"A LOOK AHEAD."

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Before glancing at the future, it will be advisable to look back about seventy-five years at the condition of steam engineering, and, knowing what has taken place in the meantime, we will be better able to forecast what may possibly take place in the next fifty years.

In the years 1816 to 1820, Perkins, the father of steam heating (if an art can be said to have a father), was in business in Philadelphia, of the firm of Perkins & Sellers, and in the reminiscences of Geo. Ecoll Sellers, published in the *American Machinist* in 1884, he gives us a perfect picture of the mechanic arts, as they then existed.

I will call attention to the case of "Blind Hawkins." In order that I shall not be misunderstood, I shall quote direct from Mr. Sellers:

"He had evidently tried, or had tried for him, many experiments with steam; his whole thoughts were on that subject. He said he had satisfied himself that the greatest economy was in using steam at very high pressure, and also the greatest safety from explosion; he even talked of using steam of 1,000 lbs. pressure to the square inch, and of the great reduction in the weight of furnaces, boilers and steam engines for ocean navigation that he should make, and that by his system dangerous explosions would be an absolute impossibility, as the steam for every stroke of the engine would be generated as used. He claimed to have demonstrated that the spheroidal state of water, when thrown on heated metal, was entirely prevented by using highly heated tubes of great strength, and maintaining in them an attenuated vapor at a pressure of not less than 175 lbs. This was done by the escape valve being loaded to that pressure. His plan was to inject into

these tubes just the quantity of water required to generate the steam at the pressure wanted, and required to fill the cylinder and make the stroke. He had another modification that had grown out of the difficulty of regulating the jets of water with absolute certainty. This was to keep his heavy, strong and highly heated tube-generators full of water, and to allow just so much highly heated water to escape and flash into steam as was required for each stroke of the engine. I do not recollect the exact mode he proposed to accomplish this. Toward the latter part of the time father was connected with Mr. Perkins, Hawkins had succeeded in getting, by subscription, what he thought would enable him to demonstrate his theories. This subscription was headed by two retired merchants from Charleston, who had settled in Philadelphia, and had known Hawkins in his early days; part was by shops in the shape of work; a brass founder subscribed the brass castings; a coppersmith the steam pipes, &c. Hawkins was given the use of bench and tools in the P. & S. shops, and there he brought the different parts of his engine together, which he erected under a shed in a yard in the vicinity. Perkins took great interest in the work as it went on, and, no doubt, gave him much aid. On the first trial of this engine, *the soft solder of two wiped joints* of the *small copper steam pipe melted*, and it blew apart in a few minutes after the engine started. Here Hawkins' trouble commenced. For the copper pipes he substituted musket barrels, *joining them by conically counter sinking one and tapering the other to fit into it*, drawing them together by clamps and bolts. There did not seem to be any serious trouble with his generator, but the great heat of the high pressure steam burned out the hemp packing of his piston and his piston rod. Then came a long series of experiments with *metallic packing*, which at the high heat, for want of lubrication, fastened to the cylinder. Then followed a most ingenious device. He put on a large steam cylinder to work with lower pressure, a condenser to give him hot water from the escaped steam; simultaneous with the flash of highly heated steam, or water flashing into steam, hot water was in-

jected, reducing the temperature and increasing the volume of steam at a lower pressure. He had a scheme of open and single stroke engines, with a plan of lubricating, that I do not remember."

At this time that Mr. Sellers is describing, steam engineering was in its infancy, tools and appliances were of the crudest form, there were neither factories nor furnaces, railroads nor steamships (that is, using the words factories or furnaces in their proper sense); there were a few foundries working for the flour and saw mills, principally on water wheels, shafting and gearing. The first railroad train in the world did not begin to run until 1830, yet here was a blind engineer whose conception of the proper functions of steam and steam generators was almost perfect. Automatic supply of water as generated into steam, and high pressure water tube boilers, are the highest perfection yet reached in boiler engineering.

Mr. Sellers paints another picture of one of Philadelphia's early mechanics. I shall again quote from him direct:

"Isaiah Lukens was chiefly engaged in making town clocks, but found time, with never more than the assistance of one or two men, to finish two or three small lathes and an air-gun or two in the course of a year, for which there were always ready purchasers."

