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Improved Hot Air Furnace.

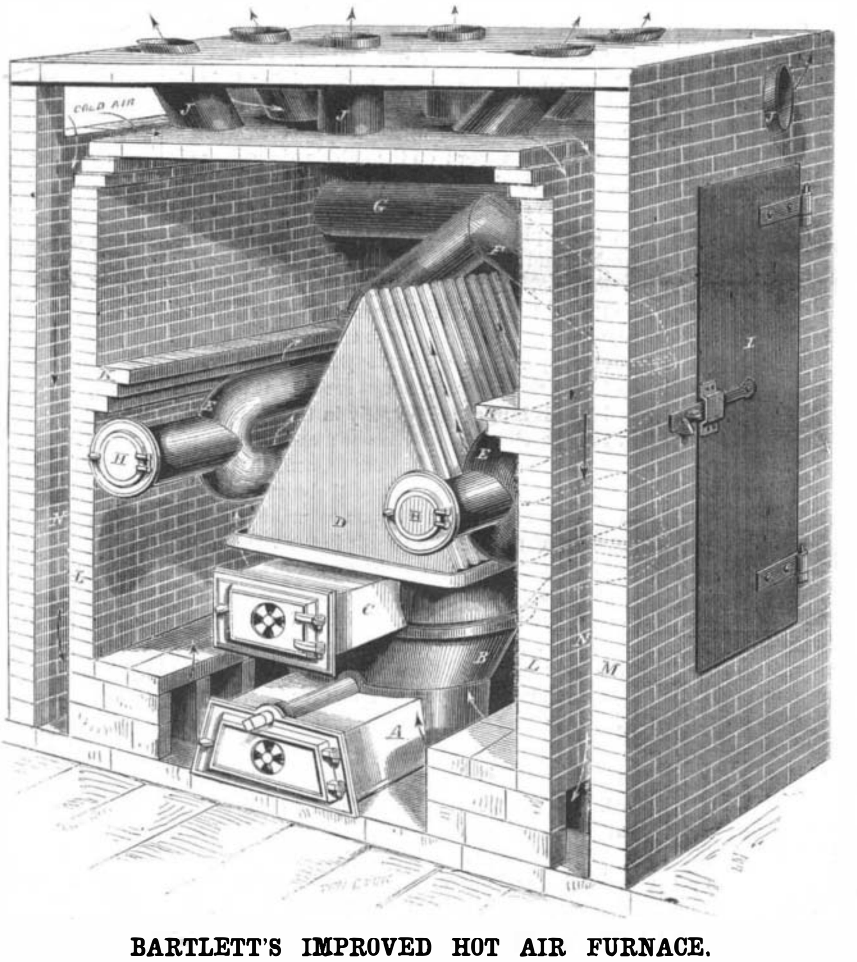
The accompanying engraving represents an alleged improvement in furnaces for warming dwellings with hot air, designed by A. H. Bartlett, of this city. The inventor has long been engaged in manufacturing and selling furnaces, and his aim in devising this was, not to advance a startling novelty, but to so combine the modifications suggested by experience as to produce an economical and convenient furnace, one that should utilize all the heat, be easily managed by an unskillful servant, and afford the greatest possible facilities for cleaning and repairs.

The engraving represents the furnace set in its hot air chamber of brick work, with the front wall of the chamber removed in order to show the parts. A is the ash pit, B the fire pot, C the feeder, D the cast iron corrugated radiator, E E the flues, H H doors for cleaning the flues, F the connecting pipe, G the smoke pipe, I the manhole door, K K projections in the brickwork to turn the air inward around the flues, J J J J hot air pipes, L the inner wall of the air chamber, M the outer wall and N the space between the two.

The fire pot, B, being supplied with coal through the feeder, C, the radiator and flues become heated, and thus warm the air chamber. The cold air enters through an opening in the outer wall as indicated by the arrows, and, passing around the inner chamber, enters through openings in the bottom in a horizontal direction, so as to be thrown directly against the furnace. As it rises it is deflected inward by the projections, K K, against the flues, and lastly against the upper part of the radiator, D, which is the hottest portion of the furnace. This is an important feature in this invention; as the air can become progressively heated only by coming first in contact with the cooler parts of the furnace, and lastly with those which are the hottest.

The flues are made in pieces of moderate length, and their joints, as well as all others in the furnace, are deep sand joints, thus giving perfect security against the leakage of air or smoke. The flues do not descend in any part of their course, and from their size and position they are very easily cleaned. No piece of the whole furnace is too heavy to be removed by one man in case of repairs being required.

The patent for this invention was granted Sept. 18, 1860, and further information in relation to it may be obtained by addressing Bartlett & Lesley, at No. 426 Broadway, New York.



BARTLETT'S IMPROVED HOT AIR FURNACE.

A CUBIC inch of gold is worth one hundred and forty-six dollars; a cubic foot, two hundred and fifty-two thousand, two hundred and eighty-eight dollars; and a cubic yard, six million, eight hundred and eleven thousand, seven hundred and seventy-six dollars. The quantity of gold now in existence is estimated to be three thousand millions of dollars, which, welded in one mass, could be contained in a cube of twenty-three feet.

