THE CHEMICAL HISTORY OF A CANDLE.

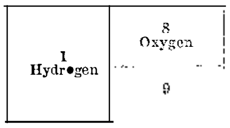
By Professor Faraday.

A Course of Six Lectures (adapted to a Juvenile Audience) Delivered before the Royal Institution of Great Britain.

LECTURE IV.—(Continued.)

Products: Water from the Combustion—Nature of Water—A Compound—Hydrogen.

We shall now begin to understand more clearly our experiments and researches; because when we have examined thesethings once or twice we shall soon see why a candle burns in the air. When we have in this way analyzed the water—that is to say, separated or electrolyzed its parts out of it, we get two volumes of hydrogen and one of the body that burns it. And these two are represented to us on this diagram, with their



Oxygen	88.9
Hydrogen	11.1
Water	100.0

weights also stated, and we shall find that oxygen is a very heavy body by comparison with the hydrogen. It is the other element in water.

I had better, perhaps, tell you now how we get this oxygen abundantly, having shown you how we can separate it from the water. Oxygen, as you will immediately imagine, exists in the atmosphere; for how should the candle burn to produce water without it? Such a thing would be absolutely impossible, and chemically impossible without oxygen. Can we get it from the air? Well, there are some very complicated and difficult processes by which we can get it from the air; but we have better processes. There is a substance called the black oxyd of manganese; it is a very black looking mineral, but very useful, and when made red hot it gives out oxygen. Here is an iron bottle which has had some of this substance put into it, and there is a tube fixed to it, and a fire ready made, and Mr. Anderson will put that retort into the fire, for it is made of iron and can stand the heat. Here is a salt called chlorate of potassa, which is now made in large quantities for bleaching, and chemical and medical uses, and for gunpowder and other purposes. I will take some and mix it with some of the oxyd of manganese (oxyd of copper or oxyd of iron would do as well), and if I put them in a retort, far less than a red heat is sufficient to evolve this oxygen from the mixture. I am not preparing to make much, because we only want sufficient for our experiments; only, as you will see immediately, if I use too small a charge, the first portion of the gas will be mixed with the air already in the retort, and I should be obliged to sacrifice the first portion of the gas because it would be so much diluted with air; the first portion must therefore be thrown away. You will find in this case that a common spirit lamp is quite sufficient for me to get the oxygen, and so we shall have two processes going on for its preparation. See how freely the gas is coming over from that small portion of the mixture. We will examine it and see what are its properties. Now, in this way, we are producing, as you will observe, a gas just like the one we had in the experiment with the battery, transparent, undissolved by water, and presenting the ordinary visible properties of the atmosphere. (As this first jar contains the air together with the first portions of the oxygen set free during the preparation, we will carry it out of the way, and be prepared to make our experiments in a regular, dignified manner.) And inasmuch as that power of making wood, wax, or other things burn, was so marked in the oxygen we obtained by means of the voltaic battery from water, we may expect to find the same property here. We will try it. You see there is the combustion of a lighted taper in air, and here is its combustion in this gas [lowering tha taper into the jar]. See how brightly and how beautifully it burns—you can also see more than this—you will perceive it is a heavy gas, whilst the hydrogen would go up like a balloon, or even faster than a balloon, when not encumbered with the weight of the envelope. You may easily see that although we obtained from water twice as much in volume of the hydrogen as of oxygen, it does not follow that we have twice as much in weight; because one is heavy and the other a very light gas. We have means of weighing gases or air; but without stopping to explain that, let me just tell you what their respective weights are. The weight of a pint of hydrogen is three-quarters of a grain; the weight of the same quantity of oxygen is nearly twelve grains. This is a very great difference. The weight of a cubic foot of hydrogen is one-twelfth of an ounce; and the weight of a cubic foot of oxygen is one ounce and a third. And so on, we might come to masses of matter which may be weighed in the balance, and which we can take account of as to hundredweights and as to tuns, as you will see almost immediately.

