PROPORTIONS OF BOILERS.

A common question, among the many that are sent to us, is as follows: "What are the dimensions of a boiler suitable for an engine of a given horse power?" It is impossible to answer this question generally, from the fact that the economy of engines of different design varies so greatly. Thus, while a large engine of the most approved form may produce an indicated horse power with a consumption of 15 lbs. of steam per hour, it is not uncommon to see engines which require many times this amount. When the amount of steam required, however, is known, it is possible to give approximate figures for the dimensions of a boiler that will evaporate this amount of water, and an approximate estimate can also be made of the quantity of steam which will be required for any particular style of engine. We propose, in this article, to consider these questions in detail, and give plain rules, which will doubtless be of interest to very many of our readers. The data upon which these rules have been constructed are taken from the most reliable records at our command, and give the results of average performance; so that very good boilers will do much better than is indicated by the rules, and some few will fall below this standard. This, however, is to be expected from any general rules for cases of this nature.

A. Dimensions suitable for a boiler which is required to have a given evaporation:

(*a*) To ascertain the grate surface, in square feet: Divide the number of pounds of water to be evaporated per hour, from and at 212°, by 75, for cylinder boilers; by 77, for flue boilers; by 78, for tubular boilers; by 80, for locomotive and vertical boilers.

Evaporation "from and at 212°" signifies evaporation at atmospheric pressure, from feed water having a temperature of 212°. This is assumed as a convenient standard, since in practice the pressures at which evaporation takes place and the temperatures of the feed water are quite variable. Two tables are appended, by the aid of which the necessary reductions can readily be made. The second table is taken from Professor Rankine's "Treatise on the Steam Engine."

TABLE I.—PRESSURE AND TEMPERATURE OF STEAM.

Pressure by gage.	Temperature Fahrenheit.	Pressure by gage.	Temperature Fahrenheit.
0	212°	110	344°
10	239°	120	350°
20	250°	130	356°
30	274°	140	361°
40	287°	150	366°
50	298°	160	370°
60	307°	170	375°
70	316°	180	379°
80	324°	190	384°
90	331°	200	388°
100	338°		

TABLE II.—FACTORS OF EVAPORATION.

Temperature of the steam.	Temperature of the feed water.										
	32°	50°	68°	86°	104°	122°	140°	158°	176°	194°	212°
212°	1·19	1·17	1·15	1·13	1·11	1·10	1·08	1·06	1·04	1·02	1·00
230°	1·20	1·18	1·16	1·14	1·12	1·10	1·08	1·06	1·04	1·02	1·01
248°	1·20	1·18	1·16	1·14	1·13	1·11	1·09	1·07	1·05	1·03	1·01
266°	1·21	1·19	1·17	1·15	1·13	1·11	1·09	1·07	1·06	1·04	1·02
284°	1·21	1·20	1·18	1·16	1·14	1·12	1·10	1·08	1·06	1·04	1·02
302°	1·22	1·20	1·18	1·16	1·14	1·12	1·11	1·09	1·07	1·05	1·03
320°	1·22	1·21	1·19	1·17	1·15	1·13	1·11	1·09	1·07	1·05	1·03
338°	1·23	1·21	1·19	1·17	1·15	1·14	1·12	1·10	1·08	1·06	1·04
356°	1·23	1·22	1·20	1·18	1·16	1·14	1·12	1·10	1·08	1·06	1·04
374°	1·24	1·22	1·20	1·18	1·17	1·15	1·13	1·11	1·09	1·07	1·05
392°	1·24	1·23	1·21	1·19	1·17	1·15	1·13	1·11	1·09	1·07	1·06
410°	1·25	1·23	1·22	1·20	1·18	1·16	1·14	1·12	1·10	1·08	1·06

The following examples will illustrate the use of these tables:

If a boiler evaporates $8\frac{1}{2}$ lbs. of water per lb. of coal, the steam pressure being 150 lbs., and the temperature of the fuel water 120°, what is the equivalent evaporation from and at 212°? The temperature of the steam is 366°. According to table II., the factor of evaporation is about 1·15 (using the temperature of steam and feed water in the table, nearest to those given in the example). Hence the evaporation at and from 212° is 1·15 times $8\frac{1}{2}$, or about $9\frac{8}{10}$ lbs. of water per lb. of coal.

Suppose that a cylinder boiler is to be proportioned for an evaporation of 500 lbs. of water per hour, at a pressure of 75 lbs., the temperature of the feed water being 80°. The equivalent evaporation will be 1·17 times 500, or 585 lbs., and the grate surface 585 divided by 75, or $7\frac{8}{10}$ square feet.

(*b*) To ascertain the heating surface in square feet: Multiply the grate surface by 11, for cylinder boilers; by 17, for flue boilers; by 30, for tubular, locomotive, and vertical boilers.

(*c*) To ascertain the cross section of flues or tubes in square feet: Multiply the grate surface by 0·134. This is an average value for good practice, and it can be varied between the limits of 0·125 and 0·143, as may be most convenient.