Why Does Gunpowder Drive a Ball from a Cannon?

When gunpowder is burned, the elements of which it is composed are changed from the solid to the gaseous form, and, as gases, they occupy some three or four hundred times more bulk than they do in the solid state at the same temperature. But the substances, at the same time that they are changed into gases, are intensely heated, and by this means their volume or pressure is still more augmented. Various statements have been made in relation to the amount of pressure produced by the burning of gunpowder, but the best experiments that we have seen any account of were made by some of the officers of our army. Little cylinders furnished with solid pistons, and containing oil, were inserted in the metal of the gun, opening at right angles into the bore, so that the pressure of the gases would drive in the piston, compressing the oil. An arrangement was made by which the piston marked the distance to which it was forced into the cylinder, thus registering the compression. The force required to compress the oil to the same extent was afterwards ascertained by means of a lever and weight. The pressure in the several parts of the bore was thus measured, and was found to be about 25,000 lbs. to the square inch near the breech and to diminish rapidly towards the muzzle.

Gunpowder is composed of three substances—saltpeter, sulphur and charcoal. Saltpeter is the nitrate of potash, its constituents being nitrogen, oxygen and potassium. In the best gunpowder, the ingredients are so mixed that the composition consists of one atom of potash to one of nitric acid, three of carbon and one of sulphur (KO, NO_5+C_3+S), and, by explosion, this is changed into $KS+N+3CO_2$, that is, one atom of sulphuret of potassium, one of nitrogen and three of carbonic acid. In this change 100 parts by weight yield 59 parts by weight of gas (nitrogen and carbonic acid); the other 41 parts being solid sulphuret of potassium. The increase of volume in this case is 300 for 1 at the same temperature, and the increase of temperature is variously conjectured, from 2,000° to 5,000° Fah.

The Origin of Coal Oil.

At a meeting of the Manchester Geological Society, Nov. 20, 1860, Mr. E. W. Binney, F.R.S., F.G.S., read a paper on "Dorin Holland Moss," in which he discussed at length the origin of coal oil. His views coincide exactly with those of Dr. Stevens, published on page 370 of the last volume of the SCIENTIFIC AMERICAN, and these views were generally supported by the Society in the discussion which followed. After considering and rejecting other explanations of the origin of the coal oil, Mr. Binney says: "These circumstances led to the conclusion that it is produced by the decomposition of the upper bed of peat, where it is overlaid by the sand."

Mr. Dickinson, F.G.S., said that it was not at all uncommon to observe mineral pitch or petroleum oozing from a stratum of coal in our pits, distillation having taken place in the bed where external heat could have no influence.

Mr. Binney stated that "Petroleum or rock oil is found in various parts of the world—in the Burman empire, on the banks of the Irawaddi, are powerful springs of it; it is abundant in Persia; it occurs in Barbadoes; at Tegernsee, in Bavaria; in Auvergne, near Claremont; in Switzerland, near Neufchatel; at Amiano, in Italy; and in Sicily; and near the volcanic isles of Cape de Verde the sea is sometimes covered with it."

It will be remembered that Dr. Stevens' explanation of the origin of the coal oils was, that the coal or other carbonaceous deposit is decomposed by the operation of natural forces, producing results similar to those which occur when coal is distilled in a retort for the artificial manufacture of oil. Some difference of opinion was expressed by the members of the Manchester Society, in regard to the necessity of external heat to effect the decomposition of coal. Some geologists believe that the decomposition takes place spontaneously from the natural disposition of the elements of organic compounds to fall asunder.

TIME AND PHOTOGRAPHY.—Sun pictures may be taken in various modes, some requiring several minutes and others only an instant. Photographs of rapidly moving objects, as race horses, the waves of the sea, &c., are taken in the hundredth part of a second. In English experiments, an image was taken in the ten-thousandth part of a second; and a rapidly revolving wheel was taken in so brief a space that it seemed perfectly well defined and stationary, being illuminated by a single discharge of an electric battery, occupying, according to Wheatstone, only the millionth part of a second.

THE CHEMICAL HISTORY OF A CANDLE.

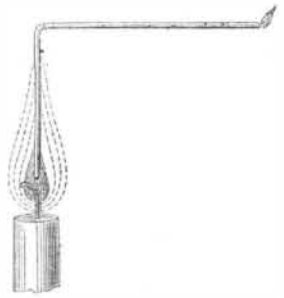
By Professor Faraday.

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

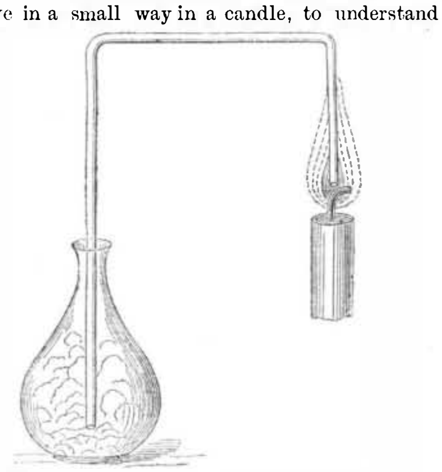
LECTURE II.