"It affords me great pleasure * * * to pay my tribute to one of the greatest of our pioneer mechanics who was emphatically the young beginner's best friend, and a sound mechanic to the core. He was a bachelor of rather eccentric habits. He lived in his shop, sleeping in an adjoining room, taking his meals at an old hostelry on Market Street * * * He always took a Summer vacation of from six to eight weeks. At these times he would lock up his shop, and with his fishing tackle, mineral hammer, and change of clothes in his gig, his trusty air gun by his side, he would drive off on his solitary excursions, never hinting to his most intimate friends what course he would take. I doubt if he knew himself; but he was free to be guided by circumstances * * * He took an assistant, I cannot say as to an apprentice; he called him his

pupil, and he did honor to his preceptor. I refer to Joseph Saxton, who has left his mark in his scales for the U. S. mint * * * and as head of the department of weights and measures of the United States."

Mr. Sellers also refers to Pat Lyons, the distinguished blacksmith and machinist, and to many others of those early mechanics, among them Oliver Evans, engineer and millwright, the first and greatest American engineer. I call particular attention to them to illustrate the conditions that existed so short a time ago, and particularly to the fact that in Perkins & Sellers' shop was born the art of steam-fitting, unless we concede that the coppersmiths, who had done all the steam fitting up to that time, which was very little indeed, were steam fitters. I shall merely refer to Perkins, whose special trade was banknote engraving, going to England, his introduction of high-pressure generators and heating apparatus, and his connections with the leading mechanics there, and his pupil, Mr. Nason, coming to this country and beginning the business of steam and water heating; the beginning of all the specialties of manufactures connected with it, that exist to-day; how that business has developed we all know; how it will develop in the next seventy-five years is to my mind plainly indicated by how it is developing to-day, and I shall try to point out in a few directions what I conceive to be the natural advance of the mechanic arts, connected with steam fitting and steam engineering, leaving to your imagination many others. Before proceeding, however, I wish to state that in the period between our time and Hawkins' and Perkins' time, they have had worthy successors in Philadelphia. Morris, Tasker & Co. and Robt. Briggs are well known; not so well known perhaps was John Peace* (I believe the inventor of lap welding and chaser dies), and the Camden Tool & Tube Works, and there were many able mechanics with Murphy & Allison

* John Peace introduced lap welding in the U. S., but was not the inventor. See Richard T. Crane's paper read at Chicago.

and others; and I trust that some one that knew these men and their work will think it his duty to make a record of it and present it to this association. I will now proceed to look at what I conceive to be pending changes, and if I am too altruistic or too utopian, you must remember that my subject warrants that license.

In the near future direct radiators will be designed that are poems in art; I would not by this state that there are not pretty radiators at present, or that a radiator is a hideous, but necessary, monstrosity. The radiator specialist has done well in the last ten years; we will encourage him to do better. The radiator of the near future will encircle the fireplace; it will be the fireplace mantel; it will have its gas logs and its ventilating flue; the air will be admitted back of it, whether from the room or from outside; it will be connected with the steam or hot-water boiler in the cellar, *with one pipe not exposed in the room*, and regulated with a foot valve, having also connection of course with the thermostatic regulator. (This is simply a Backus or similar heater in the room connected with an ordinary heater in the cellar.)

The days of the old-style handle valve are over; in fact, the days of all globe valves or globular valves are about over; the straight-way valve is now perfect for all purposes and pressures. This radiator I speak of will, with its gas logs, waste but very little heat, as the gas heat will be utilized in re-evaporating steam or re-heating water. Let the radiator man study beauty; his business is an artistic one.

The gate valve is the valve of the future, and exposed pipes in buildings will not be tolerated in an artistic age, unless they are also made beautiful.

The natural development of architecture will lead to hot-air heating by indirect steam or water, and by the use of fans with the indirect heating; hollow walls will soon become a necessity of architecture, and these we will utilize for sending up to the rooms fresh warm air. It is a curious thing that we guarantee to heat rooms to 70 degrees in zero weather and never do it uniformly. Let any one make the experiment by

taking a dozen thermometers, first testing them for uniformity and accuracy, and place one outside the window, another one inside the window, one at the ceiling, one on the floor, another at the vent flue, and others at the inside and outside walls, and one just above the radiator or register. It will probably be 10 degrees above zero outside, 80 degrees at the ceiling of the room, 60 degrees at the floor, if it is a first floor and the ceiling is about 11 feet high; 69 to 72 degrees at the exact centre of the room, and this will be also about the average of the different thermometers, and it will be probably 65 degrees at the vent flue, and just above the radiator or register of course will be found the highest temperature in the room. This difficulty will be overcome by hollow walls and hot-air heat.

