A NEW FORM OF CUPOLA FURNACE.*

By JAMES RILEY.

THE cupola furnace which I have to submit to the members of the Institute is the outcome of an earnest desire to shorten the duration of the operations necessary in making open hearth steel. These operations may be divided as follows, taking for illustration a charge of soft steel of 12 tons (say nine tons pig iron with three tons steel scrap, and working with ore): Charging, one hour; melting, three to four hours; boiling and finishing, six hours; repairing furnace, about half an hour.

Looking at these operations with a view to reduction of cost, one naturally asks, Can you not shorten the time occupied in charging, and reduce its cost in labor by substituting machinery for manual labor? I know that others besides myself have given a good deal of thought to this matter, but probably with the same result—that no contrivance yet hit upon for charging solid materials is cheaper than manual labor. But if our considerations turn in the direction of charging fluid metal, it will be at once apparent that this can be done in a very small fraction of the time now taken up, and with the very important advantage that we avoid the cooling down of the furnace due to the long operation and to the furnace doors being open the while. By these means we would have a gain of nearly 10 per cent. of time—equal to one charge more per week—as well as a considerable saving in fuel and repairs. Arrived at this point, it seems natural that we should look for an additional and a much greater saving than that just mentioned; for surely by charging fluid metal we must save the three or four hours usually occupied in melting? Under this conviction, or with a view of determining whether this assumption were correct, Mr. Hackney many years ago tried at Landor the experiment of premelting the pig iron in cupola, whence the fluid charge was readily and quickly transferred to the melting furnaces. He has somewhere published the result, which was an almost inappreciable reduction of the time usually taken up in working the solid charge. At the instance, and to satisfy the Directors of the Steel Company of Scotland, immediately after I came to Glasgow I had two melting furnaces worked for a week with fluid charges obtained by pre-melting the pig iron in the foundry cupola. In estimating the result, we concluded that there was a doubt-

through the nozzles inserted in the sides of the furnace hearth, as shown.

The cupola is of ordinary foundry type, of nearly equal dimensions from the bottom to the charging hole, which is at about the usual height from the hearth. It is in two parts, the lower being removable, and the upper supported on pillars as shown. The hearth has a slight downward inclination to allow of the molten metal flowing readily into the furnace body. The hearth of the cupola is arranged so that it can be easily removed for repair, and another substituted, when necessary.

This hearth-piece and the furnace-body may be lined with either basic or acid material, as may be most suitable to the pig iron, etc., being melted and treated; for, besides melting, we are of opinion that with a basic lining and necessary mixtures and arrangements, we shall be able to remove the phosphorus in the hearth of the furnace. If we can accomplish this, then we shall be able to melt common iron in the basic-lined cupola, remove the phosphorus, and afterward finish the charge in the acid-lined open-hearth furnaces. With the permission of my directors, Mr. Dick, manager of the Blochairn Works, made a tentative experiment with a kind of improvised furnace and gas-generator, very similar to 1, conjoined to a small foundry cupola. The furnace having been heated, pig iron was charged into the cupola through the ordinary charging hole—about 12 ft. about the hearth—tumbling it in upon the hearth, and filling up to near the charging level. The blast was then turned on from the Roots' blower, ordinarily used for blowing the cupola, and after about two hours' blowing we had the satisfaction of seeing the metal begin to melt and run down into the hearth, whence it was shortly afterward tapped into the ordinary foundry ladle and run into castings. The experiment was continued long enough to indicate a few weak points in our apparatus, and also to remove some lingering doubts of the possibility of success. One or two short trials having been made, I was anxious to make a more lengthened one—long enough, in fact, to furnish reliable data for action upon a large scale. Accordingly we heated up the furnace on Monday, put on blast on Tuesday morning, and worked almost without intermission night and day until the following Saturday. After some days' work in melting pig iron, finding that everything was satisfactory, and that we had a very high temperature in the furnace, I determined to try to melt the steel

A NEW FORM OF CUPOLA FURNACE.

ful gain of a quarter of an hour per charge, obtained at the expense of the coke and labor expended at the cupola. The explanation of the discrepancy between the expected and the actual result is known to many, but may, nevertheless, be briefly stated. During the melting of a charge in an open hearth furnace a large proportion of the silicon and carbon are removed, leaving little more than half the carbon to eliminate in the subsequent operations.

