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PREVENTING WASTE OF HEAT IN BOILERS.

When the temperature of the atmosphere is very low and dry, persons do not feel the effects of cold so sensibly as when it is damp and more elevated in temperature. This is attributable to two causes. One is the great capacity of moisture for heat, which affords a reason for the heat of the body being carried off so quickly when the atmosphere is charged with moisture. The other consists in the superior non-conducting qualities of dry air, by which the heat of the body is prevented from being carried off so rapidly when the atmosphere is dry. The fur of the quadruped is furnished by nature as a non-conducting covering, to enable the creature to withstand the cold of winter. There is no more heat in fur than in iron; it is only a superior agent to iron in preventing the conduction of heat, hence the reason why it feels warmer in a cold day. Air is one of the very best non-conductors, and the so-called warmth of fur, wool, and feathers is really owing to the air that is confined within their interstices. In order to economize the heat of the human body during cold weather, it should be covered with the best non-conducting material that is obtainable, and the same advice is applicable to the covering of steam boilers, cylinders, &c. In setting a steam boiler, the walls should be made double, so as to include an air space. A solid wall of brick surrounding a boiler will radiate twice as much heat outside, as a double wall of the same thickness of brick. In Constantinople where fuel is scarce and high in price, all the baths are situated between double sides with air spaces between, so as to economize the heat. Furnace doors should also be made double, to prevent radiation of heat outside. Marine boilers are usually covered with felt, which is a good non-conductor, but all such coverings are put on without due regard to an air space, which is the best non-conductor. Every boiler, stationary and marine, should be entirely covered, including an air space in the covering, for confined air is by far the cheapest non-conductor and economizer of fuel that can be employed in all such cases.

HOW TO USE CALLIPERS.

It may be safely assumed that comparatively few mechanics use callipers properly. There are many different forms of callipers with which all mechanics are familiar, such as those having springs, and those which are secured, when set, by set-screws biting on an arc. While all these have their several merits, commend us after all to the old-fashioned sort made with two legs, two washers and a good rivet. Now what is the reason that one man will always make a good fit when turning a shaft to fit a bore, or the reverse, while another man makes a botch of it? The reason is that the former knows how to take a size, while the latter is ignorant of that duty. Sizes when turning are generally taken either with a pair of callipers or a standard gage. It would naturally be supposed that with the gage, inaccuracy of measurement would be impossible. It is possible, however, and frequent, because the workman has not sufficient delicacy of touch to use the gage properly. Callipers are very sensitive and are often used for extra nice work; if, however, the work has to be multiplied many times, then the use of callipers is not economical, and we must substitute some other method; moreover, gages are costly tools, and but few shops are able to own complete sets; for general work, therefore, we must rely upon the callipers. Blacksmiths have tools which resemble callipers, but they are uncouth and rude. The majority of men of that calling, when using them, set their callipers somewhere near the size they want, and then upon comparing the work with them, *jab* them over the rod or shaft, as if they were going to cut it in two. The consequence is that the size of the work finished depends very greatly upon the resistance which the joint opposes to the blacksmith's strength. It is needless to remind the machinist that violence or pressure, applied to tools of this kind, only distorts the measurement and results in "bad jobs." The object with some workmen seems to be to find out how much the callipers will spring in going over a shaft without altering; not to ascertain how much metal must be removed before the requisite dimensions are attained. It is safer to go by the sense of sight than it is by the sense of feeling, in all cases where it is practicable to do so. When we can see that the callipers barely touch the object measured, we know it is of the proper size, but when we only feel of it, accuracy depends almost wholly upon a delicacy of feeling which all persons do not possess. When we say accuracy, we do not mean hap-hazard accuracy, that will admit of being somewhere in the neighborhood of the right size, but we mean absolute mechanical integrity, such as is obtained in the sewing machine and in the manufacture of our best steam engines. Many new inventions are rendered useless and thrown aside as impracticable, solely because rudely made; let us then endeavor in the use of all tools, but more especially in the employment of those upon which the proper working of other parts depends upon good fits, to be as faithful as our abilities will allow us to be.

