Railway mechanical and electrical engineer

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RAILROAD JOURNAL,

AND

MECHANICS' MAGAZINE.

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44

GEORGE C. SCHAEFFER Editor.

Assisted by the contributions of several distinguished Engineers and others devoted to the cause of internal improvements.

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The commencement of a new volume of this Journal, affords a suitable occasion for announcing such arrangements as have been made, with a view to increase the value of the matter contained in its pages. Guided by past experience, it has been our aim to enlist as many contributors as possible. We have accordingly obtained from severel distinguished professional gentlemen the promise of contributions. It was intended to announce the names of those who had been so kind as to lend their aid (permission having been given so to do,) but time enough to hear from those already addressed, not having elapsed, we prefer waiting until the next number appears. Numerous engagements have prevented us from making application to many of our oldest friends, whose readiness to assist us has always been shown by frequent communications. We would therefore respectfully request that all who may feel disposed to be enrolled in our list of contributors, should send us their assent at their earliest convenience.

We are most happy to embrace this opportunity of returning thanks to those gentlemen who have hitherto favored us with communications, as well as to those who have so kindly and promptly answered our more recent call.

It will thus be seen that the pages of the Railroad Journal will embody a complete system of practical engineering, adapted to the various circumstances of our extensive territory. The names of the writers as well as the character of the articles will be sufficient to show the correctness of our assertion.

As an additional means of giving variety and value to the work, it is proposed to give original translations and abstracts of such French professional papers as may be deemed suitable.

If sufficient encouragement is offered, a series of original articles may be expected on the most important topics relating to the theory and practice of the profession. Without entering more into detail at present, it is proposed to leave the value of these improvements to be estimated rather from the pages of the work, than from any mere assertions on our part.

In conclusion, we have only to remark, that if the same spirit of kindness, and desire to support the Journal which has already been manifested in several quarters, is continued and extended, we have no hesitation in promising, under such auspices, a corresponding effort on our part to do every thing tending to the satisfaction of our readers.

NEW EXPERIMENTS ON FRICTION, MADE AT METZ, IN 1831, 1832, AND 1833, BY ARTHUR MORIN, CAPT. OF ARTILLERY.

[Translated and abridged for the American Railroad Journal.

Remarks by the Translator.—A well conducted and extensive series of experiments upon friction, has long been a desideratum in mechanical science, both for the specific application of particular results, and for the general laws deducible only from trust worthy and exact experiments.

The best treatises extant upon this subject have hitherto led to approximate or even erroneous laws, and hence their authority, when followed out into extreme cases, has been shown to be worth but little. For instance, the application to railroad mechanics, where great pressure and high velocities are concerned, has proved so fallacious in many cases, that hypothesis has been freely used to reconcile well observed facts with the laws as originally announced.

The experiments of Mr. Morin are of a different character, undertaken at the request of the French government, and carried on at their expense—advantages have been afforded inaccessable to previous observers. The result has been, an accuracy sufficient to confirm in the most satisfactory manner the general laws of friction, together with special results of the highest value for immediate practical use.

Another remarkable advantage to be derived from the labors of M. Morin, is this—they may safely be taken as the ground work of all future experiments, and thus other observers in this department of science, instead of painfully retracing each step, may confidently go on from where M. Morin has left off, and add new facts without re-examining those which may be assumed as established.

The uncommon ingenuity manifested in the contrivances of M. Morin, have almost tempted us to go into the detail of his machinery and calculations. This, however, could not be done without very cumbersome plates and a formal copy of so large portions of the works as to greatly exceed the space which we can afford. We have, therefore, preferred the report of the committee, which, from its succinct account of the mode of operation, and the high reputation of its author, is worthy of attentive perusal.

In future numbers we intend to give, if necessary, some of the general results of the author, and the whole of his numerical results condensed into one complete table.

REPORT OF A COMMITTEE OF THE ACADEMY OF SCIENCES, UPON THE NEW EXPERIMENTS ON FRICTION, BY M. MORIN.

Com. Messrs. Poisson, Arago, and Navier.

The Academy has heard with, much interest, the summary which has been read by. M. Morin, of the results which he has obtained. The object of these new researches, has a most important influence in physics and the mechanic arts, and the processes employed by the author are very remarkable, and seem to give superior exactness and precision to experiments of this sort.

The resistance arising from friction is the principal cause of the loss of power which cannot be avoided in the use of machines. It appears that the first attempts to estimate its influence are due to Amontons, whose paper is inserted in the Memoirs of the Old Academy of Sciences for the year 1699. According to this skilful *physician*,* the resistance of friction is independent of the extent of the surfaces in contact, which, since then, has been confirmed; moreover, that this resistance is very nearly the same for different substances, such as wood, iron, copper, lead, etc., when the surfaces are covered with grease, and its value is about one-third of the pressure of one body upon the other.

These results served for a long time as a guide to mechanics.—But Coulomb having presented to the Academy of Science, for a prize offered in 1781, a very extensive treatise, containing numerous and varied experiments, for the measurement both of friction

* We do not hesitate to use this word in the sense in which it is used in the original, and which is now becoming quite usual in Europe. No single word has hitherto been employed to denote a person devoted to the study of physics, but the vague and imperfect term *philosopher* or *natural philosopher* has been adopted. This might, with equal propriety, be applied to the Astronomer, the Chemist, Zoologist or Mathematician. [Ed.]

and of the rigidity of ropes, the rules deduced from it have been generally admitted.

The work in question, published in 1785, in the tenth volume of the *Savans etrangers*, from the justly celebrated name of its author has acquired great authority—but, nevertheless, if we compare it with the observations presented by M. Morin, we shall find ourselves compelled entirely to reject a part of the results which it contains.

The mode of observation employed by Coulomb consisted in causing one body to slide horizontally over the other, by means of a weight suspended from a cord passing over a pulley. The velocity of the motion was estimated from the time consumed by the sliding body in passing over each half of a space six feet, and sometimes even only four feet in length.

The results present very great inequalities, and are not in general sufficiently numerous, in each series of experiments to give entire certainty to the conclusions.

Such as they are, they have in all cases led the author so far as to announce the general laws of the phenomenon, which consists chiefly in this, that the resistance due to the friction of solid bodies is proportioned to tho pressure of one body upon the other, and is independent of the extent of the surfaces in contact, and of the velocity of the motion. It appears even, according to the recent experiments, that these laws are more generally exact and less subject to exceptions than Coulomb himself had thought.

This physician appears to have been the first to recognise the necessity of distinguishing in the estimation of friction, the case of a continual motion, and that in which the two surfaces which have been in contact for sometime, separate and commence to slide the one upon the other. But the numerical values of the intensity of friction which are given in his Memoir, for these two cases, are not at all confirmed by the results obtained by M. Morin.

In the volume of the *Philosophical Transactions* of the Royal Society of London, for the year 1785, we find some experimental researches by Dr. Vince, whose results do not entirely agree with those of Coulomb. These experiments having been made on a very small scale do not appear to be of a character capable of giving us exact notions upon this subject. We may say the same in regard to the more recent experiments of Mr. George Rennie, published in the volume of the same collection for the year 1829.*

* This paper was republished in the 4th and 5th vols. of the Journal of the Franklin Institute, and contains the most recent experiments of any extent hitherto accessible to the English reader. [Ed.]

The mode of observation was nearly the same, as well as the principal numerical values. We may remark among the latter, the measurement of the friction of steel skates sliding upon ice, for which the author found various results, comprised between the 24th and the 70th of the pressure. This resistance would be far less than all those which have been observed, even in the case of the hardest and most polished metals.

In regard to the observations made by M. Morin (the results of which are announced in the Memoir presented Dec. 12th, 1831, and an additional note, Feb. 6, 1832,) they are distinguished by various circumstances, according to which, it appears that they should give more exact and satisfactory results than all those which have hitherto been published.

First. The slide was made to pass over a much greater space, (nearly 4 metres—13 ft.,) which allowed the nature of the motion communicated to be ascertained with greater certainty.

Second. The force acting upon the slide by which the friction was overcome, could be calculated by knowing the amount of the descending weight, having proper regard to the resistance arising from the friction and inertia of the pulley and to the rigidity of the cord. The author actually made this calculation with great care in determining the resistances of which we have spoken by special observations. But besides this, all the successive values, thro' which the force acting upon the slide, passed during each experiment, have been directly observed by means of an ingenious apparatus, the idea of which was given to the author by M. Poncelet, officer of Military Engineers, and Professor of the School for the application of Artillery and Engineering. This apparatus consists of a spring by which the force in question is transmitted, and which carries a moveable pencil, the position of which varies according to the tension of this spring. While the spring is in play, a disk carried with it, by the progressive motion of the slide, and moved circularly by the effect of the same motion, receives the mark of the pencil and thus preserves a faithful imprint of all the variations which can take place in the tension of the cord by which the slide is continually drawn. These two processes, altogether distinct, have exactly agreed in giving the same values for the tension.

Third. The nature of the motion communicated to the slide has been observed with an exactness no less remarkable, by a method analagous to the preceding. This last process consists in the employment of a piece of clock work, placed in a fixed position, and which communicate to a pencil a regular motion by which it describes, with a constant velocity, verified at each experiment, a circle of 0.14 metre, (5½ inches) in diameter. A disk is fixed to the axis of the pulley to which the descending weight communicates a rotatory motion, which is always in a determined proportion to the progressive motion of the slide; a sheet of paper placed upon this disk receives the mark of the pencil. The curve traced affects various figures, the nature of which is determined by the combination of the proper and regular motion of the pencil and of the motion, sometimes uniform, oftener variable, communicated to the slide and the pulley by the motive weight and the resistance to be overcome. The success of these delicate processes has required great study and care. The author uses a very delicate hair pencil filled with India ink. The traces of the curves obtained in these experiments, a great number of which have been exhibited to the Academy, show the extreme of delicacy and regularity, and evidently leave no uncertainty as the appreciation of the results which they are intended to exhibit.

The frictions hitherto studied by M. Morin* are those of woods, either dry or moistened with water, sliding upon each other, of iron, brass, of leather and cordage, dry or moist, upon oak. The elements of observation have varied within much wider limits than in the experiments of Coulomb. The velocities having been carried beyond 3 metres (9 ft. 10 in.) per second, the extent of surface as high as 30 sq. decimeters (465 sq. inches,) and the pressure as high as 1100 killiogrammes, (2430 lbs.) In all these experiments the motions observed have been strictly uniform, uniformly accelerated or uniformly retarded and thus indicate plainly that the resistance due to friction is constant and independent of the velocity of motion. Moreover this resistance has been found equally independent of the extent of the surfaces in contact, and exactly proportioned to the pressure.

The general laws announced by Coulomb are thus found to be confirmed, and as we have said above, the result of the experiments, at least, for those circumstances under which observations have been made, that is for the case where the substances are dry or moistened with water, and where no coating of a greasy nature has been employed, lead us to think that the laws in question should be regarded as in exact conformity with natural effects, and not mere approximate rules which we could employ in the application to the arts without the risk of any dangerous error.

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* It is to be remembered that this remark applies to the first of the three Memoirs. [Ed.]

The author as well as Coulomb, has recognized the necessity of distinguishing the momentary effort necessary to separate two surfaces which have been for some time in contact, and the continued effort which is exerted during the sliding. The first of these two forces is generally much greater than the second. It appears, too, that its value does not present the same constancy and regularity, that it varies according to certain accidental circumstances, and that it cannot be fixed with the same degree of precision. Moreover, M. Morin has observed a remarkable fact, which is this, that always when the slide at rest is solicited by a force sufficiently great to overcome the friction which should take place in a continued motion, but too small to cause the first separation of the surfaces in contact, a slight vibration given to the apparatus is sufficient to start the sliding body. It results from this observation, that when it is desired to measure the forces which are necessary to retain in a state of equilibrium, a construction exposed to any shocks, it would not answer, in general, to attribute to the resistance due to friction a greater intensity than that which is manifested in the case of a continued motion.

In regard to the absolute values found in these experiments for the relation of the friction to the pressure, they differ much from the results given by Coulomb, and lead us to attribute a much higher degree of intensity to this kind of resistance. Thus, according to M. Morin, the friction of wood sliding upon wood, when dry, or of iron upon oak, presents in the case of a continued motion, values comprised between .32 and .62 of the pressure, while, according to Coulomb, the same friction presents values between .7 and .17 of the pressure. The difference of these results cannot, evidently, be ascribed to errors of observation; we must necessarily admit that the two observers have not operated under similar circumstances.

M. Morin remarks, that in the friction of wood upon wood, or of metal upon wood, when there is no coating of grease, repeated sliding does not polish the surfaces—on the contrary, the surfaces mutually wear away, and this alteration shows itself by the formation of grains of dust which must be removed from time to time, in order that the nature of the results may not be changed. It is no longer the same when the surfaces of the sliding bodies are impregnated, even slightly, with grease, and the intensity of the friction is considerably diminished thereby. The author believes that this observation will explain the want of agreement between the results which he has obtained and those presented by Coulomb. He supposes that in the experiments which are given by this celebrated physician as having been made with dry wood or metals sliding upon each other when dry, substances may have been used, which, in a preceding experiment had been covered with grease, which he had satisfied himself with merely wiping off, while he should have entirely renewed the surfaces. We abstain from pronouncing an opinion upon this subject, in order to do which it would be necessary for us to undertake special researches to which we are not able to devote ourselves.

Whatever may be the explanation of the discrepancy referred to, the work presented by M. Morin appears to deserve great confidence, on account of the number and extent of the observations—the agreement of the results, and the nature of the new and remarkable processes which have been employed.

It would be superfluous to insist, in this place, upon the importance of researches of this nature, to the progress of physical science, the arts—constructions and mechanics, properly so called—or upon the real utility of the pains and expense bestowed upon these researches, which have been made at the public cost by the orders of the minister of war. We think that the Academy should approve the work presented by M. Morin by ordering its insertion in the collection of the *Savans etrangers*, and encourage him by its vote to continue his researches and extend them as far as possible.

Poisson,
Arago,
Navier.

For the American Railroad Journal and Mechanics' Magazine.]

INJUDICIOUS CONSTRUCTION OF RAILWAYS, AND THEIR MACHINERY IN THE UNITED STATES.

In the Journal of the Franklin Institute for May, is contained an article on the injudicious policy pursued in the construction and machinery of many railroads in the United States, by John C. Trautwine, Civil Engineer.

These remarks by Mr. Trautwine, have been induced by the perusal of Mr. Ellet's pamphlet on the same subject, which has already been noticed in this Journal, and about which there has been some controversy. The complimentary tone in which he speaks of that pamphlet, at first, caused us to fear that he was about to endorse *Mr. Ellet's wooden road, without grading, to cost* $1000 *per mile, and with a half of a ton engine*; but we have been greatly disappointed on finding that he does not countenance a road below a cost of

$10,000 per mile, with an engine of 6 to 8 tons, which, at the present prices of labor and materials, would build a road with an edge rail, and furnish it, comprising a fair proportion of the indispensable ingredients of *power, speed,* and *safety.* So far we feel relieved.

There are, however, some views of Mr. Trautwine in regard to the failure of railways, which, like those of Mr. Ellet, may be noticed as to broad. They assume that the causes of all our misfortunes in railways are to be found,

1st. *In a departure from first principles by our Engineers as a class.*

2d. *In a too imitative propensity in our people, and among our Engineers in particular.*

The first cause, is, we suppose, interpreted to mean either that *too much money* had originally been laid out on our roads, as based on the supposed trade and travel expected to be done by them—or that our Engineers were not gifted with the requisite prescience to enable them to avoid all difficulties in a new enterprise, at the first jump. In looking around among all the river lines, we find that they have all, more or less, been actively engaged, very shortly after their completion, in remedying the defect, found radical in nearly every department, of *too little money* having been *fairly* spent on them, and counting the miserable abortions of speculations; but looking at all the notable routes of railway, there is yet living evidence about them, that if a violation of first principles of that sort attaches, it has been one of parsimony and not one of prodigality. A road may have cost a great deal, without a due proportion having been faithfully applied towards its judicious construction.*

There can be yet, nothing *fully* determined, or final, about ei-

* Pennsylvania has been peculiarly the victim of bad and extensive railways. Her main one, the Columbia, has had to be relaid. All the minor ones, such as the Norristown, the Trenton, the Woodbury, the Little Schuylkill, Bearer Meadow, Danville and Pottsville, Mountjoy, Chambersburg, Elmira, etc., having flat bars, and otherwise too cheaply built, have all been rendered nearly useless under the effect of the lightest useful locomotive. The sufferers by these roads are the most effective denouncers of the improvement generally; and it is not to be wondered at that the public mind in Pennsylvania is so wrongly impressed in regard to it. All this has tended much to increase the difficulty and opposition otherwise raised against the Philadelphia and Pottsville railway, a genuine sample, which, if properly studied, will be found unequaled, as a whole, and which cannot fail ere long to be understood.

Between Albany and Buffalo, the railways are all flat bar, and their success would seem to favor that mode of construction among the undiscriminating, but this success is owing to their being restricted to only half the functions of the railway—travel, which is slow, and rough, attended also with the worst of all feelings—that of insecurity. The heavy expenses of the travel are lost in their large receipts, but give them freight to carry, and they could not get on without a solid edge railroad.

ther the construction or management of this improvement—its present standard, and that a tolerably high one, has been reached through the trials and failures incident to all new enterprises, and by the same means, are we to look for a continued amelioration of it. The school of experience was as necessary to further the profession of engineering, as that of any other, and bating those of a merely speculative character—the more legitimate railways have been built, and most of their original defects corrected at a cost by no means disproportioned to their immense public benefit, and a fair remuneration yielded to the stockholders. There is not much grief spent over the hosts that have perished in perfecting the science of medicine; why, therefore, regret, if it can be said that a few dollars have been wasted in advancing that of engineering?

The second cause of too much imitation of the English by our engineers, is still less tenable. It is, as we understand it, in the other way—the later inventions about the railway, have all come from our engineers and mechanics, to which the English with their unlimited means, have been enabled to give the most effect, and they are yet behind us in several items. The *white metal*, invented by Babbott, Boston, for journals of wheels, and for all parts on which there is revolving or sliding motion, the anti friction qualities of which, to a railway, are incalculable, is yet unknown to them, and it is allowed that our locomotive, the *mainspring* of the improvement, is at least, 30 per cent. better than theirs. Our resemblance to the English, therefore, as the effect of imitation, is very faint, either in solid weight of rail, in extent of stone masonry, in straight lines, in level grades, in *inferiority* of locomotive car, and still less in profusion of ornament. How do the wooden sheds at either end of the *Camden and Amboy* road, compare with the terminations of the London and Birmingham railway? This matter of failure is then more justly reducible:

1st. To a want, mainly, of that knowledge which is only reached by time and experience, and is natural to the inception of all new projects.

2ndly. To that uncontrolable propensity in man to turn every thing to his own selfish ends; and railways, as well in England as here, were a favorite prey among the Vultures, so common to both countries in the past ten years of debauched morals.

Under these two potent causes of *inexperience and plunder*, surprise is not to be felt for the failure of those schemes terminating in the roads, or left there unfinished; but the highways have had, moreover, to bear up against the further evils of a reckless competition from rival lines and corrupt management, so that the mass of stock and loan holders finding, for the most part, disappointment, aggravated by expectations raised too high at first, have, together with the public, been *bewildered* into the conclusion that all railways must be failures, and it is scarcely possible to awake them from their stupor. Something more, however, of a spirit of inquiry is getting abroad, induced, principally by this improvement being so successful and so great a favorite in the more intelligent New England States.