(*d*) To ascertain the length of boiler: Cylinder boilers should be from 10 to 12 times the diameter; flue boilers, from 5 to 6 times the diameter; tubular boilers, and shells of locomotive and vertical boilers, from 3 to $3\frac{1}{2}$ times the diameter.

There is very great variation from these figures in practice; but the numbers given above represent the most general limits, so far as they can conveniently be classified. There are some other proportions which are of interest, such as area over bridge wall, and size of chimney. These may be given in a future article treating of the setting of boilers.

B. To ascertain the quantity of water that must be evaporated to supply an engine of a given horse power:

[In determining this quantity, the computations are made for small engines, such as were considered in the article on "The Power of Small Engines," page 33 of our current volume; and in the use of the term "horse power," the effective power that can be exerted to produce useful work, and from which the power required to overcome the friction of the engine has been deducted, is to be understood.]

Multiply the number expressing the horse power of the given engine by the amount of water required per hour for one horse power, as given in the accompanying table:

Pressure of steam in boiler by gage.	Pounds of water per effective horse power per hour.	Pressure of steam in boiler by gage.	Pounds of water per effective horse power per hour.
10	118	60	75
15	111	70	71
20	105	80	68
25	100	90	65
30	93	100	63
40	84	120	61
50	79	150	58

The following example calls for the application of all the foregoing rules:

What are the dimensions of a tubular boiler for an engine that is to develop $4\frac{1}{2}$ horse power, with a steam pressure of 100 lbs., the temperature of the feed water being 160°?

The equivalent evaporation required per horse power per hour is 1·1 times 63, or $69\frac{3}{10}$ lbs. The total equivalent evaporation is $4\frac{1}{2}$ times $69\frac{3}{10}$, or about 312 lbs. Hence the grate surface, being the quotient arising from dividing 312 by 78, is 4 square feet. The heating surface is 30 times 4, or 120 square feet.

The cross section of the tubes should be about 0·536 square feet (4 times 0·134), or it should vary between the limits of 0·5 (4 times 0·125) and 0·572 (4 times 0·143) square feet.

SUSPENDED ANIMATION AS A PRESERVING AGENT.

Among the many experiments which have been made in order to discover some way of preserving fresh meat for an indefinite period of time, none have as yet been conducted, so far as we are aware, with the object of finding out how to keep the flesh other than in a dead state, to preserve, in other words, the living animal itself. A rather anomalous suggestion, the reader may say to himself, for will not the mere presence of life answer that end? Certainly, we reply, if the animal be fed and cared for, and that is not the question. The problem we set out with is: How can we box up an ox, for example, in the narrowest space, strike him into the hold of a vessel, pile other boxes of oxen on top of him like bales of goods, nail down the hatches, and transport our bovine cargo for a hundred days' voyage, and at the expiration of that time take out our animals, kill them, and proceed to eat them up?

In all original investigations, there is but one source for answers to our questions, and that is Mother Nature. What hints, then, will that venerable dame accord, which seem to bear on our subject, and through which at some time perhaps a clue may be found leading to a solution? Three: first, the power which some animals have of rendering their natural prey utterly insensible for an indefinite period; second, the peculiar effect of cold on some of the lower animals, which reduces them to a state not death, nor yet the ordinary torpidity caused by low temperature in other organisms; third, hibernation. We propose to consider, briefly, each in turn.

There abounds in this country a peculiar species of wasp known as the "digger." The male insect does no work, but the female does the double duty of bearing offspring and providing for its wants. She begins by boring a hole in a clay bank, in order to form a nest, and then sets out on a hunt for the peculiar spider or other insect which forms her natural prey. Pouncing upon her victim, she pricks it very gently with her formidable sting. No sooner is the wound made than the assailed insect falls paralyzed: even the great tarantula succumbs as quickly as the tiniest spider. Seizing the apparently inanimate body, the digger flies off to her nest, therein deposits it, and, renewing her hunt, captures victim after victim, until a sufficient supply is secured to feed one of her larvæ to maturity. Then she deposits her egg among the bodies, seals up the nest, sets to work on a new hole and a new hunt, and thus she continues until her stock of eggs is exhausted. In course of time the larvæ, soft white maggots, appear; but before they are ready to form cocoons, several weeks must elapse, during which time their nourishment must be fresh meat. It has doubtless already been divined how beautifully Nature provides for this want, for were the captured insects shut up in the nest dead, they would speedily putrefy and be unfit for their purpose. Kept alive, however, though inert and senseless, they remain in natural condition indefinitely, or until eaten by the maggot; and this is the effect of the digger's sting. The wasp administers a hypodermic injection of something—some virus, perhaps, which paralyzes the brain and its sensory ganglia, while the spinal system remains awake. Nature suggests to us a definite question to be put to her, through the chemist and physiologist, namely: What substance, injected hypodermically into the veins of an ox or sheep will reduce the animal to the state of the digger's prey? What will produce complete anæsthesia, to last as long as we choose, without causing death or injury?

