea of the completeness and magnitude of its construction and fittings.

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