Now, in the case of the fluid charge, which has been pre-melted with coke in the cupola, these changes have not taken place, and the time required to remove the impurities from the fluid metal, after being charged in the open hearth furnace, is almost as long as that required to melt and purify the solid charge.

Long ago it occurred to me that if I could substitute gaseous for solid fuel in melting in the cupola, I might be able to alter the conditions and accomplish the much desired end. About 18 months ago I determined to try if this could not be done, and accordingly got out designs for a cupola, which, however, seemed unsatisfactory in one or two parts.

Some time later I discussed the matter with my friend, Mr. Crossley, with the result that we modified the designs to pretty much what I now submit to you. The diagrams before you show two types of the cupola furnace, similar in principle, although differing in form. In the Fig., the fireplace or gas generator and the furnace body are of a rectangular form in plan. In the other form the furnace is circular in plan, with a gas generator, also of circular horizontal section.

In both cases the gas generator has a closed grate, and is dependent upon forced blast—obtained from an ordinary blower—for supporting combustion in the production of gas from the coal, which is charged in at the top in the customary manner.

In like manner the air for supporting combustion in the body of the furnace is obtained from the blower, and in the case of No. 1 is passed through the pipes or nozzles placed transversely across the body of the furnace, almost directly over the bridge which divides the generator and furnace. These pipes are inclined so as to direct the flame down upon the bath of metal held in the hearth of the furnace. In this design the air for combustion is heated in the passages in the back wall of the generator, through which it is sent to the nozzles above referred to. In No. 2 the air for combustion passes twice round the hearth of the generator, in the pipes shown in the figure, thence to the crown of the furnace body, whence—being thoroughly heated—it emerges by the air port directly over the gas port leading into the furnace and to the cupola; and in addition we can, if desired, turn this heated blast

scrap which would ordinarily be charged into the steel furnace. Commencing with the addition of 10 per cent. of scrap, the proportions of pig and scrap were very gradually changed, until, at the termination of our experiment, we were melting charges in which the proportions were six of steel scrap to one of pig iron.

Our operations were stopped by the failure of the furnace lining, which, being only ordi- rily good fire-brick, could not successfully resist the high temperature to which it was exposed.

At the earlier stages of the experiment, when melting pig iron alone, as much as possible was made into castings, which were very satisfactory, being tough and clean. Analysis showed that we had removed one per cent. of the silicon, and one-half per cent. of the carbon. Subsequently, by admitting more air into the furnace, and when melting steel scrap, the silicon was reduced to 0.29%, and the carbon to 1.0 per cent; so that we may conclude that, when the fluid metal can be charged into the open hearth furnace, the time required for its conversion into mild steel will be very greatly shortened. As these trials were made at a considerable distance from the steel melting furnaces, and we were unable to transfer the metal from the cupola to the latter, I am not in a position to support this opinion by facts, but we are so satisfied on the point that we are now erecting a large cupola furnace near to the steel melting furnace, and I hope very shortly to have it in full operation. In the small experimental trials we melted at the rate of close on two tons per hour; in the large one we expect to put through double this quantity, or sufficient to supply four twelve ton melting furnaces as at present charged; but as we expect to save about half the time of the operations in the latter, and that two furnaces will thus require the same weight of charge as is now taken by four, our cupola is placed midway between two of them, and at such an elevation that when it is tapped the metal shall flow directly into either of the melting furnaces.

The cupola is being erected to the circular designs. The pig and scrap will be placed direct from the wagons on to the charging-carriage at the foot of the incline, up which it will be raised and tipped into the charging-hole. The charging apparatus is one which was designed by Messrs. Westray and Copeland, of Barrow, and has been in use at their works for several years. We are erecting a gas-generator in connection with the cupola for two reasons: first, because we have no surplus supply of gas available at the works; and next, because I am not sure that we should obtain as satisfactory results when using cold gas from our mains as when it is passed hot from the generator direct into the furnace.