A Candle; Brightness of the Flame—Air Necessary for Combustion—Production of Water.

We were occupied, the last time we met, in considering the general character and arrangement as regards the fluid portion of a candle, and the way in which that fluid got into the place of combustion. You see, when we have a candle fairly burning in a regular, steady atmosphere, it will have a shape something like the one shown in the diagram, and looking pretty uniform, although very curious in its character. And, now, I have to ask your attention to the means by which we are able to ascertain what happens in any particular part of the flame; why it happens; what it does in happening; and where, after all, the whole candle goes to: because, as you know very well, a candle being brought before us and burned, disappears, if properly burned, without the least trace of dirt in the candlestick—and this is a very curious circumstance. Now, in order to examine this candle carefully, I have arranged certain apparatus, the use of which you will see as I go on. Here is a candle; I am about to put the end of this glass tube into the middle of it—into that part which old Hooker has represented in the diagram as being rather dark, and which you can see at any time if you will look at a candle carefully, without blowing it about. We will examine this dark part first.



Now I take this bent glass tube, and introduce one end into that part of the flame, and you see at once that something is coming from the flame, out at the other end of the tube; and if I put a flask there, and leave it for a little while, you will gradually see that something from the middle part of the flame is drawn out and goes through the tube and into that flask, and there behaves very differently from what it does in the open air. It not only escapes from the end of the tube, but falls down to the bottom of the flask, like a heavy substance, as indeed it is. We find that this is the wax of the candle converted into a vaporous fluid—not a gas. You must learn the difference between a gas and a vapor; a gas remains permanent—a vapor is something that will condense. If you blow out a candle, you perceive a very nasty smell consequent on the condensation of this vapor. This is very different from what you have outside the flame; and in order to make it more clear to you, I am about to produce and set fire to a larger portion of this vapor—for what we have in a small way in a candle, to understand



thoroughly, we must, as philosophers, produce in a larger way if needful, that we may examine the different parts. And, now, Mr. Anderson will give me a source of heat; and I am about to show you what that vapor is. Now, here is a glass flask, and I am going to make it hot, as the inside of the candle flame is hot, and the matter about the wick is hot. [The lecturer placed some pieces of wax in a glass flask and heated them over a lamp.] Now, I dare say, that is hot enough for me. You see that the wax I put in it has become fluid, and there is a little smoke coming from it. We shall very soon have the vapor rising up. I will make it still hotter, and now we get more of it, so that I can actually pour the vapor out of the flask into that basin, and set it on fire there. This, then, is exactly the same kind of vapor as we have in the middle of the candle; and that you may see that that is the case, let us try whether we have not got here, in this flask, a real combustible vapor out of the midddle of the candle—[taking the flask into which the tube from the candle proceeded, and introducing a lighted taper]. See how it burns. Now this is the very vapor from the middle of the candle, produced by its own heat; and that is one of the first things you have to consider with respect to the progress of the wax in the process of combustion, and as regards the changes it undergoes. I will arrange another tube carefully in the flame, and I should not wonder if we were able by a little care, to get that vapor to pass through the tube to the other extremity, where we will light it and obtain absolutely the flame of the candle at a place different from it. Now, look at that. Is not that a very pretty experiment? Talk about laying on gas—why, we can actually lay on a candle! And you see from this that there are clearly two different kinds of action—one the *production* of the vapor, and the other the *combustion* of it—both of which take place in particular parts of the candle.

I shall get no vapor from that part that is already burnt. If I raise the tube to the upper part of the flame, so soon as the vapor has been swept out, what comes away will be no longer combustible; it is already burned. How burned? Why burned thus: In the middle of the flame where the wick is, there is this combustible vapor; on the outside of the flame is the air which we shall find necessary for the burning of the candle; between the two, intense chemical action takes place whereby the air and fuel act upon each other, and at the very same time that we obtain light the vapor inside is destroyed. If you examine where the heat of a candle is, you will find it very curiously arranged. Suppose I take this candle and hold a piece of paper close upon the flame, where is the heat of that flame? Do you not see that it is not in the inside? It is in a ring, exactly in the place where I told you the chemical action was; and even in my irregular mode of making the experiment, if there is not too much disturbance, there will always be a ring. This is a good experiment for you to make at home. Take a strip of paper, have the air in the room quiet, and put the piece of paper right across the middle of the flame (I must not talk while I make the experiment), and you will find that it is burnt in two places, and that it is not burnt, or very little so, in the middle and when you have tried the experiment once or twice, so as to make it nicely, you will be very interested to see where the heat is, and to find that it is where the air and the fuel come together.

