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Contents:

(Illustrated articles are marked with an asterisk.

LOSSES OF POWER IN THE STEAM ENGINE. WHERE IT MAY BE IMPROVED AND TO WHAT EXTENT.

The mechanical equivalent of heat, as we have had frequent occasion to state, is reckoned at 772 foot pounds per thermal unit—that unit being the quantity of heat necessary to raise one pound of water one degree in temperature The fact is so very important that we shall be excused. however frequently we may present it.

A pound of pure carbon yields, in burning, 14,500 units of heat, equivalent to $14,500\times772=11,194,000$ foot pounds of energy. A pound of good coal containing 91 per cent carbon, as shown in the report of the committee of the American Institute testing steam boilers in 1872, produces about 13,200 units of heat, and its mechanical equivalent is $13,200\times772=10,190,400$ foot-pounds of work.

The very best classes of modern steam engines very seldom consume less than two pounds of coal per horse power per hour, and it is a good engine that works regularly on three pounds. A horse power raises 1,980,000 pounds one foot high per hour. Consequently, a pound of coal, in our very best engines, developes but $\frac{1980000}{2}=990,000$ foot pounds instead of the 10,190,400 which it would give us were there no loss of power.

The first-class steam engine, therefore, yields less than 10 per cent of the work stored up in good fuel, and the average engine probably utilizes less than 4 per cent.

A part of this loss is unavoidable, being due to natural conditions beyond the control of human power, while another portion is, to a considerable extent, controllable by the engineer, or by the engine driver.

Scientific research has shown that the proportion of heat, stored up in any fluid, which may be utilized by perfect mechanism, must be represented by a fraction, the numerator of which is the range of temperature of the fluid while doing useful work, and the denominator of which is the temperature of the fluid when entering the machine, measured from the "absolute zero"—the point at which heat motion is supposed to cease entirely—461° Fahr. below the zero of the common scale.

Thus, steam, at a temperature of 320° Fahr., being taken into a perfect steam engine, and doing work there until it is thrown into the condenser at 100' Fahr., would yield $\frac{320-100}{320+461}=0\cdot28+$, or rather more than one fourth of the 10,190,400 foot pounds of work which it should have received from each pound of fuel.

The ratio, $\frac{990000}{2853312}=0.34=\frac{1}{3}$, of the work done by our best class of engines, to this possible performance of a perfect engine using 75 pounds of steam, shows us how much we have to hope for in improving the steam engine.

The proportion of work that a non-condensing, but otherwise perfect, engine, using steam of 75 pounds pressure, could utilize, would be $\frac{320-212}{320+461}=0\cdot14=\frac{1}{7}$; and, while the perfect condensing engine would consume two thirds of a pound of good coal per hour, the perfect non-condensing engine would use $1\frac{1}{3}$ pounds per hour for each horse power developed, the steam being taken into the engine and exhausted at the temperature assumed above. Also, were it possible to work steam down to the absolute zero of temperature, the perfect engine would require but 0·19 pounds of similar fuel.

We may therefore state, with a close approximation to exactness, that, of all the heat derived from the fuel, about seven tenths is lost through the existence of natural conditions over which man can probably never expect to obtain control, two tenths are lost through imperfections in our apparatus, and only one tenth is utilized in even good engines.

We have intended to include boiler and engine when writing of the steam engine above. In this combination, a waste of probably one third at least of the heat derived from the fuel takes place in the boiler and steam pipes, on the average, in the best of practice, and we are therefore only able to anticipate a possible saving of $0\cdot2\times0\cdot75=0\cdot15$, about one sixth of the fuel, now expended in our best class of engines, by improvements in the machine itself. This is a most important fact to ingenious and enthusiastic but uninformed inventors.

The best steam engine, apart from its boiler, therefore, has 0·85, about five sixths, of the efficiency of a perfect engine, and the remaining sixth is lost through waste of heat by radiation and conduction externally, by condensation within the cylinder, and by friction and other useless work done within itself. It is to improvement in these points that inventors must turn their attention if they would improve upon the best modern practice by changes in the construction of the steam engine.

