lins' steamers; because if there is "no difficulty" in giving their paddle wheels an increased number of revolutions in the ratio of 31 to 50: then, as the Pacific has already accomplished the trip in 9 days 20 hours, she of course can do it in $\frac{9.83 \times 31}{50} = 6.1$ days. It is scarcely necessary to say that the difficulty in the way of speed exists precisely in this point; the number of revolutions can *not* be increased ad libitum.

But there is another remark which calls for notice. Mr. N., to demonstrate that slip is not loss of effect, says, after calculating what would be the vessel's speed if there were no slip, that, "as there is no slip in the water, the propeller is of no use for propelling the vessel; it can as well be taken off, and the remainder will be 375.92 horse power from the steam engine, which will drive the vessel 15 miles an hour with no propeller !!!"

Admitting the principle involved in this declaration, it is equally clear that wheels are entirely unnecessary to the functions of a locomotive engine, because in that case there is no slip, and consequently the wheels may be taken off, and the remainder will be the whole effective power of the engine, which will drive the locomotive at — miles per hour, *without wheels.*

Is it necessary to remind Mr. N., that "slip" is nothing more than recession of the fulcrum against which the paddle or propeller blade acts? and that therefore the loss involved in it, is a loss of space passed over in a given time; hence a loss of velocity; and therefore that it is what is commonly called "loss of effect," or more correctly speaking, loss of useful effect.

This article has already so far transcended the limits within which I had proposed to retain it, that for the demonstration of the above stated principle, I must appeal to the reflection of Mr. Nystrom, and of those (if any) who, persuaded by his denial, may have allowed themselves for a moment to doubt the truth of a theory so well established.

For the Journal of the Franklin Institute.

Practical Rule for finding the Thickness of Cast Iron Water Pipes. By

JOHN C. TRAUTWINE, *Civ. Eng.*

Books afford to practical men no guide by which to determine the thickness of cast iron pipes for resisting the pressures of different heads of water. Most authors who allude to the subject, content themselves with merely giving theoretical rules, which are well known to furnish results entirely too low for use in practice.

Thus, Barlow's Rule gives, for a 16-inch pipe to support a head of 100 feet, a thickness of but $\frac{1}{16}$ th part of an inch, or about twice that of a sheet of ordinary letter paper.

Other writers, again, give the results of some very incomplete experiments, altogether too limited in number to serve as general data; while others either pass over the subject in silence, or at most, with an intimation that it admits of no specific instructions.

The fact that the theoretical thicknesses are so entirely insufficient for

practice, appears to have deterred scientific men from a more thorough investigation of the cause; and practical ones have, in consequence, been compelled to adopt such limited results of experience as they could chance to obtain, taking care generally to err on the safe side. In some instances, this precaution has been attended with useless expenditures of heavy sums of money.

The principles involved in the investigation of this subject, although presenting difficulties to a scientific solution, admit, as I conceive, of a simple and sufficiently satisfactory one in practice.

Mr. Barlow, in giving his Rule, (see the Transactions of the Institution of Civil Engineers,) assumed the *safe* cohesive strength of cast iron at 18,000 pounds per square inch; but Hodgkinson has since conclusively shown by numerous experiments, that it is not safe to employ more than 15,000 pounds per square inch as the *ultimate* cohesive strength of ordinary cast iron. This being the case, I have assumed 5000 pounds per square inch as the *safe* limit for water pipes, abstractedly considered; and modifying Barlow's Rule in this particular only, have prepared the following table. But it will be evident to any one practically conversant with the subject, that even the thicknesses given by the table are not sufficiently great for actual use, and the question arises, why are they not so? The answer appears to be simply this—that in the smaller pipes a greater thickness is necessary to ensure safety from breaking while being transported, handled, and laid; and that, in both small and large ones, it is extremely difficult to cast them of the proper lengths, and at the same time of an *uniform thickness*, and without more or less imperfection from air bubbles, &c. Consequently an excess becomes necessary, in order to counteract these sources of weakness. Moreover, after the pipes are laid, the soil below them may settle unequally, and a greater or less length of pipe may thus become a kind of tubular girder, sustaining the mass of earth which rests upon its upper side.

From a careful examination of a great number of instances collected from various sources, I conceive that I am warranted in asserting that the additional thickness required to guard against irregularities in the casting, will at the same time suffice for security in handling, and for as great a resistance to fracture, from unequal settlement, as we shall find it expedient to aim at in ordinary practice. Any attempt to obviate the last difficulty *entirely*, would in many cases be attended with an expense so great as to restrict the use of water pipes within very narrow limits. It is generally advisable, therefore, not to make the attempt, but to submit to the *comparatively* trifling inconvenience of those occasional fractures which almost invariably attend the execution of extensive systems of water pipes.