On the important point of consumption of fuel in melting, we were abundantly satisfied, for the coal

charged into the generator during the about nine shifts' work only averaged 1.44 cwt. to the ton of metal charged into the cupola, thus surpassing the most economical cupola working which has come under our notice. On the results we obtained, we think we are justified in believing that, beside its adaptability to the end I had in view in commencing these trials, this furnace is also extremely well fitted for extensive iron-foundry practice, where continuous melting is required, and also, and more especially, to Bessemer steel works, where fluid metal is not available; and in this connection I may state that, as the flame can be made to a large extent oxidizing or reducing at will, the composition of the metal need not be changed during melting, the silicon, etc., necessary in the Bessemer operation remaining therefore untouched.

RAILWAY FUEL ECONOMY.

By FRANK C. SMITH.

ONE of the largest fields for the reduction of expenses on a road is in the coal consumed by the engines. This item alone is from 11 to 15 per cent. of the total expenses of a road, dependent on the accessibility of coal mines and the care and manner with which coal is used. It is the practice of too many roads to allow all record pertaining to the coal account to disappear after it is purchased and delivered to the locomotive department, where too often engineers take much or little, use it carefully or wastefully, as they see fit. It has been well said that a road might as well furnish each engineer with money to buy his coal with, and keep no individual account of the money, but make one grand charge of it to "coal account," as to follow the practice so many of them do.

A great many roads store their coal on docks, fitted with cranes for lifting half ton buckets for delivery to engines, the engineers giving a check for the amount of coal received; and so far as this is concerned, no fault can be found. But the fault commences in keeping account of the coal, and in the abuses of the premium system. When roads pay the engineers a premium—generally half the value of the coal he saves over a given limit per car mile—it is too frequently the case that engineers bribe the dockmen with a quarter of a dollar to put an extra ton on their tenders, which, as an investment, is profitable to the engineer, since if coal be worth, say, two dollars per ton, the engineer gets credit for saving a ton, which means one dollar less what he gives as a bribe to the dockmen, and this is clear gain to the engineer. Such "rings" as this are much more common than is believed, inasmuch as the dockmen are the cheapest class of laborers, whose only duty is to shovel coal and receive the checks for it, and a small bribe makes a very effective lever with them. As the coal account is never balanced, that is, the amount of coal left on the dock weighed at stated times and added to the amount charged out to the engines, to ascertain if it tallies with the amount dumped on the dock from the cars, no trace of the extra tons surreptitiously given out is to be found.

Injustice, unintentionally, is done the engineers, where their record for premiums or good standing is based on the number of cars hauled a given distance for a given amount of coal, from the fact that few roads have a correct rating for the real amount of coal consumed in hauling mixed trains of light and loaded cars. That is, one road may guess that two light cars are equal to one loaded car; another, that five light cars equal three loaded cars; another, that seven light cars equal three or four loaded cars. As this is all guess-work, the engineer who happens to haul trains in which the error, whichever way it may be, of this guess predominates, suffers. However, it is said that this is as fair for one engineer as another, and possibly it is, but it is evident that the injustice still remains.

In this connection may be mentioned the fact that few or no roads separate the coal consumed into engine and car miles. That is, the engine itself requires a certain amount of coal to propel it, and unless this amount is known and separated from the car miles, it all goes in to swell the amount consumed per car mile. Now it is clear that as this amount remains constant, the amount per car will be greater as the number of cars are less, and less as the number of cars are increased, so that when business is good on the road, the engineer apparently is burning less coal per car mile, and when business is light, the showing is against him.

To get at anything like a fair and equitable arrangement as well as a profitable one for the road, the coal business should commence from the bottom. A road in buying coal should test it practically by taking a train with engine, loading the tender with a known amount of a certain kind of coal, running the train under conditions of speed, stop, etc., which are recorded, and ascertain how far or how much coal is consumed per car mile; then with the same train and engine under the same conditions test another kind of coal, and in this way ascertain which is the cheapest coal to use.

The coal business, down to the time it is delivered to the engines, might well be placed in the hands of a coal agent, who is independent of the locomotive department, in order that the results may be disinterested, as many master mechanics have a prejudice for or against engines of their own or other builds, and such prejudices are apt to shade the results of their performance. By this means the relative value of different types of engines may be determined, and the bad record of a "pet" engine or class of engines brought to the surface.