To pass to the second hint: Dr. Grusselbake, Professor of Chemistry in the University of Upsala, Sweden, has succeeded, we are told by a foreign scientific contemporary, in so treating a little serpent, by cold, that the reptile, to all appearances, becomes dead, and as stiff and as rigid as stone. By rubbing it, however, with some stimulating substance, the reptile revives and becomes as lively as when captured over ten years ago. Now, this is not the effect of hibernation, for, as will be seen below, there is an entire absence of irritability—nor yet is it identical with the torpidity produced by cold. It is a state difficult to explain, and is the same as that of several species of fish which, if completely congealed, die; but yet, when frozen stiff, possess sufficient vital action in the circulatory organs to ensure their revivification when thawed in warm water. What the condition is remains to be seen; and such an examination would lead us to tue thought of whether there is not a point at which the higher animals may be brought to the same state. If there is, then can it be attained by the skillful use of chemical freezing mixtures in lieu of ice? Or, if an ox cannot thus be reduced, can he be rendered actually torpid by cold?

Lastly, we have to deal with the phenomenon of hibernation, or that peculiar lethargy into which certain animals fall, principally during winter. During this period no nutriment is required; the blood-making processes cease; respiration is very nearly or entirely suspended; the heart beats regularly, but the circulation is very slow; the blood, from the absence of respiration, is entirely venous. The muscular irritability of the left ventricle, highly increased, however, permits it to contract under the weak stimulus of the non-oxygenated blood: and it is this exaltation of a single vital property which preserves the animal life. Sensation and volition are quiescent. Respiration is, however, quickly excited by irritating the animal, and the call of hunger and the warmth of returning warm weather will cause a cessation of the lethargy. Hibernation is, however, not due to cold, since the tenrec, a nocturnal insectivorous mammal, passes three of the hottest months in the year in that condition; and the hedgehog, the dormouse, and the bat hibernate regularly every twenty-four hours. The influence of cold is due only to its tendency to produce sleep, to which state of the body hibernation is closely allied, differing only in degree. Most animals lay up a store of fat under the skin, which is slowly absorbed during the lethargy.

Whether it is open to discovery to find a way of making brutes hibernate, when that state is not peculiar to them, is a question difficult to consider in view of the little that is known regarding the trance condition in any organized being. It is a wise law of Nature which provides for the animal in seasons when its food is hard to obtain, or is absent altogether: and it is perhaps akin to that merciful interposition of insensibility which relieves the human being at instants of acute suffering.

Perhaps, some day, some one will find solutions to the questions suggested above. Perhaps we shall transport not merely living brutes, but living men. Imagine a military transport ship, with the soldiers stored in tiers with the beef and pork barrels. Perhaps Poe's sarcastic prediction, that the time will come when, sick of the turmoils and troubles of life in the nineteenth century, we will step across the street to our physician, and have our animation suspended, say for a hundred years or so, waking up in a new era, will, at some future period, be realized. There was a story once of an ancient German being found frozen in the snows of the arctic regions; and, on being thawed, his life returned. Another apocryphal yarn engendered the item in the papers that a live mastodon, preserved in the ice of Siberia since primeval days, had melted out and was roaming the wilderness of that country. Will these be realized? Edmond About's desiccated man with the broken ear, and Poe's revived mummy, are fancies absurd enough; but if we ever succeed in suspending sensation and volition at will in the animals next below us in the scale of creation, it is but a step to extend the same operation to ourselves.

SCIENTIFIC AND PRACTICAL INFORMATION.

BEES IN THE UNITED STATES.

The California *Agriculturist* says: There are two million bee hives in the United States. Every hive yields, on an average, a little over twenty-two pounds of honey. The average price at which honey is sold is twenty-five cents a pound; so that, after paying their own board, the bees present us with a revenue of $8,000,000. To reckon in another way, they make a clear gift of over a pound of pure honey to every man, woman, and child in the vast domain of the United States. Over twenty-three and one third million pounds of wax are made and given to us by these industrious workers. The keeping of bees is one of the most profitable investments that our people can make of their money. The profits arising on the sale of surplus honey average from fifty to two hundred per cent on the capital invested.

CEMENT FOR TEETH.

A recipe for a new kind of cement for plugging hollow teeth is published by Ostermeier, as follows: 7 parts burnt lime and 16 parts glacial phosphoric acid are mixed together and pressed into the cavity, which has already been carefully dried.

A PHOTOGRAPHIC DIAGNOSIS.

Dr. Ultzmann, teacher at the University of Vienna, lately read a paper before the Medical Society of Lower Austria, on the "Use of Photography in Medical Studies." He mentioned, on the authority of Dr. Vogel, that an eruption of small pox had been made evident by photography twenty-four hours before it actually came out. Although no one could as yet observe anything on the skin of the patient, the negative plate showed stains on the face which perfectly resembled the variolous exanthem, and twenty-four hours afterward the eruption became clearly evident.

THE California orange crop of last season, received at San Francisco, was the largest ever produced in the State and amounted to 5,280,000, principally grown in Los Angelos county. The annual requirements of the San Francisco market are over 10,000,000, of which 5,000,000 are imported from Tahiti and Mexico