THE ANALYSIS OF THE DIAMOND.

Lavoisier, the great French chemist, undertook the examination of the diamond (Prof. Roscoe remarks), and it is worth while noticing how carefully he went to work—how he proceeded slowly from one step to another in the logical sequence until he arrived at the true solution of the question which he had undertaken to investigate—that is, until he was able to tell exactly what happens when the diamond evaporates in the fire, and why it did not do so when surrounded with charcoal. In the first place, he evaporated the diamond by means of the burning-glass, and he observed that no visible vapor or smoke was given off, but that the diamond disappeared. He thought that perhaps the solid diamond had in some way been dissolved by the water, and that by evaporating the water which was in the lower part of the bell-jar in which he burnt the diamond he might obtain the constituents of the diamond, in a solid form; but he found that no solid residue was left on evaporation, and thus no trace of the diamond could be found. His next experiment was that of placing a diamond in a focus of a less powerful lens than the one he had formerly used, so that the diamond was not heated to so high a temperature as before, again placing it however, in a bell-jar over water. He then found that the diamond, when not heated quite so strongly, lost only about one-quarter of its weight; it did not disappear altogether, but the remarkable fact was noticed that it became covered with a black substance, which Lavoisier describes as being exactly like lampblack or soot, so that it dirtied his fingers when touched, and made a black mark upon paper. Hence he concluded that the diamond is susceptible of being brought, under certain circumstances, into the condition of charcoal, so that it really belongs to the class of combustible bodies. He was, however, yet far from having proved this point, and he went on experimenting. He next measured the volume of air in which he was going to burn the diamond, and found it about eight cubic inches. Then he burned the diamond in this volume of air by means of a lens, and found that the air had diminished to a volume of six cubic inches, thus showing that the air had undergone some change by the combustion of the diamond, and that two out of eight volumes of air had disappeared. The next experiment he made was to examine the condition of the air in which the diamond had been evaporated. What changes had gone on in the air in consequence of the evaporation of the diamond? After allowing the glass in which he had burned the diamond to stand for four days, he poured clear lime-water into the jar in which the diamond had been evaporated, and he says this lime-water was at once precipitated, in the same manner as if it had been brought into contact with gas evolved into effervescence and fermentation, or that given off in cases of metallic reduction. Here, then, he had got on the track of what he wanted. Hitherto the diamond had apparently disappeared, and nothing was found to account for its disappearance; but now he had found that there was something contained in the air in which the diamond was burned which was not contained in the air before. The next step he took was to examine the white precipitate or powder which formed, and he found that the substance thus precipitated from lime-water by the air in which the diamond had been evaporated effervesced on treatment with acid, and evolved what was then known as fixed air, but which we now know as carbonic acid gas. Here, then, in his last experiment, he completes his proof, showing that exactly the same effects are observed when charcoal is experimented upon instead of diamond. Lavoisier had now run his quarry to earth; he had determined exactly what it is that is formed when a diamond is burned. He has shown that a diamond, when burned, produces exactly the same substance that is produced when common charcoal is burned, and he, therefore, legitimately concludes that the diamond is only another form of the element carbon. The reason that the diamond did not burn in the furnace when surrounded by a mass of charcoal was that the air, or rather the oxygen of the air, could not get to the diamond, because it was kept off by the charcoal, which burned instead of the diamond.

PUDDLING WITH CULM.

