diameters than that for which they were made. To make patterns or cutters for every pair of wheels that are required would entail great expense on manufacturers, hence they generally have recourse to methods of their own, or use those laid down in text-books, for the purpose of constructing teeth; some of which, for fine pitches, are almost equal to the epicycloid and admit of more extended application with different diameters. Our method, which I have found to work well in practice, is to lay off the points of the teeth with the pitch, and for the roots, set one point of the compasses in the center of one tooth, and with the other point describe the root of the adjacent tooth; but where the disparity in the diameters is very great, this rule will have to be departed from, especially in large pitches, in which case the tooth of the pinion should be determined first, in order to obtain adequate strength at the root, and the teeth of the large wheel adapted to the peculiar form of the pinions. Epicycloid teeth, when properly constructed, require no clearance, or at most but a trifle, except at the bottom where good clearance should always be given, as much of the noise heard in gearing running is caused by the teeth "bottoming," often occasioned by the shafts springing or the journals and boxes wearing.

In departing from the epicycloid more clearance should be given between the teeth. The forward side of the driving tooth should come in contact with the rear side of the driven tooth first, and not, as I have observed in some instances, in ill-constructed teeth when the reverse was the case, the teeth in first meeting wedging and tending to press the wheels asunder, thereby consuming useful power in doing useless work. More clearance is required when the teeth are cast than when cut. In the former there is always some irregularity, even where there has been the utmost care exercised with the pattern, owing to the unequal contraction of the metal or the rapping of the pattern and mending up of the molds.

There are various methods of arranging the teeth of gear wheels, but in every departure from the plain spur there is a measurable amount of detriment. The step gear when a tooth is divided into a series, and each alternate one placed out of line with the other, is a favorite plan with some where heavy work is to be done. But I have failed to be convinced of its superiority over the continuous tooth. Unless set with the greatest accuracy some teeth will sustain more than their proper amount of strain while others will sustain less. These assertions can be verified by any one examining such gear and observing the inequality of the wear. The double oblique tooth is resorted to where strength of tooth is required and the face limited. In this style the teeth unite in an apex at the center of the face and diverge obliquely with the axis. While this method gives a strong tooth it is a consumer of power as well as a transmitter. Of all the abominations of gearing the single oblique tooth is probably the greatest. In this style of gearing the teeth present inclined planes to each other, and there is a constant tendency in the teeth off or forcing the wheels asunder in a line with the axis, which tendency is resisted by the wheels being secured to the shafts, and a great amount of power is absorbed by these antagonistic tendencies. I have seen a pair of such wheels, designed by an eminent engineer, absorb half the power of a pair of four-horse trunk engines.

Let me here condemn the practice prevailing to some extent of endeavoring to make many teeth bear at the same time. The number of teeth bearing depends altogether on the diameters and pitch, and any attempt to make more teeth bear than these will properly admit of, must necessarily cause a departure from the proper curve of the tooth or a disproportioned length. If strength is the object better give a little more face.

Cast teeth when true are much better than cut teeth, the outside scale wearing longer than the softer metal within. Especially are these remarks applicable to bevel gear, in which it is impossible to cut the teeth properly with the means usually employed in cutting engines, owing to the curve of the tooth being a varying one from end to end. After a perusal of the foregoing, the following facts must be impressed on the mind. 1st. The pitch is the arc between the centers of two contiguous teeth, hence the ordinary rule, (Dia. × 3·1416) ÷ pitch = No. of teeth, or (Dia. × 3·1416) ÷ No. of teeth = pitch, is the proper one. 2nd. The plain spur is the best form of a gear wheel. J. C.

Washington, D. C.

### Window Glass.

Messrs. Editors:—I read in your last number a description of "How Window Glass is Made," which, though I have read many similar before, seems to me now so awkward in process—not in description—that I cannot help entering my protest against the idea, though it seems to be a fact, that there has been no essential improvements in glass making since the time the "Arabs camped, and burnt seaweed," etc.—you all know the story of its discovery. To take a lump of viscid tenacious material on the end of an iron tube, and blow it, and twirl it into such a shape that it is possible to make it flat, after a deal of further trouble, and this to be the only means of effecting this result now known, seems to me to be a disgrace to American inventive genius.