DESTRUCTIVE EFFECTS OF IRON RUST.

The last published report of the Smithsonian Institution contains a translation from a German publication on the above subject, which affords considerable information of a useful and interesting character, some of which we shall present in a condensed form. It states that it has been frequently observed that in the timber of old ships the wood in the proximity of iron bolts is entirely altered in its character. Around each bolt for a space exceeding one inch, part of the wood is dissolved away, and the remainder is quite brittle and easily broken. The appearance of such wood is such as if it were produced by driving in red-hot iron bolts. This injurious effect of iron rust is one of the principal causes of the want of durability in iron-fastened ships. Rust not only originates where the iron is alternately exposed to water and the air, but also where the iron is permanently submerged under water. It is generally known that rust is an oxide of iron, but as soon as it comes into contact with wood it gives off part of its oxygen, and becomes the protoxide. The latter takes up a new portion of oxygen and transfers it to the wood, and by the uninterrupted repetition of this process, a slow decay of the wood is effected. The protoxide of iron in this case plays a part similar to nitric oxide in the manufacture of sulphuric acid.

In order to demonstrate the fact that oxide of iron is reduced by mere contact with organic substances (such as wood) not yet in a state of putrifaction, M. Kuhlman, of Lille, has instituted different experiments, the results of which confirm the correctness of this assertion. When hydrated oxide of iron, for example, was mixed with cold solutions of logwood, cochineal, corcuma and mahogany, they were decolorized, and the iron was found in a state of protoxide, the oxide having lost a portion of its oxygen by the action of the coloring matter. In every-day life the destructive effects of the oxide of iron have been noticed. For example, linen or cotton cloth containing ink stains becomes tender in its texture in the stained spots after repeated washings, and the spots ultimately fall out, leaving holes in the fabric. When cloth that is colored with copperas to form a black, is submitted to an alkaline ley, the protoxide of iron is changed into an oxide, and the cloth becomes feeble in the texture; and the usual saying in such cases is, "It is burnt in dyeing." According to Kuhlman, the oxide of iron transfers oxygen directly to the cloth, producing slow combustion of the fiber. This is useful information for dyers, as it explains the cause of an evil connected with preparing cotton cloth, which has hitherto baffled much scrutiny and experiment to discover. It is also well known to bleachers that when pieces of cotton cloth become stained with iron rust they are liable to drop out, leaving holes, as if they had been sprinkled with sulphuric acid. Every spot of iron rust should, therefore, be immediately discharged when noticed, by the use of dilute hydrochloric acid and warm water, or oxalic acid and warm water.

In shipbuilding, iron nails and bolts should never be used. In all cases copper or brass fastenings should be employed where first cost is not an essential object. In cases where the expense will not warrant the use of copper bolts, the iron bolts should be galvanized. Recently we have noticed with much satisfaction the extended use of zinc-covered iron bolts by our shipbuilders. This is a step in the right direction; but so far as we are informed, such bolts are confined to the construction of sea-going vessels. All our river boats and schooners should be fastened with the same kind of bolts, because they are nearly as essential for vessels running on fresh water as those on salt.

GUN COTTON FOR ARTILLERY.

When gun cotton was discovered by Schonbein, in 1847, it was hailed as a most valuable invention for war and other purposes in which gunpowder is used, but upon repeated trials with it in fire-arms, it was found unsuited. The following defects were attributed to it:—It was very hygrometic, and attracted so much moisture during wet weather as to render it useless. It was also deficient in granular construction. To explain this second defect, it is necessary to state that different kinds of fire-arms require powder of a different grain. Thus for fowling-pieces a fine-grained quick powder is required; for rifles, a much coarser powder, and for cannon a very large-grained powder. Every variety of fire-arm, whether the variation be as to length, twist of grooves or caliber, involves a special size in the grains of powder to obtain the best results. Gun cotton possesses no such variable qualities. It also explodes so rapidly that it could not be used in common fire-arms, because of its bursting effects; the best steel barrels of rifles having been shattered by common charges.