This is most important for us as we proceed with our subject. Air is absolutely necessary for combustion; and what is more, I must have you to understand that *fresh* air is necessary, or else we should be imperfect in our reasoning and our experiments. Here is a jar of air, I place it over a candle, and it burns very nicely in it at first, showing that what I have said about it is true; but there will soon be a change. See how the flame is drawing upward, presently fading, and at last going out. And going out, why? Not because it wants air merely, for the jar is as full now as it was before; but it wants pure air, fresh air. The jar is full of air partly changed, partly not changed; but it does not contain sufficient of the fresh air which is necessary for the combustion of a candle. These are all the points which we, as young chemists, have to gather up; and if we look a little more closely into this kind of action, we shall find certain steps of reasoning extremely interesting. For instance, here is the oil lamp I showed you—an excellent lamp for our experiments—the old Argand lamp. I now make it like a candle [obstructing the passage of air into the center of the flame]; there is the cotton; there is the oil rising up it; and there is the conical flame. It burns poorly because there is a partial restraint of air. I have allowed no air to get to it, save round the outside of the flame, and it does not burn well. I cannot admit more air from the outside, because the wick is large; but if, as Argand did so cleverly, I open a passage to the middle of the flame, and so let air come in there, you will see how much more beautifully it burns. If I shut the air off, look how it smokes; and why? We have now some interesting points to study: we have the case of the combustion of a candle; we have the case of a candle being put out by the want of air; and we have now the case of imperfect combustion, and this is to us so interesting, that I want you to understand it as thoroughly as you do the case of a candle burning in the best possible state. I will now make a great flame, because we need the largest possible illustrations. Here is a larger wick [burning turpentine on a ball of cotton]. All these things are the same as candles, after all. If we have larger wicks we must have a larger supply of air, or we shall have less perfect combustion. Look now at this black substance going up into the atmosphere; there is a regular stream of it. I have provided means to carry off the imperfectly-burnt part, lest it should annoy you. Look at the soots that fly off from the flame; see what an imperfect combustion it is, because it cannot get enough air. What, then, is happening? Why, certain things which are necessary to the combustion of a candle are absent, and very bad results are accordingly produced; but we see what happens to a candle when it is burnt in a pure and proper state of air. At the time when I showed you this charring by the ring of flame on the one side of the paper, I might also have shown you, by turning to the other side, that the burning of a candle produces the same kind of soot—charcoal or carbon.

But, before I show that, let me explain to you, as it is quite necessary for our purpose, that, though I take a candle and give you, as the general result, its combustion in the form of a flame, we must see whether combustion is always in this shape—when I say "shape" I mean condition—or whether there are other conditions of flame; and there are, and they are most important to us. I think perhaps the best illustration of such a point as that, being young ones, is to give you the result of strong contrast. Here is a little gunpowder. You know that gunpowder burns with flame; we may fairly call it flame. It contains carbon and other materials, which altogether cause it to burn with a flame. And here is some pulverized iron, or iron filings. Now, I purpose burning these two things together. I have a little mortar in which I will mix them. (Before I go into these experiments, let me hope that none of you, by trying to repeat them for fun's sake, will do any harm. These things may all be very properly used if we take care, but, without that, much mischief will be done.) Well, then, here is a little gunpowder, which I put at the bottom of that little wooden vessel, and mix the iron filings up with it, my object being to make the gunpowder set fire to the filings and burn them in the air, and thereby show the difference between substances burning with flame and not with flame. Here is the mixture, and when I set fire to it you must watch the combustion, and you will see that it is of two kinds. You will see the gunpowder burning and the filings thrown up. You will see them burning too, but you will see them burning otherwise than in flame. They will each burn separately. [The lecturer then ignited the mixture.] There is the gunpowder which burns with a flame, and there are the filings; they burn with a different kind of combustion. You see, then, these two great distinctions; and upon these differences depend all the beauty and all the utility of flame which we use for the purpose of giving out light. When we use oil, or gas, or candle, for the purpose of illumination, their fitness all depend upon these different kinds of combustion.

There are such curious conditions of flame that it requires some sharpness and some cleverness to distinguish the kinds of combustion one from another. For instance, here is a powder which is very combustible, consisting, as you see, of separate little particles. It is called *lycopodium*, and each of these particles can produce a vapor and produce its own flame; but, to see them burn, you would think it was all one flame. I will now set fire to a quantity, and you will see the effect. We saw a cloud of flame, apparently in one body; but that rushing sound [referring to the sound produced by the burning] was a proof that the combustion was not a continuous or regular one. This is the lightning of the pentomimes, and a very good one too. [The experiment was twice repeated, by blowing lycopodium from a glass tube through a spirit flame.] That is not a combustion like that of the filings I have been speaking of, to which I must now bring you back again.

[To be continued.]

Hard India-Rubber.

The following is another very interesting article on this subject from the London *Mechanics' Magazine*, as a continuation ot the essay on page 67, present volume, Scientific American :—

The value of hard india-rubber has never been doubted by any who have given it their attention. In the United States, where they are far ahead of us, large factories have been erected *for its manufacture alone*, and you come into daily, almost hourly contact with vulcanite or bone rubber—one of their names for it—at every turn and in every form. The heels of your boots are made of it; the buttons on your vests, coats, and trousers are india-rubber; your jewelry is mounted with it. The handles of the knifes in imitation of buckhorn, and at a quarter of the price, to say nothing of their much greater durability; the rings round the napkins, the cane you carry, your brushes and combs, soap-dishes and other utensils, are all made from it; and your easy chair rolls on castors of the same material. When we see our sharp-witted and cute American cousins thus awake to its value, we may rest assured there is something in it.