Why cannot a pot of melted viscid substance like glass be drawn out into sheets, as well as a continuous sheet of paper from the tank full of pulp, or a continuous lead pipe from a crucible full of melted lead. Guessing, *a priori*, I should say much easier, and better, and smoother, for the substance to be worked is of just the right nature to yield with ease and without danger to the manipulations of machinery, and be worked into all shapes, without breakage or chemical corrosion. "But," will say the glass workers, "it is the excessive temperature at which it must be worked that is the difficulty." My friends, if it took a machine as heavy as a Fondrinier paper machine, and all made of platinum, it seems to me it would pay if a sheet of glass could be run out like a sheet of paper, and I believe it can, and will be done some time. I have seen a glass thread spun at the rate of many thousand yards a minute, and it seems to me a sheet is only, theoretically, a multitude of threads.

When we open up the immense soda and potash fields of the Western desert, and when the pine forests and other timbers are exhausted, the question, of what shall we build houses, and construct a great many other things, now made of wood, will lie between glass, iron, and paper.

Cheap soda, potash, and fuel, and a glass (paper) machine to make it on, will decide the question in favor of this indestructible material, so far as it is applicable.

Who is there that has capital and spunk enough to try the experiment? A small apparatus to run out a sheet ten inches wide, made of platinum, and set in the furnace, running out a stream of window glass, through proper orifices and annealing ovens, I believe to be a possibility, and a not far distant accomplishment. C. Boynton.

### A Good Puddling Furnace.

Messrs. Editors:—I notice in a late number of the Scientific American, an extract from an English paper showing the extraordinary economy of E. B. Wilson's patent puddling furnace now in use in England and elsewhere. It seems, however, that the consumption of sixteen hundred weight of coal to the tun of puddled bars, is about the best that can be averaged, with his furnace, running night and day. This shows a great saving over what has been used as a general thing in England, or wherever coal is cheap; but it is not so economical as a double puddling furnace built in the Cold Brook Iron Works, this place, by Mr. John Wilson, an English furnace builder, now here: This furnace made 42 tuns 10 hundred weight of six inch bars (Scotch pig iron) with 27 tuns of coal, I think half Cumberland and half Pictou, equal to 12 hundred weight and three-quarters to the tun of 2,240 pounds. I doubt if a more economical furnace has ever been built. E. G. S.

St. John, New Brunswick.

### Poor Work on Agricultural Machines.

Messrs. Editors.—"Fulton" under the head of "Good Agricultural Machinery" in your issue of Jan. 23, page 54, current volume, says he noticed an article headed "Poor Mechanical Work on Agricultural Machinery" referring to issue of Dec. 16, volume XIX, page 393, which he claims "does a great injustice to a large class of manufacturers," etc. I noticed the same article and was greatly pleased that your ever-welcome paper should speak a word on that subject in the way of relief to the farmer.

As I was born and raised on a farm I have had considerable experience with agricultural machinery and can testify, as well as all other farmers, that nine-tenths of the machinery sold us are made only to sell and not to fit, "Fulton" to the contrary notwithstanding.

I never have seen a reaper that could be set up and run without the aid of a file or cold chisel, and sometimes new holes have to be made in order to get in some of the bolts; as was the case with some half an acre of reapers painted in high colors and shipped to this place last season, in pieces, to be set up "from the pile," not one of which could be set up without the assistance of a whole kit of blacksmith and carpenter tools.

While it is necessary that the greatest skill should be exercised in constructing this class of machinery, which is subjected to constant jerks and strains of different parts, by its movements over uneven ground, and being in all sorts of positions, the mechanical workmanship is fully developed only in other classes of machinery that set firmly on their feet or ride on easy springs. The prices that farmers have to pay for their machinery would warrant a better class of work.

Western Farmer.

Waukon, Allamakee Co., Iowa.