Now, as regards this very property of oxygen supporting combustion, which we may compare to air, I will take a piece of candle to show it you in a rough way and the result will be rough. There is our candle burning in the air; how will it burn in oxygen? I have here a jar of this gas, and I am about to put it over the candle for you to compare the action of this gas with that of the air. Why, look at it; it looks something like the light you saw at the poles of the voltaic battery. Think how vigorous that action must be! And yet during all that action nothing more is produced than what is produced by the burning of the candle in air. We have the same production of water; and the same phenomena exactly, when we use this gas instead of air, as we have when the candle is burnt in air.

But now we have got a knowledge of this new substance, we can look at it a little more distinctly, in order to satisfy ourselves that we have got a good general understanding of this part of the product of a candle. It is wonderful, you see, how great the supporting powers of this substance are as regards combustion. For instance, here is a lamp which, simple though it be, is the original, I may say, of a great variety of lamps which are constructed for divers purposes—for lighthouses, microscopic illuminations, and other uses; and if it was proposed to make it burn very brightly, you would say, "If a candle burnt better in oxygen, will not a lamp do the same? Why, it will do so. Mr. Anderson will give me a tube coming from our oxygen reservoir, and I am about to apply it to this flame, which I will previously make burn badly on purpose. There comes the oxygen; what a combustion that makes! But if I shut it off, what becomes of the lamp? [The flow of oxygen was stopped, and the lamp relapsed to its former dimness.] It is wonderful how, by means of oxygen, we get combustion accelerated. But it does not affect merely the combustion of hydrogen, or carbon, or the candle; but it exalts all combustion of the common kind. We will take one which relates to iron, for instance, as you have already seen iron burn a little in the atmosphere. Here is a jar of oxygen, and this is a piece of iron wire; but if it were a bar as thick as my wrist, it would burn the same. I first attach a little piece of wood to the iron, I then set the wood on fire, and let them both down together in the jar. The wood is now alight, and there it burns as wood should burn in oxygen; but it will soon communicate its combustion to the iron. The iron is now burning brilliantly, and will continue so for a long time. As long as we supply oxygen, so long can we carry on the combustion of the iron, until the latter is consumed.

We will now put that on one side, and take some other substance; but we must limit our experiments, for we have not time to spare for all the illustrations you would have a right to, if we had more time. We will take a piece of sulphur: you know how sulphur burns in the air; well, we will put it into the oxygen, and you will see that whatever can burn in the air can burn with a far greater intensity in oxygen, leading you to think that perhaps the atmosphere itself owes all its power of combustion to this gas. The sulphur is now burning very quietly in the oxygen; but you cannot for a moment mistake the very high and increased action which takes place when it is so burned, instead of being burned merely in common air.

I am now about to show you the combustion of another substance—phosphorus. I can do it better for you here than you can do it at home. This is a very combustible substance, and if it be so combustible in air, what might you expect it would be in oxygen? I am about to show it to you not in its fullest intensity, for if I did so, we should almost blow the apparatus up; I may even now crack the jar, though I do not want to break things carelessly. You see how it burns in the air. But what a glorious light it gives out when I introduce it into oxygen! [Introducing the lighted phosphorus into the jar of oxygen.] There you see the solid particles going off which cause that combustion to be so brilliantly luminous.

Thus far we have tested this power of oxygen and the high combustion it produces, by means of other substances. We must now, for a little while longer, look at it as respects the hydrogen. You know that when we allowed the oxygen and the hydrogen derived from the water to mix and burn together, we had a little explosion. You remember also that when I burnt the oxygen and the hydrogen in a jet together, we got very little light but great heat; I am now about to set fire to oxygen and hydrogen mixed in the proportion in which they occur in water. Here is a vessel containing one volume of oxygen and two volumes of hydrogen. This mixture is exactly of the some nature as the gas we just now obtained from the voltaic battery; it would be far too much to burn at once; I have therefore arranged to blow soap bubbles with it and burn those bubbles, that we may see by a general experiment or two how this oxygen supports the combustion of hydrogen. First of all we will see whether we can blow a bubble. Well, there goes the gas [causing it to issue through a tobacco pipe stem into some soap suds]. Here I have a bubble. I am receiving them on my hand, and you will perhaps think I am acting oddly in this experiment, but it is to show you that we must not always trust to noise and sounds, but rather to real facts. [Exploding a buble on the palm of his hand.] I am afraid to fire a bubble from the end of the pipe, because the explosion would pass up into the jar and blow it to pieces. This oxygen will then unite with the hydrogen, as you see by the phenomena and hear by the sound, with the utmost readiness of action, and all its powers are then taken up in its neutralization of the qualities of the hydrogen.