Experiments are being made at the works of the Towanda Iron Manufacturing Company, at Towanda, Pa., with the culm or dust of the Loyalsock mines. This coal is called semi-anthracite; it looks very much like the bituminous coal in the vicinity of the works, but lacks the bitumin, is remarkably free from sulphur, and contains over 90% of carbon. The first trial made with the culm was under the boilers, and it was quickly demonstrated that more steam could be generated with it than with coarse coal; and not only so, but that it could be done in less time and with a lighter weight of fuel. Experiments were next made in puddling iron. A common double puddling furnace was used, temporary alteration having been made for the purpose. The firebox was lengthened from 12 feet to 21 feet, so as to increase the grate surface, this being necessary from the fact that the fire must be kept very thin—not over three inches; the grates were placed close together, and contained numerous small holes, their diameter being about the eighth of an inch—in a bar three to four inches wide and two and one-half to three feet long, there would be from 400 to 500 of these holes, and there was about two feet of dead surface between the grate and the bridge-wall. These were the only alterations made, the furnace itself not having been changed. The fuel was introduced in the ordinary way, only it was necessary to spread it very evenly over the grate, and a blast was used. The person who is conducting the experiments says he can get up steam and melt iron quicker with this fuel than with any other coal he ever used, and the iron produced is claimed to be of a superior quality, owing to the freedom of the fuel from sulphur. The works are 25 or 30 miles from the mines, but the owners of the latter offer to deliver the culm at a price not to exceed 85 cents per ton. Further experiments are to be made.—*Coal Trade Journal.*

AMERICAN LOCOMOTIVES ABROAD.

The London *Colliery Guardian* says: Our American advices informed us last week that 19 locomotives had left the Baldwin locomotive works, Philadelphia, this month, for Brazil. Each engine was accompanied by an engineer and fireman; a number of machinists also went with the engines. We further learn that 22 more engines are to be despatched, in the course of this year, from the Baldwin works to the great South American empire. The Baldwin works have forwarded besides a specimen locomotive to one of the Australian colonies, and the New Zealand government is also about to make a trial of one of the engines of these now celebrated works. Such facts as these show forcibly enough the energy and enterprise with which American firms are endeavoring to find fresh outlets for the products of American industry. Jonathan is rubbing shoulders with John in all the great markets of the world, and unless John bestirs himself he will find Jonathan rather a formidable rival. One circumstance which, perhaps, tells in favor of American locomotive builders in South America, is the disinclination which English capitalists now display—and not unnaturally—to embark their savings in the securities, so called, of South American governments. We call them South American governments partly by habit and partly by courtesy, but what is a South American government only too often? What but a knot of desperate adventurers who have contrived to seize the helm of State for a time, and who hold it until they are shot down or dispersed by a fresh band of lawless conspirators. We have been fleeced too smartly and too recently by such wretched republics as Venezuela, Honduras, Ecuador, Uruguay, Costa Rica and Peru, to be very eager to acquire any more South American bonds. Brazil and Chile certainly maintain a good credit at present, but neither of these States could raise new loans upon the English market so readily or so advantageously as they once did; and the consequence is that American locomotive builders compete with English firms upon rather more equal conditions than formerly. They ought certainly to do so, since they have not to carry their engines so far over the sea. Perhaps one cause which has rendered the Americans more eager competitors against us—not merely in the matter of locomotive building, but in almost every other branch of human effort—is the dullness of trade within the American republic itself. The Americans have been compelled *per force* to seek for fresh fields and pastures new because they have not been doing quite so well at home.

The appearance of American locomotives upon the railways of Australia is perhaps even a still more serious matter to English mechanical concerns than the dispatch of Baldwin engines to Brazil. Hitherto our Australasian friends have naturally almost entirely relied upon us, their kinsmen, for such locomotives as they required. They have certainly made desultory efforts to build locomotives for themselves, but they have not been very successful in doing so, and in the main they have applied to us when they have wanted some of those mighty iron horses which may be said to be the proudest results of British mechanical skill. But now our Australian friends have listened to the blandishments of Jonathan even in the matter of locomotives.