The Scientific American.—In these days, when new and worthless publications are being thrown on the market by the score, it is with a pleasing satisfaction that we come face to face with our old, tried, and trusty friends. We have not yet reached that millennial period in newspaperdom when a successful journal is born in a day. The process is like the processes of nature: "first, the blade, then the ear, and then the full corn in the ear." Among the newspaper successes in this country, none is more noteworthy than the Scientific American. For an American journal it is old in years, but young in strength and vigor, leaving all its imitators and would-be rivals, and there is a host of them, in the distance. It is safe to say that there is a degree of freshness, strength, and originality in the Scientific American that are found no where else among journals professing to occupy a similar sphere. A complete file of this paper from the original date of publication, would be a library in itself.—*American Builder.*

Artificial Ebony.—This substance, now used to a considerable extent in Europe, is said to be prepared by taking sixty parts of seaweed charcoal, obtained by treating the seaweed for two hours in dilute sulphuric acid, then drying and grinding it, and adding to it ten parts of liquid glue, five parts gutta-percha and two and a half parts of India-rubber, the last two dissolved in naphtha; then adding ten parts of coal tar, five parts pulverized sulphur, two parts pulverized alum, and five parts of powdered rosin, and heating the mixture to about 300 degrees Fahrenheit. We thus obtain, after the mass has become cold, a material which, in color, hardness and capability of taking a polish, is equal in every respect to ebony, and much cheaper.

For the Scientific American.

### "WASTE" AND "ECONOMY" OF FUEL.

NO. 4.

How much remains to be done in connection with economizing the fuel consumed by our engines in the production of "work," will be comprehended, if we fully realize the fact, that not more than ten per cent of the real power of the coal burnt under our most perfect modern steam boilers, is turned to useful practical account.

In the year 1702, Savary constructed a steam engine by means of which, a weight of 1,000 tuns could be raised one foot high by the combustion of one bushel of coal.

In 1720, Otto Guericke Newcomen made an atmospheric engine which lifted 3,500 tuns by the consumption of the same amount of fuel.

Watt's original engine raised 6,000 tuns, the modernized Watt's engine raises 15,000 tuns by the same weight of coal.

The average duty of the ordinary improved Cornish engines of our day is equivalent to 56,000 tuns raised one foot high by the combustion of the same quantity of coal as above. Large as this last amount may seem to a superficial observer, it is yet infinitely below the probable realizations of the future, as the following computation conclusively demonstrates.

If we consider the calorific value of the combustion of one pound of average coal, as equal to 6,000 or 7,000 centigrade units of heat, and if each of these units, as has been proved by recent elaborate researches, is equivalent to 420 kilogrammetres or nearly 2,700 foot pounds, we find, that one pound of coal produces a force equal to 16,200,000 or 18,900,000 of foot-pounds.

The most economical engines in the world, do not on an average, reach a higher figure than 1,398,094 foot-pounds per pound of coal consumed, this being only 0·074 to 0·086 of the whole theoretical amount, or only from $7\frac{4}{10}$ to $8\frac{6}{10}$ per cent of the real power concentrated by nature in one pound of coal.

We must be careful not to confound the amount of foot pounds which are equivalent to the combustion of one pound of coal with the quantity of heat needed to vaporize a certain amount of water, this being a quite different thing.

If it takes 635·5 centigrade units of heat to evaporate one lb. of water and if one lb. of coal evolves on an average 6,500 centigrade units, then theoretically 10·22 lbs. of water should have to be evaporated from a lb. of such coal. We find in practice, that 8 lbs. of water from 1 lb. of coal may be taken as a fair average, so that in this case 2·20 lbs. of water or 22 per cent only have really been lost. By greater care and attention, this amount of waste may be further reduced, so as to assimilate still more closely the practical with the theoretical results.

What really becomes of the 90 per cent, more or less, of foot-pounds, lost, during the combustion of one lb. of coal, as mentioned above? This is a question which we expect to be asked and which we will here attempt to briefly elucidate.