So now I think you will perceive the whole history of water with reference to oxygen and the air, from what we have before said. Why does a piece of potassium decompose water? Because it finds oxygen in the water. What is set free when I put it in the water, as I am about to do again? It sets free hydrogen, and the hydrogen burns; but the potassium itself combines with oxygen; and this piece of potassium, in taking the water apart—the water, you may say, derived from the combustion of the candle—takes away the oxygen which the candle took from the air, and so sets the hydrogen free; and even if I take a piece of ice, and put a piece of potassium upon it, the beautiful affinities by which the oxygen and hydrogen are related are such that the ice will absolutely set fire to the potassium. I show this to you to-day, in order to enlarge your ideas of these things, and that you may see how greatly results are modified by circumstances. There is the potassium on the ice, producing a sort of volcanic action.

It will be my place when next we meet, having pointed out these anomalous actions, to show you that none of these extra and strange effects are met with by us—that none of these strange and injurious actions take place when we are burning, not merely a candle, but gas in our streets, or fuel in our fireplaces so long as we confine ourselves within the laws that Nature has made for our guidance.

Great Improvement in Making Sugar.

L'Opinion Nationale, of Paris, under the heading, "A Revolution in the Manufacture of Sugar," announces a discovery by M. Rousseau, which, it says, will *more than double the yield from a given quantity of cane.* The process is exceedingly simple, and the editor says that he has repeated it with complete success in the laboratory, and sees no reason why it should not succeed as well on a large scale.

It is known that saccharine juice as obtained from plants, alters rapidly in the air, because it contains albuminous matters which become brown or black by the action of oxygen. M. Rousseau removes the albuminous matters by heating the juice with about three one-thousandths of its weight of crude pulverized plaster. As soon as the liquid arrives at boiling heat, a thick scum forms on the surface, and by decantation, a perfectly clear liquid is obtained. This liquid left in the air would become as black as ink; but by mixing with it 6 to 8 per cent of its weight of hydrated peroxyd of iron, all the alterable organic matters are removed in a few seconds. It will then remain for an indefinite time without color, and it is only necessary to boil it down to obtain crystallized sugar.

Fence and Hedge-Row Timber.

The following, condensed from "Morton's (British) Cyclopædia of Agriculture," will be of use and interest to many of our farmers and others, at this season of the year :—

Trees are cultivated in hedge-rows for the sake of their timber, for shelter to the adjoining fields, and for embellishment ; and in many situations all these valuable objects are obtained in the same locality. It is true, that where timber generally rises to the greatest size and value, the situation which produces it is that which stands least in need of shelter ; but where trees fail to become specimens of excellent growth, on account of the climate and exposure, the value of the timber is often compensated for by the shelter which the trees impart to the fields in their vicinity. The quantity of timber grown in rows along roadsides, around the extremities of estates, and in the division of fields, throughout England, is supposed to be greater than that produced in close woods and forests. Many of her sheltered plains are overcrowded, and present the appearance of one continuous forest. In all windy situations, plants should be employed stout in proportion to their hight, and with lateral branches down to the surface of the ground. The figure of trees varies considerably, according to their kinds, their age, and according to the physical circumstances in which they are placed ; such as soil, situation, climate, and, above all, to their proximity with other trees. Their natural form and outline, under different circumstances, can only be known when they stand alone. The sturdy oak alone, in poor soil, and cold elevated situations, becomes a bush ; in the rich and sheltered valley plantation, it rises to a lofty tree with a tall trunk.