To convey some idea of the sweeping nature of Mr. Tautwine's remarks on the course of our engineers, we make the following extract:

"But the American engineers, as a class, do not descend to first principles. It is enough for them, that such and such improvements have been introduced in England. Omitting all considerations of the premises, they look only to the conclusions, and the imitative faculties are forthwith called into requisition without any regard to the modifying and controlling circumstances peculiar to their own case. They dash on blindly in their operations, deluded by the impression that they cannot err if they only adhere closely to their English models.

When the engineer commences his location, his aim, almost invariably, is, to obtain the best abstract line; and whether his road is to obtain 5000 or 50,000 tons annually, the character of his grades curves, superstructure, etc., will be precisely the same. His standard of propriety is an invariable one; it adapts itself to no contingencies; it admits of no accommodation to difference of objects to be effected. It is summed up in the brief sentence, 'the English do so.'

A deficient trade has, after all, been the real rub, and for this the President, Directors, and Stockholders are certainly more responsible than the engineer, who might supervise, but whose estimate, in particular, was not to be taken as the only guide for the quality of the work. That conspiracies among them to beget large and wasteful expenditures, were occasionally formed, is scarcely to be doubted, involving in the same ruin the money of the projectors and the character of the improvement. This collusion, Mr. Trautwine admits, where he says finally, to make both ends meet an exhibit of probable revenue concocted, *to suit the report*."

Availing himself of all the lights furnished by the trials and failures so far, Mr. Trautwine, himself, has tried to supply us with a true model and estimate of a railway. In this, however, he carries us back to the point at which the improvement commenced, the flimsy flat bar of 24 tons per mile, or 15 lbs per yard. And of this he speaks in the following enraptured terms:—

"I entertain a high regard for the flat bar road, and conceive that the odium which has been attached to its memory has been unjustly incurred.

"Now, so far from expecting this superstructure, (as per model given,) to be knocked to pieces in a few years, as the old flat bar roads generally were I should calculate on its annual repairs being less than, perhaps, on any railroad in the United States, and that not from any inherent virtue in the road itself, but from simple fact that all its parts *are proportioned to the offices they have to perform.* We should have no crushings or difficulties here, but with its light engines, (6 ton engines used up the Winchester and Potomac road, and did little work besides.) it would be one of the stiffest roads in the Union, and, moreover, a much more agreeable one to ride on than any of those of more permanent construction. Besides which, it would annually yield 8 per cent. clear profit on its cost, when doing only the moderate business of a trip, daily, in one direction, with a small model engine, over grades of 60 feet per mile; or should the business require an eight ton engine, it would yield 12 per cent. profit on the same number of trips; or should two trips, daily, in each direction, be necessary with such loads, it would yield 24 per cent."

Here is pretension enough to perfection, but on which he is not singular and alone, as both Mr. Ellet and Mr. Heron, make a similar claim, the first for a pure and purely wooden plan, and the second on the other extreme for one of a complicated wooden trellis consuming nearly *a forest* for each mile.

But nothing is more easy than thus in our closets to produce the results necessary to bring about our plans—the road is *there* made to cost *just so much*—ample trade and travel provided, and the charges of our own selection—their regularity ensured, and all the machinery to work *just so.* Is not this the very basis on which nearly all the engineers have acted, of whom Mr. Trautwine has been so unsparing. The clause in the above extract, modestly italicised by himself, is therefore a mere conceit, and on which in practice his scheme, like many of those of his denounced brethren, would be sure to fail, because, 1st. An engine of 6 tons* could not be relied upon to draw at all times, if at all, 30 tons gross load, over a flat bar and grade of 60 feet.

2d. The trade and travel which might *average* 30 tons daily, gross load, would often as natural to it, come in irregular and capricious quantities, varying at times, perhaps double the amount on which the other proportions of the machine had been adjusted, when there is any provision for such a call, nor is any thing allowed for an increase of traffic, which may not be far from right, for a flat bar road, although a rapid consequence of the edge railroad; and it is not difficult to make any sort of road pay, where it can dictate the charges, and make them double those usual on other roads for the same distance, as done by Mr. Trautwine.

It is therefore, that when the railway is *really called for*, the truest economy is to prefer the *permanent* to the *temporary*, itself a chief impulse to the progress of a community—its chief quality should be a provision for that progress No road, using steam, is now renewed with a flat bar, and too many we know of, that would rejoice in the means of replacing it by an edge rail.

Mr. Trautwine further says. " it is not *the best railroad*, but the *best paying* railroad that should be aimed at."

It may be inferred that we hold the two to be synonymous; and to show that this *paying quality*, desirable as it is, is not always to be ranked first, we quote from Mr. Ellet's Laws of Trade, and subscribe freely to the views of the following extract.

"Such works are rarely if ever undertaken, exclusively as objects of immediate speculation. Capital is too valuable here to be invested in enterprises, which can at best be expected to return a moderate interest, and that at a day so distant, that the capitalist looks upon his subscription rather as the property of *his heirs* than of himself. And in consequence, investments are seldom made in such objects with a view to the immediate profitableness of the venture, and an interest paying fund."

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* We allude to the old plan of engine, for such has been the rapid improvements of late on this machine, that it is hard to keep pace with them. Baldwin has now the model for a 6 wheeled draught engine, much simplified, the whole weight being applied as adhesion, by which one of 6 tons is made as effective as one of 10 tons of the ordinary make. The foreign engineers from Russia, Austria, &c., now here, approve highly of this model, and we hope soon to see one in actual operation on the Pottsville Railway. It is common for some engineers to abuse heavy engines, when they can only be called so, where the power that sustains them, is inadequate. An engine of 11 tons is not heavy on a 50 lb. edge rail, while one of 6 tons is so on a flat bar road, on which the great object of the railway, despatch, is neutralized; and except at enormous outlay for repairs to both road and machinery cannot be maintained on them.

This, as a general view, is the most liberal one to take; if a present sacrifice must be sabmitted to, it is more than made up by the indirect and ulterior advantages. And truly is exemplifield in the case of the Philadelphia and Pottsville railway, the cost of which, at 5,000,000 of dollars, we will suppose, owned among the mass of coal consumers, who now require one million of tons, on which a reduction of at least 1 1-2 per ton is effected by this railway, equal to $1,500,000 per an. or, to an indirect dividend of 30 per cent on its cost. Let this FACT be well pondered by those who talk abusively of railways, and of *this one* in particular.

From the Civil Engineer and Architect's Journal.

MR. VIGNOLES' LECTURES ON CIVIL ENGINEERING, AT THE LONDON UNIVERSITY COLLEGE.

Second Course.—Lectuee IV. Laying out Railways.—In the preceding lectures the subject of the motive power had been much enlarged upon, from its necessarily influencing the manner of laying out a line. Mr. Vignoles said the student may be referred to study, at greater leisure and in detail, the principles laid down in the works of various authors on laying out both roads and railroads—M'Neill, Parnell, Navier, Tredgold, etc.—and the rules laid down by them may be taken as sound first principles, though modified at present by the improvement of motive power and other causes which could not have been known *a priori.* Railroads have so completely superseded many of the principal roads, and the public convenience has been thereby so much interfered with, that it becomes a matter of importance to run the trains as often as possible, and this becomes a new element in laying out a line of railway. Hitherto this has been done under the impression that the engines would always carry maximum loads, and though it is true that main lines radiating from the metropolis, into which a number of tributaries fall, may be laid out with a view to maximum loads, yet it becomes a consideration whether it would not be better in general to lay out railways with a view to the trains going often, and with light loads, and thereby to make the gradients suitable to the ground over which they pass. On this subject Mr. Tredgold has always judged soundly. Seventeen or eighteen years since he made various calculations on the comparative expense of ascending and descending inclined planes, and of cutting them down to a level; and he states, in his *Treatise on Railroads*, that it will be much less expensive to follow nearly the undulations of the surface, and "if a few examples (of the comparative expense) be added, it will assist in removing those extravagant notions of cutting and embankments, by which the capital of the country is wasted in unprofitable speculations." But the practice of engineers has been directly opposed to this, although we had almost a daily improvement in locomotive power, affording means of overcoming the difficulties of steep gradients. Before determining upon the inclinations which he will adopt, therefore, the engineer should make estimates of the comparative expense of forming and working flat gradients, and gradients of an inferior description, and it will be found the gradients of 50, 60, and even 80 feet in a mile, may be advantageously introduced, especially where the traffic is not very considerable. And if lines were laid out upon these principles, instead of the traveller being overcharged with the expense of the capital sunk, as at present, he would be charged with the expense of the motive power, which bears a very small proportion to the total amount exacted from passengers. Locomotive power only is scarcely more than $\frac{1}{4}$*d.* per passenger per mile, whereas the ordinary charge to passengers is 2*d.*; and this may explain why railway companies do not lease the working of their lines, for they make most of their profit as carriers, and not as capitalists.

In laying out railways there are generally two distinctive descriptions of country which the engineer meets with, each of which requires a different description of treatment with respect to his operations. The first is where there is a certain summit or ridge of country to be surmounted; the rule in this case will apply both to roads and railroads—viz., to get a uniform inclination, if possible, up to the summit; but if that be not practicable, to lay out the line in stages, taking care that, having once attained any intermediate elevation, the line does not, if possible, descend again. In a country of this description there will be much more difficulty in the details than in striking out the first general idea, for it will require the greatest care and patience to lay out the line so as to ascend to the summit at the least possible expense, by winding along the sides of hills, and crossing lateral valleys and ravines to the greatest advantage, etc.

The other description of country is where the extreme points of the line to be laid are on a level, or nearly so, and the ground varies. In this case his judgment will be principally exercised in determining the general direction of the road, in taking trial levels to determine the line of least cutting and embankment, in avoiding valuable property, and in securing the largest amount of traffic; and in a country like England, which is so full of improvements, gentlemen's seats, roads, streams, etc., it is an exceedingly complicated duty to make choice of the best line under such circumstances; but it may be laid down as a general rule, that in any difficulty it is always better to incur a positive known expense, which will not entail future liability, than by diminishing the expense in the first instance to run the risk of undergoing future loss. Thus, for example, if a line of railway upon a slight embankment should cross a road on the surface of a wet and marshy country, it will be better to raise the road to a sufficient elevation to pass it over the railway, though the height of the bridge and approaches be thereby greatly increased, than by slightly lowering and passing it under the railway at a greatly reduced expense, to render it liable to be continually laid under water. And these are the kind of circumstances that require so much care and consideration on the part of the engineer, to enable him to judge of the comparative amount of cost and maintenance of the different systems which he can adopt, and to regulate his design accordingly. Now we might go on thus increasing railway gradients until they approached nearer and nearer to those of a turnpike road, were it not for the difficulty of regulating the descent of them with safety. On a turnpike road, writers have suggested that from 1 in 36 to 1 in 40 is the best slope, because horses may gallop down without danger, and, at the same time, it is a good trotting road upwards. But on railways it is not safe to go down such inclinations as that. Professor barlow lays down that when the inclination is greater than 1 in 160, all advantage from gravity in the descent is lost, from the necessity of applying the break, and he has formed tables to show the amount of loss sustained in the ascent; thus, he states, that going up one mile of 1 in 100 is equivalent (of course with a maximum load) to going 2½ miles upon a level; but he will not allow that any corresponding advantage is gained in the descent of this, or any plane steeper than about 1 in 180. Now, if this be the case, we must have a totally different set of elements in forming lines of railway from what I have been laying down. But, as has been already stated, this is not the case in practice, for trains can have, with perfect safety, the full benefit of gravity on all descents up to 1 in 100, and the engines seldom carry maximum loads. The same line of argument has been pursued with respect to turnpike roads, where, however, there are many circumstances in operation which do not occur on railways—such as the unsteadiness of horses and coachmen, which influence the question: but the great point to be considered is whether it is most economical to lay out railways with respect to stationary or to locomotive power. On this subject M. Navier very sensibly remarks, that great rapidity being the characteristic of railways, it has been considered necessary to employ locomotive engines, which system presents an important advantage in being able to increase gradually the number of engines as the demands of commerce require it, whereas, on the stationary system, it is necessary to provide at once for the greatest amount of traffic that can ever occur. But in the event of this increase, we have still the means of using light and frequent trains for transporting a heavy traffic over a line of inferior gradients, and reducing the charge of the interest of that capital to the public. But whatever be the description of country which the engineer may meet with, he should first of all make or procure detailed plans on the largest scale, and upon them lay down a number of surface levels, and from them, as from a model, to find the line of least expense and greatest accommodation. The magnificent Ordnance maps of Ireland, from their great scale and numerous surface levels, will render the task of the engineer in that respect easy, should the long deferred introduction of railways into the country be ever carried.

Lecture V.—On the comparative Advantages of Different Rail-

ways. The class will, no doubt, be inclined to think that I have dwelt too long in the first four lectures of the present course, upon the principles of economy in motive power, but I assure you, that if, in after years, any of you follow up the profession, you will find the subject one of the most vital importance. I shall this evening draw your attention to the different elements of comparison which should guide the engineer in forming a selection from different proposed lines of railway, and shall take, as a text book for that purpose Mr. M'Neil's translation of M. Navier's work *On the Means of Comparing the respective Advantages of Different Lines of Railway*—a work which I highly recommend for your private study, on account of the clearness and accuracy of the views it contains. M. Navier states "that the elements of comparison of different lines of railway may be divided into two heads; first, the establishment of a very rapid mode of transport—a consideration which should give a preference to the shortest lines, the velocity being supposed to be the same in all; second, the increase of wealth which may result from the establishment of a line of railway. The construction of a railway, like that of a common road or a canal, is favorable to the advancement of wealth; in the first place, because the actual expense of transport in this direction, is diminished; and, in the second place, because this diminution in the cost of transport increases the value of the neighboring properties, facilitates the establishment of new works, and increases production;" and the saving effected is not merely a private advantage to those individuals who may be directly benefitted by it, but is so much actual increase of the wealth of the country at large. "The first of these effects—that is to say, the diminution obtained on the actual cost of transpot—is the cause of the second, so that this diminution is the principal circumstance, and that which should be principally considered." Taking it as established, therefore, that diminution in the cost of transport is the principal thing, we come to the result that the cost of motive power, on which this is dependent, is the leading point to be attended to in the formation of any line of railway. Indeed, M. Navier goes so far as to say that this is almost the only circumstance to be attended to; in his own words, "we should even say that the rate of reduction which is obtained upon the actual cost of transport, by the establishment of a new communication, is almost the only circumstance which should be thought of;" but he goes on to say, very justly, "it is also necessary to consider the quantity of goods which if carried, or which may be carried hereafter, in this direction," for the very essence of the rail ay system is to increase its own traffic; for it is evident that it may be less advantageous to the country to produce a great economy in the cost of transport upon a line where there is but little to carry, and more advantageous to produce a less economy upon a line where there is a large quantity of merchandise is carried." These are the principles which I have been endeavoring to impress upon your minds, and which from their importane, I cannot too often repeat. "It is therefore," says M. Navier, "generally necessary to take into consideration, in the comparison of different lines, the quantity of traffic which may be established on each, and even the increase in the value of properties, and the development of production to which the establishment of these lines may give rise respectively, according to the nature of the countries which they traverse." I would observe, as a passing remark, that the word *developement*, in French, generally refers to length; thus the development of a line of railway will be spoken of—meaning the length of that line—whilst, in English, the word refers to an extension of superficies. M. Navier does not go minutely into the examination of these last elements of the question, which rather belong to statistics and political economy than to engineering, but confines himself to the "consideration of the reduction which the establishment of a railway can effect upon the actual cost of transport—a most important consideration—to which, as already remarked, it is always necessary to attend; and this will form, in every case, the principal element of the comparison between different lines, and often leads to determinations purely geometrical or mechanical, and, consequently, exempt from arbitrary deductions."

M. Navier then goes on to state, that "the cost of transport on a railway, as upon a road or canal, depends on two principal points, which it is necessary to distinguish and consider separately; the first of these is the expense of constructing the railway, and the second is the expense of conveying the goods on the railway, when it is constructed. The expense of the construction of the railway is independent of the quantity of merchandise and of passengers that will pass over it. The expense of transport, properly speaking, upon the railway supposed to be constructed, depends, on the contrary, upon the quantity of merchandise or of passengers—that is to say, all other things being equal, the expense will evidently be in proportion to the tonnage." Now, a few years back, the whole time of the House of Commons was taken up with comparing the merits of rival lines of railway, for no sooner was one line proposed than directly a rival line was started. It is well known that, for the Brighton Railway, four different lines were proposed—the discussion on the respective merits of which extended over a considerable length of time. But it is a curious fact, that, in all these discussions, the principle which has been laid down this evening was never once alluded to. Now, in the practical working of railways, the diminution of expense of transport is generally quite independent of the quantity of goods carried, for, after a line is constructed, the charges are generally arranged with reference to rival lines, or to the competition which may exist with the railway; and the interest of the money laid out is scarcely thought of, however much it may have entered into the *a priori* calculations. The Paris and Versailles Railways may be mentioned; two lines were started, one on each side of the river—the

Government did not like to treat either party harshly, and passed both bills, and both lines are actually executed; and, from the great competition between them, the charges for transport of goods and passengers will probably bear little or no relation to the interest of the capital expended. There is, however, another element which renders the calculation of a very complicated nature. The railways are different from common roads or canals, over which, after they have been once constructed, the public have been left to find their own way—considerations of public safety render it necessary to incur great expenses in terminal and local stations, &c.; and there are also secondary expenses, such as the annnal cost of repairs, police, and management, of which it may be said that they depend partly on the interest of the cost of constructing, and partly on the amount of tonnage carried. Now, from experience a general idea can be formed of the expense of these items, but, before going into the details, I will return to M. Navier, who says—"We may, therefore, admit, without falling into any serious error, that the annual cost of transport on a railway is, in all cases, formed of two parts—the one proportional to the expenses of the construction of the way, and the other proportional to the amount of tonnage carried; and we should also observe, that the cost of transport of one ton of merchandise cannot be specified, unless the number of tons which shall be carried annually from one extremity of the line to the other be known." Now, hitherto we have been unable to determine *a priori* what these amounts are—but we can tell with great accuracy what they have been on the different lines of railway now in operation. The following tables give the average of these expenses on several lines of railway:—

MERCHANDISE TRAFFIC.

Heads of charge.	Coal on colliery railway in the north.	Goods on the Liverpool and Manch. Rlwy.
Locomotive power—wages and repairs	0·355*	0·425*
" fuel	0·025	0·125
Total	0·380	0·550
Wagons	0·190	0·227
Conducting traffic	0·075	1·080
Maintaining railway	0·208	0·307
General expenses	0·100	0·354
Total cost	0·953	2·518

* Per ton per mile—in decimals of a penny.

PASSENGER TRAFFIC.

Heads of charge.	Lond. & Manc. Railw.—average 60 passengers per train.	Dublin & Kingstown Railw.—av. 40 passengers per train.
Locomotive power—wages and repairs	0·170*	0·173*
" fuel	0·100	0·115
Total	0·270	0·288
Coaches	0·054	0·031
Conducting coaching	0·104	0·113
Maintaining railway	0·085	0·050
General expenses	0·091	0·174
Total cost	0·604	0·656

* Per passenger per mile—in decimals of a penny.