The equivalent of the combustion of one lb. of coal being as above stated 18,900,000 foot lbs; we may suppose 10 per cent of this quantity to be converted into useful work by the engine and another 10 per cent to be entirely wasted (by remediable causes), during the production of steam. This gives a total consumption of 20 per cent or of 3,780,000 foot-pounds, leaving an apparent loss of 15,120,000 foot-pounds which have vanished during the vaporization of 10 lbs. of water. In such a case we might affirm that 15,120,000 foot-pounds have really been absorbed or rendered latent in the work of converting one lb. of water into steam, for which purpose every centigrade unit of heat evolved by the coal must have had to furnish no less than 2,520 foot-pounds of hidden work. A much larger quantity of fuel than 10 per cent, is however, in most cases, wasted by remediable causes.

We have shown in previous articles, in the Scientific American, how bad stoking causes a waste of fuel, which may reach 25 per cent; how, the necessary blowing off in cases of salt or impure water produces a loss of 33 per cent, and how priming and scale may add another 30 per cent to the above.

This however is but a fraction of what often takes place, as waste by radiation of heat and consequent condensation of steam in the boilers, steam-pipes, and cylinders are another source of very considerable loss. This radiation may, to a considerable extent, be obviated by the use of external coverings of felt or canvas, by superheating the steam, by steam jackets, or better yet, by the combined effect of these various remedies.

Leaks are another frequent cause of loss of fuel, the amount of which can only be determined by the calculation of the units of heat in every lost pound of steam or water, remembering that the waste by leakage of one lb. of steam exceeds by 5½ times at least, that which would originate from the leakage of one lb. of hot water from the boiler. As is known to every tyro, repacking of the slides, pistons, blow-off nozzles etc., are the preventives of loss by leakage.

An imperfect vacuum leads to a waste of fuel, as the required power will in such a case, have to be obtained from a lower step of expansion and with a corresponding increase in the consumption of fuel.

The neglect to "ease" and "stop" in time, the urging of the fires, the unnecessary friction of any of the rubbing surfaces of the engine, the excess or the deficiency of draft in the furnaces, the use of bad coals, and many other causes too numerous to be here enumerated, all concur to increase to an almost indefinite extent, the waste of fuel.

The sum total of remediable waste in our ordinary carelessly managed engines, frequently reaches formidable figures, and this before the very eyes of the proprietors of the same who seem totally blind to the fact, that wasting fuel is injurious to their pockets.

It is not of the highest importance, as is sometimes believed, that an engine should run beautifully smooth and easy; it is however, most essential, that every bushel of coals burned under its boilers should be made to furnish their maximum of usefulness, a result, which can be attained only by constant care and vigilance, two words which in themselves comprise the whole duty of the engineer, and ought to be his motto.

## ALUMINUM.

BY PROF. C. A. JOY.

Forty years ago a few grains of this metal were prepared by Professor Woehler, at the University of Goettingen. He sealed the little pellets in a glass tube, and it was not thought that the metal could ever have any useful applications. The discovery rested dormant for thirty years, when attention was called to it by the eminent French chemist, Deville.

The circumstances were as follows: The Emperor Napoleon, anxious to display some interest in scientific matters, appropriated fifty thousand francs to defray the expenses of researches into the properties and uses of aluminum, and Henry St. Claire Deville was authorized to make the experiments. We happened to be in Paris when this took place, and were one day invited by Professor Deville to witness the preparation of the metal in the presence of the Minister of War, Professor Dumas, and of other celebrities. Deville, who is the most genial, popular, and successful of the French chemists, received his guests with great cordiality, and explained in the clearest possible manner, every step of the operation. He extracted a pure, silver-white metal from a lump of clay. The way he did this was very simple. Chlorine gas was passed over heated clay mixed with charcoal, and the chloride of aluminum thus produced was driven over melted sodium. The chlorine first extracted the metal from the clay, and was in turn decomposed by the sodium. In chemistry, might makes right and every compound can be attacked and forced to capitulate, if the proper weapons are brought to bear upon it. The aluminum was first seduced from its strong citadel of clay by the chlorine, and was then attacked and captured by the sodium.

The experiments, in a small way, having proved successful, extensive works were established in the neighborhood of Paris, where aluminum was manufactured on a large scale. At the Paris exhibition of 1867, Mr. Paul Morin exhibited numerous objects manufactured from pure aluminum and from its alloys.