To attain further economy, after having perfected the machine in these particulars, they must contrive to use a fluid which they may work through a wider range of temperature, as has been attempted in air engines by raising the upper limit of temperature, and in binary vapor engines by reaching toward a lower limit, or by working a fluid from a higher temperature than is now done down to the lowest possible temperature. The upper limit is fixed by the heat-resisting power of our materials of construction, and the lower by the mean temperature of objects on the surface of earth, being much lower at some seasons than at others.

In the boiler, the endeavor must be to take up all the heat of combustion, sending the gases into the chimney at as low a temperature as possible, and securing, in the furnace, perfect combustion without excess of air supply.

The best engines still lack 15 per cent of perfection, and the best boilers, as an average, over 30 per cent.

This is not as much as some of our readers had supposed. We know of instances in which they are wasting time, money and energy, in the confident anticipation of making one pound of coal do the work that now requires ten, and we have endeavored here to show them what is the amount of actual waste and where it occurs, in order that they may detect the fallacy which has misled them, as well as in order to instruct and interest the general reader.

GOVERNMENT TELEGRAPHY.

We have observed the progress of the efforts that are now being made in Congress to place the institution of telegraphy, like that of the mails, in the hands of the general government. In theory, the idea is pleasing and on the whole popular. Sooner or later, doubtless it will be done. But if any one expects that messages will be transmitted any cheaper, quicker, or better than at present, we think they will be disappointed. Then, in the matter of damages suffered, individuals will have no remedy against the government, whereas, with the telegraph in private hands, the courts hold the companies to the strictest accountability for their blunders or neglect. The interests of the companies are thus made to depend in a very great degree on the promptness and accuracy with which they transact their business. But in government hands, no such incentives will exist. The courts could not then punish the stockholders, and the telegraph, like all other government machines, would be conducted in a slow and comparatively careless manner.

Then as to cost, under the existing *régime* those who use the telegraph pay the expenses. But when we place the lines in the hands of the government, the people at large will be taxed to pay for the purchase and make good the inevitable annual deficiency. In England and other parts of Europe, the telegraph is operated by the governments, and the statistics show that messages are not so promptly delivered, and cost quite as much or more than in this country under the present arrangements, and that the receipts fail to meet the expenses. Our Postmaster General, Mr. Creswell, has become quite a strenuous advocate for the postal telegraph, and in an official report made upon the subject he presents a variety of information; but unfortunately it is full of inaccuracies which impair its value, and will be apt to perplex those who attempt to deduce practical instruction therefrom. For example, he estimates that for about twelve millions of dollars the government could build telegraph lines equal in extent to all now in use in this country, or one hundred and seventy-five thousand miles in total length. Singularly enough, this estimate is adopted on the evidence of Mr. Chester, who put up the fire telegraph in this city, six hundred and twenty-six miles in length, and charged the authorities eight hundred and fifty thousand dollars therefor. At the rate of Mr. Chester's price for New York city, the cost to the government for the postal telegraph would be over two hundred millions of dollars.

We earnestly hope that Congress will move deliberately in this matter. Our present telegraph system works exceedingly well; indeed, no other country is better supplied. Let well enough alone is a safe rule. But if we must have a change, Congress ought first to procure, for the information of its own members and the people, the most full and accurate estimates of the cost, and the advantages, if any, which would be likely to ensue. We think that a special Congressional committee might be appointed, charged with the duty of collecting and arranging the real facts in the matter. Such an investigation, honestly conducted, would be approved by the public.

THE NEW YORK INDUSTRIAL EXHIBITION.

Quite a number of wealthy citizens of New York city have, for some time past, been considering a plan of establishing a permanent industrial exhibition building in some convenient locality in the metropolis. At a recent meeting a committee was appointed to examine into the subject, from the lately published report of which we glean the following particulars regarding the scheme: The Industrial Exhibition Company is a regularly organized corporation under the State laws. It has contracted to purchase a piece of land lying between 98th and 102d streets, and Third and Fourth avenues, in this city, consisting of eight blocks of ground, for the sum of $1,700,000. $200,000 of this has been paid. The estimated cost of a suitable building and ground improvements is seven million dollars. A proposition has been made by a New England firm to construct a dome over the court, which dome shall be the largest and most magnificent in the world. The estimated cost of this structure is $3,000,000, but all the builders ask in payment is a perpetual lease of it above the spring of the arch. Finally the hope is expressed that Congress will favor the idea of the World's Fair being opened in this building in 1876. It is not proposed to interfere with Philadelphia's "Centennial," but, as the committee state, "we, New Yorkers, cannot but feel that we may celebrate in our own way so important an occasion."