Some system which keeps a constant pressure on each engineer to do better should be adopted. The premium system acts upon an engineer's avarice, and appears to give the best results; another system—that of "black-listing" or posting up in the round house the names of engineers who burn over a given limit of coal—is supposed to act on the engineer's pride; while the system of suspending an engineer who exceeds the limit for two or more consecutive months acts on his fear and indirectly his avarice, as it stops his pay for the time being.

In order to get a proper rating, the fuel consumed to run the engine alone should be ascertained, and then the amount to haul a loaded and a light car. This can be easily ascertained, and by so doing the exact amount per car, whether loaded or light, and independent of the amount to propel the engine can be charged against the engine. This should be ascertained for winter and

*Paper read before the Iron and Steel Institute.

summer, as it is plain that the amount will increase in winter, when the losses from radiation of heat, slipping of engine, and greater friction of car-journals from stiffened oil will require more power and consequently more fuel.

It will be charged by practical men that such a system would involve a great deal of clerical labor, which is not true, as the practical man for want of experience in the keeping of accounts is afraid of them, and exaggerates the matter. Any road with officials at the head of its locomotive department who understand the importance of the saving which can be effected by a proper course in the matter can, by changing their present plan to one based on this system, effect the result with no increase of clerical work; for the plan is not more complicated than many unsatisfactory ones in use, and it does not involve complication or increase of labor, but simply a correct systemization of accounts, and it would therefore in many cases decrease the clerical labor, and in no case augment it. The saving which may be expected to result will vary from 10 to 15 per cent. As an example of this, the writer may cite a case in his personal knowledge in which seven passenger engines of the same build, size, and condition are pulling indiscriminately—that is, “first in first out”—the through passenger trains of a certain road. Two of these engines average five tons of coal for a round trip, while the other five use from that amount up to nine tons. The difference is not in the engines but in the men, for either of the two men using five tons has done the same with each of the other five engines, and the two engineers using but five tons admit they could save from one-half to three-quarters of a ton if they tried hard to do so. This road has no system at all for reducing the coal consumption, and the want of it is seen from this statement. As the road referred to is a large road of several divisions, these results may be taken as a sample of what the rest of the engines are doing. The road has some three hundred engines, and taking the performance of these seven engines as a standard, it will be seen that they average about three tons of coal each unnecessarily burned per day, for a service of three hundred days per year. The result is astonishing, since the coal is worth \$2 per ton on the tender, and the product of the whole gives \$540,000 as the value of the coal unnecessarily burned. But even if this estimate be five times too large, the waste still amounts to over \$100,000 per year; a sum any road might well save. It is, perhaps, unnecessary to add that the road referred to is in the hands of a receiver.—*American Railroad Journal*.

[Continued from SUPPLEMENT, No. 512, page 8173.]

THE PRESERVATION OF TIMBER.*

REPORT OF THE COMMITTEE OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS ON THE PRESERVATION OF TIMBER, PRESENTED AND ACCEPTED AT THE ANNUAL CONVENTION, JUNE 25, 1885.

BURNETTIZING.

THE original mode of application employed in burnettizing was by steeping the timber in a solution of chloride of zinc, in the proportion of one pound to every four gallons of water. This was found exceedingly tedious, and somewhat ineffective, and Sir Joseph Burnett subsequently adopted Bethell's process (as applied to creosote, of placing the timber in a closed iron cylinder, forming a partial vacuum, to extract the sap, air, and water as far as practicable, and then forcing in the preserving liquid under pressure. The process has since been improved by using steam in the preparatory stage in the cylinder, in order the better to open the pores of the wood to receive the antiseptic, as well as by several devices which will hereafter be described, to prevent the chloride of zinc, which is a very deliquescent salt, from washing out when exposed to moisture.

It is probable that some of the failures which will be described are attributable to the early imperfections in Bethell's mode of application.

On this page is a table of the experiments of which the committee has been able to obtain record.

COMMENTS ON BURNETTIZING.

Burnettizing seems to have been first introduced in this country at Lowell, Mass., in 1850, as stated in the letter of Mr. Francis (Appendix No. 2). It was there worked by the Bethell process till about 1862, when it was abandoned to return to kyanizing, the latter being thought more effective for bridge and building timber.