In the growth of useful hedge-row timber the English elm is the tree most generally cultivated in England. When a plant, it naturally forms a bushy root ; and, if properly nursed, it admits of removal at a size beyond that of most trees. Its figure is erect, and the spread of its branches does not extend very far.

Next to the elm, various sorts of oak are to be recommended as valuable hedge-row trees, although generally they do not stand so erect as the English elm ; yet they are less destructive to the crops in their vicinity ; their roots generally strike deeper than most trees, and, consequently, are less dependent on the surface-soil for their support ; and, being late in expanding their leaves, they do not overshadow the crops in their vicinity early in the season. All the common varieties of oak are adapted for hedge-rows. The larch, although seldom introduced into the hedge-rows of highly cultivated districts, possessed of a superior climate, is, nevertheless, a very suitable tree ; it forms an agreeable variety, and breaks the monotonous appearance of some districts. It is profitable, being of rapid growth, and valuable as timber, and is less subject to disease in an isolated position than in masses. No tree is less injurious to grain crops ; its leaves enrich the soil, and, when shed, are commonly deposited on the surface around its roots. In rough situations, however, it is apt to be bent by prevailing winds, and to become unsightly.

For avenues, where a depth of embowering shade and seclusion are required, the lime tree, with its large umbrageous head yielding sweetly-scented blossoms, has no superior. The horse chestnut also is generally a favorite in such places. The Spanish chestnut, sycamore, Scotch elm, beech, and planes, are all of that large and spreading habit of growth which recommend them for such purposes.

For situations too rough and exposed for trees, in general, the sycamore, service tree, mountain ash, beech, Scotch elm, and hoary poplar, are most likely to succeed. The three kinds first named are remarkable for their unyielding character in cold or windy situations ; and, even at great elevations, they grow erect, and produce well-balanced heads.

Among the flowering plants for ornament, the varieties of thorn, laburnum, and scarlet horse chestnut are pre-eminent. A ready method of establishing lines of the numerous species of the first-named genus is, by selecting strong stems of the common hawthorn, in a vigorous-growing hedge. Such will readily train to a considerable hight, when they may be grafted with the varieties and species of the tree. Those most handsome and attractive in flower are the scarlet and double red.

In planting hedge-row trees, their roots should not be sunk under the surface beyond their natural depth; the upper fibres should be so situated as to be influenced by every shower. For the first few years after the tree has been inserted, its vigor of growth is much accelerated by the surface of the ground being loosened and kept clear of herbage, around a space comprehending the range of its roots.

The mode of pruning trees, under any circumstances, is of great importance ; but never more so than when they are placed in hedge-rows. In the forest, their proximity to one another, to a great extent, supersedes the necessity of much pruning ; but when situated individually, no part of their management is more important than that this operation should be performed skillfully. It should be attended to early, so that there shall be no necessity for the removal of large branches. The method of pruning trees, for useful purposes, appears to be ill understood. The common method is to clear the trunk of lateral branches to a considerable hight, and allow the higher ones to take their course. This has a tendency to produce a large head, widely spread and ramified ; and, where this figure of growth is desired, we know of no other method which will so speedily accomplish the purpose, because it has the effect of establishing a host of branches equal in magnitude to the leader. This retards the hight, and adds to the breadth of the tree. Where bulk of useful timber is aimed at, the mode of treatment should be very different. It is then necessary to direct attention chiefly to the top or leading shoot, and to the branches in its vicinity, with the view of continuing the length of the trunk, and preventing it from dividing into forks or clefts. This is accomplished by preserving one leading shoot, and in shortening competing ones.

Ten Years' Imports of Cotton.