In general pipe fitting, I think cast fittings will disappear and be succeeded by malleable and wrought fittings, and also steel fittings. Screwed joint will to a great extent disappear and be succeeded by electric welding, and new fittings, and new methods of connecting will dispense with both flange and screwed joints; progress in the use of new metals and alloys will make many changes, for instance, in the use of aluminum or of alloys of it. The exhaust steam from engines that is now thrown away in cities will be saved by having one large central main pipe, say fifteen or twenty feet in diameter; all engines will have to exhaust into this; steam for heating will be taken from this whenever required and the hot water will be used for the boilers. Central heating plants will increase; they are only in their infancy. The boilers in these plants will be vertical water-tube boilers, working at 1,000 to 1,500 pounds pressure; they will not be set in brick work, but have iron casings; our present practice of setting boilers in brick, illustrates our poverty of expedient; a true engineer is a worker in metal and leaves bricks to the architect. The feeding of coal to these boilers and the removal of ashes will be entirely automatic; mechanical conveyors will take the coal to the automatic stokers, and later the use of petroleum or gas for fuel will become general; water will of course

be fed automatically and heated by high-temperature heaters; boilers will then become complicated machines worthy of the engineer. There will be no patents on these boilers; we have passed the age of patents. There is not to-day, in my opinion, a valid patent on a boiler or radiator, or any other article connected with heating or steam engineering. Their value depends on how much litigation the owners can stand. Take boilers, there is hardly a form made to-day that is not shown in Burgh's treatise on boilers to have been introduced forty years ago. Robert Briggs advocated the abolition of patent laws, and I believe claimed that they were never of benefit, as engineers would devise the necessary machines when there was occasion for it. Events seem to point to the fact that patent laws were once of some value, but to-day as applied to steam engineering they are only of use to tickle credulous stockholders.

It seems to be the general opinion that in the future our electricians may make electricity and heat interchangeable terms, and our heat be on tap without the steam fitter, but I doubt it. At the Boston convention Mr. Kendricken brought up the subject of electric heating; but the discussion was not carried far. A recent issue of the "New York Herald," (May 28), contained the following description of an electric heating apparatus. While the whole description has that peculiar vagueness characteristic of the daily press, it shows that electricians have started at the heating problem in earnest:

"This particular dwelling is the home of Mr. Geo. Foster Peabody, of Brooklyn. * * * All that is necessary is to tap the regular electric mains and wire the house in the same form as for light, the only difference being that the terminals lead to heaters. A separate circuit was used for the heating, cooking and lighting. Starting from the switchboard, to which all branches lead, and passing into the cellar, the ordinary hot air furnace is found there; from the furnace cold air boxes leads one large main pipe in which is placed an electric heater, then from this main, branches start in each of

which is also placed an electric heater, the idea being to heat the cold air in the main pipe to a certain degree and then superheat it in the separate pipes."

"In mild weather the main heater suffices, but in colder times all the auxiliary heaters are required. A constant circulation of air is kept in the pipes by an electric fan placed in the cold air box, thus insuring a steady supply of fresh air. Even with a winter as vigorous as the last one, not a shovelful of coal has been used in the house during the entire season.

"Though nearly all of the heating is done through the old furnace pipes, thus entailing no extra expense for running wires, other heating accessories are used in some of the rooms. This only needs a peculiar form of electric radiator and the wires leading thereto. Of all the modes of producing artificial warmth, none, of course, can compare with electric heat, which eliminates all bother from ashes, dust, gases and many other nuisances which accompany all other heat-producing agents. It is the mildest and most enjoyable of all heats, and when it is no longer required, by simply turning a switch all expense is stopped.

"It is upon the electric heaters that dependence must be placed in future to reduce the price. They are not perfected as yet and are still quite wasteful. Some American inventor will probably some day bring forth a heater which is economical, and thus put electric heating within the reach of all."

The foregoing is very good as far as it goes, but it does not go far enough.

I have very little faith in the electric transmission of heat *economically*, while I believe that motion, force, heat, electricity are in their essence the same, and while the wonders that have been done by electricians should make one who knows nothing about electricity withhold his opinion, I feel that the lineman is not going to supersede the fitter in the immediate future, *but it is the impossible that becomes possible*, and the art of steam heating, like many others, may become a lost art when man has no further use for it. The running of hot

blast fans by small electric motors (the stack and motor placed at the base of indirect flues), is the best application of electric heating that I have seen thus far.