Water pipes of the usual length of about 9 feet, cannot well be cast of a less thickness than $\frac{3}{8}$ -in., and in very large pipes, $\frac{5}{8}$ -in. is not too great an excess over the calculated thickness, to allow for irregularities and defects in the castings. Therefore, I will venture to offer the following as a practical rule for the thickness of cast iron pipes, to sustain safely different heads of water under ordinary circumstances, viz:

To the thicknesses given in the following table, add $\frac{3}{8}$ -in. for all pipes under 12 inches diameter; $\frac{1}{2}$ -in. for those of from 12 to 30 inches; and $\frac{5}{8}$ -in.

for those of from 30 to 48 inches diameter. Or, if it should be considered expedient to allow something for rusting, add respectively, $\frac{1}{2}$, $\frac{5}{8}$, and $\frac{3}{4}$ -in., instead of $\frac{2}{3}$, $\frac{1}{2}$, and $\frac{5}{8}$ -in.

Inner diameter or bore of Pipe in inches.	HEAD OF WATER IN FEET.															
	100	150	200	250	300	400	500	600	800	1000	1200	1400	1600	2000	2500	3000
	Pressure of Water against sides of Pipe, in pounds per square inch.															
	43.4	65.1	87	109	130	174	217	260	347	434	521	608	694	868	1085	1302
Thickness of Pipe in inches.																
2	.009	.013	.018	.022	.027	.036	.045	.055	.075	.095	.116	.139	.161	.210	.277	.352
3	.013	.020	.026	.033	.040	.054	.068	.082	.112	.143	.173	.207	.242	.315	.417	.530
4	.017	.026	.035	.045	.053	.072	.090	.110	.149	.191	.232	.278	.322	.420	.555	.704
5	.022	.033	.044	.056	.067	.090	.113	.137	.186	.237	.290	.347	.402	.525	.695	.880
6	.026	.040	.053	.067	.080	.108	.136	.165	.224	.287	.347	.415	.485	.630	.835	1.06
7	.030	.046	.062	.078	.093	.126	.159	.193	.261	.333	.406	.485	.565	.735	.970	1.23
8	.034	.053	.071	.089	.107	.144	.181	.220	.298	.382	.465	.556	.644	.840	1.11	1.41
9	.039	.059	.079	.101	.120	.163	.205	.247	.335	.427	.520	.622	.724	.945	1.25	1.58
10	.044	.066	.089	.112	.134	.181	.227	.275	.373	.475	.580	.695	.805	1.05	1.39	1.76
12	.053	.080	.106	.134	.161	.217	.273	.330	.448	.575	.695	.830	.970	1.26	1.67	2.12
14	.061	.093	.124	.156	.187	.253	.318	.387	.523	.666	.813	.970	1.13	1.47	1.94	2.47
16	.069	.106	.142	.178	.214	.288	.363	.440	.596	.763	.930	1.11	1.29	1.68	2.22	2.82
18	.078	.120	.159	.201	.242	.326	.409	.495	.670	.850	1.04	1.24	1.45	1.89	2.50	3.18
20	.088	.132	.177	.223	.267	.361	.454	.549	.746	.950	1.16	1.39	1.61	2.10	2.77	3.52
24	.105	.159	.213	.268	.321	.433	.545	.660	.895	1.15	1.39	1.66	1.94	2.52	3.33	4.23
30	.122	.198	.267	.336	.402	.543	.681	.825	1.12	1.42	1.74	2.08	2.41	3.15	4.17	5.28
36	.156	.238	.318	.402	.483	.651	.819	.990	1.34	1.71	2.08	2.49	2.91	3.78	5.01	6.36
42	.184	.279	.372	.469	.562	.759	.955	1.16	1.57	2.00	2.44	2.91	3.39	4.41	5.83	7.42
48	.210	.317	.425	.535	.641	.866	1.09	1.32	1.79	2.29	2.79	3.32	3.87	5.04	6.65	8.45

Barlow's Rule.—Multiply the pressure against the inner diameter of the pipe in pounds per square inch, by half the inner diameter in inches, and divide the product by the difference between the cohesion of the metal per square inch, (assumed in the above table at 5000 lbs.), and the pressure in pounds per square inch. The quotient will be the required thickness in inches.

Seasoning Timber. By SAMUEL CLEGG, JR.*

Seasoning timber is the extraction of all the vegetable juices and moisture from the woody fibre, leaving it perfectly dry and free from the effects of that unequal expansion and contraction of moisture between the fibres which causes timber to warp, twist, and crack. Seasoning is effected by natural and artificial means.

Timber loses both in dimensions and weight by seasoning, as shown in the following table of experiments, instituted in order to ascertain the weight of a cubic foot of different kinds of wood,—the foreign when first imported, those of the growth of England when felled, also the weight of each when fully seasoned, showing at the same time the loss sustained in dimensions during the process of seasoning.

* From the London Architect, for September, 1851.