Taking the Liverpool and Manchester Railway as an example, we find the number of passengers to average sixty per train. This may, on the whole, be considered as a fair average on all the railroads throughout the country. Seven years working of the same railway gives, as the average expense of locomotive power, 0·27*d.* or about ¼*d.* per passenger per mile. The gradients do not exceed six or seven feet per mile, with the exception of the inclined plane, and this also is an average amount for most railways—in fact, fuel and wages are so nearly the same on all lines, that the expense of this head can be calculated with great exactness. The expense of locomotive power, also, is the only one which depends upon the gradients. The other expenses, which are independent of the gradients, are—coaching, conducting ditto, maintaining way, and general expenses, altogether amounting to 0·33*d.*, which added to 0·27*d.*=0·60*d.*, or, in round numbers, three fifths of a penny per passenger per mile for the expense of transport. Now, let us examine the relative expense of the merchandise traffic. We have, for the expense of locomotive power, 0·55*d*, or, in round numbers, ½*d.* per ton per mile; for the cost of wagons and secondary expenses, 1·97*d.*, which added to 0·55*d.*, gives 2·52*d.*, or, in round numbers, 2½*d.*, per ton per mile as the actual cost of transport. Now, let us mark the very striking result of this comparison. Even with all the most recent improvements, and cutting down every expense that can be reduced, the mere transport of passengers costs three-fifths of a penny per passenger per mile, whilst that of goods is only 2½*d.* per ton for the same distance, and of this 1*d.* may be thrown out, arising from other sources, leaving the cost of transport—passengers, three fifths of a penny per passenger per mile; goods, 1½*d.* per ton per mile. In the first case, we have an amount exceedingly high, in proportion to the present means of transport, whilst the second case presents a result as strikingly low. A ton of goods is equivalent to the weight of fourteen passengers, with 20 lbs. of luggage each.

When the loads to be carried are light, and the velocities at which they are carried considerable, the steepness of the gradients is a matter of comparatively little consequence, but as soon as the engine is loaded to its maximum power, the railway system becomes unable to compete with the canals, so far as relates to the carriage of goods. If these are the results offered to you by past experience, do you not see at once how it affects the question of laying out lines in remote districts, where but a small amount of traffic can be calculated upon? Again, referring to the table, with reference to the difference between carrying slowly and carrying quickly, we find that the expense of locomotive power on the Liverpool and Manchester Railway is 0·55*d.*, or nearly three fifths of a penny, yet that the expense upon the best railways, where goods are carried at a moderate velocity, is only 0·38*d.* and the remaining expenses 0·57*d.*, so that it comes to this, that we have—Liverpool and Manchester Railway, 2½*d.* per ton per mile; other railways, with moderate speeds, 1*d.* per ton per mile. M. Navier proposes a case not quite so strong, perhaps, as might be made out, and I will, therefore, refer to the Brighton Railroad for example, the expense of which, for the 40 miles, has been about £2,600,000, or £60,000 per mile, the interest of which, at 6 per cent., is 10*l.* per mile per day, which is the net receipt, after all expenses are paid, requisite to insure a decent interest to the shareholders. I shall not enter further into the question now, but if those students who are sufficiently advanced will take up the subject, they will soon be able to appreciate my arguments for increasing the limits within which gradients are usually kept—for, supposing the expense of carrying a passenger should be only ¾*d.* per mile, yet, if you will calculate the additional expense of the interest of £60,000 per mile, you will find ruinous results.

M. Navier having said that the cost of transport is the chief point to be attended to in laying out a railway, goes on to determine the amount of power requisite to draw a given train over a given railway. The elder students will, in connection with this subject, be aware of the opinion which has been pretty generally entertained amongst engineers, that a rise of twenty feet per mile is equivalent to a mile in length. M. Navier says—"Let us observe that, upon a horizontal line, the power required to draw a given weight is considered as being equal to almost the two-hundreth part of this weight; " but, as I have shown in a previous lecture, the formula for the expression of this power will be $\frac{F}{n}$ taking F as the friction per ton, and n the number of pounds in each ton, so that what M. Navier calls the two-hundreth part of the weight will be friction divided by the number of pounds in a ton, Taking the friction at 9 lb., we have $\frac{9}{2240}=\frac{1}{249}$ nearly. At 11 lb.,

$\frac{11.2}{2240}=\frac{1}{200}$; and I must here repeat what I have so often before stated to you, that, although experiments have been made, which give so low a friction as 4 lb. per ton, that, on an average, M. Navier is nearly right, when we take into consideration the numerous causes of friction. M. Navier considers the power acquired to draw a given weight "to be independent of the absolute velocity of transit, although there is reason to believe that the tractive power increases with the velocity." Now, it has been said that the friction is the same at all velocities. I cannot fully concur in this opinion. I think the axletree friction may be constant under all velocities, but that, from other causes, there appears to be, I will not call it increase of friction, but an increase of resistance, the amonnt of which has not been satisfactorily determined. M. Navier goes on—"We conclude from this, that, in order to transport, with any velocity whatever, constant or variable, a weight, W, to a distance represented by *a* on a horizontal line, it is necessary to employ the power represented by $\frac{W}{200}\times a$—that is to say, the power necessary to raise the weight to the height $\frac{a}{200}$," or, in other words, to transport a weight any given distance, on a horizontal line, is equivalent to raising it the two-hundreth part of that distance in vertical height; and, although this is not quite correct, it is sufficiently so for general purposes. We have before assumed that it is the same thing to go a mile round as to go over a hill rising twenty feet in a mile. Now, a mile being 1760 yards, or 5280 feet, we have $\frac{W}{200}\times 5280$ as the power required, which is equal to raising the weight 26 feet. But as the friction varies, I think we have sufficient experience now to say it is about the same thing to rise 30 feet in a mile as to go a mile round; but this is quite independent of the question, whether you should or should not allow on one hand, and deduct on the other, when the slope exceeds the angle of repose. I have explained to you, on previous occasions, the difference of opinion that exists on this point. Both Mr. Barlow and M. Navier allow the advantage up to a certain point, which they fix at about 1 in 180, beyond which point they consider the whole advantage gained to be destroyed by the necessity of putting on the break. Now, in practice, we do not find this to be the case, until we come to 1 in 80, or thereabouts; however, we may take, as a general rule, M. Navier's concluding words on this subject:—"The length of the line remaining the same, the amount of power consumed to effect the transit depends entirely upon the length of the line, and the difference of the level of its extreme points." The practical result which I have endeavored to lay before you this evening is, that the cost of transport is the cost of the power combined with the interest of the original cost of the line, and that the calculation of this combined expense must form the element of comparison between different lines of railway.

INSTITUTION OF CIVIL ENGINEERS.

Description of the Mill, Forge, and Furnaces of a Welsh Iron Work. *By* THOMAS GIRDWOOD HARDIE, *Assoc. Inst. C. E.*

The author commences by describing the general plan of an iron work, consisting of six blast furnaces, four double-fire refineries, and a forge and mill, capable of converting into bar iron the produce of the six blast furnaces. He then enters very fully into certain alterations of the interior shape of the blast furnaces introduced by him at the Blaenavon works, from which have resulted an economy of fuel, regularity of work, and an improved quality of iron. The principal alterations appear to be, making the interior diameter greater above that at the boches, and establishing a proper ratio between the diameter of the boches and that of the charging place, and proportioning both to the height of the furnace. The opinions are supported by calculations of the quantity of blast used in smelting given quantities of ore, and the effect which the form of the furnaces must have in directing the current of the blast through the materials, by which also the point of fusion would be necessarily affected, and the chemical combinations varied. The particulars are then given of the construction of the furnaces at Blaenavon, and the details of the blowing engines, blast mains, regulators, valves, &c., with calculations of the quantity of blast used in the various processes of the manufacture. The construction of the casting houses, with the mode of ventilating by the iron roof, is detailed. The general arrangements of the balance pits, coke yards, mine kilns, and bridge houses, are shown, and the author proceeds to describe the forge and mill, which have 35 puddling furnaces, with hammers, shears, rolls, and heating furnaces in proportion. He then condemns the usual practice of leaving the coupling boxes loose upon the spindles, as liable to break the rolls, shafts, or machinery, and gives the theoretical and practical reasons for preferring fixed couplings. The communication is illustrated by three drawings, showing all the details of construction of the iron works.

Remarks.—Mr. Lowe believed that there was an incorrectness in the statement of the iron, after being freed from its oxygen by the heat of the furnace, taking up a dose of carbon from the coke, thus becoming a carburet of iron, which is a fusible compound, and as such fell melted into the hearth. On the contrary, he thought that the iron was combined with carbon in the ore, and that there was not any necessity for the medium of the fuel to charge it with carbon.

Dr. Farraday, in reply to "Why the ore required, or why the iron carried away any of the carbon of the fuel?" stated, that the ore being essentially a carbonate of iron, the first action of heat, either in the mine kilns or in the furnace, was to draw off the carbonic acid and leave an oxide of iron, and then the further action of the fuel (besides sustaining a high temperature,) was to abstract the oxygen of the oxide, and so to reduce the iron to the metallic state, after which a still farther portion of the carbon of the fuel combined with the iron, bringing it into the state of easily fusible or pig iron. As carbon can be communicated to the iron in two ways, distinct in their nature, either by contact with solid carbon, as in the process of cementation (that by which steel is commonly converted), or from the carbonated gasses, either carburetted hydrogen, or carbonic acid, which occupy nearly every part of the air-way of the furnace, it would be desirable to distinguish, as far as may be in any furnace having a particular form or action, what proportion of the whole effect is due to the one mode of carbonization or the other.

Mr. Wallace stated that the ore was a carbonate of iron, or a protoxide of iron and carbonic acid united, and not a carburet of iron (or iron and carbon simply), as was generally believed. In smelting, the carbonic acid was driven off, the simple oxyde remaining; the oxygen of which, being carried off by the heat, left the pure iron, which, combining with the carbon of the coke, formed a fusible carburet of iron, or the pig iron of commerce.

Mr. John Taylor observed that his brother, Mr. Philip Taylor, being sensible of the advantages to be expected from the use of anthracite in smelting iron, made a series of experiments several years ago, from which he derived the opinion that the carbon absorbed by the metal, and which is necessary to produce it in the shape of pig iron, must be presented in a gaseous state to the mass in fusion; and as anthracite did not afford a sufficient supply of coal gas during combustion to produce the proper effect, he proposed to adopt a very ingenious method, by which this gas would have been thrown into the furnace in such proportions as might be found necessary, mixed with the common air emyloyed as the blast. Circumstances interrupted the course of these experiments, or it is possible that the use of anthracite for this important application might have taken place at a much earlier period than it has happento do.

Description of Chelson Meadow Sluice. *By* THEODORE BUDD, *Grad. Inst. C. E.*

The sluice which is described in this communication was erected from the designs of Mr. Rendel, for the Chelson Marshes in Devonshire, which, being very low, had previously suffered much from floods, but now are entirely relieved. The novelty in the construction consists in hanging each of the doors respectively by two hinged flat bars of iron, of 18 ft. 6 in., and 15 feet 3 in. in length, and thus, by placing the centre of motion so high above the centre of gravity of the doors, give greater freedom of action than by the modes usually adopted in similar works. The dimensions of all the parts, and the method of construction, are given in great detail, and are illustrated by a drawing.

Remarks.—Mr. Rendel explained that the sluice doors which had been superseded by those described by Mr. Budd, were of the ordinary description, placed side by side. They were frequently hinge bound and clogged up; which caused the land to be flooded sometimes for three months during the year; the hinges were attached in the usual manner to the frames, close at the head of the doors, and they required a pressure of at least 6 inches of water to act upon them either way. He considered the principal advantages of these doors to consist in the freedom of action given by the length of the bar hinges by which they were suspended, their giving the full extent of opening, and the pressure of one inch head of water sufficing either to open or close them.

Mr. Prior inquired whether there was any similarity between these sluice doors and that erected by the President near Blackfriars Bridge, at the bottom of Fleet Ditch. That door was so well hung as to be even acted upon by the wind; and the slightest pressure of water sufficed to open or to close it.

The President explained that the principle was not the same; at the Fleet Ditch sluice double hinges were used, or rather hinges with a link between the part attached to the frame, and that which was screwed to the door;—that form of hinge always acted freely, and allowed the doors to open with a slight pressure.

On the mode practised in India for obtaining solid foundations for bridges, &c., in sandy soils, by means of wells. By Captain Goodwin, *B. E., Assoc. Inst., C. E.*

Piling for the foundation of buildings appears to be entirely unknown in Hindostan; the ordinary mode for securing a foundation, where the superstratum is tenacious and rests upon loose sand, is to dig a well until water is reached; a curb of timber is then placed and upon it a cylinder of brick, 7 1-2 feet exterior, and 3 1-2 feet interior diameter, is built to the height of 3 or 4 feet above the ground. As soon as the masonry has hardened sufficiently, the well-sinker fixes a plumb line to the top of the cylinder as a guide, and descends withinside, carrying an instrument called a "Phaora, or Mamooti," somewhat similar in shape to a hoe; with this he excavates the earth until the water is too deep; he then commences the use of the "Jham," which resembles the "Phaora" in shape, but is about 36 inches long and 27 inches wide, and is suspended to a cord passing over a pulley above the cylinder. Upon this instrument the well-sinker decends, and diving into the water excavates with the "Jham" the soft earth under the sides of the curb, and is at intervals drawn up with the instrument. The cylinder descends gradually from 6 inches to 2 1-2 feet per day, as the earth is withdrawn from beneath it, and relays of workmen keep it constantly going, lest the sand should settle around it, and cause it to hang up. The natives are very expert in this operation, and not unfrequently remain under water more than a minute at a time. The cylinders have been sunk as deep as 40 feet: but with extreme labor.

A series of these wells being sunk at intervals of 1 foot between them, they are filled with a grouting of lime and rubble stone, and separately arched over; arches are then thrown transversely from the centre of each parallel pair, and another set of arches turned over the adjacent wells longitudinally; the whole is then covered with masonry, and the pier or other building raised upon it; such foundations are found to answer perfectly in situations where almost any other kind would be washed away.

The communication was accompanied by a drawing of the process, and of the tools used, showing also the modification of the system proposed by Colonel Colvin, of the Bengal engineers, for obtaining foundations for a curtain, or line of wall, by sinking square masses of brickwork, with two or more wells in each, through which the workmen could excavate the soil.

In answer to questions from the President, Captain Goodwin observed, that the greatest peculiarity of this system was that the sinker worked under water; such had been their custom for ages. Upon this kind of foundation, many of the large fortresses in India were constructed, and they stood remarkably well; whereas, if timber piles had been used, the white ant would have destroyed them in a short time.

Lieutenant Sale observed that another main reason for not using piles was, that timber was scarce and dear, whereas labor was plentiful and cheap. Hence the general use of brick cylinders.

Mr. Parkes conceived the most ingenious part of the proceeding to be, the sinking through the water, and thus avoiding the risk of bringing up large quantities of sand, and the combination of arches for distributing the weight of the superstructure equally among the brick shafts. Such shafts had been used by the Chinese, and sunk in the same manner from time immemorial.

In answer to a question from the president, Mr. Simpson described the process now so much practised for sinking wells through bad strata by means of cast iron cylinders; excavating the earth from within the cylinder by an instrument called a "miser," which is a conical iron shell with a valve opening inwards; it is suspended by iron rods 1¼ inch square, and worked from the level of the ground without pumping up the water: it is not uncommon to excavate to a depth exceeding 100 feet in that manner. The "miser" can bring up a cubic yard of earth each time it is raised. Cast iron cylinders are preferable to brick shafts, which frequently hang up, and in that case give much trouble, whereas if the iron cylinders do not descend freely, they will bear the application of considerable force to drive them down. They are frequently forced through the indurated ferruginous gravel. Light planking is also sometimes used, particularly in such cases as in the well he is now sinking at Chelsea, which is 20 feet square, lined throughout with 3 inch planking. It has reached the quick sand at a depth of 32 feet, and will be stopped there.

Mr. Davison had just completed a well at Messrs. Truman and Hanbury's brewery, with cast iron cylinders, 8 feet diameter, and 193 feet deep, an account of which he promised to present to the Institution.

The President was now sinking a set of cast iron cylinders through sand which was liable to be washed away; they were to be filled with concrete and used as the foundation for a lighthouse at the Point of Air. An account of the construction was, he believed, preparing for the Institution.

REGULATIONS ON RAILWAYS IN FRANCE.

The Minister of public Works, in conformity with the opinion of the committee on steam engines, has provisionally issued the following orders:

1. The employment of locomotives on four wheels is forbidden with passengers' trains.

2. Neither tender nor any other carriage on four wheels to be placed at the head of the trains before the locomotives.

3. The locomotives to be placed at the head of the train, and never behind.

This regulation never to be violated, except in case of changing the direction of the trains at the stations, or in case of a train being stopped by accident, and that it should be necessary to send assistance from behind the train; but in such case the speed of the train not to exceed 22 kilometres the hour (13.7 miles).

It is, moreover absolutely forbidden to enclose a train between two locomotives, one before and the other behind.

4. Until a better mode shall have been discovered to diminish the effect of shocks and collisions, there shall be placed one wagon without passengers at the head of each train, composed of five carriages at most, and of two wagons, when the number of carriages in the train shall exceed five.

5. The passengers' carriages never to be locked.

6. Every railroad company to keep books, in which shall be entered the state and length of service of every axle-tree, whether straight or curved.

7. The Prefect will publish an ordinance, stating the interval at which two trains are to succeed each other.

8. The speed of the trains in their descent from Versailles to Paris, on either line, not to exceed 390 kilometres per hour (24 miles.)

Independently of the above measures, the Minister of Public Works has requested the committee on steam engines to examine—

1. Whether in the descent from Versailles to Paris, and in fact in all rapid descents, it would be adviseable to prohibit the use of more than one locomotive, and, if not, under what regulations they should be tolerated.

2. To discover the best mode of preventing inflammable matter from being communicated by the locomotives.

The Minister is moreover about to appoint a special commission to make experiments—

1. Upon the degree of perfection to which the axletrees of locomotives may be brought, and the length of time they ought to remain in use.

2. Upon the different means to be employed in order to diminish the effects and danger of collisions on railroads.—*Ib.*

VELOCITY OF WATER THROUGH PIPES.

(From Report of Lecture by Dr. Melson in the Medical Counties Herald.)