The cotton trade of Great Britain, vast as are the proportions it has already reached, is, like most other branches of trade, steadily on the increase. Whilst England's imports of cotton are enlarging, her consumption proceeds in an equal ratio, the amount taken by the trade in 1860 being 2,632,000 bales, or 338,000 bales over 1859. So industriously is her manufacturing power plied, that with increased imports, we find the supply on hand below the relative average amount, the stock on the 1st instant amounting to but 1,145,000 bales. In fact, the supply of the year 1860 is found inadequate to British requirements, and now that the prospect of a more extended market for English goods presents itself, it is not surprising that the manufacturing interest should have taken alarm at even the rumor of uncertainty as to the future adequacy of present sources of supply. There is nothing in our American advices to show that the next cotton crop, if the season be propitious, will not be larger than that of 1860. It is worth while to look to the extent to which the United States have answered the demand of English manufacturers the last ten years. In 1851, they exported to England 1,395,000 bales ; in 1852, 1,792,000 bales ; in 1853, 1,531,000 bales ; in 1854, 1,667,000 bales ; in 1855, 1,626,000 bales ; in 1856, 1,758,000 bales ; in 1857, 1,482,000 bales ; in 1858, 1,863,000 bales ; in 1859, 2,098,000 bales ; and in 1860 the amount reached 2,582,000 bales. The immense increase of late years in the United States supply will not fail to excite attention in this retrospect. There has been an occasional falling off in a year's supply as compared with that preceding, but the whole increase in this stated period amounts to no less than 1,187,000 bales, or from 1,395,000 in 1851 to 2,582,000 in 1860. The exports of Brazil to England have decreased in this time 7,000 bales—that is, from 109,000 bales in 1851 to 102,000 in 1860, though, it should be stated, that in 1859 her supplies were 118,000, and in 1857, 168,000 bales, the highest amount yet realized. The West Indies have doubled their produce in the last ten years, but only from 5,000 bales in 1851 to 10,000 in 1860 ; Egypt has increased its British supply in the last ten years from 68,000 bales to 110,000, and India from 326,000 to 563,000 bales. The total number of bales imported by Great Britain in 1860 amounted to 3,367,000 or 538,000 bales over the amount imported in 1859, and 1,464,000 bales over the receipts of 1851, an increase almost corresponding to the increased imports from the United States, those of 1860 exceeding those of 1851 by 1,187,000 ; looking for the balance, we find it in the increase of India supplies for the same time.

Progressive Increase in the Introduction of American Patents into England.

Of all the forms in which the power of a people is recognized by foreigners, there are none which furnish a ground for nobler pride than the reading of its literature and the adoption of its inventions ; for these are recognitions of its intellectual power. The hard crust of English prejudice has been pretty effectually broken up by the reaping machine, the revolver and the sewing machine, and there is a constantly increasing disposition to adopt inventions which are really good, even though they come from the United States. Since our last summary of American inventions patented in England, we have received a large number of Blue Books containing the printed specifications and drawings of American patents, secured through the Scientific American Patent Agency, from which we make the following notices :—

Improved Mode of Hanging Window Sashes.—Patented by Thomas Fry, of Brooklyn, N. Y.—Slides are arranged to move up and down in suitable grooves in the frame, and to these slides the sash is attached by pivots at the sides, so that they may be turned round, thus giving ready access to the outside of the sash for cleaning, and enabling the window to be fully opened, either for taking in and out such articles as cannot be conveniently carried through the house, or for securing more thorough ventilation. This invention was illustrated on page 8, Vol. III (new series), SCIENTIFIC AMERICAN.

Improvement in Railway Tracks and Carriage Wheels.—William Wharton, Jr., of Philadelphia, patentee.—The object of this invention is to allow one or more of a series of trains that run over a common railroad to pass the switches at the branch tracks designed for other trains without being turned out of their course, while the cars specially designed for the branch tracks will run upon them without any change of the switches, thus dispensing with the services of men to attend the switches. To accomplish this, the wheels of the cars have additional treads to run upon raised rails at the turnouts. (See engraving on page 208.)

Calendars for Clocks.—Patentees, Wait T. Huntington and Henry Platt, of Ithaca, N. Y.—This improvement relates to the mechanism through which the clock or time keeper effects the variable movements of the index for the day of the month, and the index for the name of the month of the calendar, which variable movements are rendered necessary by the variations in the length of the month in a quadrennial period. For the day of the month index a wheel is employed having 31 teeth, three of which are shorter than the other 28, a detent entering the wheel at different depths according to the number of days in the month. The days of the week are marked on one cylinder, and the names of the months on another cylinder, both of the cylinders rotating opposite openings in the face of the clock, so as to bring the several names in view at the proper times. The devices by which all these movements are effected are exceedingly ingenious.