The india-rubber trade generally has received more attention there than here—more capital has been brought to bear upon it, their factories are larger, and their machinery better. With the exception of the manufactory of Messrs. Charles Macintosh & Co., there have been none started in this country until within the last few years, and these only on a comparatively small scale, or simply devoted to the making of waterproof garments. The trade, as far as the exercise of inventive genius in its application to new purposes is concerned, has been at a standstill, and the manufacture of hard india-rubber is only now being begun.

Goodyear's introduction of it into this country did not lead to any practical results, from the fact that he had no manufactory; all the beautiful specimens he exhibited were the product of American skill. This of course rendered their cost too high either as substitutes or improvements upon anything in use. Had he lived we believe it was his intention to have established large works here, which would doubtless have led to great results, but his death prevented this, and its development is left to other hands.

Till very recently all the articles made from hard india-rubber have been imported from America, France, or Belgium—large factories being established in the two latter countries for the production of combs and other goods. The importation of this one article into England amounts to a sum that would astonish any one ignorant of the large amount of trade done in combs generally. One house alone we believe imports £10,000 worth annually. This state of things, however, we do not suppose will long exist. It has been caused to a great extent by the fact of the manufacture itself being a secret; and the cause of failure in those who have attempted to produce it has arisen from an ignorance of the nature of the process and the principles by which it is governed.

The chemistry of india-rubber, or rather of its manufacture, would form an interesting volume, which we should like to see published; and we hope some future Goodyear may yet give us the result of new experiments and point out new facts in its history. As we stated in our first article, we know of no material which has been introduced of late years which contains in itself so many elements of wonderful adaptability to such numerous purposes. We have therefore faith in its future; that what we have already admired and wondered at, is yet destined to work many further important changes, and be turned, by the application of inventive and studious minds, into other and still more useful channels.

The great waste which attended the manufacture of india-rubber at first, and indeed until very recently, has now been done away with by a recent patent. Vulcanized rubber is submitted to a process by which it is *recovered* and made capable of re-use; Goodyear's belief that the old overshoes instead of being thrown away when worn out would be saleable to the old clothesmen has come true, and the piles of what was formerly considered worthless rubbish have, like the cinder heaps, become little banks of riches. The facility with which india-rubber may be molded, and the delicate patterns which may be impressed on its surface, render it far before any other material, more particularly on account of its elasticity under blows which would utterly annihilate a more fragile substance. A sheet of hard india-rubber with the finest raised pattern impressed on its face during the process of vulcanization may be struck with a heavy hammer without marring in the least its beauty. This renders it eminently adapted for panels, for ornamental work, carriages and other purposes.

The ready admixture of india-rubber with other gums also allows many things to be advantageously joined with it without injuring the consistence of the mass, and permits the production of various articles which are not required of a fine quality, at a much less cost than would otherwise be possible.

Amongst the most recent appliances of hard or semi-hard india-rubber we may mention the following as the most important to which our attention has been drawn: Shuttles, spools, bobbins, bosses, and covered rollers; army accouterments and ornaments; musical instruments, such as fifes and piccolos; knife, sword and pistol handles, and pens. Insulators for telegraphic wires we have previously mentioned, but we may add that these have been used in the United States for many years past with perfect success. With reference to its application to machinery in the instance of shuttles, bobbins, &c., its advantages are very great. Hard wood, which has hitherto been used for this purpose, is liable to split and warp, indeed is of common occurrence. The india-rubber not being subject to this renders it of great value. This also applies equally to the *bosses* used in flax spinning, which are being supplanted by india-rubber as far more durable. Its application, however, to the coating of iron rollers where equal pressure with a certain amount of *elastic resistance* is required, bids fair to become of very great value, nothing having been yet found to meet this requirement. Army accouterments and ornaments excel those in present use from their extreme lightness, and from the resistance to blows which would indent metal, as well as from the facility with which they may be cleaned. As applied to flutes, fifes, or piccolos it is far superior to wood, from its being unaffected by heat or cold, moisture or dry weather. The fifes and flutes we have seen are perfection in appearance, and their tone remarkably clear without being hard or loud, arising no doubt from the peculiar non-porosity of their substance, and the beautiful surface given to their interior in the process of manufacture. As handles to ordinary knives, pistols, or swords, there is a superiority over anything hitherto used, both in touch and wear, the blades not being liable to start when placed in hot water, as is so commonly the case with bone or ivory—whilst its application to pens will doubtless ere long be as common as steel, combining as its does all the qualities of the metal with the extreme freedom and ease of the quill. Hard india-rubber had also been applied to the coating of iron pins for insulators, the covering of gun-barrels in place of *browning*, and the coating of harness irons in place of leather, being found far more durable, not affected by heat or wet, and requiring far less trouble in cleaning.