The calculations for the head of water necessary to keep up a given velocity for every 100 ft. run of pipe, have been so ably deduced, from experiment, by Mr. Rofe, of the Birmingham Waterworks, that the lecturer could not forego the pleasure of pointing them out a little more in detail, and of giving the tables by which the necessary calculations were effected. The tables were two, and were both deduced from absolute experiment—not from experiments conducted by means of tin tubes of small diameter, fit only for laboratory uses, as there was too much reason to fear many of the tables previously published had been constructed, but from the absolute cast iron tubings themselves, as laid down in Birmingham and its vicinity. The tables were two: in the first, V represents the table of velocities in feet per minute, and T the constant numbers of those velocities :—

V	T
60	8·62
70	11·40
80	14·58
90	17·95
100	21·56
110	25·35
120	29·70
130	34·
140	38·00
150	44·
160	49·50
170	55·66
180	62·13

In the latter D represents the diameter of the pipes in inches, and *t* the constant numbers for those diameters :—

D	*t*
3	
4	·028
5	·053
6	·078
7	·104
8	·134

As an application of these tables, the following problem was proposed; it having been premised that the formula for their use was

$$\frac{T}{D \times t} = H$$

where H represents the height, or head of water. It is required, then, to determine what head of water will be necessary to send water by an engine through 1,500 ft. of six-inch pipes to an elevation of 80 ft. at a velocity of 180 ft. per minute. Now, by the table we see that the constant number for 180 ft. velocity is 62·13, and the constant number to be added to 6 inches is ·078,

$$\text{and } \frac{62{\cdot}13}{6{\cdot}078} = 10{\cdot}22 \text{ inches.}$$

which is the head of water required to keep up the velocity of 180 ft. per minute for every 100 ft. run; which being multiplied by 15 (the number of hundred yards through which it has to pass), gives 153 in., or 12 ft. 9 in. This, added to 80 ft., will give 92 ft. 9 in. as the column of water which the pump must lift.—*Ib.*

American Marine Engines.—We have been both astonished and gratified by the reception of a drawing sent to us from America, of an excellent side lever marine engine, constructed by Messrs. Stillman and Co. of New-York, for two steamers built for the Spanish Government, "El Regent" and "El Congresco." It has been so much the habit of Europeans to regard the American machinery as rude and dangerous, as well as unsuited to vessels intended for the navigation of the ocean—an impression in which, to a certain extent, we ourselves participated—that this drawing has, we confess, surprised as much as it has delighted us; and it is an act of justice we feel called upon to render to say that, so far as this drawing will enable us to form an opinion, Messrs. Stillman's performance will not suffer by a comparison with the work of even the first of British manufactures. The framing of this engine resembles the framing of Messrs. Fawcett, Caird, and Borrie, and every part of it appears to us well proportioned and arranged. The ingress and egress of the steam to and from the cylinder is regulated by spindle valves wrought by an eccentric; whether these valves are of the single or double beat description, the drawing does not specify. The eccentric rod is provided with a long nut furnished with a right-handed and left-handed thread, so as to shorten or lengthen the rod at pleasure. There is an expansion valve of the common description situated in the steam pipe, and wrought in the usual manner. We should have been glad to have possessed more precise information respecting the interior of these engines, as for example, the nature of the piston packings of the valves, air pump buckets, as well as some particulars respecting the construction of the boiler, the consumption of fuel, and the nature of the performance as determined by the indicator. We trust we may be favored with such details, and no effort of ours shall be wanting to make the merits of the machinery of America as extensively known and as highly appreciated as its excellence appears to deserve.—*Ib.*

The Tartarus steam vessel, Commander T. W. Smith, arrived at Woolwich on Monday, April 23, from the West Indies. She has been upwards of four years in commission, traversing during that period a distance of 73,000 miles, and consuming about 5400 tons of coal, without, in a single instance, being detained one hour from service for repairs to either hull or boilers.

Railways in France.—The Chamber of Peers assembled on Monday, 9th May, in their committee rooms, for the purpose of electing a committee to report on the railway bill, brought up from the Chamber of Deputies. This bill contains—first, a general classification of the lines intended to be constructed: second, a second system of execution, which imposes on the departments traversed by those railways the payment of two-thirds of the value of the ground to be purchased. It likewise enacts that the Government shall pay the remaining third, together with the expense of embankment, the executions of works of art and stations, leaving the cost of fixing the rails and the *materiel* to the charge of the companies who shall undertake to complete them. Third, the allocation of funds amounting together to the sum of 126,000,000f. applicable to the following sections:—

	Francs.
From Strasbourg to Hommartin, - - - - -	11,500,000
" Dijon to Chalons, - - - - - - - - -	11,000,000
" Marseilles to Avignon, - - - - - -	30,000,000
" Orleans to Tours, - - - - - - - - -	17,000,000
" Orleans to Vierzon, - - - - - - - -	12,000,000
" Paris to Lille, - - - - - - - - - -	43,000,000
For sundry expenses, - - - - - - - - - -	1,500,000
	126,000,000

The entire plan consists of seven of the first order, setting out from Paris, and leading—1 to the Belgian frontier through Lille and Valenciennes. 2. To England, by one or several points on the coast, to be hereafter determined. 3. To the German frontier, through Strasbourgh. 4. To the Mediterranean, through Lyons, Marseilles, and Cette. 5. To the Spanish frontier, through Bordeaux and Bayonne. 6. To the Atlantic Ocean, by Nantes. 7. To the centre of France, through Vierzon, with a prolongation to be hereafter determined, with a branch to Bourges. And of two lines of the second order, from frontier to frontier directed—1. From the Mediterranean to the Rhine, through Lyons, Dijon, and Melhouse. 2. From the Mediterranean to the Atlantic Ocean, through Bordeaux, Toulouse, and Cette.—*Ib.*

The Hon. Company's Steam Frigate Acbar. — On Sunday noon, the 15th ult., this splendid war steamer left her anchorage at Gravesend, bearing the pendant of Commodore Pepper, of the Indian navy, who will assume the command of all the Company's ships-of-war now serving in China, under Admiral Sir W. Parker. The Acbar is a steam frigate of the first class, armed with two eight-inch guns, and four long 32 pounders, with a complement of

160 men, carrying five boats, on two of which are mounted brass 12 lb. howitzers. The engines are of the collective power of 350 horses, manufactured by Robert Napier of Glasgow, and are of a very superior description. She has four copper boilers of about seven tons each. The armoury is filled up with 100 percussion muskets, pistols, cutlasses, and musketoons, etc., the whole in beautiful order, and presenting a most warlike appearance. The Acbar carries 500 tons of coal, which, with a consumption of a ton an hour, will enable her to steam 20 successive days. She made her passage from Gravesend to Falmouth, a distance of 370 miles, in 36 hours, which gives an average speed of more than ten miles an hour.—*Ib.*

Steam Navigation on the Thames.—There are now 16 steam vessels running daily between Gravesend and London, the same number to Woolwich, 20 to Greenwich, numerous small steamers, the boats of the Waterman's Company, and of the Old Woolwich Company—between Greenwich and Blackwall; there are eight steam vessels constantly going up and down the river on their way to and from Dover, Ramsgate, Herne Bay, Southend, and Sheerness. The General Steam Navigation Company musters 49 steamers, all sailing from London, a fleet superior to the steam fleet of any of the continental powers, and which carry merchandize and property to the amount of 1,000,000*l.* sterling weekly, and whose consumption of coals exceeds in value 50,000*l.* per annum. There are not less than 50 other large steam vessels trading between London and various ports in Great Britain and Ireland; 23 steam-tugs carrying from 30 to 100 horse power each, exclusively engaged in towing ships between Gravesend and the Pool; 20 iron and wooden steamers navigating the river above bridge, between London Bridge and Chelsea; 2 constantly running between the Adelphi Pier and Putney, and 5 to Richmond.—*Ib.*

Scott's Monument.—An engraving has just been published, from a drawing by the architect, Mr. Kemp, of the monument to the memory of Sir Walter Scott, at Edinburgh. It is a Gothic elevation, something in the style of what are called "crosses," and bears in some portions a resemblance to the great tower of the Cathedral at Antwerp. It is in style between the florid and the simple Gothic, having flying buttresses, finials, crockets, etc., and being ornamented with quatre feuilles, and more minute embellishments. There are many tabernacles, but they are not occupied by figures. The statue of Sir Walter is placed in the centre, beneath the principal arch; it is robed in a flowing drapery, and stands on a pedestal. The pedestal does not partake of the character of the building, and gives rather an incongruous effect to the whole. There is an appearance of lightness and elegance about the design, but it may be questioned whether the building has not too much of the monastic or clerical style to suit exactly the character of him it is intended to commemorate.—*Ib.*

ARTESIAN WELL IN LONDON.—The sinking of the Artesian well in Piccadilla has, we believe, been attended with the most perfect success, and there is now every probability of an exhaustible supply of the purest water. After boring to a depth of 240 feet water was arrived at, which immediately rose to within 80 feet from the surface. Over the well a handsome iron pump is in progress of erection, and the inhabitants may now reckon upon a certain and plentiful supply of fine spring water. The expense of this useful work is estimated at 600*l.* Such as has been the success of the undertaking, and so many the advantages, that it is said to be in contemplation to carry out the plan in St. George's parish, by causing Artesian wells to be sunk in different localities, best calculated to contribnte to the convenience of the parishioners.—*Ib.*

WELLAND CANAL.—NEW STONE LOCKS.—We are informed on the authority of a letter received from Mr. Killaly by the engineer in charge of the New works on the Welland Canal, that, in consequence of advices received from England by the steamer Caledonia, at the Government House, Kingston, of a full guaranty of abundant means from the Home Government, preparations are to be made for the immediate commencement of the enlarged stone locks on this work, six of which, near the mountain ridge, a guard lock at the junction, and a ship lock of 185 by 45 feet within the chambers, at Port Maitland, (Broad creek,) will shortly be placed under contract, to be finished with all reasonable despatch.

Cleveland Herald.

MORRIS CANAL.—We learn that the Receivers have leased the Morris Canal to Lewis S. Coryell, Esq., who is now busily engaged in completing the repairs, and expects to have it ready for navigation by the first of next month. This canal runs from Easton to Jersey City, through the immense iron region of New Jersey. It cost above four millions of dollars. The company became insolvent, and the property went into the hands of Receivers, by order of the Chancellor of New Jersey. The notes issued by the company are not receivable for tolls on the canal.

LETLERS IN THE ALPHABET.—The Sandwich Island Alphabet has 12 letters; the Burmese 19; the Italian 20; the Bengalese 21; the Hebrew, Syriac, Chaldee, Samaratin and Latin 22 each; the French, 23; the Greek 24; the German and Dutch 26 each; the Spanish and Slavonic 27 each; the Arabic 28; the Persic and Coptic 32; the Turkish 33; the Georgian 36; the Armenian 38; the Russian 41; the muscovite 43; the Sanscrit and Japenense 50; the Ethiopic and Tartarian 202.—*Savannah Georgian.*

Among the strange craft that navigate the Ohio, is a floating glass manufactory. A large flat boat is filled up with a furnace, tempering oven, and the usual apparatus proper for such an establishment. It is in full blaze every night, melting glass ware, which is retailed all along shore, as the establishment floats down stream. It hails from Pittsburg, and is owned by Ross & Co.

AMERICAN

RAILROAD JOURNAL,

AND

MECHANICS' MAGAZINE.

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We take great pleasure in announcing the names of the following gentlemen as occasional contributors to this Journal. Several others whom we have addressed have not yet returned answers.—There are, also, many others who have continually lent us their aid, but who are at present absent from their usual places of residence, and whose names we shall be most happy to add at some future time. The following gentlemen may, therefore, be considered as contributors to the Journal, as their leisure may from time to time allow:—

Joseph E. Bloomfield, Esq.
Wm. R. Casey, C. E.
P. P. F. Degrand, Esq.
Chas. Ellet, C. E.
Chas. B. Fisk, C. E.
E. F. Johnson, C. E.
Benj. H. Latrobe, C. E.
Wm. C. Redfield, Nav. Eng.
and agent Steam Nav. Co.
Jas. Renwick, L. L. D.
Prof. Nat. and Exp. Phil. and Chemistry.
J. E. Shipman, C. E.
Edw. Shotwell, C. E.
Chas. B. Stewart, C. E.
L. A. Sykes, C. E.
Jas. Ed. Thompson, C. E.
John C. Trautwine, C. E.

To all these gentlemen we beg leave to offer our thanks for their prompt reply to our communications, and for the kind interest they have showed in behalf of our undertaking.

NEW EXPERIMENTS ON FRICTION, MADE AT METZ, IN 1831, 1832, AND 1833, BY ARTHUR MORIN, CAPT. OF ARTILLERY.

[Continued from page 8.]

The mode of conducting the experiments having been described in the last number, the results will now be given in a tabular form. It may, however, be remarked, that in the original memoirs each experiment is given in detail with the calculated results, and in most instances with full remarks upon the attendant circumstances. The large number of the curves, traced during these experiments, are shown; but as the object of these, as well as of much of the substance of the memoirs, is to demonstrate the general laws of friction, they need not be repeated. Enough has already been said to convince our readers of the accuracy of the results; and, when we add that each numerical value, contained in the tables, is the mean of a number of experiments, made at different velocities and pressures, and with surfaces of various extent, it will be seen that these values can be employed with the most entire confidence.

The general laws are announced as follows:

I. The friction is proportioned to the pressure.

II. Independent of the velocity.

III. Independent of the extent of surface in contact.

These laws, formerly considered as approximations, are now demonstrated to be strictly and exactly true.

The inspection of the tables will at once give rise to many reflections, which each one may apply for himself, we omit, therefore, all this portion of the work, which being appropriate during the detail of individual cases, is no longer needed when the whole is brought under the eye at once.

The first table contains all the values of frictions ascertained for bodies in motion. The second, (to follow in another number) the frictions caused by substances having remained some time in contact, or what might be called the friction of separation. The third, taken exclusively from the third memoir, refers entirely to the friction of building materials.

Explanation of the Tables.

The first table contains the number of the results, and has been added for convenience in referring to the table.

The second column contains the names of the substances employed, and the order of position: thus, oak upon iron will be found in one place, and iron upon oak in another. The difference caused by the change in position will be found highly interesting, particularly in the case of the metals.

The third column indicates the nature of the substance applied to the surfaces. For the sake of convenience in reference, we have abridged the prolixity of the original tables without leaving any thing unexpressed. The values standing at the head of the table are from the first memoir, and were made without any unguent, properly so called. The condition of the surface is denoted by the terms *wet* and *dry*. When the surfaces are said to be *wet*, it is to be understood, that if capable of being thoroughly soaked in water, they are in that condition. In the remaining portion of the table, (taken from the second memoir) the sign 0 denotes a naked or unprepared surface; *water* is to be understood with the same qualification as above; *olive oil, tallow* and *lard*, denote these substances in their ordinary conditions. The *dry soap* used, was the best quality of blue Marseilles soap, very hard and dry, and pieces of oak well rubbed with it, and then wiped, showed to a casual observer nothing upon their surface, yet the friction was reduced from ·478 to ·164. The substance called *mineral tar*, or asphaltum oil, is said to be viscous, of a reddish brown color, and very much resembling thick molasses. It is found at Bechelbronn, Lower Rhine, and has long been used for the axles of wagons, &c. The author remarks that this substance, unless abundantly used, allows the resistance to increase rapidly until it attain a value nearly as great as if no unguent had been used. This is not the case with paper fats or oils, and is evidently owing to the volatility of the naptha which constitutes a large portion of it. The anti-attrition compound, denoted as *lard* and *plumbago*, consists of *four* parts of the former and *one* of the latter. The term *wheel grease* (*cambouis*) is applied to the substance taken from the axles of vehicles long in use, and, of course, of a very tenacious consistency. Before the experiment it was freed from foreign substances and remelted. No mention is made by the author of the original materials of this composition; we presume that it is nearly or quite the same that is used generally for this purpose.

The word *greasy* denotes that state in which surfaces are left after grease has been employed and then wiped off as much as possible. It is evident, as the author observes, that it is not always possible to produce the same amount of unctionity, the results are therefore not entirely comparable, still they are useful as representing the state in which surfaces may be found after having discontinued the use of an unguent for some time.

The fourth column describes the direction of the fibres both mutually and in reference to the direction of motion. It appears that in all cases the fibres of the lower piece were parallel to the direction of motion, so that the terms in this column may be understood as referring to both. Thus *parallel* denotes that the fibres of the sliding body were parallel to those of the one beneath and to the motion; *perpendicular*, that they were at right angles with the fibres beneath and the direction of motion; *vertical*, that the sliding piece of work is placed on end, the rest remaining as before. In the case of a fibrous substance sliding over bronze or cast iron, the reference is of course only to the direction of motion.

The fifth column contains the numerical values expressed decimally; we have retained this form as being the best suited for comparison and calculation. A few of tne results, from the first memoir, from 1 to 18, will be found repeated in the remainder of the table with slightly different values. In this case the latter are always to be preferred as the most correct.

TABLE I.

FRICTION OF PLANE SURFACES IN MOTION.

No.	Nature of Surfaces.	Condition of Surfaces as to unguent.	Arrangement of fibres.	Proportion of friction to pressure.
1	Oak on oak,	Dry,	Parallel,	·48
2	" "	"	perpendicular,	·32
3	" "	wet,	"	·25
4	elm on oak,	dry,	parallel,	·43
5	" "	"	perpendicular,	·45
6	ash on oak,	"	parallel,	·40
7	fir on oak,	"	"	·36
8	beech on oak,	"	"	·36
9	wild pear on oak,	"	"	·40
10	wrought iron on oak,	"	"	·62
11	brass on oak,	"	"	·62
12	dressed leather on oak,	"	"	·27
13	rough sole leather on oak,	"	leather laid flat,	·52
14	" "	"	leather laid edgewise,	·34
15	" "	wet,	"	·29

No.	Nature of Surfaces.	Condition of Surfaces as to unguent.	Arrangement of fibres.	Proportion of friction to pressure.
16	Thong of hemp on oak,	Dry,	Parallel,	·52
17	plait of small cords of hemp on oak,	"	"	·32
18	hempen rope ½ in. in diameter, on oak,	"	"	·52
19	oak on oak,	dry soap,	parallel,	·164
20	" "	tallow,	"	·075
21	" "	lard,	"	·067
22	" "	greasy,	"	·108
23	" "	0	perpendicular,	·336
24	" "	tallow,	"	·083
25	" "	lard,	"	·072
26	" "	greasy,	"	·148
27	" "	0	vertical,	·192
28	beach on oak,	tallow,	parallel,	·055
29	" "	greasy,	"	·153
30	elm on oak,	dry soap,	"	·137
31	" "	tallow,	"	·070
32	" "	lard,	"	·060
33	" "	greasy,	"	·119
34	hide leather on oak,	0	"	·296
35	wrought iron on oak,	water,	"	·256
36	" "	dry soap,	"	·214
37	" "	tallow,	"	·085
38	cast iron on oak,	0	"	·490
39	" "	dry soap.	"	·189
100	" "	water,	"	.218
101	" "	tallow,	"	·078
102	" "	lard,	"	·075
103	" "	olive oil,	"	·075
104	" "	greasy,	"	·107
105	copper on oak,	tallow,	"	·069
106	" "	greasy,	"	·100
107	hemp on oak,	water,	perpendicular,	·332
108	elm on oak,	dry soap,	parallel,	·139
109	" "	greasy,	"	·140

No.	Nature of Surfaces.	Condition of Surfaces as to unguent.	Arrangement of fibres.	Proportion of friction to pressure.
110	oak on elm,	0	"	·246
111	" "	dry soap,	"	·136
112	" "	tallow,	"	·073
113	" "	lard,	"	·066
114	" "	greasy,	"	·136
115	cast iron on elm,	0		·195
116	" "	tallow,		·077
117	" "	olive oil,		·061
118	" "	lard 4 parts and plumbago 1 part,		·091
119	" "	greasy after tallow,		·125
120	" "	greasy after lard and plumbago,		·137
121	wrought iron on elm,	0	parallel,	·252
122	" "	tallow,	"	·078
123	" "	lard,	"	·076
124	" "	olive oil,	"	·055
125	" "	greasy,	"	·138
126	oak on cast iron,	0	perpendicular,	·372
127	" "	tallow,	parallel,	·080
128	" "	greasy,	"	·168
129	elm on cast iron,	tallow,	"	·066
130	" "	greasy,	"	·135
131	hornbeam on cast iron,	0	"	·394
132	" "	tallow,	"	·070
133	" "	lard,	"	·071
134	" "	lard and plumbago,	"	·055
135	" "	olive oil,	"	·068
136	" "	mineral tar,	"	·060
137	" "	wheel grease,	"	.095
136	" "	greasy,	"	·136
137	lignum vitæ on cast iron,	tallow,	"	·074
138	" "	olive oil,	"	·076
139	" "	greasy,	"	·121
140	wild pear on cast iron,	0	"	·436
141	" "	tallow,	"	·067
142	" "	lard,	"	·068
143	" "	greasy,	"	·173
144	hide leather on cast iron,	0	leather flat,	·559
145	" "	water,	"	·365