Improvement in Pianofortes.—Patentee, Spencer B. Driggs, of New York.—The inventor of this improvement is the same gentleman whose profound article on the mechanics and mathematics of musical vibrations was published on page 146 of our last volume. The invention consists in a graduated sound-board and bridge, that is to say, in so arranging and applying the sound-board and strings, and so constructing and applying the bridge or bridges of a pianoforte, that the depth of bridge at the bearing point of the several strings, and the distances of the several strings from the board are in proportion, or nearly so, to the lengths of the vibrating portions of the strings.

Iron Pavements.—Patentee, Baron Otto des Granges, of New York.—This invention consists in the construction of cast iron blocks for pavements in which each block has a number of similar upright six-sided cells, and a base of quadrangular forms, beyond the sides of which the upper parts of the said cells project horizontally in such a manner, that when the quadrangular bases of a number of blocks are laid close together, the said projecting parts of the cells of each block fit between the cells of and lap over the bases of the adjacent blocks, and thus make all the blocks mutually supporting, so that none can sink without the neighboring ones on all sides of it going down with it.

Carpet Looms.—Patentee, Charles Crossley, of Bridgeport, Conn.—This invention consists in the application to a Brussels carpet-loom of a peculiar combination of devices intermediate between the stay and the harness or heddles, the object of which is to throw up the worsted or loop forming thread to the right and left alternately over and above the cotton warp threads. The devices require diagrams to be understood.

Preparing and Spinning Hemp.—Patentees, Joseph C. Todd and Philip Rafferty, of Paterson, N. J.—This invention relates to improvements in machinery for effecting three different operations required to be used in preparing and spinning hemp or other fibrous materials used for the manufacture of rope. These machines are an improved lapper or heckling machine, improved drawing rollers and endless belts or aprons of leather in place of the drawing rollers.

Apparatus for Warming Buildings by Steam.—Patentees, Lewis W. Leeds and Calvert Vaux, of New York.—Steam from a steam boiler is introduced into a vessel of water so as to warm the water; and through this vessel the air pipes pass by which means air is heated, when it is distributed in the usual manner over the building. Or the steam is used directly to warm the air chamber without the intervention of water. The patent also covers a regulator for regulating the heat automatically.

Printing Blocks.—Patentee, T. Crossley, of Bridgeport, Conn.—This invention consists in the production of an electrotype printing block, having a plain face, with margins of metal, and the body of felt or its equivalent, and highly raised above its base, and having perpendicular sides. The blocks are for printing calico, &c.

Nippers for Attaching Blocks and Tackles to Ropes.—Patentees, William H. Allen and Andrew J. Bentley, both of New York.—A pair of nippers, with jaws bent on one side and fashioned to grasp a rope, are made with eyes in the ends of the handles for the supporting cord or rope to pass through, so that the greater the weight on the block or tackle the more firmly will the rope be grasped by the nippers.

Mode of Attaching Tools to Handles.—James E. Emerson, patentee, of Trenton, N. J.—A stirrup is secured to the pick or other tool, the stirrup having a socket to receive the handle. This forms a very neat and substantial tool, and we are happy to know that it is meeting with extensive sale, as applied to picks and other tools.

Valves and Valve-Geer for Steam Engines.—Patentees, Addison Crosby, Simeon Savage, and Herman S. Stearns, all of Fredonia, N. Y.—This is an improvement in oscillating valves and their connections, which could be made plain only by engravings.

Rotary Planes.—Patentee, John Sperry, of New York.—Though a very simple engraving would convey a clear idea of this invention, it is a mere waste of words to attempt to render it intelligible by letter press description.