The following from the Pittsburg *Dispatch* of June 3d, entitled, "Heat in Electricity," is very important, if true:

"WASHINGTON, June 2.—A most important discovery in the use of electricity for heating purposes is described in a report from Consul-General Mason, of Frankfort, which will be published by the State Department within the next few weeks. The invention is the joint achievement of two Belgian scientists, Messrs. Lagrange and Hoho. When they applied for German patents, some months ago, the means as designated in their claim appeared so simple, and the result therein described so incredible, that the patent examiners demanded that before issuing the patent a practical demonstration of the process should be made in their presence. This was so successful that it was repeated before the Electro-Technical Society of Berlin, by permission of the inventors, and with brilliant results.

"The apparatus consists of a glass or porcelain vase lined with lead, which is connected with a strong conductor of positive electricity. The base is filled to three-fourths of its capacity with acidified water. A pair of iron tongs with insulated handles is attached by a flexible conductor to the negative pole of an electric current, generated by an ordinary dynamo.

"The electrical current having been switched on, a bar of wrought iron or other metal is taken up with the tongs and plunged into the water, which immediately begins to boil at the point of contact; the immersed portion of the iron quickly rises to a red, then to a white heat, emitting a stream of brilliant white light, and in a few moments the heat becomes so intense that the iron melts and falls off in sparks and bubbles, leaving a clear glowing surface in perfect condition for welding. The heating process is so rapid that neither the water nor the end of the bar held within the tongs is more than slightly warmed.

"By the use of a stick of carbon, instead of a bar of metal, it has been demonstrated that a temperature of 4,000 degrees Celsius is developed in the manner described. The rapidity of the heating and the limit of temperature desired are easily governed by the strength of the current employed, so that the whole process is under absolute control of the operator.

"During the Berlin experiments a tension of one hundred and twenty volts and an energy of two hundred and twenty ampères were registered, and it was estimated that fully 50 per cent. of the current was directly utilized as heat, whereas the practical limit has not hitherto exceeded 20 per cent. The inventors say that by employing a still stronger current, a temperature of 8,000 degrees Celsius has been developed, or nearly three times greater than that required to extract iron from the ores, the most refractory of which fuse at about 2,700 degrees. Consul-General Mason explains the process in these words: 'One of the well-known effects of electricity is to separate compound fluid bodies through which it passes into primitive elements. The current, passing through the tongs and metallic bar into the water, decomposes the latter into its two gaseous elements, oxygen and hydrogen. The oxygen is attracted and gathered on the relatively large surface of the lead lining, and produces no noticeable effect. The hydrogen, on the other hand, gathers around the immersed portion of the bar, and as this has a comparatively limited surface area, it is immediately surrounded with a close envelope or jacket of hydrogen, which, being a bad conductor of electricity, creates a powerful resistance to the passage of the current, and thus develops the heat which causes the bar to glow and melt.

"'It is merely an application of the well-known law that friction or resistance to the passage of an electrical current causes heat, and the apparent paradox of a piece of cold metal plunged into cold water rising rapidly to a metal glow, is as simply and clearly explained as the incandescence of a platinum coil in a vacuum bulb.

" 'Respecting possible applications of the new process, Mr. Mason writes:

" 'The quality which entails the largest possibilities, and which has been as yet only superficially investigated, is the capacity of this process to heat quickly and to any desired temperature the end or submerged surface of a mass of iron, while the remainder of the mass is left cool and comparatively unaffected by the heat. It is believed that this may lead to other important results in the hardening and tempering of armor plates and other objects in iron and soft steel in which great resistance to penetration or abrasion by friction is requisite, while preserving the interior tough and fibrous to resist concussion or restrain, as in many parts of machinery. At Essen, Messrs. Krupp & Co. are experimenting with it in the hardening of steel cannons, and it is believed that in chemistry this method of producing an intense and easily regulated temperature may lead to the successful manufacture of diamonds, rubies and sapphires, through the production of the larger forms of crystallized carbon.' "

I have given this dispatch in full, because I believe that those who are interested in heat cannot afford to ignore electricity, as it is the revolutionary agent that is transforming our civilization.