No.	Nature of Surfaces.	Condition of Surfaces as to unguent.	Arrangement of fibres.	Proportion of friction to pressure.
146	hide leather on cast iron,	tallow,	leather flat,	·159
147	" "	olive oil,	"	·133
148	" "	leather greasy, iron wet,	"	·229
149	" "	water,	leather edgewise,	·238
150	" "	olive oil,		·135
151	cast iron on cast iron,	0		·152
152	" "	water,		·314
153	" "	soap,		·197
154	" "	tallow,		·100
155	" "	lard,		·070
156	" "	olive oil,		·064
157	" "	lard and plumbago,		·055
158	" "	greasy,		·144
159	wrought iron on cast iron,	0	parallel,	·194
160	" "	tallow,	"	·103
161	" "	lard,	"	·076
162	" "	olive oil,	"	·066
163	" "	wheel grease,	"	·124
164	steel on cast iron,	0	parallel,	·202
165	" "	tallow,	"	·105
166	" "	lard,	"	·081
167	" "	olive oil,	"	·079
168	" "	greasy,	"	·109
169	brass on cast iron,	0		·189
170	" "	tallow,		·072
171	" "	lard,		·068
172	" "	olive oil,		·066
173	" "	wheel grease,		·134
174	" "	greasy,		·115
175	bronze on cast iron,	0		·217
176	" "	tallow,		·086
177	" "	olive oil,		·077
178	" "	greasy,		·107
179	hemp on cast iron,	tallow,	perpendicular,	·194
180	" "	olive oil,	"	·153
181	oak on wrought iron,	tallow,	parallel,	·098
182	" "	greasy,	"	·149
183	cast iron on wrought iron,	tallow,	,	·098

No.	Nature of Surfaces.	Condition of Surfaces as to unguent.	Arrangement of fibres.	Proportion of friction to pressure.
184	" "	lard,		·058
185	" "	olive oil,		·063
186	" "	wheel grease,		·155
187	" "	greasy,		·143
188	wrought iron on wrought iron,	0	parallel,	·138
189	" "	tallow,	"	·082
190	" "	lard,	"	·081
191	" "	olive oil,	"	·070
192	" "	greasy,	"	·177
193	steel on wr. iron,	tallow,	"	·093
194	" "	lard,	"	·076
195	bronze on wr. iron,	0	"	·161
196	" "	tallow,	"	·081
197	" "	lard and plumbago,	"	·089
198	" "	olive oil,	"	·072
199	" "	greasy,	"	·166
200	lignum vitæ on bronze,	tallow,	"	·082
201	" "	olive oil,	"	·053
202	" "	greasy,	"	·146
203	hide leather on bronze,	tallow,	leather flat,	·241
204	" "	olive oil,	"	·191
205	" "	leather greasy bronze wet,	"	·287
206	" "	tallow,	leather edgewise,	·138
207	" "	olive oil,	"	·135
208	" "	leather greasy bronze wet,	"	·244
209	cast iron on bronze,	0		·147
210	" "	tallow,		·085
211	" "	lard,		·070
212	" "	olive oil,		.067
213	" "	greasy,		·132
214	wr. iron on bronze,	0	parallel,	·172
215	" "	tallow,	"	.103
216	" "	lard,	"	·075
217	" "	olive oil,	"	·078
218	" "	wheel grease,	"	·168
219	" "	greasy,	"	·160
220	steel on bronze,	0	"	·152

No.	Nature of Surface.	Condition of Surfaces as to unguent.	Arrangement of fibres.	Proportion of friction to pressure.
221	" "	tallow,	"	·056
222	" "	olive oil,	"	·053
223	" "	lard and plumbago,	"	·067
224	" "	wheel grease,	"	·170
225	bronze on bronze,	0		·201
226	" "	olive oil,		·058
227	" "	greasy,		·134

CAUSES OF FAILURE OF CERTAIN RAIL-ROADS IN THE UNITED STATES.

The pamphlet recently put forth by Mr. Ellet, on this subject, has very properly excited a great deal of attention, on account both of the important nature of the subject, and the remarkable views of the author. The pamphlet having been republished in this Journal, together with certain articles in its favor, and at the same time the opposite side of the question having been argued very fully in certain other articles, our readers are doubtless by this time fully acquainted with the merits of the question. We have expressed our individual opinion as adverse to the views of Mr. Ellet, nor have the arguments more recently brought forward in favor of his position tended to change our previously expressed opinion that these views, however correct in a few instances, are by no means as generally applicable as seems intended.

It is, however, far from our intention to prevent a free and fair discussion of the subject, which is demanded, both by the standing of the parties and the useful results which may grow out of it.

Discussions of this kind are very apt to deal in generalities, and gradually lose sight of the actual points at issue. Desirous of avoiding this, it is proposed to give a few hints of the leading heads under which the legitimate discussion of the question must ultimately fall. It has occurred to us that the observation of those gentlemen who seem disposed to advocate Mr. Ellet's side of the question has generally been directed to a different section of the country from that of those who entertain different views, hence we may be allowed to suppose that the defects complained of by Mr. Ellet prevail more generally in some sections of the country than in others. In short, that while extravagance in the construction of roads and a blind imitation of the English system *may* be noticed in individual instances, the same faults may not be observed, even in unsuccessful Rail-roads, in other parts of the country. In order to satisfy all parties upon this point, and in fact to lay the very foundation of all argument upon the question it will be necessary to obtain a list of all the Rail-roads commenced or completed in the United States; their lengths, cost and annual receipts and expenditures, together with such other statistical details as may be required to form a correct judgment of their actual condition.

Another very important circumstance to be considered, is the difference between the actual condition and value of a stock and its price in the market. To persons at a distance and unacquainted with the mysteries of stockjobbing, the price of stocks is considered a fair criterion of the value of the undertaking. Nothing can be more delusive than such an opinion. In the commencement of the construction of a Rail-road, one or more instalments must be called in, and the immediate effect will be a decline of 5 per cent. or more, according to the amount called in and the scarcity of money at the time.

Again, the operation, technically known as cornering, may raise the price to an unprecedented height without any change in the circumstances of the company. The facility with which the stocks of uncompleted works may be obtained has been the means of greatly swelling the list of what are called "fancy stocks," which are ever after the mere foot-ball of speculators who have not the slightest desire of forwarding the true interests of the undertaking.

The discredit attached to this kind of speculation has indirectly produced unfavorable effects upon the character of Rail-roads as an ve stment, from which, however, they are now recovering. It must also be remembered that many of the best Rail-roads never appear in the lists of stock quotations to counterbalance the low character of the "fancy stocks."

Many Rail-roads, properly constructed and adapted to an extensive traffic, have been ruined by subsequent mismanagement, either from the ignorance or fraud of directors. Improper interference, from the same quarter, with the location of the work has produced the same results.

Finally, it would be difficult to assign any cause or causes for the failure of Rail-roads that would not apply to all other unsuccessful operations in these times of distress and depression, and the reasons assigned for these last are as many as the miles of Rail-road in the United States. May we not, therefore, justly conclude that no one two or three causes can be found for the want of success of *all* of the unsuccessful Rail-roads in the United States.

Enough has been said to show the amount of research necessary for the accurate investigation of this question, and we need say no more to convince our readers of the injury that may be caused by the improper management of the discussion.

[For the American Railroad Journal, and Mechanics' Magazine.]

"A PRACTICAL DESCRIPTION OF HERRON'S PATENT TRELLIS RAILWAY STRUCTURE."—*Carey & Hart, Philadelphia.*

There is no country in the world—not even England herself—so much interested in the subject of railroads as the United States. And this is the case, not alone, because we have more capital invested in them, and a much greater extent of them in actual operation, than any European country, but because they are more necessary to us—to the developement of vast resources and the progressive improvement of our boundless territory—than they can possibly to any other people. It is natural, therefore, that we should look with a deep interest to any improvement which may tend to remove the serious defects, acknowledged on all hands to exist in the present methods of railway superstructure. The high hopes that were entertained a few years ago, as to the results of the system, have certainly not been realized. As a profitable investment of capital it may be considered a complete failure, and this is sufficient to put a check to its further progress, unless some effectual remedy be devised for the evil which lies at the bottom of the system.

* The failure of our railroad system is not attributable to the want of patronage; for the receipts on most of our principal lines for the transportation of freight and passengers, are immense; but they are nearly all swallowed up in the constant repairs of *road and machinery*; and it is well known to all practical engineers that the whole mischief grows out of the *defects of the present modes of superstructure.* The great end of railway structures being the attainment of a permanently *hard even elastic surface, which will offer the least possible resistance to the bodies that have to pass over them,* the slightest deviation from this standard constitutes an imperfection in the structure, which goes to defeat its object and lessen its value. No one who will travel over even the best of our railroads, or cast his eye along their undulating surfaces, will require any other argument to convince him that the great end of Railway structures *is not attained.* "The whole line is a series of short elastic planes, divided only by the regid points of support. This gives to the en-

* We need hardly say that we conceive these assertions to be erroneous.—Ed.

gines and carriages the ruinous undugatory or bounding motions, and as the deflexure of the rails is more considerable next the joints a lurch is added to the bound, which thus results in an awkward wabbling quit, that very soon destroys the engines, carriages, and railway, causing the enormous amount of annual repairs, that absorbs in so many cases the whole income of the railway." We venture to assert, without fear of contradiction, that *no railway has ever yet been constructed in England, or in this country, that has preserved the characteristics of a perfect railway for one moment after the first locomotive and train have passed over it!* From that moment it is *more or less* deranged. The cause is obvious. The superstructure is dependent on, and identified with, the road-bed; and as it will always be found impossible to make all descriptions of soil to "settle" equally, and be equally effected by frost and moisture, so will it be found that the railroad structures *which are dependent upon them*, must yield to their inequalities, and present, instead of a perfectly even surface, a long succession of small hills and valleys; the effects of which are found in the rapid wear and tear of the machinery, as well as of the road itself; the constant necessity for watching and propping the ricketty superstructure, the increased friction, the decreased speed, the frequent accidents, the breaking of axles, the jumping off the tracks, &c. It results then: *First*, that all the evils of the system are in proportion to the extent of the imperfection of the track; or its deviation from the standard of a perfect railway. *Secondly*, That this imperfection, and all its train of evil consequences, must continue as long as the present erroneous principle of construction shall continue; which makes the superstructure dependent for its evenness of surface on the road-bed; which, in the nature of things, never can be relied on for that purpose.

Enough has been said, if indeed it was necessary to say any thing, to show that our whole system of railway superstructure is extremely defective, and based on wrong principles. This has long been acknowledged, but it was more easy to see and deplore the evil than to devise a remedy for it. This remedy however we sincerely believe has at last been found, and we acknowledge an honest pride in knowing that it is to the genius of one of our own countrymen we are indebted for an improvement, which, in its practical results, will be of great importance to our country; and will, at the same time, aid us in carrying on with foreign nations, that noble commerce in the products of science and genius by which we acknowledge ourselves to have been so often benefited, and what we are always happy to reciprocate.

The "practical description of the Trellis Railway Structure," published by Mr. Herron, renders it unnecessary, in a notice of this kind, to enter into the details of his improvements; for those who take an interest in such subjects will refer to the work itself, which ought to occupy a place in the library of every engineer. We will proceed, however, to point out the distinguishing characteristics of the new system. As all the evils of the old system grow out of the dependence of the superstructure on the road-bed, and from its too limited surface bearing on the soil; the grand desideratum attained by the new system, is the almost entire independence of the superstructure of the road-bed. Instead of cross ties and string pieces loosly connected and having little bearing on the surface, the improved tract is a trellis frame work, deriving immense strength from the mechanical principle applied in its construction, and having a very extensive bearing surface on the soil. It is in fact a *strong continuous bridge* which cannot be affected by ordinary inequalities in the road-bed; *nor admit of the slightest vertical or lateral derangments as long as the materials last of which it is constructed.* There are many other improvements, such as a *new* scarph for joining the ends of the string pieces, a new wrought iron chain for securing the ends of the iron rails, and some of minor importance, constituting the whole a beautiful system, and showing in the inventor a thorough and practical knowledge of all the difficulties to be encountered, and an ingenuity and talent fully equal to the task of surmounting them. His estimates prove that the improved structure will cost *less* than the present ones, and this is corroberated by the experiment made on the Baltimore and Susquehanna Railroad. This experiment made on the Baltimore and Susquehanna Railroad two years ago, it appears, from the Baltimore papers, has realized all that was expected from the new system. "*It is in as perfect order, after having stood the breaking up of two winter's frost, as it was the day it was laid down, although it has not received the slightest repair. It has not been touched!*" On a recent visit to Baltimore, we visited and examined the new tract laid down on the Baltimore and Susquehanna Railway near the city, and were struck with the contrast between it and the adjoining track laid down on the old plan. Although it had been in operation two years it was still a *perfect railway,* not having suffered the slightest displacement, vertical or lateral while constant ramming and propping could not keep the adjoining road, constructed on the old plan, in as good condition!

No scientific engineer could read Mr. Herron's work and study his plates and models without being convinced of the soundness of his principles, and yielding to the cogency of his reasoning; but for the world at large something more was necessary the actual test of experiment was required. This is now triumphantly appealed to, and all interested in the subject may satisfy their minds by referring to Charles Howard, Esq. President of the Baltimore and Susquehanna Railroad Company for a confirmation of the facts herein stated.

[From the Civil Engineer and Architect's Journal.]

INSTITUTION OF CIVIL ENGINEERS.

"*Description of the Tanks for Kyanizing the Timber for the permanent way of the Hull and Selby Railway*" By John Timperley.

Upon the recommendation of Messrs. Walker and Burges, the Engineers, it was determined that the sleepers of this railway should be kyanized in close vessels, using exhaustion and pressure, instead of in the open tanks usually employed. The present communication, which includes a description of the kyanizing vessels, and an account of the various circumstances connected with the operation, commences by describing the apparatus, to consist of two tanks, a reservoir, two force pumps, and a double air pump. The tanks are cylindrical, with flat ends, and are made of wrought iron plates, nearly half an inch in thickness; they are 70 feet in length, and 6 ft. in diameter; at each extremity is a cast iron door, flat on the outside, and concave on the inner side, provided with balance weights for raising and lowering it. Each end is strengthened by five parallel cast iron girders, whose extremities are held by wrought iron straps rivetted on to the circumference of the tanks. Notwithstanding the great strength of these girders, several were broken by the pressure applied during the process. The vessels are lined with felt, upon which is laid a covering of close jointed fir battens, fastened with copper rivets; this precaution is necessary to prevent the mutual deterioration which would arise from the contact of the iron and corrosive sublimate. There was originally only one brass force pump, 2 in. diameter, and 6 in. stroke; this being found insufficient, another was added of 4 in. diameter, and henceforward a pressure of 100 lb. per square inch was easily obtained. The air pump is 10 in. diameter and 15 in. stroke. Its construction is of the ordinary kind. The author gives in an appendix to the paper a minute description of the various parts of the apparatus, with the details of their dimensions and weight. The process is simple and rapid; the corrosive sublimate is first mixed with warm water in a trough, in the proportion of 1 lb. of the former to 2 gallons of the latter; the clear solution is then poured off into the reservoir, where water is added till it is diluted to the proper point, which may be ascertained by an hydrometer; a more perfect test is the action of the solution upon silver, which it turns brown at the requisite degree of saturation. The operations of exhaustion and pressure employ eight men for five hours, the whole process occupying about seven hours, during which time from 17 to 20 loads are kyanized in each tank. It is desirable that the timber should remain stacked for two or three weeks after kyanizing before it is used. It was found that about ¾ lb. of corrosive sublimate sufficed to prepare one load (50 cubic feet) of timber. About 337,000 cubic feet of timber were kyanized, the average expense of which, including part of the first cost of the tanks, was about 5*d.* per cubic foot. The timber was tested after the process, and it was found that the solution had penetrated to the heart of the logs.

The paper contains some interesting tables exhibiting the quantity of the solution taken up by different kinds of wood with-without exhaustion; from these it appears that the saturation per cubic foot, in the latter case did not exceed 2·25 lb. with specimens of Dantzic timber, whereas it ranged between 12·24 lb. and 15·25 lb. with pieces of home-grown wood. The author observes that this striking difference may be partly due to the greater compactness of the foreign timber. Appended to this communication is a correspondence between Mr. J. G. Lynde and Mr. James Sampson relative to the best tests of the presence of corrosive sublimate, accompanied by letters from Mr. Colthurst and Dr. Reid; the former of these describes the process of kyanizing adopted on the Great Western Railway, and the latter suggests the three following tests:—1st, dilute hydro-sulphuret of ammonia; 2nd, a strong solution of potassa; dilute nitric acid and proto-muriate of tin, also gold-leaf with this solution; and 3rd, iodide of potassum. Directions are given for the application of these tests.

Mr. Lynde also mentions the use of a solution of nitric acid. and by the application of hydriodate of potash detecting the presence of mercury in a specimen taken from the heart of a log of timber 10 in. by 5 in., and 9 ft. long. He also details appearances of the destructive action of the corrosive sublimate upon the iron-work with which it came into contact, which would be prejudicial to the use of iron bolts in kyanized sleepers.

A drawing explanatory of the whole apparatus accompanied the communication.

Remarks.—In answer to questions relative to the process of exhausting the air from the receiver in which the bank-note paper was wetted at the Banks of England and Ireland previously to being printed, Mr. Oldham stated that as an experiment a packet of 1000 sheets of paper had remained a whole day in water without being wetted through; whereas by exhausting the air from the vessel containing them to a partial vacuum of 22 inches of the barometer, and admitting water, they had been perfectly saturated in five minutes; the edges of the paper in simple immersion would rot away before the mass was saturated; by the exhausting process 5,000 sheets of bank-note paper would absorb 16 lb. of water.

Mr. Simpson conceived that exhaustion would facilitate the process of kyanizing; but he believed that if time was allowed, pressure would accomplish the same end as perfectly, for he had observed that pieces of wood which had remained four or five days in a water-main under pressure had become perfectly saturated. Captain Scoresby, in his account of the whale-fishery, remarks that when a whale carries a boat down it rarely rises again, most prabably because the fish plunges to such a depth that the extreme pressure water-logs the boat; instances had been known of the specific gravity of the planking being doubled by being carried down.

Mr. Newton remarked that immersion of timber in close tanks had been practised by Mr. Langton many years since for bending timber; a boiling fluid was used in the tanks, and the wood was subjected to heat for a considerable period. He had understood that Mr. Newmarch of Cheltenham was the first person who used corrosive sublimate for preserving timber, and that he had prepared and employed considerable quantities of wood. Mr. Kyan subsequently revived the system.

In Mr. Oldham's process of wetting paper, pressure was not requisite, on account of its open texture. About the year 1819, Mr. Oldham had tried the same process with perfect success for preserving meat.

Exhaustion had been tried by Mr. Harris for cleansing wool. The cops of wool were put into an exhausted receiver, a solution of an alkali was then admitted; after remaining a short time in the liquid, a sufficient quantity of diluted acid was added to neutralize the alkali, and the wool was washed out in clean water. The process succeeded perfectly, but was too expensive.

