

FAIRBAIRN ON STEAM BOILERS.

There is another question relating to the strength of boilers which requires careful attention, viz., the internal flues and their resistance to external uniform pressure. In calculating the strength of boilers the internal flues, until of late years, were never taken into account. They were always considered much stronger than the exterior shell, and that there was no danger from collapse. Yet, in the very face of these conclusions, numerous instances of fatal explosions occurred, not from the weakness of the boiler itself, but from collapse of the flues which, at a subsequent period, were found from actual experiment to be the weakest part of the construction.

From the first commencement of boiler construction to a very recent date we all of us acted under the impression that the flues were the strongest part of the boiler, and that a perfectly cylindrical tube, when subjected to a uniform pressure, converging upon its axis, was equal in its power of resistance, irrespective of its length. This was, however, an erroneous opinion, as I found, on submitting a series of cylindrical and elliptical tubes to external pressure, that they were weak, and in many cases, in long boilers, were only one-third or one-fourth the strength of the boiler. This anomalous condition of boiler construction will account for the numerous accidents that have occurred. It has now been remedied; and, by a very simple and inexpensive process, the flues may be strengthened to almost any degree of tenacity, by the simple introduction or attachment of T-iron hoops at certain distances in the length of the flues.

From these experiments, I found that the resistance of flues or tubes varies in the inverse ratio of their diameters; inversely as the lengths, and directly as a power of the thickness. Or it may be stated that the strengths decrease in the ratio of the increase of the diameters and the lengths, and increase nearly as the square of the thickness of the plates. The general formula for calculating the strength of wrought-iron tubes is, where

P = collapsing pressure in lbs.
 K = thickness of plate in inches.
 L = length of tube in feet.
 D = diameter in inches, we have

$$P = \frac{806,300 K^2}{L D}$$

or it may be calculated by logarithms, in which case it may be written—

$$\text{Log. } P = 1.5265 + 2.19 \text{ log. } 100 K - \text{log. } (L D).$$

To illustrate this remarkable law, if we take three flues perfectly similar in every respect, one 10, one 20, and the other 30 feet long, we shall find the first twice the strength of the second, and three times the strength of the third.

It will not be necessary to pursue this part of the subject further except only to direct attention to the following tables, which have been constructed from the experiments bearing directly upon the elastic force of steam, internally as relates to tension, and externally as relates to the collapse of the flues:—

TABLE SHOWING THE BURSTING AND SAFE WORKING PRESSURE OF BOILERS, AS DEDUCED FROM EXPERIMENT WITH A STRAIN OF 34,000 LBS. ON THE SQUARE INCH AS THE ULTIMATE STRENGTH OF RIVETED JOINTS.

Diameters of boilers.	Working pressure for 1/2-in. plates.	Bursting pressure for 1/2-in. plates.	Working pressure for 3/4-in. plates.	Bursting pressure for 3/4-in. plates.
ft. in.	lbs.	lbs.	lbs.	lbs.
3 0	118	708 1/2	157 1/2	914 1/2
3 3	109	653 1/2	145 1/2	871 1/2
3 6	101	60	134 1/2	809 1/2
3 9	94 1/2	550 1/2	125 1/2	755 1/2
4 0	89 1/2	531	118	708 1/2
4 3	83 1/2	501	111	660 1/2
4 6	78 1/2	472	104 1/2	622 1/2
4 9	74 1/2	447 1/2	99 1/2	596 1/2
5 0	70 1/2	425	94 1/2	566 1/2
5 3	66 1/2	403 1/2	89 1/2	539 1/2
5 6	63 1/2	380 1/2	84 1/2	515
5 9	60 1/2	359 1/2	82	492 1/2
6 0	59	340	78 1/2	472
6 3	54 1/2	326 1/2	75 1/2	451 1/2
6 6	51 1/2	314 1/2	72 1/2	436 1/2
6 9	50 1/2	303 1/2	70 1/2	419 1/2
7 0	48 1/2	293 1/2	67 1/2	404 1/2
7 3	47 1/2	283 1/2	65 1/2	390 1/2
7 6	46 1/2	274	63 1/2	377 1/2
7 9	45 1/2	265 1/2	61 1/2	365 1/2
8 0	44 1/2	257 1/2	59	354 1/2
8 3	42 1/2	250	57 1/2	343 1/2
8 6	41 1/2		55 1/2	333 1/2

Rule for 5/8th inch plates:—Divide 4250 by the diameter of the boiler in inches; the quotient is the

working pressure, being one-sixth the strength of the joints.

Rule for 1/2 in. plates:—Divide 5666.6 by the diameter of the boiler in inches, and the quotient will be the greatest pressure that the boiler should work at when new; that is, at one-sixth the actual strength of the punched iron.

The above table may be considered perfectly safe for the construction of boilers of good iron, to be worked at the pressure indicated in the second column; and the following table of equal strengths of cylindrical flues may also be relied upon for a collapsing pressure of 450 lbs. per square inch:—

TABLE OF EQUAL STRENGTHS IN THE CYLINDRICAL FLUES OF BOILERS, FROM 1 FOOT TO 4 FEET IN DIAMETER, AND FROM 10 FEET TO 30 FEET IN LENGTH, SHOWING THE REQUISITE THICKNESS OF METAL FOR A COLLAPSING PRESSURE OF 450 LBS. PER SQ. INCH.

Diameter flue in inches.	Collapsing pressure of flue in lbs. per square inch.	Thickness of plates in parts of an inch.		
		For a 10 ft. flue.	For a 20 ft. flue.	For a 30 ft. flue.
12	450	.291	.399	.480
18		.350	.450	.558
24		.399	.548	.659
30		.442	.607	.730
36		.480	.659	.794
42		.506	.707	.851
48		.538	.752	.905

[To be continued.]