Nail Plate Feeder.—Patentees, John W. Hoard and Thomas A. Searle, of Providence, R. I.—This is an improved apparatus for feeding the plates from which nails are cut to the nail-making machine. It would require diagrams to make it intelligible, but it is a very ingenious arrangement.

Breech-Loading Cannon.—Patentee, Charles F. Brown, of Warren, R. I.—This invention was illustrated and described on page 240, Vol. III. (new series), Scientific American.

Apparatus for Lifting Vessels Out of Water.—Patentee, Horace I. Crandall, of New Bedford, Mass.—This lifting dock was illustrated and described on page 406, Vol. III (new series), Scientific American.

Great Storms in England—The Crystal Palace Damaged.

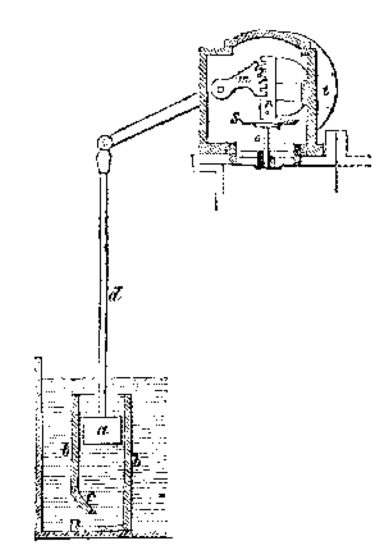
By the recent news from England, we learn that very severe storms have visited the British Isles, and done much damage to shipping and buildings. Several American ships have been wrecked, and about 140 British driven on shore in one night. One of the towers of the Crystal Palace, at Sydenham, has been destroyed. The wind coming in terrific gusts communicated a dangerous vibratory motion to the tower until at last it toppled over with a terrible crash. The iron columns were broken into little pieces as if they had been glass, and the ruins presented the appearance of being shattered by a tremendous explosion. The main part of the Palace was not the least affected. This tower will not be erected as it was of little use, nor will its absence injure the general effect of the structure.

ROMANCE OF THE STEAM ENGINE.

Article XVI.

WATT—THE DASH POT.

In our last article we illustrated the indicator invented by Watt, to measure the actual power developed in the cylinder of an engine. The accompanying figure represents the "dash pot" which Watt invented to graduate the descent of the puppet valve into its seat, to prevent it from slamming. There are two common methods of operating valves through the rods. One is by a *positive*, and the other by a *free* motion. The former is exemplified in engines having slide valves, the rods of which are positively united to the eccentrics; the latter is exhibited on the beam engines of our steamboats, the valve rods of which are lifted by toes or wipers, then fall into their seats by their own gravity. James Watt used puppet valves similar to those on common beam engines; these were operated by tappets on a "plug frame," and the valves dropped into their seats. A small vessel or cistern containing water was placed under the valve box, and in it was secured a small cylinder, *b*, with a plunger, *a*, in it, connected to the valve by a rod, *d*. A valve, *c*, opened into the cylinder, communicating with the cistern, and the plunger, *a*, has a water space around it. When the plunger, *a*, is drawn up, the valve, *c*, opens and the water flows into the cylinder; but when the plunger, *a*, descends, the valve, *c*, closes, and the water which is displaced rises between the plunger and the cylinder. The resistance



thus offered to the descent of the plunger prevents the valve dropping violently into its seat, as the water forms a graduating cushion to the descent of the plunger. At the same time, the plunger, by moving in water, enables the valve to be operated almost like a balanced valve in its lifting action.

In other arrangements, Watt hung balance weights on horizontal levers that vibrated on a joint, so as to permit his valves being operated easily—an arrangement which is substantially applied to many of our approved engines of recent construction.

The dash pot is now employed in our American beam engines, the valves of which are operated by vibrating lifters; but so far as we have been able to learn, it was first thus applied, about eighteen years ago, in connection with Sickle's cut-off, and at that time was supposed to be a new invention. And, indeed, we believe there are few who are fully aware of the age of this device, as, in a conversation which we had not long since with one of our old and experienced engineers, he expressed surprise when we told him that the dash pot on his engine was one of Watt's creations. The plunger in the dash pot of our engines has a space in it, into which the water enters during its descent, but otherwise the principle is the same as that here represented. The mode of connecting the valve stem, *o*, with the rod through tooth connections, *m n*, as represented in this figure, is not employed on the engines of the present day.