Mr. Palmer had employed the kyanizing process for large pieces of timber, for the ribs of lock gates, but had no means of ascertaining the depth to which the mercury had penetrated. The use of corrosive sublimate was first suggested by Sir H. Davy in his lectures at the Royal Institution, as a means of destroying the vegetating process in timber by the combination of the chlorine in the former with the albumen of the latter. Mr. Palmer much doubted whether the means used for exhausting the capillary tubes effected the object, unless the timber was in a dry state, and he considered it equally doubtful whether the solution could be forced to any considerable depth by compression, especially if any moisture actually filled the capillary tubes. The application of pressure in the process of salting meat suggested by Mr. Perkins many years ago, was a complete failure.

Mr. Simpson observed that in the experiments of Messrs. Donkin and Bramah, pressure alone had been used, and it could easily be understood that owing to the cellular formation of meat, the pressure, instead of forcing the salt through it, caused the substance to collapse and the brine was prevented from penetrating.

Mr. Braithwaite explained that in Payne and Elmore's process, although pressure had been found indispensable, the meat was more perfectly prepared when exhaustion was also employed, therefore both were now combined.

Mr. May reverted to the subject of kyanizing timber; he believed that exhausting the air from the tanks previously to the admission of the solution was a loss of time—the fluid should be admitted first, or at least while the exhaustion was proceeding; labor and time would thus be saved, and the air would be more completely expelled from the capillary tubes before pressure was applied. It was essential that the timber should be as far as possible deprived of its sap as well as dried; as either sap or moisture appeared to prevent the proper action of the corrosive sublimate.

Mr. Cubitt regretted that experiments had not been made on the same kinds of wood both with and without exhaustion. The experiments on small pieces of foreign (Memel and Dantzic) timber with 80 lb. to 100 lb. pressure without exhaustion, showed an increase of weight of from $1\frac{1}{2}$ to 2 oz. in pieces of about $\frac{1}{10}$ part the size of a sleeper, and that result agreed very nearly with his practice with sleepers of Memel and Dantzic timber, when kyanized without exhaustion under a pressure of 80 lb. to the inch; sleepers of $2\frac{1}{2}$ to $2\frac{3}{4}$ cubic feet, gaining from 3 lb. to 5 lb. in weight by the process. No result had been given of experiments with the sleepers of foreign fir timber, in which both exhaustion and pressure had been applied, but it appeared that the Scotch fir sleepers weighing 100 lb. when kyanized under exhaustion and a pressure of 100 lb. to the inch, gained 33 per cent. in weight, which was equal to three gallons of water being forced into less than 3 cubic feet of timber; he thought that this difference could not be all due to exhaustion, but that it must depend greatly upon the quality of the wood, because under a pressure of 100 lb. to the inch, the air contained in a tubular substance (such as fir timber) would all be compressed about $\frac{1}{8}$ of its natural bulk without previous exhaustion, so that the differenc between 5 lb. and 30 lb. forced into a sleeper, could not, he thought, be all due to exhaustion, but must depend upon other circumstances not explained in this paper.

The President thought that the greater degree of absorption by the Scotch fir might be accounted for by its open texture, whereas the foreign timber was more compact and also contained more turpentine. It might also have been wetter than the Scotch fir, which he believed had been the case.

Mr. Taylor observed that hitherto the attention of the meeting had been entirely directed to mechanical action, but that the chemical combination of the corrosive sublimate with the albumen of the wood, was the point most insisted upon by Kyan; it was supposed to be similar to the operation of tanning hides, in which the tanning of the bark combined with and saturated the animal gelatin, which would not otherwise be permeable by the fluid in which it was placed.

Lieut. Oldfield suggested ~~that~~ if the timber, when piled in the tank was subjected to the action of heat at 212°, the moisture contained in the capillary tubes would be expelled in the form of steam, and that on the admission of the solution, the tubes would instantly be filled with it, because of the partial vacuum formed in them.

Mr. Colthurst observed with regard to the tests for ascertaining the amount of saturation of the timber, that he had tried all those described by Mr. Lynde, and had not been able to discover the presence of mercury in the heart of any of the timbers prepared for the Great Western Railway; their dimensions were 6 in. by 12 in. Dr. Faraday had, he believed, detected it by the aid of the galvanic battery in the heart of a piece of timber 2 ft. square, after simple immersion in the solution for fourteen days.

Mr. Moss had tried many experiments as to the most delicate tests for ascertaining the depth to which the mercury had penetrated; the most satisfactory test was gold-leaf, as from its strong affinity for mercury, the presence of the latter was immediately detected. The mode of proceeding was to put some fibres of the wood to be tested into a small test tube, mixed with a portion of dry carbonate of soda; then to place over, but not in contact with it, a small piece of gold-leaf, and apply heat to the bottom of the tube. If any mercury was present, in however small a quantity, the fumes would rise and discolor the gold-leaf.

Mr. W. Cubitt said that timber was at all times, more or less, charged with moisture; he had found deals, supposed to be dry, lose 10 per cent. of their weight from steam drying; it was evident that the presence of moisture in the pores of the wood must militate against the success of kyanizing by simple immersion, unless it was continued for a very long period. In close tanks, when exhaustion and pressure were resorted to, the moisture was perhaps of less importance; but still, if the sap was extracted, and the timber previously dried, the process of kyanizing would be more efficient.

Mr. S. Seward adopted Mr. Palmer's position, as to the almost impossibility of forcing the solution through the capillary tubes of a long piece of timber, the pressure being applied equally all over the surface: he believed the present method of kyanizing to be very imperfect, and alluded to a number of sleepers so prepared for the West India Dock warehouses having been recently discovered to be decayed.

Mr. Martin confirmed this account of the decay of the sleepers; fifty out of seventy were destroyed; they had been prepared by simple immersion, and had been down about five years. He had understood that some of the wooden tanks in which the solution was kept at the Anti-Dry Rot Company's yard were decayed.

Mr. C. May believed that the destruction of the tanks might have arisen from the constant corrosive action of the mercury, and not from decay. The capillary vessels of timber filled with air and sap, under exhaustion the air would expand and drive before it a considerable portion of the sap and moisture. In preparing the compressed treenails and wedges he used steam, and found that the pores were opened by it. He suggested that steam should be blown through the tanks until all the timber in them was raised to a certain temperature, and then by opening the communication with the reservoir the solution would rush in and fill up the vacuum.

Mr. Cowper believed that it was only necessary to bring the chlorine of the corrosive sublimate and the albumen of the timber into contact, when sufficiently dry, to insure the preservation of the wood. He had occasion to try experiments with paper pulp, and was constantly annoyed by its decaying—but the addition of a small quantity of chlorine had preserved it good for two years, and he believed that it would continue unchanged.

General Pasley confirmed the statement as to the increase of the specific gravity of timber from long immersion at considerable depths. He had found all the timber, except the mainmast, in the Royal George, at a depth of about 90 ft. water-logged. The oak timber had increased on an average more than 50 per cent. above its usual specific gravity.

Mr. F. Braithwaite remarked upon the doubt which appeared to exist among members as to the correctness of that part of Mr. Timperley's paper where a sleeper containing 3 cubic feet of timber was reported to have increased to 30 lb. in weight. Mr. Braithwaite had made some experiments, the results of which showed that a piece of Memel timber containing 533 cubic inches, and weighing when dry 9lb. became double its weight when subjected to a pressure of about 320 lb. per square inch without previous exhaustion; the machine which he used not being provided with an air pump. A smaller piece of American pine, containing 76 cubic inches, and weighing 1 lb. 7 oz. increased in weight to 3 lb. under a similar pressure. This, he contended, established the correctness of Mr. Timperley's Report. There appeared also to be a misconception as to the amount of corrosive sublimate employed; the paper states that ¾ lb. was the quantity used for each load of timber of 50 cubic feet. He promised to make some further experiments, and report them to a future meeting.

Mr. Bull had prepared considerable quantities of boards for the Calder and Hebble Navigation, by immersing them in the solution for two or three days, which was about double the period allowed by the patentees. He had some specimens of the boards, and in almost all of them there was an appearance of decay in various stages. An oak board, 1 in. thick, kyanized in 1839, had lain ever since upon the damp ground exposed to the air; the sap part was decayed, but the heart remained sound; fungus was, however, growing upon it. Poplar boards, kyanized in 1838, 39, and 40, were all partially decayed; those which were not prepared, and had been exposed in the same situation for the same period, showed, however, more symptoms of decay. In preparing the timber he had always followed the instructions of the patentees, and had tested the strength of the solution with the hydrometer, but had mixed up fresh solution even more frequently than was supposed to be required. On dismantling one of the tanks for holding the solution, he found the iron-work partially destroyed and entirely covered with globules of mercury.

Mr. Thompson explained that the hydrometer was not a correct testing instrument if any vegetable matter was present in the solution; that the tanks on the premises of the Anti-Dry Rot Company were necessarily made of unprepared timber; that the bichloride of mercury in solution would penetrate any length of timber, if the extremities of the sap vessels were exposed to its action, but that it would not penetrate laterally without pressure; it was not, therefore, surprising that a water-tight tank of unprepared wood should decay on the outside, even if filled with the solution. With regard to the strength of the solution, at first it was believed that 1 lb. of corrosive sublimate to 20 gallons of water was sufficiently strong, and much timber had been so prepared, but experience had since proved that the strength of the mixture should not be less than 1 lb. to 15 gallons, and he had never found any well-authenticated instance of timber decaying when it had been properly prepared at that strength: as much as 1 in 9 was not unfrequently used. In a cubic foot of wood prepared under a pressure of 70 lb. per square inch, mercury had been found by the galvanic battery to have penetrated to the heart.

Mr. Horne mentioned that a new process had been invented by Mr. Payne for rendering timber proof against dry or wet rot, and the ravages of insects; for increasing its durability and rendering it incapable of combustion. The mode of proceeding was to impregnate the wood with metallic oxides, alkalies or earths, as might be required, and to decompose them in the interior of the wood, forming new and insoluble compounds.

Mr. Taylor drew the attention of the meeting to a Memoir on the Preservation of Woods which had been read before the French Academy of Sciences by Dr. Boucherie. It was argued, that all the changes in wood were attributable to the soluble parts they contain, which cause fermentation and subsequent decay, or serve as food for the worms that so rapidly penetrate even the hardest woods. By analysis it was found that sound timbers contained from three to seven per cent. of soluble matter, and the decayed and worm-eaten, rarely more than one or two per cent.; since, therefore, the soluble matters of the wood were the causes of the changes it underwent, it became necessary for its preservation, either to abstract these soluble parts, or to render them insoluble, by introducing substances which should prevent their fermenting. This might be done by many of the metallic salts or earthy chlorides. Pyrolignite of iron was particularly recommended as being a very effective substance and cheaper than corrosive sublimate. The process was, to immerse the end of a tree, immediately after it was felled, in the solution of metallic salt, when, the vital energies not having ceased, the fluid was absorbed throughout all the pores of the tree, by a process which is termed "aspiration." The fluid had been applied in bags, to the base of the trees when in a horizontal position, or to one of the branches, or by boring holes to the heart, a few branches and a tuft of leaves being always left at the top of the principal stem. It was necessary to apply the process speedily after felling the timber, as the vigor of the absorption was found to abate rapidly after the first day, and became scarcely perceptible about the tenth day, whilst in dead wood, or where there was any accidental interruption of the flow of the sap during growth, the "aspiration" entirely failed; resinous trees absorbed less of the fluid than any other. The ends proposed to be attained by this process were chiefly—preserving from dry-rot; increasing the hardness and the elasticity; preventing the usual changes of form or splitting; reducing the inflammability and giving various colors and odors, according to the nature of the fluid absorbed.

Mr. Bethell remarked that the process described in Dr. Boucherie's pamphlet, was identical with that patented by him July 11th, 1838, two years before Dr. Boucherie's was mentioned in Paris, which was in June, 1840. The specification filed by Mr. Bethell stated "that trees just cut down may be rapidly impregnated with the solution of the first class, hereafter mentioned (among which is included the pyrolignite of iron) by merely placing the butt ends in tanks containing the solution, which will circulate with the sap throughout the whole tree; or it may be done by means of bags made of waterproof cloth affixed to the butt ends of the trees and then filled with the liquid."—Mr. Bethell found that some solutions were taken up more rapidly by the sap and circulated with it more freely than others, and the pyrolignite of iron seemed to answer best; he had not hitherto introduced the process in England, because it was much more expensive than the oil of tar, the pyrolignite costing from 6*d.* to 9*d.* per gallon, and the oil being delivered at 3*d.* per gallon.—Mr. Bethell had used similar tanks to those described in Mr. Timperley's paper for preparing wood with the oil of tar, but as the oil is very penetrating, previous exhaustion of the air had been found unnecessary, the hydrostatic power being sufficient. The mode of working the tanks was to charge them with timber, close them and fill them with the oil; a hydrostatic pressure of from 100 lbs. to 150 lbs. to the inch was applied by means of the force-pumps, and kept up for about six hours; this was sufficient to cause the wood to absorb from 35 to 40 gallons per load. By this means a charge of timber was easily prepared daily, the cost being about 14*s.* per load. This was the plan pursued at Manchester for the Manchester and Birmingham Railway, by Mr. Buck (upon the recommendation of Mr. Robert Stephenson), and also at Bristol and Bridgewater by Mr. Brunell. Mr. Bethell preferred egg-shaped ends for the tanks as they resist the pressure better than flat ends. The solution of corrosive sublimate used at Hull appeared to Mr. Bethell to be very weak. The advice given by Sir Humphrey Davy to the Admiralty many years since was, to use 1 lb. of corrosive sublimate dissolved in 4 gallons of water, and Mr. Kyan in the specification of his patent states that strength, but according to the paper it appeared that 45 gallons of water were used to 1 lb. of the salt instead of 4 lbs.

In answer to a question from Mr. Pellatt. Mr. Bethell stated that his experiments on the use of silicate of potash or soluble glass for rendering wood uninflammable, were not yet concluded; he had proved its efficacy in this point—that as soon as the prepared timber was heated, the glass melted and formed a filmy covering over the surface which protected it from the oxygen of the air and prevented its catching fire. The silicate also hardened the wood and rendered it more durable. This process was included in his patent of July 11, 1838.

Professor Brand could add but little to what had been said on the subject, but he mentioned a curious appearance in a beech tree in Sir John Sebright's park in Hertfordshire, which, on being cut down, was found perfectly black all up the heart. On examination, it was discovered that the tree had grown upon a mass of iron scoriæ from an ancient furnace, and the wood had absorbed the salt of iron exactly in the same manner as had been described in the new process. The degrees of absorption of various solutions by different woods demanded careful experiments, as some curious results would be obtained; it was a question whether a solution of corrosive sublimate in turpentine, or in oil of coal tar would not be advantageous, as both substances were so readily absorbed by timber.

REPORT OF THE ENGINEER IN CHIEF OF THE GEORGIA RAIL ROAD AND BANKING COMPANY.

ENGINEER DEPARTMENT, Geo. R. R. and B'kg. Co.
Greenesboro', April 15th, 1842.

To the Hon. JOHN P. KING, President Geo. R. R. and B'kg. Co:

SIR,—The enterprise as originally contemplated by the Georgia Rail Road and Banking Company, may now be considered as finished, and the expenditures constantly accruing during its construction, have been brought nearly to a close: upon which auspicious event, I offer the stockholders my sincere congratulations.

The cost of the entire Road—147½ miles in length—and outfit, consisting of Locomotives, Cars, Shops, Machinery, Depots, Water Stations and Dwellings, exclusive of Real Estate, Right of Way, &c., (not included in the original estimate) is \$2,283,000; the estimated cost was \$2,250,000. Including Real Estate, &c., &c., the cost is \$2,363,000. A few expenditures yet remain to be made, but they are of little consequence and will not materially vary the result. Of the 147½ miles of road mentioned above, there are 104 miles from Augusta to Madison on the Great Southern Mail Route, called the main line; nearly 40 miles on a branch to Athens, and 3¾ miles to Warrenton. Of the main line 29 miles are constructed with a T rail of 46 lbs. per yard, and the remainder a flat bar of 29 tons per mile. The shortest radius of curvature, on any portion of the road, is 1,910 feet, and steepest gradient 7-10ths in 100 feet; (rather less than 37 feet per mile,) and this occurs west of Greenesboro' only. These maximum rates can be preserved without difficulty, on the extension from Madison to the terminus of the Western and Atlantic Rail Road; upon which line the greatest inclination throughout its course to the Tennessee river is 33 feet per mile, and shortest curve 1,000 feet radius.

The surveys and construction of your road have occupied over seven years, during which time I have had the honor to conduct its operations, both in relation to the planning and execution of the work, and the organization and general management of the business of the road. As most of the members of the present Board were not among those with whom I first commenced my operations, I shall briefly refer to some past occurrences, for the purpose of explaining the origin of the present organization for conducting the transportation of the road, which it is important to the proper understanding of the subject, should be recollected. When but a small portion of the road was completed, the Board appointed a superintendant to whom I then, in consequence of the extent of my other engagements, hoped to have committed the entire charge of the work as it was placed in readiness for transportation. A very short trial of his qualifications, however, convinced them that these expectations could not be realised. A new organization then becoming necessary, a resolution was passed by the Directors, empowering me to organize the Departments requisite for conducting the business of the road in use, and to appoint all officers and fix their rate of compensation. In compliance with the duty thus imposed on me, I proceeded to effect the organization, which, with a few changes of Officers, has continued to the present time. By this arrangement, I continued in general control of the operations of the finished Road, and divided the several Departments, as follows:

1. For the Department of Transportation proper, a Superintendant was appointed, whose duty it is to see to the regular and safe transmission of all produce, merchandise, &c. sent by the Road. He also acts as assistant Gen. Agent of the Company, and in the latter capacity has, during the absence of the General Agent entire control of the other Departments. The purchase of supplies for the road, is likewise entrusted to him.

2. To the Superintendant of the Motive Power Department, the repairs and preservation of the Locomotives are entrusted, together with the general operations of the Machine Shops.

3. A Superintendant of the Car Factory, who is charged with the building and repairs of all the cars and other incidental carpenter work of the Company.

The two last officers also engage in the active manual labor of their shops.

4. The Maintenance of the Road, was confided to two Supervisors, now increased to three. To one is given the 49 miles of the Road, and the Branch to Warrenton; to another the remainder of the Main Line, 55 miles; and to the third, the Athens Branch, 40 miles. It is also the duty of the Supervisors to inspect all lumber for repairs and measure the wood obtained on their divisions for the Locomotives, &c.

The office of Superintendant of the first and most important department, was filled by the appointment of RICHARD PETERS, JR., (who had previously acted as my principal assistant engineer on construction,) the duties of which appointment he has continued to fulfil, with zeal and ability, up to the present time. The heads of the other departments, have since the first organization, been changed. The names of the present Superintendants will be found in Statement No. 8, together with a list of all the Officers of the Road and their rate of compensation.

This organization is thought to be as efficient as any that can be made; if however the Board should think a remodelling of it desirable, I beg that they will not consider me in the way of *any* change in the system that may seem to them best for the interest of the Stockholders.

The receipts of the Road for its ordinary business this year, exceeded those of last year, by $66,050 52. The number of passengers carried is 32,784, which is nearly the same as last year, but in consequence of the greater proportion of through travel, the amount received from them is increased $6,607 77. About 20 per cent of the whole travel, is brought to the head of the road in stages. the remainder of the increased receipts is on freight, except a small addition for mail service, and it is remarkable that the Up and Down freights only differ a few hundred dollars. The first, however, is derived chiefly from through transportation, while the latter is in a great measure picked up at the Way Stations. For instance, at Greenesboro', the receipts for Cotton are $6,450, and on Up Freight but $3,315; whilst at Madison, the receipts for Up Freight are $38,458 81 and for Down but $30,324; the disparity on the Athens Branch is still greater. The reasons for this are obvious.