The treatment which the native india-rubber has to undergo in its manufacture and the machinery used varies according to the different requirements of manufacturers, but we may glance at the process of cleansing and mastication, which is necessarily much the same in all factories, as showing the great strength of the material and the power required to tear it asunder and rework it into one consistent mass. We have stated in a former article that the gum as imported is very largely mixed with clay, bark, and other things, which have to be removed before it can be worked into any article of commerce. This process consists of the cutting by a knife, into small pieces, the blocks or bottles of rubber, and then, after soaking them for some time in hot water, placing them in a closed cylinder with revolving spikes or teeth, which tear it into shreds, and allow a stream of water, which passes through the machine, to wash away all the dirt and impurities. This action being continued for some time, generates sufficient heat in itself to make the whole adhere in one mass, which is then taken out, and subjected to other machines, where it may be rolled into sheets, or shaped in any way the most convenient for storage. The gum thus prepared is ready for solution or grinding with sulphur, colors, or other admixture that may be required. The power that is necessary to turn one of these machines is very great, and the strength of the grinders in proportion, their size varying according to the extent of the factories in which they may be used, some being capable of masticating two hundred pounds and others not more than twenty or thirty at a time.

The whole of this outlay is caused by the manner in which the gum is treated, previous to its being sent over to this country, and which by a knowledge of the requirements of our manufacturers, and a little outlay in teaching the natives, or better still, founding establishments of our own, might readily be done away with. The gum, as we named in our first paper, comes from the tree in a milky juice, and if placed in air-tight vessels with a little spirit, may be brought over in that condition. In this pure state it readily, on exposure to the air, assumes the tenacious character of the bottle gum, and is equally valuable for all the uses of the masticated material.

Nature and Uses of Gums.

There is a very general misapprehension of the nature of those substances called *gums*, and as a consequence of this, the misapplication of the term is quite common. Various resins are frequently called gums, such as india-rubber called "gum-elastic," while it does not possess the main property of a true gum. In chemistry, there are classes of substances, such as gums and resins, which have certain distinctive properties different from others, and unless a person is acquainted with the nature of these substances, he is very liable to commit mistakes when he has occasion to speak of them. Some particular information on this subject will therefore be of general benefit. A pure gum is chiefly distinguishable by being soluble in water and not in alcohol; this is a test of its character which makes a distinction between it and resin. There are several species of gums, generally arranged into three varieties—gum-arabic and its analogues dissolve entirely in water, and their principal is called *arabin*; gum-tragacanth simply softens and swells in cold water, its principle is called *tragacanthin*; cherry gum only partially dissolves in water, its principal is called *cerasin*.

Gum-arabic is perhaps the oldest and best known gum. It is obtained from the Arabian acacia, and many persons suppose that the *shittah* tree mentioned in the Bible in connection with the building of the temple was the acacia. The gum of this tree exudes in a liquid state from the trunk and branches, and hardens by exposure to the air. The largest quantities are obtained from the trees in the hot and parching months of July and August; and the more sickly the tree the more gum it yields, and the hotter the weather the more prolific it is. It is stated that pearls are formed in oysters by the secretion of crystalline matter caused by wounds, hence these gems have been called "the tears of the oyster." Upon the same classic basis gum-arabic may be truly called "the tears of the acacia." Many persons suppose that this substance is found exclusively in Arabia, but this is not the case; it is also obtained in Egypt and various other parts of the Turkish empire. It occurs in globular pieces or tears; its color is generally a pale amber, and it is inodorous and brittle.

Gum-arabic dissolves in both hot and cold water. Leibeg holds this gum to be a hydrate of carbon, and expresses its composition by the formulæ C_{12}, 11HO. When boiled with very dilute sulphuric acid it is converted into grape sugar; borax coagulates it, and alcohol precipitates its *arabin* in a white mass from its solutions. It is much used in medicine as a demulcent; and usually forms a component part of cough lozenges. A small piece of it, if allowed to dissolve slowly in the mouth, tends to allay a troublesome cough by diminishing the irritation of the fauces as it sheathes the affected part from the atmosphere and dilutes the acid secretions. It is therefore a very excellent and mild substance to use by persons who have throat affections. It is also an excellent sustainer of life, as a food. The native Kaffirs sometimes live upon gum for many days during long journeys in the desert. Formerly gum-arabic was much used as a vehicle of colors in printing, but it has been superseded by dextrin.

Barbary-gum is obtained from Morocco, and is of a light greenish color, occurring in small irregular tears.

Gum-senegal is an African product, and is derived from several species of the acacia. It occurs in larger tears than gum-arabic, and these are chiefly of a light brown color. *East-India* gum is very similar to the gum-arabic, at least some specimens of it, and is probably the product of a kindred tree. South Africa also furnishes *Cape gum*, which is obtained from a species of acacia resembling that of the Arabian desert. It is of a pale yellow color, and generally held to be of a rather inferior quality. The Kaffirs make quite a business of collecting this gum for export to England. Gum-mezgnite, known as *musgnit*, is an American product, obtained from a tree which grows in the high and dry regions of Texas and New Mexico. It is a pontaneous semi-fluid exudation, concreting by exposure into tears, and sometimes rounded balls about the size of hazel nuts, semi-transparent and of an amber color. It contains 84.96 per cent of arabin, and is therefore an excellent gum, but it has not yet become an article of common merchandise. None of the nomadic tribes of the American deserts have yet made a business of gathering it in the warm season, as the Kaffirs do the gums in South Africa. The *musgnit* is a true gum, as it is not soluble in alcohol, but is so in water, with which it makes an excellent mucilage.