The specific gravity of the metal is 2·67. It is tin white, fusible at a red heat, brilliant, malleable, ductile, sonorous, an excellent conductor of electricity, insoluble in dilute sulphuric acid, and in concentrated nitric acid; easily soluble in hydrochloric acid and the alkalies. It does not decompose water, as was at first supposed, and does not oxidize materially in the air.

Professor Henry Wurtz, of New York, has recently discovered that if it be rubbed with mercury it oxidizes so rapidly as to produce great heat. It was at first found impossible to solder the metal, but this difficulty has been at length overcome. When fused with iron it forms a crystalline mass not malleable. Mixed with copper in the proportions of ten parts of aluminum, and ninety parts of copper, it forms a beautiful alloy, possessed of the color and many of the properties of gold. This alloy is called aluminum bronze, and is now frequently employed for the manufacture of watch cases, watch chains, and imitation jewelry. Nearly all the aluminum now manufactured is converted into the above alloy and the interest in it, which at one time began to flag, is once more revived, and several new establishments have arisen for its manufacture.

Four hundred pounds a month are now manufactured in France, and sold at twelve dollars a pound. It is also largely produced in England.

Aluminum is one of the most abundant metals on the earth. It is found in brick and porcelain clay, in feldspar, in cryolite, in granite, in slate rocks, in the ruby and sapphire. When iron rusts, it turns to a red powder, which can be washed away. When aluminum rusts, or is fused at a great heat among the crystalline rocks, it gives to us the precious stones called the ruby and sapphire.

As soon as the metal is required in large quantities, some method will be devised for producing it at a cheap rate; and when that time arrives we shall not have to fit out expeditions to go and search for the ore in remote regions, but we can dig for it under our feet, nearly everywhere, and make a mine of every stone quarry.

The beautiful tone of the metal has suggested its use in the manufacture of bells, and a successful application of it for this purpose has been made.

Aluminum has been employed by chemists as a reducing agent in the preparation of some of the rare metals, and we may have to record a more extensive use of it for this purpose.

There have recently been introduced into use in Paris two new alloys of aluminum. The first is called aluminum silver, or third silver (tiers argent), and is composed of one-third silver and two-thirds aluminum. It is chiefly employed for forks, spoons, and tea service, and is harder than silver and more easily engraved. The second is called minargent, and is made of one hundred parts copper, seventy parts nickel, five parts antimony, and two parts aluminum. It is a very beautiful, permanent, and brilliant alloy, capable of replacing silver for many purposes.

It must be acknowledged that the applications of aluminum in the arts are not so numerous as was at first predicted, and its manufacture, as compared with other metals, can, at the present time hardly be called a metallurgical one. The metal is so light that a little of it will go a great way. A cubic foot of it weighs one hundred and sixty-eight pounds, whereas a cubic foot of gold weighs twelve hundred pounds, and silver weighs six hundred and fifty-six pounds, iron four hundred and fifty pounds, and even granite weighs one hundred and eighty-six pounds to the cubic foot.

If the price of it were the same as that of silver, it would still be much cheaper, as only one-fifth as much would be required to cover the same space.

So abundant is this metal, that it is safe to predict that the day is not far distant when our houses may be built of it instead of bricks, and we shall use it for many purposes now unknown. —*New World.*

## EXPLOSIVE COMPOUNDS FOR ENGINEERING PURPOSES.

Mr. Perry F. Nursey a few weeks ago read a paper on the above subject before the Society of Engineers, of London, from which we extract the following:

"Although many attempts have been made to supersede gunpowder, but few have practically succeeded, and this arises not so much from any inadequacy on the part of the substitutes, as regards power, but on account of the extreme liability of most of them to premature explosion from varying causes. Gunpowder itself is open to this objection, and hence the propositions to reduce the risk by mixing it with protecting ingredients. But this is not enough, we must go a step further. What is required is a material over which we can have perfect command, one which shall do more than burn when in contact with air, but which shall equal, if not exceed, gunpowder in its power when ignited in an air-tight chamber, as in a bore hole, or the barrel of a gun. The necessity for this is evidenced almost daily in one or other of our mining districts, where a large percentage of the explosions occur in the blasting operations. How frequently is gunpowder ignited by stray sparks, even when standing about, but much more frequently do accidents arise when tamping is going on. Here the contact of the metal rod with the rock leads to many a fearful accident. So much is this so, that the Royal Cornwall Polytechnic Society have taken the matter up, and have suggested safe methods of performing this dangerous operation. But however careful a miner may be, there never can be perfect immunity while he has to deal with a material which carries within itself all the elements of danger and destruction. To meet the case a perfectly inexplosive material is required, one which will not explode so long as the atmosphere has access to it, but in which all the active energy of gunpowder is developed immediately it is fired out of contact with the air.