There are quite a number of fulminating agents which it would be convenient to use in place of gunpowder, were it not that they are violently explosive, without producing great projectile results; that is, they will shatter strong steel barrels to pieces with a small charge, but they cannot project missiles to such great distances as gunpowder. This is the case with the fulminates of mercury, silver and gold. The propulsive force of any material, such as gunpowder or the fulminate of mercury, depends on two qualities, namely, the volume of gas which it liberates when it explodes, and the time involved in the liberation of this gas. These are important distinctions. If the substance liberates its gas at once, or in a space of time infinitely short, like the fulminates of mercury and silver, it is not suitable of application for discharging projectiles, because the bursting or shattering effect of those is prodigious, while their projectile effect is small, as the volume of gas liberated by these fulminates is less in volume than the gas of gunpowder, hence the latter is a superior projectile agent. As water expands into 1,700 volumes of steam, it is evident that it must be a superior expansive motive agent to alcohol, which does not expand in vapor to more than 640 of its original volume. Gun powder and the fulminates are governed by the same law. Gun cotton, owing to its complete ignition, and leaving very little residue, was held to be superior to gunpowder in projectile effect; but its want of granular construction, its rapidity of combustion and its affinity for moisture were defects which till now have prevented its adaptation to fire-arms and artillery. All these defects have been overcome (it is stated in the *Austrian Gazette*) by Baron Lenk, and it is now used in the Austrian army. The method employed to prevent it from absorbing moisture is by immersing it, when being manufactured and before it is dried, in dilute soluble glass, which acts the part of a varnish, without injuring the igniting qualities of the gun cotton. The same quality as granulation in gunpowder is obtained by forming the cotton into twisted strands of different sizes, and making it into cords, which are cut to form charges for cartridges. Batteries of guns in which gun cotton is used now form part of the Austrian military equipment. The guns are shorter and lighter than those of the same caliber for which gunpowder is employed. A military commission appointed to examine into this subject has reported that the weight of Baron Lenk's gun cotton, to produce effects either in heavy ordinance or in small guns, is to the weight of gunpowder as 1 to 3. In 1860, trials were made with it in a bronze 4-pounder, and after firing 2,000 rounds the gun was not in the least injured. In 1861, fifty tuns of this substance were made with out the occurrence of any accident. It leaves but a very slight residuum in firing, and the smoke which results from it is not so disagreeable as that of gunpowder. Some of this gun cotton was sunk under water for six weeks, then it was lifted and dried, and was found to be as powerful in projectile force as before it was submerged. These advantages stated to have been obtained from the improved Austrian gun cotton deserve general attention, for if this explosive agent can be substituted for gunpowder, of course saltpeter may be dispensed with, as the nitrate of soda is used to manufacture the nitric acid that is employed in making gun cotton. Flax will answer as well as cotton, if the latter cannot be obtained.

HUMAN VEGETATION.

The power of vegetation seems to be almost universal and perpetual. The stone taken fresh from the quarry soon becomes covered with grey lichen and green moss, and the very bread that we use becomes coated with vegetable floss when exposed for a few days in a warm damp atmosphere. Not only the face of the earth, but every object upon its surface, seems instinct with vegetable life. In some situations it springs up so suddenly and unexpectedly that many persons suppose it to be endowed with spontaneity. In its growth and development its domain is not confined to inanimate creation, but it is also extended over animal life. Bees may frequently be seen flying, with plants, nearly as large as themselves, protruding from their heads; silk worms are sometimes affected with a vegetable moldiness called muscardine, and gold fish may oftentimes be seen covered with a white vegetable mold. Insects, reptiles, fowls, fishes, and animals of the higher grades are subject to parasitic vegetation; and man himself is not exempt from the same influences. The scald head, the ring-worm, and dandruff are vegetable growths. Some forms of it attack the children of the poor almost exclusively, where sufficient attention is not paid to cleanliness; while other forms of it occur at all ages and are found in all ranks and conditions of society. The vegetable growth of scald head is described in the Bible (13th chapter of Leviticus), and it is one of the unclean diseases of the Hebrews. It appears in patches of yellow scales; the hair becomes dry and brittle, and disorganized. Examined with the microscope, the scales are found to contain masses of seeds. A very formidable type of this disease occurs frequently in Poland, and is called *plicapolonica.* The parasitic plant which causes diseases of the human scalp is called *acarion schönleinii*, and is the frequent cause of baldness. It has been noticed that baldness is almost unknown among a barbarious people. American Indians, Africans, Malays, and Chinese have all bushy heads; and it is asserted by the Rev. H. Macmillan, F.R.S., in an essay on this subject in *Macmillan's Magazine*, that baldness was unknown among the primitive inhabitants of the British Isles. Baldness has increased with civilization, but whether owing to increased intellectual activity, or vegetable parasites developed under favorable conditions from modern habits, is not a settled question.