One at least of the Baldwin bogie engines has gone to one of the British settlements in Australia properly so-called, and the New Zealand government is also disposed to give a Baldwin engine a trial. The introduction of American bogie engines upon Australian and New Zealand railways fairly suggests the question whether English mechanical firms are not too rigid and perhaps even too antiquated in their ideas and notions. The bogie locomotive makes little progress upon English railways, but it is just the thing for young colonies and thinly-inhabited countries, in which railways are constructed in a lighter and more make-shift fashion than could possibly be introduced in Great Britain. A bogie engine will run with safety upon a rougher road-bed, and will overcome sharper curves than an engine with an inflexible frame of the ordinary English type. Let any one watch a train rushing along even upon a well appointed English railway, and he will see that it sways more or less about, although in 999 cases out of 1,000 it contrives to keep to the track. Such an observer will be fain to ask himself whether our express trains would not be safer—even when they glide over a first-class permanent way—if they were drawn by bogie locomotives readily adapting themselves to the little obstacles and difficulties of a line? Even if the inflexible framed engine holds its own pretty well upon a permanent way of the excellence of the London and Northwestern, its bogie competitor is far more adapted to a lightly-ballasted Australian road-bed, or to a line which has to climb some of the hills or mountains of New Zealand. When young Australian colonies map out new lines it is of supreme importance that they should be able to construct them cheaply. Sharp curves and severe gradients have a tendency to reduce construction expenses; the bogie locomotive is at home upon such curves and gradients, and therefore it is just the engine for the antipodes. We may admit this readily enough, because we ought to be able to make bogie locomotives just as easily as they are now made by our American competitors.

A Railway Pile-driver.—A pile driver in use in Nebraska is thus described: The engine, hammers, derrick, ladders, etc., and hoisting apparatus are all confined within an ordinary sized freight car. Heavy timber and beams make a strong frame-work for the foundation of the bed of the car. It is built on a circular turntable which is worked on the car, and it can be turned either way, the pile-driver reaching out 20 feet beyond the width of the track. Piling for bridges can be driven on end or side of the track simply by shifting the box of the car around. The machinery is placed within in the most compact and convenient form possible, and embraces all the modern improvements in the latest improved pile-drivers. It works with unusual rapidity, and it is but the work of a moment to attach it to an engine or train.

THE PROTECTION OF CARS AGAINST LIGHTNING.

The following is from Spang's "Practical Treatise on Lightning Protection," a work recently published by Claxton, Remsen & Haffelfinger, of Philadelphia: A locomotive, with its escaping smoke and steam, moving or at rest, in a thunderstorm, will also invite a lightning discharge, and the liability of damage thereto depends upon the quantity of water that has fallen previous to the discharge, the electrical connection made by the rails with the road-bed, the conducting nature of the road-bed and the earth beneath it; also whether iron cars are in the train. When a number of iron cars, like those used in the transportation of petroleum, are in a railway train, a lightning discharge will be diffused over them and greatly weakened, and thereby lessen the liability of damage to, or ignition of, the contents thereof. But in the case of a wooden car, the discharge will invariably pass through its interior and over inmates or contents in order to reach the earth, the contents being generally a path of much better conductivity than the wooden body of the car. The liability of injury or death of passengers and live-stock, and the ignition of powder or other combustible material by lightning can be greatly lessened by providing two metallic paths (one near each end) between the metal roof and the pedestals, axles and wheels of each wooden car used for their transportation. This can be done at a small expense by applying flat iron bars, two inches wide and one-eighth of an inch thick or four inches wide and one-sixteenth of an inch thick, along one of the sides and bottom of the body of the car, and connecting them with the metal roof and center plates attached to the body, and also metallically connecting the center plates of the trucks with the nearest or most convenient metal rod or bar communicating with the pedestals, thereby forming continuous metallic paths from the metal roof to the center plates, thence to the pedestals, axles, wheels and rails to the earth. During the summer season the rails of a railway track do not constitute very good earth terminals for a lightning conductor, owing to the dry condition and poor conductivity of the road-bed, which generally consists of broken stone or furnace cinder, a foot or more in depth, and their capacity for diffusing a lightning discharge will depend principally upon the quantity of rain that has fallen previous to the discharge and the conductivity of the road-bed and the earth beneath.

STEEL LOCOMOTIVE BOILERS.