Our whole receipt for Passengers, is $73,193 65. which, if we had had the privilege of charging at the low rate of 6 1-4 cents per mile, the amount would have been $91,867, an increase nearly sufficient to pay the whole expenses of "Conducting Transportation," and at this rate, I would venture to assert, that there would be no sensible decrease in the travel. I have before called the attention of the Company to this subject, and I again refer to it, from a conviction of its great and growing importance to their interest. I am aware that there is an opinion prevalent in the country, that low prices produce the largest net profits, and that this opinion, as erroneous as it is in its general application, is maintained by many of your own Stockholders. There is doubtless a medium rate, which will give to the Company the largest profits, and this rate, instead of being uniform and applicable to all roads, as generally supposed, is controlled by the amount and character of the travel on each work.

In Europe and the more densely peopled sections of our own country, where, in addition to an amount of travel proportioned to the greater population, there is a class of mechanics and laborers who would not use railroads at high rates—low fares are no doubt both politic and profitable. But with us, this class is almost unknown, and our whole travel only averaged us 40 in 1839, and this year, 31 per day each way. When it is remembered that it costs nearly as much to convey these 31, as a train containing two or three hundred, it will at once be admitted that the rates adopted for that Road where this number can be obtained, are not applicable to our circumstances; yet such appears to have been the views of those who applied for our act of incorporation.

I have also objections to the limitations on our rates of freight, though in the aggregate they are sufficiently high. The true policy, it appears to me, is to allow these matters to be governed by the natural laws of trade, untrammelled by legislative restrictions. If, however, such must be imposed on the company, it should be on the amount of their dividends, which might be limited to a reasonable per centage on the cost of the work. Then, the several sources of the revenue of the Company, will be left free to bear each its due proportion of the current expenses.

It is conceded that there may be circumstances, even on our own road, which would justify a resort to low fares on a portion of the travel, not however lower than our present rates, (5 cents per mile;) but it would only be admissible under an agreement for a general reduction throughout an extended line, thus embracing a large amount of population, and with a view to divert the travel from other channels.

Such a project, having for its object a competition for the travel that now flows up the Mississippi, has been entertained by the several Railroad and Stage Companies on the great mail route, from Baltimore to Mobile, and favorably received by all except the S. C. Canal and Railroad Company, and in consequence of their opposition, has been abandoned for the present.

A reduction was made in our rates of freight on Cotton, after the commencement of the season, in conformity with the general wish of the Board of Directors, which has decreased our net receipts some $6,000. That we may be ultimately benefitted by this reduction is probable. After this season it is proposed to take Cotton by weight, instead of by the bale, in consequence of the advantage which many of the planters have taken of the company by enlarging the size of their bags; the price to vary according to circumstances, from 45 to 50 cents per 100 lbs. per 100 miles for Round Bales, and a reduction of 10 per cent. for Square Bales.

To encourage trade on the Athens Branch, the freight on Grain, the only article of export from that region which will bear transportation, has been greatly reduced. In consequence, some 2000 bushels of Corn, have been sent down since December last, which will no doubt steadily increase with the increased production of the country, stimulated by the demand created by the opening of a new market.

With a view of increasing our trade with East Tennessee and North Alabama, I sent an Agent into that region during the past summer, for the purpose of satisfying the merchants as to the advantages of shipping their goods by our route, His visit has been the cause of a considerable addition to our transportation, but was more especially beneficial in awakening the citizens of North Alabama to the policy of forming a direct mail communication with the head of your road. Representations were made from that region to the P. O. Department, simultaneously with those sent from this section, exhibiting the great importance of the connexion to the commercial and planting interests of the countries proposed to be connected, which have resulted in the invitation by the Post Master General, for proposals to transport the mail from Rome to Gunter's Landing, on the Tennessee river, and thence in steamboats to Ditto's Landing, (11 miles from Huntsville,) and to Decatur.—From Decatur the mail passes over the railroad to Tuscumbia, whence it is to be continued in coaches to LaGrange, and to Memphis, on the Mississippi river. The route is to be let this month, and will go into operation on the 1st of July next. From the head of your road to Rome, there is already a tri-weekly line of coaches. When the whole route is established, we may expect a large increase of travel, and also transportion, as the facilities offered by our improvement shall become better known. The country penetrated by this new line, is populous and wealthy, and in seeking this avenue to market, must add greatly to the prosperity of the southern Atlantic cities.

The following statement exhibits a condensed view of the business of the road and expenses, (omitting transportation for the company,) during the year ending on the 31st of March last. Detailed statements will be found accompanying this report, giving every information that can be desired on the subject.

CR.		
By Amount for Passengers Up,	$35,565 11	
" " " " Down,	35,895 72	
" " " Way Pass. on Branches and Tickets,	2,032 82	
" " " Freight Up,	59,610 10	
" " " " Down,	59,358 56	
" " " " Between Stations,	3,737 81	
" " " Premium, Interest, etc.	902 39	
" " " Transportation of Mails,	27,153 12	
		224,255 63
DR.		
For expenses of conducting Transportation,	22,699 97	
" " " Motive Power,	30,011 05	
" " " Maintenance of Way,	38,692 51	
" " " " " Cars,	6,114 50	
	97,518 03	
Less estimated actual exp. of Comp's Transportation,	7,000 00	
		90,518 03
Leaving Net Profits,		$133,737 60

Or about 6 per cent. on our whole expenditure, a portion of which was not brought into use until late in December. Apart from the expenditures on the branches, which have as yet yielded nothing, the profits of the company would be nearly 8 per cent., and if we could have charged $6\frac{1}{4}$ cents per mile for Passengers, they would have been over that rate.

This result obtained during a period of unparalleled depression and embarrassment in the business of the country, will be considered highly satisfactory, and must afford to the stockholders renewed confidence in their enterprise, which requires only to be extended to the State work, to be made one of the most important lines in the country.

Our locomotives are generally in an excellent condition, and adequate to a much larger business than we have had this year. The Georgia and Pennsylvania, the oldest engines of the company, have undergone a thorough repair, and are now, in consequence of the better adaptation of their parts to the circumstances of our road, more valuable machines than when first received.

The accompanying statement, marked No. 7, will exhibit the performance of each engine, and the cost of their repairs; the whole distance run by all the engines, is 152,520 miles, and the expenses of the motive power department, $30,011 05—equal to 19¾ cents per mile. Or, the whole expenses of the road are equal to 63¾ cts. per mile, for each mile the engines have run. The ordinary repairs of the engines, including the re-building of the Pennsylvania and Georgia, are $8,758 28.

The completion of the Athens branch in December last, opened the question relative to the most advantageous power to be used upon it; a question which I have not yet fully determined. The existing arrangement, which is a mixed steam and horse power, answers very well under present circumstances, but when the road begins to decay, steam power will have to be abandoned entirely, or an engine procured that will be suited to the road and trade to be transported. Light engines have hitherto been so inefficient, that until the late improvement of Mr. Baldwin, by which the adhesion of the whole machine is obtained, and at the same time the truck left free to adapt itself to the curve and undulations of the road, I had despaired of their success under any circumstances.

This improvement, however, if there shall not be found some practicable objection to it, after a sufficient trial has been made, must add greatly to the value of freight roads. The adaptation of the weight of the engine to the character and circumstances of the road, which has heretofore been a desideratum, may then be considered as attained.

Mr. B. has offered to furnish an engine of the kind referred too, upon reasonable terms, which will not weigh more on the driving wheels, than is borne by either pair of wheels of our freight cars. As the purchase of such a machine would involve an expense, which under the present exigencies of the company cannot be well incurred, I have left open for future decision, permanent arrangements for conducting the business of the branch—in the mean time, the resources of the country drained by this arm of our enterprise, will be developed, and the extent of the trade to be accommodated by it better known.

As the small cost of grease used for our cars, averaging but little over $2,25 per 1,000 miles run by the trains since we commenced business, has created doubts in the minds of some, as to its correctness; I will observe that the saving in comparison with other roads has been effected by the adoption and adherence to the use of tallow, instead of oil, using but a small quantity of the latter in cold weather. During the past winter, we have been induced by the low price of lard, to make trial of its properties, which has given great satisfaction. Tallow, however, is to be preferred in warm weather.

The cost of maintaining the Way, has, this year, been considerably swelled, which is partly to be attributed to our larger business and the increased length of the road, but chiefly to the wearing out and decay of the timber, on the first fifty miles from Augusta. The average cost of keeping up the line in use, is $276 00 per mile, or for the whole road, $264 33 per mile.

For the next year, there will be a further increase in this item of our expenses, when, it will have attained its maximum, and will probably decrease.

The duration of timber in the exposed situations in which it is placed in railroads, we find will not exceed in this latitude, an average of 5 years. This rapid destruction of the chief material, that enters into the construction of railroads, calls loudly for some remedy. A number of persons stimulated by the expected profits of the discovery, have been constantly engaged in search of an antidote; among whom Mr. Kyan and Mr. Earl have attracted the most attention in this country.

The materials used by both of these gentlemen, had been previously known and applied to wood, as powerful antiseptics, and I believe their only claim to originality, is in the mode of their application, and proportions used. The process of Mr. Kyan, has been sufficiently tested, to satisfy those who have used it, that it at least doubles the duration of wood, and consequently, where this material is costly, it must be very valuable. Its cost at the existing price of corrosive sublimate, is about $10 per thousand feet, board measure, equal to the first cost of our lumber, consequently requiring an outlay which the present experience of its advantages, would not in our case justify. In Mr. Earl's process, Salts, (sulphates of Iron and Copper,) are used, that are cheap and abundant. This preparation is highly recommended by eminent chemists, and has the additional advantage of costing about one half of Kyanizing—but there is as yet insufficient experience as to its advantages.—There are a variety of other substances that have been applied to the preservation of timber, among which, common salt may be mentioned as the most important. It has been used successfully on the Camden and Amboy railroad, and is thought by the managers of that work, owing to its cheapness, to be preferable to any other. A small experiment has been made upon our road, by which its merits will be tested in a few years. Other roads in our State, are trying Mr. Earl's patent on a large scale, the result of which it will, perhaps, be our best policy to wait.

The present knowledge of this science, is too limited for us to derive any decided advantage from it, but I have strong hopes, that the daily increasing importance of the subject, will yet develope—if it has not already been discovered—some cheap method by which this great desideratum can be obtained. The advantages of such a discovery to Railroads, will be incalculable, and must add greatly to the value of their stocks.

The transportation of the United States mail, in both directions after night over our road, has, owing to the numerous freshets this year, been attended with increased hazard, and one serious accident. In consequence, several attempts have been made, without success, to get released from our contract. We have asked this concession from the Department, the more unreservedly, as one of the prominent inducements held out to us, by the then Post Master General, to enter into the contract, has failed. We were assured by him, that no detention should take place to the travel between New York and New Orleans; instead of which, there have been delays continually occurring, either at Charleston, Washington, Baltimore, or Philadelphia, and sometimes at all of these places in one or the other direction.

In consequence of the greater cheapness of the route from New Orleans to New York, by the Ohio river, we could only hope to compete for the travel—when that river is navigable—by giving it the greatest possible despatch; hence the importance attached to this promise.

It has been urged by the department, that every effort has been made that could be done *legally*, to overcome these detentions.—Such may be the case under the circumstances, but it is well known, that a more liberal and sound construction of the Act of Congress, which leaves the amount of compensation almost wholly with the Post Master General—would have enabled him to have surmounted all these difficulties. The law of Congress on the subject, allows the Department to give 25 per cent. more than similar service can be had for in stage coaches; and as if with a view to determine what that amount should be, in our case, proposals were invited for the transportation of the mails, in coaches, parallel with our road, at 7 miles per hour, and the lowest offer received, was $350 per mile; to which, if he had added 25 per cent. as provided for by Congress, would have given us $437,50; yet in the very face of this result, he decided, irrevocably, that the act referred to, fixed the maximum rate of compensation on main lines of railroads, at $237,50, without regard to circumstances. We finally accepted his terms, and found them much more onerous than expected. The degrading spectacle is now exhibited, of a *great* government receiving at the hands of a *poor* corporation, a compulsory service at less than its actual cost Ours is not an isolated case—nearly every railroad company on the Great Mail Route, has the same complaints to make of the unreasonable demands of the Government.

To show that railroad companies have not been exhorbitant in their proposals to the department, it may be stated, that in England, on the great thoroughfares, where the travel alone is sufficient to fill three or more daily trains in each direction, Government pays

$600 per mile, and at this rate, it is deemed cheaper to the Post Office Department, than the old coach service, as the increased speed of the mails, increases also the correspondence of the country, adding in a greater ratio to the revenues of the department, than to its expenses. Before another meeting of our Stockholders, we shall be called upon again, to bid for the transportation of the Great Mail, when we can obtain more favorable terms, or refuse the service altogether.

In reviewing our past year's business, I cannot but again repeat, that I am satisfied with the result. It is true that it falls short of our calculations made in 1836 and 1837—years of universal inflation in the business of the country. But it is still far short of what it will be when our road is united with the great west.

Upon a business this year of about 11,000 tons, and an average of 62 passengers per day, we have received above our expenses, $133,737 on a productive capital of about $1,800,000. A capital invested too, during the reign of these inflations, and which, if the work was now to be executed, could be done for nearly half a million less.

If results such as these, can be obtained during a period of universal despondency—"when the most prosperous among us doubt the foundation of their prosperity,"—what may we not reasonably expect when confidence shall again be restored, and we shall have become participators in the trade of the west. A trade which yields to the Erie canal a tonage 120 times greater than ours, and to various other improvements south of it, nearly an equal amount, not to include that which is floated around the capes of Florida. In considering this subject, it is not to be lost sight of, that Georgia possesses the only route to the west, south of the Erie canal, by which it can be reached, on gradients so low as 37 feet per mile.

The daily improvements in the machinery and construction of railroads, show their capabilities and value have not yet been fully developed. It has been but 12 years since their introduction as avenues of general commerce, and in that short space, they have grown so rapidly in public estimation, that now the most sceptical on the subject are constrained to admit, that they are almost in all cases, greatly superior in point of economy for the transportation of passengers and freight, to their former rivals, canals, or any other artificial way where the amount of trade to be accommodated, is sufficient to authorize their construction in a substantial manner.

That there have been many visionary railroad projects in this country commenced and executed, where the old Indian trail would have been a more appropriate avenue of commerce, is a fact too sensibly felt by a host of sanguine and deluded participators, to admit of question; nor has our own State been free from these excesses. Under the influence and abuse of the credit system, roads have been constructed in Georgia years in advance of the requirements of the population of the country through which they pass.

These instances of failures which all ought to have seen, cannot be adduced as arguments against the system. We are now, however, arriving at an era in regard to them, when the apparent mystification which has heretofore hung over their operations is clearing off, and their merits will then be properly appreciated. Respectfully submitted by

Your Obedient Servant,
J. EDGAR THOMSON,
Chief Engineer and General Agent.

STATEMENT OF THE EXPENSES INCURRED FOR WORKING THE GEORGIA RAILROAD, FROM APRIL 1st 1841, TO APRIL 1st 1842.

Conducting Transportation.		
Stationary, Printing, etc.	$777 56	
Loss and Damage,	1,909 18	
Incidentals,	1,624 68	
Oil and Tallow for Cars,	402 72	
Provisions, Clothing, Doctors Bills and other expenses of Negroes,	2,849 42	
Expenses of Mules and pay of Conductor, Warrenton Branch,	1,062 62	
Expenses of Horse Car on Athens Branch, for first Quarter,	583 34	
Wages of Laborers,	2,022 24	
Agents and Clerks,	8,742 88	
Conductors,	2,024 83	
Work done by Car Factory, repairing Depot Buildings,	220 50	
Do. making new Turning Platform, etc.,	480 00	
		22,699 97
Motive Power.		
Stationary, Printing, etc.,	13 08	
Expenses of Water Stations,	2,518 11	
Incidentals,	329 49	
Fuel,	7,186 61	
Oil and Packing, etc., for Engines,	1,538 73	
Ordinary Repairs of Engines,	8,758 28	
Extraordinary Repairs of Engines,	852 00	
Engine and Firemen,	7,079 33	
Provisions, Clothing, Doctor's Bills and other Expenses of Negroes,	1,735 42	
		30,011 05
Maintenance of Way.		
Stationary and Printing,	13 00	
Men's Wages,	19,549 58	
Provisions, Clothing, Doctors Bills and other Expenses of Negroes,	2,703 06	
Incidentals,	511 99	
Tools,	826 99	
Iron and Spikes,	550 47	
Wooden Rails, Cross Ties, etc.	11,382 80	
Supervisors,	1,733,29	

Work done by Car Factory,	511, 16	
Work done by Machine Shops,	910 17	
		38,692 54
Maintenance of Cars.		
Ordinary Repairs,	3,660 00	
Extraordinary Repairs,	1,287 00	
Renewal of Wheels,	1,167 50	
		6,114 50
		$97,518 03

Statement of Dividends declaired on the Stock of the Georgia Railroad and Banking Company.

Date of making up accounts for dividend.	No. of div.	Stock p'd in on which div. was p'd.	Amount of dividend. *Dol. Cents.*	REMARKS.
Nov. 7, 1836.	1	858,615	26,018	
Feb. 20, 1837.	2	1,170,715	41,452 80	
Oct. 2, 1837.	3	1,434,405	53,962 54	
April 2, 1838.	4	1,919,215	70,492 90	
Oct. 1, 1838.	5	2,011,895	80,300 96	
April 1, 1839.	6	2,116,810	84,178	Declared June, 1839.
Oct. 7, 1839.	7	2,143,317	86,234 68	" Jan., 1840.
April 6, 1840.	8	2,193,952	86,513 48	
April 4, 1842.	9	2,201,612	220,161 20	Res'd fund $86,546 51

OFFICE GEORGIA RAILROAD & BANKING COMPANY,
Athens, May 9, 1842.

The preceding statement, is taken from the Books of this Office.
JAMES CAMAK, *Cashier.*

THE MONSTER STEAM SHIP.—This vessel, which is nearly ready to be launched, is built by three or four spirited individuals on their own speculation in the small town of Derry, Ireland, where a few months previously it was never supposed that a vessel of her magnitude would ever be built; her dimensions are 222 ft. in length between perpendiculars, 37 feet beam, and 26 feet deep in the hold, burthen 1750 tons, B. M., she is to be fully rigged as a 50 gun frigate, the length of main mast to be 90 feet and 33 inches diameter, main yard 79 feet and 22½ feet diameter in the slings, foremast 83 feet and mizen mast 76 feet, she will be able to spread 6,400 yards of canvas. There are three decks, the upper one to be left entirely clear for action, and to be pierced for 44 guns, the windlass and catspan gear will be placed 'twixt decks. She is to be propelled by Smith's Archimedean Screw, which will be 12 ft. diam. and 14 ft. pitch, but the length will be only 7 ft.; it is to make 88 revolutions per minute, the gearing consists of a cog wheel 20 ft. diam., working into a smaller wheel of 5 ft. diam., upon whose axis is the shaft of the screws.—*Engineer and Architects Journal.*

AMERICAN

RAILROAD JOURNAL,

AND

MECHANICS' MAGAZINE.

No. 3, Vol. IX. New Series.] AUGUST 1, 1842. [Whole No. 411. Vol. XV.

NEW EXPERIMENTS ON FRICTION, MADE AT METZ, IN 1831, 1832, AND 1833, BY ARTHUR MORIN, CAPT. OF ARTILLERY.