There is also a special hair-plant called the chinwelk, which revels in the beard. It is distinguished by a red eruption of tubercules of various sizes, and it frequently destroys the hair. It was very common among the Jews of old, who, according to the Levitical law, enforced very arbitrary measures for its extirpation. Where long hair is much prized in the East, the common salutation is "May your shadow never be less, and the hairs of your head never decrease!"

There is a singular vegetable growth peculiar to the human body which has a prediliction for those parts which are habitually covered with clothing. It is called *microsporon furfur*, and consists of an efflorescence of small circular spots, which gradually coalesce and produce irregular patches, accompanied with dry scales, which are constantly renewed. These scales, when examined with a microscope, are found to contain oval seeds, tubes and knots, similar to those of miniature bamboo canes. This vegetable parasite is very common and occurs at all ages and on both sexes.

The diseases called the yaws, which is common in the West Indies; and the elephantiasis, which disfigures the Egyptians, are vegetable growths. It is also well known that in hospitals, especially during warm weather, white flocculent filaments are found on removing the bandages from wounds and sores. These are developed with wonderful rapidity in a very few hours, and are vegetable formations called mycoderms, which are similar to the spawn of mushrooms.

Vegetable growths are sometimes found in several of the internal parts of the human system, such as parasites on the teeth, and the thrush or whitish crust which frequently lines the membrane of the mouth and throat of infant children. The same vegetable growth is common with persons in the advanced stages of pulmonary consumption.

It has been proved that all these vegetable growths are due to seeds, most of which are so minute as to be almost invisible to the naked eye. They float in the atmosphere everywhere; dance in the air currents of every house; and they but await the proper conditions for their development wherever they alight. It is easy to account for parasitic affections of vegetable origin being highly contagious. Malaria fevers may be of cryptogamic origin, due to the diffusion of the seeds of these plants in the atmosphere. Several physicians have entertained such views. Formations closely resembling them have been found in the blood and kidneys of persons affected with typhus, and probably there is some connection between such plants and most epidemic diseases.

PAYING WORKMEN WITH ORDERS.

In very many parts of the country, it is the custom with manufacturers to pay only a fraction of the wages earned by their workmen in money; the residue is given in the form of an order upon a store kept by the manufacturer or those in collusion with him. This custom originated in a natural and sensible way. Whenever any capitalist desired to locate himself in a new neighborhood—one where water power was plenty or where timber was cheap, he was compelled from the force of circumstances to carry a stock of groceries and dry goods with him in order to supply the wants of his men. Of course, as the settlement increased and became a village, the trade was generally abandoned to the proper parties. This custom of giving orders in lieu of cash has been abused to an alarming extent; long after the necessity which occasioned the practice had ceased to exist. Workmen earning ten dollars per week will receive three dollars of that sum in money, while the balance is only to be obtained through an order for goods, of one kind or another, on the company's store. By this practice the mechanic is charged two or three prices for what could be procured at less rates were the business unmonopolized. The remedy is not clear, when avarice and chicanery combine to defraud the workmen of their rights. There would seem to be but one resource, and that one is for the workmen to move away from the scene of extortion. But this remedy is quite as bad as the disease. In too many cases men are lured to new villages by promises of large wages. The sums paid them are nominally high, but when the equivalent the workmen is obliged to give the manufacturer for articles of necessity is proportionately greater, it is difficult to see what is to be gained in undergoing the hardships and discomfort incident to settling in new places. Workmen as a rule are desirous of escaping from the noise and tumult of large cities, and they will gladly work a little harder provided they can be assured of comfortable houses in the country for their wives and children. When, however, they are obliged to submit to the wrongs above alluded to, there is no other resource but to bear it patiently; unless indeed the law steps in and either abolishes the system of orders wholly or else so limits the tender of them, as compensation for services, that they will be useless to the unjust capitalist as a means of profit.