One of the topics under consideration at the late meeting of railway master mechanics, at Cleveland, was the relative quality of iron and steel as material for railroad boilers. The testimony was almost unswerving in favor of steel as the best material for the shell of the boiler. We quote from a report of a committee as follows: With two exceptions all express themselves decidedly in favor of steel for the shell of the boiler. It is superior to iron in strength, and less difficult to shape and put together, and seems to be in every way preferable. Those who have used it most extensively for this purpose are the most decided in preferring it.

Not a single instance is reported where steel in the shell of a boiler has ruptured when cold, or in heating up, or from putting cold water in the boiler while hot, as so frequently occurs in the case of the sheets of the fire-box. Mr. Sedgley, of the Lake Shore and Michigan Southern, reports one steel sheet in the shell of the boiler to have cracked or broken in the way common to iron sheets in such cases, caused by imperfect construction or form of the boiler. Mr. Howard Fry, of the Philadelphia and Erie road, reports five steel sheets in the shell of boilers on that road to have cracked during the year 1876, but that in every case it was believed to be the result of bad workmanship or bad design in the form and bracing of the boiler, and not from the quality of the steel.

Your committee believe that the material in the shell of the boilers should be heavier than that in general use; that a greater stiffness and surplus of strength would add greatly to the length of time that they can ordinarily be used with safety, and lessen the cost of keeping them in repair from year to year. As the elastic limit of steel such as used in boilers is not much, if any, above that of iron, the same thickness of steel should be adopted as in the case of iron, notwithstanding its superior toughness. It is important that boilers should be so formed and stayed that with the highest pressure carried no part of one will change its original shape in the least by reason of the pressure. A change in shape in one direction by pressure, and returning again to its original position when the pressure is released, will sooner or later result in a crack. The same is true when braces are attached in such a way that the sheet is drawn from its true position by the strains from the brace. In designing and constructing boilers, these matters should always receive the most careful attention.

Those who have had much experience, and have given the matter close attention, give it as their opinion that steel, being more compact than iron, is less liable to waste away from corrosion, and in that respect is to be preferred. From the expressions made to your committee, we find that steel is rapidly taking the place of iron for the shell of the boiler.

Fruit Jellies.—Is the fruit jelly seen so often on the hotel table, used so frequently for dessert, and sold so abundantly by the grocer, healthful? Genuine fruit jelly is a wholesome dessert, and makes a pleasant drink when diluted with water, but most of the so-called fruit jelly put up so neatly in glass jars, so prettily colored, is not jelly at all, but a preparation from the feet and legs and bones of dead animals, that should find their way to the bone-boiler or the manufacturer of bone dust for the farmer. It is very cheap when compared with the true fruit jelly, and is made to resemble it by the color so easily given by the chemist. Chemistry is an art which has done much for civilization, but it has also done a great deal for dishonest dealers, and a great deal to destroy the health of the people. Yet strange to say, most of them are too thoughtless to use their brains to protect themselves.

KRUPP'S WORKS AT ESSEN.