In 1855 the Union (horse) Railroad of Cambridge, Mass., was laid with spruce stringers and sleepers, burnettized at Bangor, Me. The stringers are now (1883) all worn out, but Mr. K. C. Chaffee, the president, writes that “many, and I think the majority, of the sleepers are in good condition to-day,” that is to say, after twenty-eight years' exposure.

The experiment seems to have been given up because subsequent lots prepared by contract turned out badly. Mr. Chaffee writes:

“I became satisfied that it could not be got well done (by the contractors). It is of no benefit unless done while the timber is perfectly green, and then well done.”

Indeed, it may be said once for all that success in timber preservation, by whatever method, depends upon the thoroughness with which the work is done, and that no economy is so false as that which seeks to scrimp the legitimate cost.

In 1856 (experiment No. 3) the Vermont Central Railroad erected burnettizing works, and prepared large quantities of timber and ties. Some of the latter were found to be nearly sound in 1880, as stated in the letter of Mr. J. W. Hobart, General Superintendent, given herewith in Appendix No. 4.

The process seems to have been given up after four years' use, in consequence of the delays and annoyances involved in treating such large quantities of timber as are used on a railroad, only to find out after a lapse of twenty-five years what a great success it had been.

Experiments Nos. 4, 5, and 6 show that some spruce plank and track stringers, burnettized in 1857, and laid on a wharf in Boston, and on some horse railroad, were yet sound when examined in 1872, or some fifteen years afterward. We have not been able to trace their subsequent history.

* From the Transactions of the Society.

RECORD OF SOME AMERICAN EXPERIMENTS.

BURNETTIZING, Impregnating with Chloride of Zinc under Pressure.

No.	LOCALITY.	Year.	Process.	Material Treated.	Subsequent Exposure.	Results.	Authority.
1	Lowell Canal Company.	1850	Bethell.	Various.	Canal work.	Unfavorable.	J. B. Francis.
2	Cambridge Railroad.	1855	“	Spruce ties.	Railroad track.	Favorable.	K. S. Chaffee.
3	Vermont Central Railroad.	1856	“	Hemlock ties.	“	Success, 1882.	J. W. Hobart.
4	Boston Wharf.	1857	“	Spruce plank.	Wharf.	Sound to 1872.	C. Page & Co.
5	Middlesex Railroad.	1857	“	“ stringers.	Horse railroad.	“	C. W. Palmer.
6	South Boston Railroad.	1857	“	“	“	“	R. Johnson.
7	Boston and Albany Railroad.	1860	“	ties	Bridge floor.	Favorable.	E. S. Philbrick.
8	Chicago, Rock Island, and Pacific R.R.	1860	“	Timber.	Howe truss.	Success, 1882.	Hugh Riddle.
9	Erie Railway.	1861	“	“	Bridges.	Unfavorable.	W. B. Coffin.
10	Ohio and Mississippi Railroad.	1862	“	“	“	Doubtful.	T. S. Sedgwick.
11	Philadelphia, Wilmington, and Delaware Railroad.	1863	“	Ties.	Railroad track.	Abandoned.	I. Minckley.
12	Chicago, Rock Island, and Pacific R.R.	1866	“	“	“	Success.	M. Alexander.
13	Mare de Grace.	1866	“	Timber.	Bridge.	Strength injured.	E. Larkin.
14	Philadelphia and Reading Railroad.	1867	“	Ties.	Railroad track.	Hard and brittle.	W. Lorenz.
15	Lehigh and Susquehanna Railroad.	1867	“	“	“	Success, 1882.	L. L. Buck.
16	Union Pacific Railroad.	1868	“	Cottonwood.	“	Abandoned.	L. S. Bent.
17	Long Island Railroad.	1868	“	Stringers.	Pile Bridge.	Failure.	F. S. Gannon.
18	Philadelphia Railroad.	1868	“	“	Horse railroad.	Unknown.	G. S. Gandy.
19	Washington.	1872	“	Spruce.	Pavement.	Failure.	J. A. Partridge.
20	“	1872	“	“	Laboratory.	Zinc washed out.	W. C. Tilden.
21	St. Louis Bridge.	1879	Wellhouse.	Gum blocks.	Pavement.	Favorable, 1883.	C. S. Smith.
22	“	1879	“	Pine stringers.	Bridges.	“	C. S. Smith.
23	St. Louis, Iron Mountain and Southern Railroad.	1879	“	Ties.	Railroad track.	“	H. Constable.
24	Illinois and St. Louis Railroad.	1880	“	“	“	“	C. H. Sharman.
25	Atchison, Topeka, and Santa Fe R.R.	1881	“	“	“	“	A. A. Robinson.
26	St. Louis.	1879	“	Gum blocks.	Pavements.	“	H. Constable.
27	Norfolk, Va.	1880	Thilmany.	Pine piles.	Teredo.	Failure.	P. G. Asserson.
28	Chicago and Alton Railroad.	1880	“	Ties.	Railroad track.	Too recent.	W. F. Merrill.
29	Erie Railway.	1882	“	“	“	“	O. Chanute.
30	St. Louis.	1883	Zinc Gypsum.	“	“	“	T. Plate.