Cherrytree gum is obtained from the trunks of the plum, peach, apricot and cherrytree, and has the appearance of the poorer qualities of the gum-arabic. It is only partially soluble in water, and is divisible into *arabin* and *cerasin*. It is not employed for any useful purpose, so far as we know.

Gum-kino is a product of a dark red color, and is gathered from trees which grow in the East Indies, Australia and Africa. It contains tannic acid, and is a powerful astringent, capable of tanning the skins of animals. It is principally used in medicine for obstinate diarrhœa.

Gum-catechu is rather an extract than a gum. It is soluble in water, and is much used for tanning skins, and dyeing brown colors on cotton fabrics. It is an East Indian product, also called *terra-japonica* and cutch. There are several varieties of it; the best are of a dark brown color.

Gum-tragacanth or gum-dragon is a widely known and much used product. It comes from Asia Minor and Northern Persia, and is the natural exudation of the shrub *astragalus*. To secure it, the peasants clear away the earth from the root of the plant, in the months of July and August, and they then make incisions in the bark. The gum exudes the whole length of the cuts and soon becomes hard, when it is collected and put into bags. If the weather be warm and dry, the gum will be white and clear; but if damp, it assumes a brownish tinge. The finest specimens of this gum are generally shipped to France. Instead of dissolving in cold water like gum-arabic, it merely intumesces; but when it is subjected to ebullition in water for a considerable period of time, it gradually becomes like a solution of gum-arabic, and a portion of it nearly dissolves—hence some chemists suppose that it is transformed into *arabin*. The insoluble portion of gum-tragacanth contains considerable starch and lignin. This gum is occasionally employed in medicine, for the same purpose as gum-arabic. The inferior kinds of it are used as a mucilage by shoemakers to give a gloss to the heels of boots. It is also much employed in France for pasting artificial flowers, and imparting a beautiful gloss to the elegant colored prints which decorate the paper boxes in which ribbons, silks, and artificial flowers are packed. There are several other varieties of gums not particularly described; but the most important have been mentioned, with the exception of a mucilage, apparently of a true gummy character, which is obtained by steeping flax-seed in water. This mucilage is now employed for dressing some qualities of silks as a substitute for fine glue and pale gum, and it is a superior article for this purpose, especially for black silk. A wrinkled piece of black silk may be made to look as well as when it was new, by sponging it slightly on the right side with a weak mucilage of flax-seed, then ironing it with a hot flat iron on the wrong side. The table for ironing silk should be covered with several folds of fine cotton cloth, because a covering of coarse cloth will leave the print of the coarse threads upon silk. Artificial gums are now manufactured and used upon a large scale. In a future article we shall describe these and various processes for making them.

ROMANCE OF THE STEAM ENGINE.

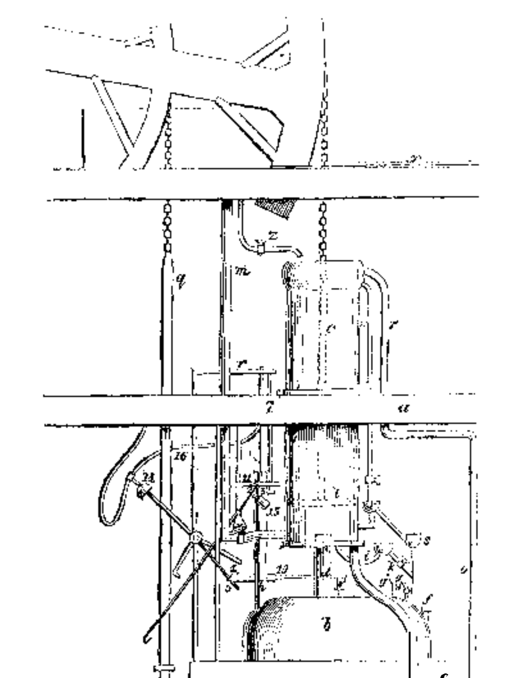
ARTICLE XI.

POTTER AND BEIGHTON.

In the last article, the first condensing pumping engine, having a piston in the steam cylinder and operating through a walking beam, was represented. The operation of it depended upon the care of those who attended it. This demanded the most unremitting observation and labor in opening and closing the steam and water cocks by hand. When the attendant opened the steam cock, he was obliged to watch the ascent of the piston, and when it had reached the proper hight, the cock was shut in an instant, and at the same moment the injection cock had to be opened. After the injection water had condensed the steam, the piston descended into the vacuum with an increasing velocity, which, if not arrested with inlet steam at the precise moment, some part of the machinery was sure to be broken in pieces. A regular series of simultaneous movements were required to operate the cocks, and an engine-man or cock-boy sat upon a seat where he had all the cocks at his command, by a set of catch-strings, which required his incessant attention.

The first person who successfully improved the devices for operating the valves was Humphrey Potter, respecting whom Desaguliers states that, having been employed, in 1713, to attend one of Newcomen's engines, in order to save himself the trouble of watching, contrived to make the engine work the levers of the valves by strings attached to the beam. In some accounts which we have read of Potter, it is stated that he was a boy not over fond of work, rather lazy in body, but we don't believe a word of this; we think he was a genuine mechanic, fruitful in expedients, and a true inventor.