Apart from the steel works of the Messrs. Krupp, the town of Essen, in Prussia, has very little interest for the traveler. As all the importance of Stratford-on-Avon is derived from the accidental circumstance that Shakespeare was born there, so all the interest that centers around Essen arises from the fact that it is the location of this remarkable steel-producing establishment. It is not always that the visitor can obtain an order of inspection, but very fortunately Dr. Edward Young, chief of the United States Bureau of Statistics, was able to do so some few years ago, and has given a record of what he saw in his admirable work entitled "Labor and Capital in Europe," published by Messrs. Trubner & Co., of Ludgate Hill. The population of Essen consists of some 52,000 inhabitants, nearly all of whom, directly or indirectly, derive their means of livelihood from these works. The number of men actually employed in the works at Essen is 12,000, and in coal mining, etc., 5,000. The cast-steel produced last year was 125,000 tons. The whole value of steel, steel guns, shafts, tires, rails, wheels, axles, etc., produced in 1871, was 12,000,000 thalers; the iron and iron-ore used was 200,000,000 pounds; the coal used per day was 30,000 centner, or nearly 500,000 tons per annum. The coal now costs 24 thalers per 100 centner, = five tons, or nearly 2,400,000 thalers. The number of crucibles used per day is 5,000; the total cost of coal per annum is 250,000 thalers; and the total cost of labor is 5,000,000 thalers. The wages of the men average $1\frac{1}{2}$ thalers per day, but the wages are regulated according to the skill of the work-people—those in the forging and finishing shops receiving the highest pay. The unskilled workmen only receive four thalers per week, though how they contrive to keep body and soul from dividing upon this payment is a problem which it would puzzle an economist to solve. The number of hours worked per day is 11, and the works are continually going. To increase their earnings many of the men work extra hours, and even on Sundays. We should be very sorry indeed to see English workmen paid so badly as to render the temptation to work on Sundays so great. At the end of the year Mr. Krupp distributes a large amount in benefactions, and these, like the weekly wages, are regulated according to the results. Workmen when sick get half wages, and are cared for in hospitals without cost. The firm contributes one-half as much as the aggregate contributions of the men. Mr. Krupp is building houses for his work-people, and in a variety of ways evidences his interest in their welfare. Speaking of the quality of the steel, Dr. Young says: "With regard to the soundness and good quality of the steel castings made in this establishment, they appear to be entirely faultless. I saw immense guns, nearly completed, intended for exhibition at Vienna next year; an immense shaft for a steam-ship of one of the German lines to New York, which seemed the very perfection of workmanship, and for which one thaler per lb. was to be paid; and great numbers of other manufactures of steel, either completed or in progress, all of which appeared to possess great excellence. In regard to tools, machinery, and appointments, these works do not, in my opinion, surpass in excellence those of the steel works of Messrs. Firth & Sons, of Sheffield. But as the products have obtained a higher reputation than those of any other manufacturer, how is this admitted excellence obtained? No doubt it is in part due to the analyses of the various ores from his mines in Germany and Spain, and from Great Britain and other countries, and from experiments made by the experienced and analytical chemists in his employ. But, in my opinion—the opinion of an inexpert in metallurgy and mechanical engineering—this firm has no secrets in regard to the admixture of various kinds of iron which, if known, would enable manufacturers to produce as good steel. The superiority is, I believe, owing to the following causes: Most of his workmen have been for a long time in his employ, and have great experience and skill; his foremen thoroughly understand their business, possess technical training, and practical knowledge. These are all attached to the proprietor by his practice of giving extra pay for skilled work, by his annual gratuities, by his generosity exhibited toward the men in every possible way, and his sympathy with them. His workmen are thus warmly attached to him, and strive to promote his interest by performing their several duties thoroughly and well. In the reputation of the establishment for excellence of workmanship, they are, therefore, interested." The works were established by Mr. F. Krupp in 1810, who died when the present Alfred Krupp was little more than 14 years of age. Leaving school, he seems to have continued the works on a very small scale at first, but gradually the quality of the work turned out brought the name of Krupp into repute, so that to-day anything that leaves his works is regarded as little short of perfection. The works have been so developed that at this time they cover a continuous area of more than 4,784,000 square yards, of which about 900,000 square yards are covered in. It must be evident from the circumstances under which the present Mr. Krupp took possession of the works that he is a man of no ordinary talent and business energy. Even since Dr. Young visited the works they have been developed still further, and it is impossible to predict what their ultimate dimensions will be.—*Mining World.*

Smokeless Furnace.—We learn from an English exchange that Erskine's patent smokeless furnace is an invention, the novelty of which consists of peculiarly constructed fire-bars, resting directly upon tubes arranged in such a manner that heated air is admitted into the furnace in such proportions as to secure combustion of the gases before the smoke is actually made; it is so arranged that the air passing under the fire, and returning through the tubes, is so greatly heated as to generate steam quickly and give a steadier supply. The bars also afford more air space, which is said to secure entire consumption of the fuel, and to greatly economize the same.