THE CROPS—BI-MONTHLY REPORT OF THE AGRICULTURAL DEPARTMENT.

We have received from the Agricultural Department of the Government the "Bi-monthly Report for April and May," and find in it the first summary of the very extensive inquiries organized by the Department in relation to the condition of the crops throughout the country. A correspondence is opened with an intelligent resident of each county in every State, who reports the condition of the crops in his county as compared with the average of the ten previous years. If the crop is estimated at just the same as the average, he marks it 10; if it is one-tenth better he marks it 11; if it is one-tenth short he marks it 9. The clerks in the Department then calculate from the reports of the several counties the mean for the whole State, and these are published in the Bi-monthly Reports. They, of course, furnish a far more valuable estimate of the yield of various crops throughout the country than can be obtained from any other source. Had we room to spare we should publish the tables in full, but as it is we can give only the summary of the Commissioner.

FRUIT CROPS.

"The tables exhibit the general condition of the fruit and grain crops on the first of June. As was to have been expected from the character of the winter, this condition presents two general differences—in the East all crops promise abundantly, but in the West the fruits and fall-sown grain crops have been much injured by the intense severity of the cold at the close of the year 1863 and the cold of February, when there was but little snow on the ground, in nearly all localities. We will briefly notice each of the crops referred to in the tables.

"Apples.—In the Eastern and Middle States the crop will be a good one, but still there are localities where the wet weather caused the fruit to fall off. In the West a general complaint is made by our correspondents of this falling-off; and although the amount of the bloom indicates sufficient for an excellent crop, yet an injury which destroys a fourth of the fruit buds so as to prevent their blooming, is usually fatal to the setting of the rest.

"Peaches.—This crop is in good condition in the Eastern States; in the Western it is destroyed, with a large number of the trees, mostly the old ones. Canning peaches may therefore be looked upon as profitable to those having them during the next fall.

"Pears.—The pear has not yet reached a point in its cultivation when it may be regarded as a general market crop, but its hardiness has recommended it to every section of the country, and it is rapidly becoming more than a simple garden product. Like all other fruit crops, it is good in the East; in the West severely injured.

"Grapes.—The column asking which variety was most injured, and which the least, has been left blank, for the answers require a more careful arrangement

than could be shown in the table. The returns connect themselves with many letters accompanying them; hence they will not be given until in our next report.

"Maple Sugar and Molasses.—It is gratifying to see the great increase in this manufacture. It will serve to keep down prices of the imported, as well as the amount of their importation. Should the crop of sorghum be favored with a good season, the country will supply its own wants and those of the smaller towns. The quality of the maple sugar is spoken of as good.

GRAIN CROPS.

"Winter Wheat.—The figures given in all the tables do not directly express the amount of the injuries. Thus 8 denotes an injury of two-tenths, and not eight-tenths, for the starting point in all estimates of an increase or decrease is at 10; thus 11 means an increase of one-tenth, and 9 a decrease of one-tenth.

"It will be seen that the winter wheat is in general good condition in the Eastern States, but in New York it is frozen out three-tenths, or thirty per cent., in Pennsylvania three and a half-tenths, in Maryland two and one-third tenths, in Kentucky and Ohio four-tenths, and in the rest of the Western States from three to three and a half tenths. This will lessen the wheat crop at least thirty per cent. from the yield of last year.

"The general growing condition is good; in some northern localities drought prevails, which reduces it below a general average in several of the States.

"Drill and Broadcast Sowing.—There is a marked difference in the loss by freezing between the drilled and broadcast sown. The cause of the injury varied in different localities; in many it was by upheaval, in others the roots were killed by exposure to intense cold without any protection, and in others by being covered with water, which froze so intensely as to destroy the roots of the wheat. The most marked difference in favor of drill-sowing was in the first of these causes. But these returns, too, so connect themselves with the information communicated by letter, that we reserve further comment until the next report.

"Spring Wheat.—This crop is looking unusually well, but it will be seen from the table that an average amount is not sown. The lateness of the spring and the great scarcity of labor prevented; but it is so nearly an average crop that, with no further drawback upon it, it will be excellent.

"Barley.—This is one of the most favorable crops, both in amount and its growing condition. It is above an average in both, and not a single complaint has been made about it.

"Corn.—The lateness of the spring retarded the planting of this crop, but the subsequent favorable weather brought it forward rapidly. In some northern localities it had to be replanted where put in early, but generally the crop never came up more favorably. The only State which returns a much lessened planting is Missouri, showing the effects of the war. In many places there are neither laborers nor fencing. In some States, as Wisconsin and Minnesota, the crop is not in good growing condition. This is occasioned by drought; but generally our correspondents speak in most satisfactory terms of the prospect when their returns were made on the first of June.

"Oats.—A few words suffice for this crop. It was never as good as now, either in amount or growing condition.

"Clover.—This crop is highly favorable, both for pasture and hay.

"Sheep.—The condition and increase of these continue as heretofore reported, and the wool crop will be excellent. The next report will show the amount of wool clipped, and whatever else in our foreign imports and domestic consumption that will be of interest to the farmer.

"Weather.—The table exhibits a large proportion of 'wet weeks.' It was this state that so much favored the crops, especially of the fall-sown kinds.

"Since the foregoing was prepared for press, personal observation, and numerous reports from others, enable us to say that the hay crop of Pennsylvania, Delaware, Maryland, and probably all the Eastern States, has seldom, if ever, been excelled in quantity and quality, and is being secured in the best condition. The crops of wheat, oats and corn, in the same sections, are also as promising as ever seen at this season."