The next person who made a decided advance in rendering the steam engine self-acting was H. Beighton, a mining engineer of Newcastle-upon-Tyne, who constructed a series of mechanical devices, consisting of levers, rocking arms, and toothed sectors all connected together, and by which the valves were opened



and closed by the walking-beam, through a vertical tappet rod connected to it. Beighton first operated his levers by hand, and they were called hand-gear; but he soon saw how the motions of the piston could do it better than an attendant, and he thus applied his devices as represented by the accompanying figure: *a* is the fire place, *b*, the boiler, *c*, piston, *d*, steam pipe, *e*, axis of the regulator, or steam valve, *d*, steam pipe, *f*, a loaded or safety valve, "which gives vent to the steam of the boiler in case it grows too strong; *g*, gage cocks with their pipes, one of which goes down so far into the boiler, as to be two or three inches above, and the other so far below the surface of the water therein," the water being of a due hight when the steam is emitted by the shorter, and water by the longest pipe; *h*, a pipe fixed to the head of the boiler, and called the *buoy* pipe, open at both ends, the lower end being a foot or more below the surface of the water in the boiler. Within this pipe is a cylindrical buoy that swims upon the water therein; and when the steam in the boiler is become so strong as, by its pressure, to force water up the said pipe, it then raises the buoy, whose axis causes the *balance*, *r*, and *inceptor*, 7, also to rise, and lifting the *notch*, 2 from 3, on one end of the lever, permits 13, a weight attached to it, to fall so far, till the *injecting-cock* at the axis of the said lever, is opened, by which an injection of cold water into the cylinder, and consequently a vacuum made by the condensation of the steam. The pressure of the atmosphere now brings down the inner end of the great lever, when one of the pins in the hanging rod, *q*, takes hold of 1, the end of lever, *o*, which, by the fall of weight 13, at the other end of it, was raised as above, somewhat higher than the parallel of its axis at *n*, and brings it down so far till the end, 3, is raised up as high, as to be again taken hold of by the notch, 2, at which time the injection-cock is thereby shut, and the regulator, *e*, is opened; *k*, a pipe for supplying boiler with hot water from top of cylinder; *l*, piston, having always eight inches of water lying upon it; there is a "circular plate in diameter nearly equal to the cylinder, and closed thereto, with leather round the edge;" *m*, injecting pipe having an injecting cock, "with its wheel, which is opened and shut by *o*, a small lever and its quarter wheel, whose ends 1 and 3 are alternately lifted up by the engine's motion;" "*p*, an axis moving between two standards, with its shanks, 4 5 6 8 9, and a slider 10—*q*, beam (or plug-frame)" hanging on the great lever, and moving up and down with it, opens and shuts the regulating and injecting cocks by three pins, set higher or lower as occasion requires it; one of which pins as the beam is going up, upon the access of the steam into it, takes hold of 8, attached to axis, *p*, and raises it to such hight, till the weight, 14, on lever 9, gets beyond the perpendicular of its axis, when by its own gravity it falls so far toward the cylinder as the piece of hard leather, 15, will permit it, by which motion the rod 5, the end of which appears in the figure at a pin in the slider, 10, is removed, and lever 4, is brought down to take its place, and striking against this pin, carries it away so far, and with it the slider till the regulator at *e*, to whose handle the slider is fixed, is by this means shut, and the steam confined in the boiler—by the same motion the lever, 6, shown slanting downward, is raised somewhat above the axis, and lies ready to be taken hold of by another pin in the hanging beam, *g*, which, upon the condensation of the steam, brings down this lever so far, till the weight, 14, is again brought beyond the perpendicular of the axis on the other side, when, by its own gravity, this again falls beyond the perpendicular of its axis on the other side; by that motion the lever, 4, is again removed from the pin in the slider, and the lever, 5, is made to strike against it, which opens the steam valve.

The steam now passes out of the boiler into the cylinder, and the pressure upon the surface of the water being abated, the *buoy* in the pipe, *h*, falls, and with it the balance, *r*, and inceptor, 7, and the notch, 2, takes hold of the end, 3, of the lever, *o*, by means of which the injecting cock remains shut, so that the steam by its force against the bottom of the piston countervails the pressure of the atmosphere, and permits it to rise along with the hanging-rod, *g*, which, by the action of the pin, shuts the regulator, when the steam being confined and the injecting cock shut, the engine remains in this position until the steam becomes strong enough by its pressure again to rise the *buoy* in the pipe, and a new stroke is begun. The outer end of the great beam works a pump; *r*, is a balance (or lever) one end of which turns up a pin, the other end is fastened to the higher end of the inceptor, 7, lower end fastened to the lever, 11; these, as have been described, rise and fall together by means of the buoy; *s* is a cup receiving overplus of water from *x*, and conveying it into boiler; *t*, a pipe conveying the injection water into cistern, having an immerged valve at the lower end; *v*, a pipe conveying waste water from the piston when it rises to the top of cylinder; *x*, a valve through which the air is forced by the steam; *z*, a cock supplying piston with water.

Such, it is stated, was the first self-acting steam engine; the movements of the valves were thus regulated accurately by the motions of the piston. This was a great step in the progress of the steam engine.