In 1860 (experiment No. 8) the Chicago, Rock Island, and Pacific Railroad built a Howe truss bridge of 8 spans of 150 feet each, which was still in use and in fair condition in 1882, as stated in the letter of Mr. Hugh Riddle, its president, published in our Preliminary Report.

In 1860 some burnettized spruce ties were placed in the floor of an iron bridge built by the Boston and Albany Railroad, in the city of Boston. They lasted nine years, and were replaced by untreated white pine, which only lasted five or six years, when chestnut ties, unprepared, were substituted, which have lasted seven years, and were replaced last season by a second set of chestnut ties, also unprepared.

A full account of this experiment (No. 7) will be found in the letter of Mr. E. S. Philbrick, published herewith as Appendix No. 5.

It will be noticed therefrom that the burnettizing doubled the life of the spruce, which would otherwise have lasted but four or five years, and that the ties finally failed by checking and splitting, so as no longer to hold the spikes. Exposure as bridge ties seems particularly liable to bring about this result, and Mr. Philbrick's experience leads him to believe that burnettizing is of more avail where timber is covered with earth than when fully exposed to sun and air. This opinion is confirmed by the statement of Mr. Hobart (Appendix No. 4), who found burnettized ties nearly sound after having laid some twenty-five years in an old side track, nearly covered with earth and grass, and this probably results from the less opportunity for the washing out of the chloride of zinc from the timber by the action of rains.

In 1861 (experiment No. 9) the Erie Railway built a set of burnettizing works at its bridge shop at Owego, New York. These works chiefly consisted of an iron cylinder 70 feet long and 6 feet in diameter, with a heavy iron door at each end, and a track running through it, on which the material was run in on small trucks, moved by a hand-power windlass. The capacity was 13,000 feet, b. m., and the Bethell process was used.

When the cylinder was filled and the rubber-packed doors closed, a powerful air-pump was applied, and as perfect a vacuum formed as possible, and maintained one hour, to withdraw the sap and air from the timber. A stop-cock was then opened in the pipe connecting the cylinder with the tank containing diluted chloride of zinc, and the liquor admitted. When the cylinder was filled, the stop-cock was closed, and a powerful force-pump set at work, which forced the solution into the cylinder under a pressure of 120 to 150 pounds per square inch. This pressure was maintained about four hours, and left sometimes in over night, when the timber was taken out.

The strength of the solution was about two or three per cent., and with labor at \$1.50 per day, the cost of the treatment is said to have been from \$1.50 to \$2.50 per 1,000 feet, b. m.

The treatment was applied almost entirely to bridge timber and plank for platforms, crossings, etc. Very few cross-ties were prepared, and only as an experiment.

The results were not entirely satisfactory, and when the works burned down in 1869, they were not rebuilt. Two-inch plank seemed to be well preserved, but large timber, taken out of bridges eight or nine years after treatment, showed a hard crust from one-quarter to one inch thick all round, but was rotten at the center, thus tending to deceive the bridge inspectors as to the soundness of bridges which might really be insecure.

Some pains have been taken to ascertain the causes of this want of success. They seem to have been as follows:

1. Original imperfections in the “Bethell” process. The partial vacuum did not properly clear the timber of sap. This has since been improved upon by previously steaming the timber, to liquefy and vaporize the sap before the vacuum is applied.