SURFACE CONDENSERS OF MARINE ENGINES.

In the condensing engines of steamboats and ships, the common method of condensing the exhaust steam, and thus obtaining a vacuum before the piston in the cylinder, is by injecting cold water into the interior of the condenser among the steam. This is undoubtedly the most simple mode of condensation, and for steamers running in fresh water it is the best. For sea-going vessels, however, the warm condensed water which is employed to feed the boilers, and thus economize some of the heat that would otherwise be lost, such condensers do not provide a supply of fresh water to the boilers. The result of this is, that as salt water is fed to the boilers, the brine becomes saturated as the steam is evaporated, and this has to be run off from the boiler. A loss of about thirty-three per cent of hot water from the boilers and about the same quantity of fuel, compared with the use of fresh water in boilers, is asserted to be thus caused by the interior condensation system in salt water. To obviate these evils, surface condensers in which the steam is condensed inside by cold salt water applied to the outside surface have been proposed and used on many occassions, and they are now used to some extent in sea-going steamers. Two faults have been attributed to these. One consists in their liability to get out of order and leak by the expansion and contraction of their metal, arising from their complicated construction, they being usually formed of a great number of tubes to obtain a large cooling surface. The other fault consists in an unlooked for chemical action of the water obtained from condensed steam upon the metal of the boilers whereby they are soon destroyed. It will be understood that the same fresh water obtained from this condenser is used over and over again in the boilers, thus obviating blowing-off as in the case of brine in the boilers. The cause of this chemical action of the condensed fresh water on the boiler is not well understood, and it is not generally admitted to be due to surface condensed water, but some other cause not yet discovered. Some interesting facts relating to this question of surface condensers are given in a recent number of *Newton's London Journal of Arts*, by Edward Humphreys, from a paper read by him before the Royal Institution, London. He states that in 1859 he designed a set of marine engines of 400 horse-power for the Oriental and Peninsula Company's ship *Mooltan*; and believing that great benefit would result from the use of surface condensers, he therefore had a pair of surface condensers built for the engines of the *Mooltan.* The boilers of the vessel contained 4,800 square feet of heating surface; the condensers 4,200 square feet. The air-pumps of the condenser were the feed pumps of the boilers, and the air which leaked into the engines was allowed to escape by an open stand-pipe connected to the highest point of the feed-pipe, thence it was carried up inside of the mast, which was a tube of iron. Each condenser contained 1,178 seamless copper tubes of $\frac{5}{8}$-inch outside diameter; five feet ten inches in length, and the thickness was .050 inch or No. 18 wire gage. The tube plates were of gun metal, and the tubes were set apart one inch from center to center. Linen tape, $\frac{7}{16}$ths of an inch in width, was used for the packing of the tubes. The salt water supplied to cool the condenser was furnished with a centrifugal pump—a new feature in marine engines. Mr. Humphrey stated that at the time he prepared his paper—about the middle of 1862—the engines of the *Mooltan* had run 42,000 miles, and he examined them after they had run 30,000 miles, when they were found quite clean on the outside, but there was a slight coating of grease inside, resulting from the escape of the tallow employed in the cylinders. The boilers were also examined, and there was no appearance of deterioration in them. But it was noticed that the lubricating material found its way from the cylinders into the condensers and thence into the boilers, and it was often obtained in large lumps at the bottom of the water