On the second floor of the building devoted to electricity at the World's Fair is a very excellent exhibit of both direct and indirect radiators from different manufacturers, also cooking apparatus, water heaters, baking ovens, and, in fact, apparatus for every domestic application of heat, showing that the transmission and transformation of electric energy for air heating is a practical fact that should have our careful attention.

In the near future, Corliss engine worship will disappear. I would not in one iota detract from the great merits of George H. Corliss; but, like Watt and Stephenson, he had contemporaries that were just as great. Both the high pressure engine of Oliver Evans and the low pressure engine of James Watt had their place in the natural economy of their time, and so

have the slow-speed engine of Corliss and the high-speed engine of Sweet; but to erect any man's engine into an idol, and by fetich worship to *attempt* to bar all advance, is a form of superstition that, while not vanished, is happily vanishing.

There are impending changes in the relation of the jobber. Very soon every contractor will buy from the jobbers only, and no manufacturers will sell direct to consumers or contractors. Every article and specialty will be distributed by the jobber. Specialization will be carried so far that no jobber would think of manufacturing and no manufacturer would think of jobbing. They could not make it pay. Margins of business will be too close and business will be too well organized to allow anything of that kind. Specialization is now carried very far in our particular business, but it will be carried much *further*. Where specialization is carried to its extreme, as in the production of one simple article, competition becomes very fierce; so fierce in fact that it destroys itself by reducing profits to such a point as to make the carrying on of business undesirable. It then becomes a case of limiting competition or declaring war. There are those who regard business as war and theirs may be sound philosophy. Talk to these men of limiting competition and they will tell you that it cannot be done, that it is necessary, that the big fish have always eaten the little ones and always will; in other words, that the fit *supplants* the unfit; that attempts to limit competition only aggravate it; that the weak must go to the wall and the sooner the better, and that this is true of everything in nature without exception. I think these men look at their philosophy in a narrow light. Competition is taking on new forms. Its virtues and its vices are becoming better understood, and with this understanding many changes are bound to take place.

Competition carried to its extreme kills itself, and the trust becomes a necessity, and competition ceases with the trust. That is, active competition is succeeded by latent competition (the fear that somebody may be tempted to compete or that the people through government may interfere). Under these

til the present year, when the associations began systematically to 'squeeze' the small dealers. The combination gave notice that it would do the radiator and boiler business of the country, and do it upon its own terms. Outsiders had their choice of submission and contribution or ruin. The famous Standard Oil Company tactics were adopted, and when a fitter not allied to the combination bid upon a job he learned that the combination had quoted ruinously low figures to prevent his getting the work, and to starve him into a capitulation. This has been going on for months, and it has become so intolerable that the steam-fitters outside of the ring, who are still numerically stronger than those inside, but not so well organized, are preparing for a desperate fight. Meantime the radiator trust is economizing to make up for the profits it has failed to squeeze out of the steam-fitters and householders.

"The constitution of the Master Steam & Hot Water Fitters of the United States provided for a species of boycott against all manufacturers and dealers who do not maintain a difference in prices in favor of its members, and that each manufacturer or jobbing house shall quote, bill, sell and collect, without rebate, from all consumers at prices to be established by a conference with the executive committee of the association. A system of espionage upon the members of the trade is also provided for.

There are still several *strong firms* outside the heating combination.

The reporter should not have added this last sentence. It gives the whole story away.

The trust to my mind is merely a step in the march towards *economic democracy*. I have spoken of product and cost; it means a great deal more than that; it means minimizing of profits also: roughly speaking, to-day net profits in business are as 20, 10 and 5 per cent. The first figure being the maximum profit, the middle figure the mean profit, and the last, at which the bulk of business is done, the lowest or minimum profit. I believe that these profits will gradually go down in

the next hundred years to 7½, 5 and 2½ per cent., or very close to these figures; everybody knows that in regular business profits are getting less all the time; it is a fixed and natural tendency and is bound to continue; the trust is the creature of this natural tendency or necessity, and business by trust is only beginning.

There are those who consider the trust as the greatest evil that menaces us at present; I think they are mistaken; good and evil are only relative terms, and there may be great good in this apparent evil. Let us have faith that it only hastens the good time coming, and with Robert Burns—"Then let us pray that come it may, as come it will for a' that; that sense and worth o'er a' the earth may bear the gree and a' that; for a' that and a' that, it's coming yet for a' that; that man to man the warld o'er shall brothers be for a' that."

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