The report was adopted, and committees were appointed, among which we may notice the names of Messrs. Samuel Sloan, Richard Schell, Paul Spofford, Wm. B. Astor, Wm. M. Evarts, R. H. Pruyn, Francis Skiddy, E. L. Tiffany, and many others. Subscription papers have been prepared and freely circulated, so that the enterprise thus fairly launched bids fair to be rapidly pushed forward to a successful completion.

CORN AS FUEL.

A curious state of affairs exists in the West. Farmers are not only burning corn for fuel at the present time, but laying in supplies to serve for that purpose during the coming winter. It is asserted that corn gives a better heat for cooking purposes than any wood excepting hickory, while, for economy of consumption, it is cheaper. Hard wood on the spot costs $7.50 per cord, corn, $5.60. As compared with coal, it is estimated that three tuns of corn will give heat equal to one tun of coal, while in economy of use, it is equal to one and a half tuns of the latter.

That this is an unpleasant commentary upon our facilities for transportation cannot be denied. The cost of food here in the East is notoriously large, and it is equally true that living expenses have in but a small degree decreased since the darkest period of the war. Yet, such are the rates of freight or the fewness of carrying lines that it seems a better paying operation to burn food than to send it to Eastern markets for sale.

A cotemporary aptly suggests that evidence is here afforded of the gradual diminution of our forests, a serious fact to which we have frequently adverted. There are strong efforts being made by the National Bureau of Agriculture, as well as by State societies, to protect the growing timber, and suggestions from these sources should be heeded and acted upon. If, as the burning of grain implies, the woodland in the neighborhood of the corn-producing districts in the West has become so sadly depleted, it is time that protective means were adopted and effective measures inaugurated which will at least supply the deficit to future inhabitants of the country. Corn may make excellent fuel for future generations, but it will scarcely answer as a material from which houses or furniture can be constructed.

Another idea worthy of consideration is that of raising a cheap variety of maize which will yield a maximum of woody or combustible fiber with a very light consequent exhaustion of the soil. There are varieties which will thrive in northerly climates, and can be cultivated at the rate of seventy-five bushels per acre. It is swift of growth, as it contains more oily than starchy qualities, and is well adapted for fuel.

THE HENDERSON IRON PROCESS.

We have heretofore chronicled the progress of this new improvement in the manufacture of iron, and are happy to be able to say that the recent tests to which it has been subjected, which have been many and thorough, have fully confirmed the great value and importance of the invention. It promises to revolutionize the art of manufacturing iron; greatly economizing in the labor and vastly improving the quality of the metal produced. The invention is by James Henderson, of New York, who for the past year has been engaged in England, in developing the merits of the discovery where it has attracted the greatest attention.

The Henderson process consists in the application of fluorine, in the form of fluor spar, and of oxygen in the form of oxide of iron to the molten cast iron. The ingredients mentioned are thrown into the puddling furnace and the cast iron is then poured in upon the mixture, which remains at the bottom. The iron is then allowed to boil for about half an hour, then rabbled for ten minutes, when the metal is balled up. The time occupied is an hour for each charge. The fluorine and oxygen remove the phosphorus and other impurities within a few minutes. The discovery is applicable to the production of wrought iron and steel of the best qualities. From cinder pig and the common brands of cast iron, a wrought iron having very great toughness is produced. Mr. Kirkaldy certifies that steel made from the Henderson wrought iron derived from common Scotch pig, gave a tensile strength equal to steel made from the best Swedish iron, and, in the form of tools, stood the wear equally well The analyses of Dr. Noad show that the Henderson process removes every impurity from the iron. The *Mechanics' Magazine* states that,

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