"Gunpowder itself is at present more largely used than any other explosive material, and it is a remarkable fact that, notwithstanding the centuries which have elapsed since its first discovery, no radical or permanent change has been effected in its composition. Slight variations, it is true, have been made from time to time in the proportion of its constituents, but, in the main, gunpowder remains much as it was 600 years ago. But the danger ever present in handling this material has always been so patent, that many years since means were devised for rendering it harmless while in store, and to restore to it its power at the time of use. Colonel Ryley was the first to propound this theory, and he submitted his plans for enveloping the grains of gunpowder in bone dust, to the Government some twenty-five years since. In later times—in fact, very recently—Mr. Gale's proposition to render gunpowder non-explosive and explosive at will has been much before the public. His plan was to mix ground glass with the powder for storage and transport, and to sift it from it again when it was required for use. This addition to a large amount of a foreign substance with the powder no doubt answers the purpose most effectually; but unfortunately there are practical difficulties in the way of its adoption. The objections are, increased bulk and weight for transport, the necessity of numerous sets of mixing and shifting apparatus, and the utter impropriety of having to prepare an explosive material just when it is required for use. Beside, in blasting operations, the accidents usually occur in charging the mine; therefore a system of this kind would be of no value whatever.

"Before quitting the subject of gunpowder, it may be interesting to notice the force this material is capable of exerting when used for blasting purposes. The following particulars show the amount of earth or rock thrown down or removed by 1 pound of powder, under various circumstances, the results being taken from actual practice. At the Round Cliff, Dover, 85,232 pounds of chalk were thrown down by 1 pound of powder. In the Leith cutting, Tunbridge, 31,860 pounds of hard white sand were moved by the same weight of powder. At Plymouth 22,000 pounds of limestone were moved per pound; in small charges only 8,900 pounds were moved. In Antrim, 45,084 pounds of white limestone, and 32,430 pounds of whinstone or basalt were moved by 1 pound of powder. At East Dunmore, 14,280 pounds of hard conglomerate were moved; and on the Londonderry and Coleraine Railway, 22,400 pounds were thrown down by 1 pound of powder. Taking the mean of these results, we have 32,832 pounds of material to 1 pound of powder.

"Numerous compounds have been brought forward from time to time, for which it was claimed they perfectly superseded gunpowder. But, until very recently, no material has been found which would answer all the practical purposes, and fulfill perfectly all the conditions and requirements of that most important material. Saltpeter is the agent to which the characteristics of gunpowder, as an explosive material of permanent character, are mainly due. It is to the substitution of other nitrates for this constituent that most attention has been given, and the nitrates of sodium, lead, and barium have been successively tried. But although the products, which have been known by the names of soda gunpowder and barytic powder, etc., have obtained a certain amount of temporary success, they have ultimately been abandoned. In fact, all mixtures of this class, when compared with gunpowder proper, have been found to exhibit important and radical defects. Chlorate of potash has been a favorite substance with inventors, notwithstanding its violently explosive nature. The object has, of course, been to tone down its violence by proper admixture with other ingredients, and the resulting products have been to some extent successful. One of the earliest mixtures of this class was German or white gunpowder, which was tried, but proved unsuccessful. Many preparations of a similar character have also been brought before the public. Of this class is Ehrhardt's powder, the invention of which is also claimed by Mr. Horsley. M. Ehrhardt's compositions are as follows:

BLASTING POWDER.