At the present time we can scarcely form an idea of the difficulties and perplexities which harassed Watt in his labors to construct the first steam engines and apply them to practical purposes. The tools which belong to the engineering establishments of the present day are so numerous and perfect in their action, that there is no difficulty experienced in executing all kinds of engineering work in the most accurate manner. It was very different, however, in the infancy of steam engineering. There was not a single machine in use capable of boring a cylinder correctly, consequently it was difficult to make the piston work steam tight; there were also no iron planers then in use, and it was almost impossible to obtain accurate joints in fitting the parts of the engines together. To all these different departments of mechanism Watt had to direct his attention, and it is fortunate for the world that he had originally been a most skillful machinist and maker of the most delicate philosophical instruments. He not only improved the steam engine in all its most essential features, but his active and inventive mind devised machines for the proper construction of its various parts; he organized the entire system of engine construction and steam engineering.

The Whaling Business.

An article in a recent issue of the Boston *Commercial Bulletin*, contains some very interesting information on this subject. For many years New Bedford, Mass., has been known, not only as the greatest whaling port in the United States, but the whole world; it is now, however, falling fast from its former oily greatness. In 1857, there were 329 vessels of 111,364 tuns belonging to New Bedford; but at the present time there are only 291 vessels of 98,760 tuns, a decrease of 38 vessels and 12,604 tuns. This reduction has not been caused by losses of ships at sea, but by their withdrawal from the trade, as the business has been very unprofitable for the past four years. The price of whale oil has been greatly affected by substitutes, especially coal oil, and the more general adoption of gas in cities and large villages. In 1860, the price of whale oil was only 50 cents per gallon, while in 1857 it was 73 cents, and this reduction of price was accompanied with another blow at whaling, namely, a very limited catch of whales. In 1857, the average catch was 800 barrels; last year it was only 500 barrels.

One-half of the whaling fleet is devoted to the sperm whale fishery, the other half to the right whale fishery. One-half of all the sperm oil obtained goes to England, and amounts to about 75,500 barrels annually, valued at $1,500,000. The right whale produces all the whalebone, most of which goes to Germany; the annual value of it is $1,000,000. The amount invested in the whaling trade in New Bedford is $10,000,000. Many of the merchants in that place are now looking around to see if they cannot enter upon a more profitable business. The total whaling fleet of the United States now comprises 514 vessels of 158,746 tuns. There has been a total decrease of 141 ships in four years. In 1858 two hundred ships went to the North Pacific for whale oil; it is expected that only one hundred will go this year.

How to Prosper in Business.—In the first place, make up your mind to accomplish whatever you undertake; decide upon some particular employment, and persevere in it. All difficulties are overcome by diligence and assiduity. Be not afraid to work with your hands, and diligently too. "A cat in gloves catches no mice." He who remains in the mill grinds; not he who goes and comes. Attend to your own business; never trust to any one else: "a pot that belongs to too many is ill-stirred and worse boiled." Be frugal: "that which will not make a pot will make a pot-lid;" "save the pence, and the pounds will take care of thenselves." Be abstemious: "who dainties love shall beggars prove." Rise early: "the sleepy fox catches no poultry;" "plow deep while sluggards sleep, and you will have corn to sell and keep." Treat every one with respect and civility: "everything is gained and nothing lost by courtesy;" "good manners insure success." Never anticipate wealth from any other source than labor—especially never place dependence upon becoming the possessor of an inheritance: "he who waits for dead men's shoes may have to go a long time barefoot;" "he who runs after a shadow hath a wearisome race." Above all things, never despair—God is where he was; "He helps those who truly trust in Him."

Wealth of Indiana.—The Auditor of the State of Indiana reports the total assessment of property in the State at $455,011,378. As the population is 1,350,802, this gives an average of $336 to each inhabitant.