2. It was probably a mistake to select bridge timber for this experiment; imperfectly as the work was done, it would have proved a far greater success if it had been applied to cross-ties.

3. Operating upon unseasoned timber. As practiced in Europe, burnettizing is exclusively applied to seasoned timber. This being generally imported from a distance, has a chance to dry in transit; or, if cut in the vicinity of the works, it is piled up for several months before treatment, or is thoroughly steamed, so that the water may evaporate and make room for the solution. Moreover, it is also well dried before using, to prevent the zinc from washing out. As a confirmation of this view, it may be mentioned that while the

bridge timber did not last well, several sets of switch ties, which had been cut about eight months, and seasoned, were burnettized at Owego, for the road department of the Erie Railway, and laid in its tracks, with the result that nine years afterward they did not show a particle of decay. These ties have been lost sight of since, but your committee has in its possession an oak tie, one of a lot of two car loads, seasoned and burnettized at Owego, which lay in the track at Susquehanna station for seventeen years, and is almost perfectly sound to-day.

4. Insufficient pressure. It has been suggested that the pressure ought to have been some two hundred pounds per square inch, and continued eight hours instead of four. This might have produced somewhat better results, but it is believed that the last cause, which remains to be mentioned, more fully accounts for the partial want of success.

5. Undue haste in the treatment. In accordance with the usual railroad practice of never ordering materials until they are imperatively required, the timber was not procured until the bridge which it was intended to rebuild was about ready to come down. Then there was great haste; the burnettizing works were hurried up, and the timber went straight from the stump into the cylinder, and from that into the bridge, with very imperfect treatment. The pressure was applied to the operatives instead of to the cylinder, and as a result the timber was “put through” without sufficient preparation, some of it hard frozen in winter.

Mr. Jas. D. Bishop, formerly Superintendent of Bridges of the Erie Railway, who had charge of these burnettizing works, writes: “All the timber used in renewals of bridges, and exposed parts of buildings, platforms, etc., upon the road, which was a very large amount, was hurried through this process, and for the want of time was done quite imperfectly. I consider the process of burnettizing timber a success in preserving the same to at least 50 per cent. beyond its natural life, if the burnettizing is well done.”

Mr. H. D. V. Pratt, formerly General Superintendent of the Erie Railway, writes:

“The timber used in bridges that was burnettized in the winter was full of frost, and burnettizing had no other effect than to confine the sap, and make the timber decay much sooner than it otherwise would have done.”

Under these circumstances, it seems to be no wonder that the results were not entirely satisfactory, but all this amounts to saying a very simple and very obvious thing—that we cannot hope to get a preservative solution into the timber unless we first contrive to make a place for it, and that, in order to be successful, the work must be done skillfully and thoroughly.

For this there must be no undue haste; but at the same time it must be acknowledged that the delays required properly to season and to prepare timber and ties are particularly exasperating to railroad men, and many of the works and experiments which have heretofore been abandoned have doubtless been given up because of the delays which they brought about in necessary renewals of bridges and of roadway.

The above information has been furnished in large part by Mr. W. B. Coffin, Superintendent of the Western Division of the Erie Railway, and it should be stated in fairness that Mr. J. D. Bishop (who had charge of the works, and to whom this statement of the experiment has been submitted) writes that we “have put it rather too strongly as to its not being a success.”

Now that the Bethell process has been improved by a preliminary steaming to season the timber, there seems to be no reason to doubt that the work can be well done at all seasons.

We may here refer to experiment No. 16, on the Union Pacific R.R. Burnettizing works were erected at Omaha by that company in 1867–68, and run about one year on cottonwood ties. The cost of treatment is stated to have been about 30 cents a tie.

The works were abandoned as impracticable, as not one-tenth of the ties used could be put through the machine. Some difficulty was also found from the brittleness of the prepared ties, probably, as will be explained hereafter, from the use of too strong a solution in order to hasten the process.

It is doubted by your committee whether it is wise to attempt to prepare artificially (by any process) ties for a road in progress of rapid construction. The quantities required are too vast, and delays are too annoying. It is clear that if it is desired to lay some three miles of track a day, requiring about 8,000 ties, works consisting of one or two cylinders, the capacity of which are from 500 to 1,000 ties a day, will not be suffi-