| | |
|---|---|
| Chlorate of potash | ½ part |
| Nitrate of potash | ½ " |
| Tannin of cachou | 1 " |
| Charcoal | 9 " |

POWDER FOR ARTILLERY.

| | |
|---|---|
| Chlorate of potash | 1 part |
| Nitrate of potash | 1 " |
| Tannin | 1 " |

POWDER FOR SHELLS.

| | |
|---|---|
| Chlorate of potash | 1 part |
| Tannin | 1 " |

"Mr. Horsley's powder is a compound of chlorate of potash and gall nuts in proportion by weight of three to one. The ingredients are ground separately to a state of fine powder, and then passed, also separately, through a very fine wire sieve. The two ingredients so prepared and thoroughly dried are blended when required to form the explosive compound. The blending of the ingredients is safely and easily accomplished by passing them in a mixed state through a series of horsehair sieves, arranged one below the other and set in motion. Upon the upper sieve the two ingredients are first mixed by being run together from two receptacles placed above the sieve, one containing a given weight of chlorate of potassa, and the other one-third of such weight of gall nuts. As the chlorate of potash is much heavier than the gall nuts, the volumes or measures of the two receptacles are about equal. Motion being imparted to the sieves, and as the two finely ground ingredients pass downwards through the sieves, they become blended, and form the explosive compound. Powders in which chlorate of potash is an ingredient are undoubtedly somewhat dangerous. The fact, however, of cannon-priming tubes, which are composed of chlorate of potash and ter-sulphide of antimony, having been prepared, stored, and used for more than thirty years past without accident, ought to relieve apprehension on that score. When treated, as it should be, with care, and not improperly blended with combustibles, chlorate of potash is practically safe. With regard to the explosive power of Horsley's powder, it may here be interesting to adduce a few facts in the shape of results of trials which came under the author's notice, and which were made to institute a comparison of its strength as against gunpowder. An eprouvette, weighing with its carriage 10 pounds, 2 ounces, was placed on a fir plank in a perfectly level position. The charge in each instance consisted of 50 grains of the various powders, and was kept in place by a small wad of thin paper. The recoil of the eprouvette, when charged with fine grain sporting powder, was $\frac{9}{16}$ inch; with very fine grain sporting powder, $\frac{11}{16}$ inch. Fine grain sporting powder in a state of meal, and compressed by a weight of 400 pounds on the square inch, gave a recoil of 4 $\frac{2}{16}$ inches. Horsley's powder in a similar state of meal, and with a similar pressure of 400 pounds per square inch, showed a recoil of no less than 11 $\frac{9}{16}$ inches. These results afford some idea of the relative power of Horsley's powder and the best gunpowder. The author has examined some blocks of elm which had been submitted to experiment to show the comparative disruptive force of Horsley's powder and of common gunpowder. In each case equal charges were used, and the eprouvette was discharged one inch from the wood and at right angles to its face. The disruptive force of Horsley's powder on the wood was as if a solid body had been driven into it, separating the fibers and tearing a hole completely into it. The force of the small grain best sporting powder merely left a mark upon the surface of the blocks.

## A Wooden Railway.

A description of the Wooden Railway recently constructed for the Clifton Iron Company between Clifton and the Adirondac mines in New York is given as follows by Mr. C. G. Myers, late President of the Company. The rails are of hard maple scantling, 4x6 inches, set on round ties, on which are framed slots 6x4. The rails, set on edge and keyed in the slots by two wooden wedges driven against each other, project two inches above the ties. The rails admit of bending sufficiently to make the curves. The ties are laid on the earth and ballasted in the usual manner to two inches of the bottom of the rail. It takes 21,120 feet, board measure, of scantling for a mile, and 1,760 ties at three feet apart. Our road is a very rough one. We have a great deal of trestle work, some of it over thirty feet high, which is vastly more expensive than a level route. The engines used weigh from ten to fourteen tuns. The rails will probably last about five or six years. An engine will move about thirty tuns of freight at about six or eight miles an hour, with heavy grades and sharp curves. The Company expects to move over the road next year from 50,000 to 100,000 tuns of freight. Trains have passed over the road, light, at the rate of twenty miles an hour, but this would not do for freight.