results right along with hand firing equivalent to those obtained during a competitive test? I do not think so, because firemen, as a rule, do not like to be beaten, and will do their very best during a competitive test to do up the other fellow; but at the same time he is wishing inwardly that the test was over so as to get back the old "style" again.

There are many plants in Canada where very good results are obtained if we take the results as made by the engineers into consideration, several of them showing a usual 14 lbs. evaporation per lb. of coal. This you will readily understand is out of the question. There are also a large number where very poor results are obtained, and these poor results are due to several causes, namely: Boilers in very bad order, dirty tubes, poor setting, poor boilers, poor firemen, etc. The man who sells boiler compounds will in all probability say that you do not use enough of his compound; your answer to that is, of course, that there are compounds on the market that are absolutely of no use whatever, and it is simply throwing money away to buy it. I myself believe in a good compound, but will admit that it is difficult to get it. You may get one barrel (the first from a new maker), fairly good, the second of no use whatever, and so on it goes. A good compound is required, and to my mind to-day we have not such a thing. All compound makers state in their advertisements to send on a sample of your water, and they will give you the very compound you require after analysis. You, of course, know what this means—that if one brand does not work they will send another brand of practically the same stuff with another name and try it. Poor boiler and poor setting; this is attributed to trying to keep down the first cost. Pay a good figure for a good boiler and have it set by competent men. Poor fireman; this is in my humble judgment the most important item, and one that should receive much consideration. The fireman may not be poor, but the work that he has to attend to, namely, firing too many boilers, makes him feel that he is neither more or less than a laborer, and as long as he keeps the steam pressure up, no matter how much coal he burns, or how he does it, there appears to be little or no attention paid to him. There are many places where the fireman is never thought of except when the steam pressure goes down, and when such is the case the usual deputation calls upon him to ascertain if he is asleep or not. A good fireman is really a skilled workman, and should be treated as such. He should receive a fair salary, and his employer should bear in mind that any reduction in his pay is far from being a saving. If he is cut down $2 per week you will in all probability find your coal bill increased about $8, and there is not much economy there. How are we to obtain better results in our boiler rooms? I think by putting in machines to do the work, and having men simply to look after them.

EVAPORATION AND THE RAISING OF STEAM IN BOILERS.*

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From the title of this paper you will notice that it is to deal with two things. First, evaporation, and second, the making of steam in boilers. These two actions are often considered as if they were distinctly different, but, I think, it can be shown that the actions are the same in the end, and that they differ only in the way in which the end is reached. In the following remarks it will be noticed that I have tried to show how the natural action of evaporation resembles the action of making steam for power, because it is always instructive to think out how the processes which we make use of every day, compare with corresponding ones in nature. Some have said that it is wasting time thinking of things in this way; if they really think so it would be wasted time, but to others it would be very instructive and pleasurable. I might say that such thoughts would be to them as salt, which though of little use in itself as a food, still makes our food more palatable. Strictly speaking the term evaporation is used to denote nature's method of changing water into vapor, and making steam in boilers is part of man's method of changing water into vapor through an intermediate state familiar to all of us called steam.

The principal actions in nature in which evaporation plays a part, have been noticed by all of us. They are the disappearing of the dew from the grass on a summer morning, and the frost later in the season; the disappearing of water when left standing in open vessels, and on a much larger scale the raising of water from our rivers, lakes and surrounding ocean. Now it is usually admitted that for every action there is a cause, and the cause of evaporation in nature is the heat of the sun. It will make our problem much simpler if we consider, for instance, a bucket of water as made up of a great number of particles of water. That this the real state of water will be seen at once if we remember that when heat is applied to water it forms steam, which is particles of water visible to the eye, and if heat be applied to steam the particles of steam are divided into smaller particles called vapor, which is invisible.

Atmospheric air, among other things, contains a certain amount of water vapor, and this water vapor as long as the sun is shining is kept suspended uniformly through the atmosphere by the sun's heat. When the sun has set and its heat no longer acts on the atmosphere this water vapor tends to condense to a slight extent and with this condensation it becomes slightly heavier than the other components of the air, and so tends to sink towards the earth, so that in a calm, clear night in summer that part of the atmosphere lying next to the earth contains more moisture than that which is higher up.

That the above statement points out the true state of the atmosphere at night is proven by noticing the land fogs. If we go up a mountain at the first of daylight on a calm, foggy morning we will notice that as we ascend the fog becomes less dense until when we have gone up about four hundred or six hundred feet we will be out of the fog altogether.

This layer of moist air coming in contact with the cool leaves of trees, plants and other vegetation, the water vapor which it contains is further condensed, thus forming dew. I wish it to be clearly understood at this point that the collecting of dew on the leaves of plants is owing to condensation and not to a falling of water as rain. The fact that dew only gathers on the top side of the leaf, and does not collect in our houses even if all the doors and windows are open, is owing to another action which has no bearing on the subject in hand.

Now we come to evaporation or the disappearing of the dew. We have the air in two layers, the moist one lying nearer the earth and the dry one higher up. The sun rising in the sky begins to send his rays of heat earthward, the layer of air lying next the earth becomes warmed first, and owing to the principle that warm air rises, it rises, and the cooler air comes down to take its place next the earth. The air which is now next the earth is dry or lacking in water vopor, so the lack is made up by absorbing a certain amount of water in a state of vapor from the dew on the plants. This circulation has not continued long before all the dew is evaporated. This process of evaporation in nature does not cease when the dew has disappeared, but goes on continually, because there is always a demand for more water-vapor in the air on account of it being partially condensed in the upper regions of air, thus forming first, clouds, and if condensed further the clouds form rain or snow.

We will now proceed to discuss the making of steam in boilers, and then its change from steam to water-vapor, after which we will compare it with the process described above. For purposes of comparison we will turn water into steam in a boiler open to the atmosphere, that is to say, we will raise steam under a pressure of 14.7 lbs. per square inch. In this we are under the same condition as the dew which was turned into vapor under atmospheric pressure also. We will suppose that the boiler which we are going to use is a small circular vessel, say 6 inches in diameter and 12 inches deep, which may be set over a stove hole, and supplied with a steam tight cover somewhat like a piston, by using which we may vary the pressure. We will now put some water in the boiler and place it over the fire, the cover being left off. Now, remembering that water is made up of particles held together by a force (in this case 14.7 lbs. per square inch, or whatever the barometer may read), which must be overcome before we can have steam, we are called upon to exert a force in opposition to the force holding the particles together. We do this by lighting a fire under the boiler. As the fire burns a certain amount of the energy of the coal is transferred to the water, causing the temperature to rise until, when it has reached about 212° F., the coal has transferred enough of its energy to the water to enable it to overcome the atmospheric pressure and water pressure, and

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