[Continued from page 41.]

Friction of Surfaces after having remained in Contact.—The force necessary to separate surfaces which have remained for some time at rest, has already been mentioned as being greater than the friction of the surfaces in motion.

Fewer experiments were made in this branch of the subject than in the other, but it was ascertained that the same laws regulate both sorts of friction. A few facts not capable of being exhibited in the tabular form may be mentioned in this place.

Nearly all the experiments show greater discrepancies than in the case of bodies in motion, which is in part accounted for by the fact already mentioned, that a slight vibration given to the apparatus will start the sliding body if a weight sufficient to overcome the resistance of friction in motion has been used, or in other words, the friction of separation is equal to the friction of motion when even slight vibrations occur. The author recommends that in all cases of construction the minimum of friction, namely, that of the surfaces when in motion, should be calculated upon, as no structure can be supposed to be free from all vibration. The author supposes that these vibrations opperate by overcoming the entanglement of fibre produced by a prolonged contact. This conjecture is verrified by another observation that he has made, that vibration does not produce this effect when metals are used, or when the surfaces of wood are thoroughly saturated with water by which the elasticity of fibre is destroyed, and as might be supposed hemp or any other substance not capable of transicoting vibration is also unaffected under the same circumstances.

In some cases a specific cause seems to increase this kind of friction, as when oak rests upon iron. In this instance the gallic acid of the wood acts upon the iron, and produces a gallate of iron which operates both as a cement, and by destroying the polish of the metal. This action is rendered visible by the inky stains of the compound formed. Metals do not appear to have their friction increased by contact to any great degree, that is, it requires little or no more force to start them than to keep them in motion—a remarkable advantage in all machinery into the composition of which they enter.

The use of unguents of any kind appears to have the same effect on this kind of friction, and this is explained by the pressure driving out the excess of unguent and reducing the condition of surface to that denominated *greasy*. Hence in the table the effect of oil, lard, or tallow, will be found nearly the same as that produced by a greasy surface. If there is any difference it is in favor of the harder kind of unguent which cannot be so completely squeezed out by pressure.

These experiments differ from those of Coulomb in assigning a much shorter period for the attainment of the maximum adhesion, while the latter give several days, the former determine a few minutes as the time.

Explanation of the Tables.

The first table contains the number of the results, and has been added for convenience in referring to the table.

The second column contains the names of the substances employed, and the order of position: thus, oak upon iron will be found in one place, and iron upon oak in another. The difference caused by the change in position will be found highly interesting, particularly in the case of the metals.

The third column indicates the nature of the substance applied to the surfaces. For the sake of convenience in reference, we have abridged the prolixity of the original tables without leaving any thing unexpressed. The values standing at the head of the table are from the first memoir, and were made without any unguent, properly so called. The condition of the surface is denoted by the terms *wet* and *dry*. When the surfaces are said to be *wet*, it is to be understood, that if capable of being thoroughly soaked in water, they are in that condition. In the remaining portion of the table, (taken from the second memoir) the sign 0 denotes a naked or unprepared surface; *water* is to be understood with the same qualification as above; *olive oil, tallow* and *lard*, denote these substances in their ordinary conditions. The *dry soap* used, was the best quality of blue Marseilles soap, very hard and dry, and pieces of oak well rubbed with it, and then wiped, showed to a casual observer nothing upon their surface, yet the friction was reduced from ·478 to ·164.

The word *greasy* denotes that state in which surfaces are left after grease has been employed and then wiped off as much as possible. It is evident, as the author observes, that it is not always possible to produce the same amount of unctionity, the results are therefore not entirely comparable, still they are useful as representing the state in which surfaces may be found after having discontinued the use of an unguent for some time.

The fourth column describes the direction of the fibres both mutually and in reference to the direction of motion. It appears that in all cases the fibres of the lower piece were parallel to the direction of motion, so that the terms in this column may be understood as referring to both. Thus *parallel* denotes that the fibres of the sliding body were parallel to those of the one beneath and to the motion; *perpendicular*, that they were at right angles with the fibres beneath and the direction of motion; *vertical*, that the sliding piece of work is placed on end, the rest remaining as before. In the case of a fibrous substance sliding over bronze or cast iron, the reference is of course only to the direction of motion.

The fifth column contains the numerical values expressed decimally; we have retained this form as being the best suited for comparison and calculation. A few of the results, from the first memoir, from 1 to 18, will be found repeated in the remainder of the table with slightly different values. In this case the latter are always to be preferred as the most correct.

TABLE II.

FRICTION OF PLANE SURFACES WHICH HAVE BEEN FOR SOME TIME IN CONTACT.

No.	Nature of Surfaces.	Condition of Surfaces as to unguent.	Arangement of fibres.	Proportion of friction to pressure.
1	Oak on oak,	Dry,	Parallel	·60 to ·65
2	" "	"	perpendicular,	·54
3	" "	wet,	"	·71
4	elm on oak,	dry,	parallel,	·69
5	" "	"	perpendicular,	.57
6	ash on oak,	"	parallel,	·50 to ·40
7	fir on oak,	"	"	·52
8	beech on oak,	"	"	·53
9	wild pear on oak,	"	"	·44
10	wrought iron on oak,	"	"	·57
11	" " "	"	"	·62
12	service tree,	"	"	·62
13	dressed leather on oak,	"	"	·74
14	rough hide leather on oak,	"	leather flat,	
15	" "	"	leather edgewise,	·43
16	" "	wet	"	·79
17	hempen cords on oak,	dry,	parallel,	·64
18	plat of hemper cords on oak,	"	"	·50
19	cord of hemp $1\frac{1}{8}$ in. diameter,	"	"	·80
20	oak on oak,	dry soap,	parallel,	·440
21	" "	tallow,	"	·164
22	" "	greasy,	"	·390
23	" "	tallow,	perpendicular,	·254
24	" "	greasy,	"	·314
25	" "	0	vertical,	·271
26	beach on oak,	greasy,	parallel,	·330
27	elm on oak,	"	"	·420
28	" "	dry soap,	"	·411
29	" "	tallow,	"	·142
30	hemp on oak,	water,	perpendicular,	·869
31	elm on elm,	dry soap,	parallel.	·217
32	oak on elm,	0	"	·376
33	" "	tallow,	"	·178

No.	Nature of Surfaces.	Condition of Surfaces as to unguent.	Arrangement of fibres.	Proportion of friction to pressure.
34	Wrought iron on oak,	Water,	"	·649
35	" "	tallow,	"	·108
36	cast iron on oak,	water,		·646
37	" "	tallow,		·100
38	" "	olive oil,		·100
39	" "	greasy,		·100
40	" "	lard,		·100
41	copper on oak,	tallow,		·100
42	horn beam on cast iron,	"	parallel,	·131
43	" "	lard,	"	·136
44	hide leather on cast iron	water	leather flat,	·621
45	" "	"	leather edgewise,	·615
46	" "	olive oil,	leather flat,	·122
47	" "	"	leather edgewise,	·127
48	" ".	leather grasy, iron wet,	leather flat	·267
49	elm on cast iron	greasy,	parallel,	·098
50	cast iron on cast iron,	0		·162
51	" "	tallow,		·100
52	wrought iron on cast iron	0		·194
53	" "	tallow,		·100
54	" "	olive oil,		·113
55	" "	greasy,		·118
56	steel on cast iron,	tallow,		·108
57	brass on cast iron,	"		·103
58	bronze on cast iron,	"		·106
59	cast iron on wrought iron,	"		·100
60	" "	"		·100
61	wrought iron on wrought iron,	"		·137
62	" "	tallow,		·115
63	bronze on bronze,	olive oil or greasy		·164

For the American Railroad Journal and Mechanics' Magazine.]

COST OF TRANSPORTATION ON RAILROADS—*By. Charles Ellet Jr., Civil Engineer.*

I have never yet seen any formula derived from the experience of active lines, by which the cost of transportation on railroads may be determined with an approach to accuracy. The expenses of maintaining a line of railroad are not all proportioned to the distance travelled by the locomotive engines, nor to the number of tons conveyed; neither are they all independent of these considerations. But the aggregate annual cost is made up of certain items, which are in fact nearly proportioned to the distance run by all the engines; of others which are strictly proportional to the tonnage conveyed; and of others which are nearly or quite independent both of the amount of the trade, and of the distance travelled.

I offer the following rule for the determination of this aggregate, in the belief that every well managed road of ordinary construction, carrying engines of ordinary power, where the transportation is affected at the usual speed, and which accommodates a respectable amount of business, will exhibit results in close agreement with its indications.

This formula is derived from the considerations which follow; and the constant quantities are supplied from the best experience I have been able to obtain from the past management of the public works of this country. In course of time, when the velocity of heavy burthen trains is reduced to 3 or 4 miles per hour, and companies learn to know where and how to economise, it is probable that some of the items may be reduced. But time and experience have yet to decide how much.

I. *Repairs of Road.*—The repairs of a railroad consist of two distinct divisions; the first of which is nearly independent of the amount of the trade, and may be estimated, on the average, at about $500 per mile. The second division is dependent on the amount of the tonnage, and represents the injury done to the road by the passage of one ton of freight. I estimate this wear and tear at $\frac{31}{100}$ of a cent per ton per mile.

II. *Expense of Cars.*—The expense of repairing and renewing the burthen cars is proportional to the distance which they run, or to the tonnage of the line; and may be estimated at $\frac{45}{100}$ of a cent per ton per mile.*

III. *The expense of Agents, Conductors, Force at Depots, Breakmen, and Contingencies of all sorts,* is likewise nearly proportional to the business of the road, and cannot be assumed at less than ***six mills*** per ton per mile.

IV. *Locomotive Power.*—The expense of repairs and renewals of locomotive engines and tenders, the cost of fuel, and the pay of engine men and firemen, is nearly proportional to the distance run; and may be estimated at 30 cents per mile, travelled by the engines.

How to express the cost of maintaining a line of road, under good management, for one year, let us represent by

N the number of miles run by all the engines in one year;

T the whole number of tons, nett, conveyed one mile; and h the length of the road in miles.

Then, according to the preceding data

$$\tfrac{3}{10}N + \tfrac{14}{1000}T + 500\,h$$

will be the aggregate annual cost in dollars (where the business exists exclusively of tonnage) of maintaining the line and its equipage.

If the road accommodates a mixed business of trade and passengers, to obtain the aggregate expense, we must add the term $\tfrac{1}{100}$ P, where P represents the whole number of passengers carried one mile.

This formula takes proper account of the difference of grades; but is not applicable to very short roads,—to roads doing a very inadequate business—by which I mean less business than can be accommodated by one engine of ordinary power—nor to the first four years' operations, while the road, cars and machinery are yet all new.

By applying this rule to the active lines of the country, it will be found that the larger establishments—those which possess a valuable trade, give very similar results. There are none on which the expenses fall within the limit assigned by the formula, excepting, perhaps, one or two which have been recently completed, and on which the expense of renewing the iron, timber, and bridges, and cars, and locomotives, is not yet very sensibly felt. It will be found to suit those cases better a few years hence.

The following translation of a sketch of German railroads has been handed to us by a friend. The list appears to be correct and has been sent to this country as good authority:

[For the American Railroad Journal and Mechanics' Magazine.]

THE RAILROADS IN GERMANY.

1st. *Finished or now constructing.*

1. The Emperor Ferdinand's Northern railroad runs from Vien

na to Bochnia. The whole length is about 60 German miles, of which 26 miles are almost finished as far as Leipzick. The branch railroads (to Brunn, Olmutz, Stockerau and Troppau,) are altogether, perhaps, 20 miles in length. The principal railroad and the branch to Brun, 23 miles in length, cost 3,765,000 German dollars.

2. The Vienna and Raab railroad, from Vienna, through Baden to Newkirchen, is finished for 8 miles, and projected from Vienna through Bruck and Polyneusidl to Pressburg, a distance of 9 miles, and from Patzneuridl through Wieselbourg to Raab, a distance of 9 miles. The railroad to Gloggnitz is 10 miles in length, of which 6⅜ miles, running to Neustadt, is double, will cost 4,550,000 German dollars.

3. The Budweis and Linz railroad, 17 miles in length, from there to Gmunden, has cost 1,680,000. Horse powor is used.

4. The Prague and Pilsen railroad is 14 miles in length, is finished only to Lana, 6⅞ miles in length, and cost 210,000 German dollars. Horse power is used.

5. The Berlin and Potsdam railroad is 3½ miles in length, was built at the expense of 1,378,000 German dollars.

6. The Berlin and Anhalt railroad, running through Wittenberg and Dessau to Kothen, is about 20 miles in length, and cost 4,200,000 German dollars.

7. The Berlin and Frankfort, on the Oder railroad, is 10⅓ miles in length and the cost is estimated to be 2,200,000 dollars, is not yet finished, but probably will be by the end of 1842.

8. Berlin and Stettin railroad is now building and will be finished in 1843. The whole length is 18 miles, and will probably cost 3,028,000 dollars.

9. The Magdeburg and Leipzick railroad runs through Kothen (connected with the Berlin and Anhalt railroad) and Halle to the boundary of Saxony, 14½ miles in length, and has cost 3,020,000 German dollars.

10. The Upper Silesia railroad commences at Breslau, and runs to New Berun, near the Vistula, where a conjunction is proposed with the emperor Ferdinand's Northern railroad. The whole length is about 28 miles, its construction to Oppeln has already made considerable progress, and these 10¾ miles of length are calculated at 1,467,000 dollars.

11. The Rhenish railroad from Cologne through Duren to Aixla Chappelle is 9$\frac{4}{10}$ miles long from there to the boundary of Belgium, 1$\frac{9}{10}$ mile in length, has cost 5,000,000 dollars, and before it is finished will probably cost 1,567,000 German dollars more.

12. The Dusseldorf and Elberfield railroad 3¾ miles in length, is built at an expense of 1,620,000 dollars.

13. The Nurenberg and Furth railroad, 1 mile in length, has cost 124,770 German dollars.

14. The Munich and Augsburg railroad, 8½ miles long, has cost 2,330,000 dollars.

15. The Saxon and Bavarian railroad, running from Leipzick through Altenbourg to the Bavarian frontier, near Hof, is 9 miles in length, and has 1 mile branch railroad from Werden to Zwickau, will cost about 6,000,000, and will be continued through Lichtenfels and Bamberg to Nuremberg.

16. The Leipzick and Dresden railroad with its continuation to the Prussian frontier, where it joins the Magdebourg and Liepzick railroad is 17 miles long, and has cost about 60,000,000 dollars.

17, The Baden railroad will terminate at Mannheim and Basil. The expense for the whole length of 37 miles, is 9,698,000 German dollars for one track, and for two tracks, 13,138,000 German dollars. The track of ⅖ mile, which was opened 13th Sept. 1840, between Mannheim and Heidelberg has cost 693,000 dollars.

18. The Taunus railroad, which unites Frankfort on the Mayne, through Kastel with Wiesbaden, has a branch railroad on which horse power is used to Bieberick, 5 1-2 miles in length, which cost 1,831,000 dollars.

19. The Brunswick and Harzburg railroad, through Wolfenbuttel and Vienenbourg, is 5¾ miles in length, with a branch from Vienenbourg to Goslar, 1 1-4 mile. The railroad of 1 3-5 mile to Wolfenbuettel, has cost about 250,000 dollars.

20. The railroad running from Hamburg to Bergedorff, a distance of 2 1-10 miles, will be commenced in 1842, and will cost 750,000 German dollars.

It appears from the above account that Germany has already finished railroads to the amount of 175 1-2 German miles, and is now building 166 1-3 miles more. Those finished have cost about 38,940,000 German dollars, or 222,000 dollars per German mile.—[This will be 33,300 Spanish dollars per statute mile.] Those now in progress will cost about 43,357,000 German dollars.

II. Projected railroads, the construction of which is almost certain.

1. The Magdebourg and Oschersleben railroad with a branch to Halberstadt, 6 1-2 miles in length, will, perhaps, cost 1,700,000 dollars. The company is formed—the requisite capital subscribed, and the consent of the government given.

2. The Oschersleben and Wolfenbuettel railroad uniting with the Brunswick and Harzburg railroad, and which the government of Brunswick has permitted to be built, is 6 1-2 miles in length, and will cost about the same sum.

3. The Breslau and Freibourg railroad with a branch 8 1-2 miles in length will cost 2,000,000 dollars. The company is formed, and the capital subscribed, and the consent of the government given.

4. The Rhine and Weser railroad, running from Deutz (Cologne) through Eberfeld to Minden, is not determined upon by government, but named in this division because the necessity for it is such that no doubt is entertained of its construction. It is about 34 German miles in length, and will cost not more than 6,120,000 dollars.

5. The Bonn and Cologne railroad runs a distance of 4 miles and will cost 750,000 dollars. It has the consent of the government for its construction, and a company with the requisite funds.

6. The Nuremberg and Bamberg railroad already decided upon by the Bavarian government, and is the continuation of the Bavarian and Saxon railroad to Bamberg.

7. The Frankfort, Darmstadt and Gresheim railroad, will be constructed by a company chartered by their governments for 2,880,000 dollars, and will be 8 1-2 miles in length.

8. The Chemnitz and Zwickau railroad will be a part of the Saxon and Bavarian railroad, which the company intends to build and it will be 6 miles in length, and will cost, according to the first calculation, 1,400,000 dollars.

9. The Brunswick and Hanover railroad. This railroad forms a part of the great railroad line between Magdebourg and Minden. A contract for its construction has been made between the Prussian, and Hannoverian and Brunswick Governments. The parts of the Magdebourg, Onhersleben and Brunswick railroad already are mentioned, and the Hannoverian part will be about 17 miles in length, and cost 3,230,000 dollars.

10. The Altona and Kiel railroad. Among the projected railroads with the greatest prospect of success is that intended to join the North sea with the Elb, as a company for its construction is chartered and the preparations are made. It will be 13 1-2 miles ln length, and cost 2,794,000 dollars.

III. Railroads, the construction of which is proposed, but in regard to which no certainty exists. Only the most important lines are named, and the distance is given by the post route from which some slight variations may occur.

1. The railroad from Dresden through Banlzen, Lobau, Gorlitz, Launzlau, Liegnitz to Breslau is 33 miles in length.

2. The railroad from Frankfort, on the Oder to Breslau is 32 miles in length.

3. The railroad from Augsbourg to Nuremberg is 17 miles in length. The construction of this railroad is now certain, and the consent is given by the Bavarian government.

4. The railroad from Augsbourg to Lindau is 18 miles in length.

5. The railroad from Munich to Salsbourg is 17 miles in length.

6. The railroad from Dresden to Prague is 25 miles in length.

7. The railroad from Berlin to Bergedorf (Hamburg) is 34 miles in length.

8. The railroad from Wismar to Boitzemburg is 12 miles in length.

9. The railroad from Vienna Neustadt to Trieste is 80 miles in length.

10. The railroad from Frankfort, on the Mayne, to Kassel is 21 miles in length.

11. The railroad from Kassel through Muhlhausen to Halle is 26 miles in length.

12. The railroad from Kassel through Karlshafen to Hamm is 16 miles in length.

13. The railroad from Heilbronn to Ulm is 16 miles in length.

14. The railroad from Ulm through Illerthal Leutkirch to Fridrickshafen is 14 miles in length. These railroads, 363 miles in length, will cost about 80,586,000 dollars.

IV. Other railroads appear necessary to connect those which are constructed or constructing.

Commerce in Germany, as elsewhere, requires the communication between ports, markets, places of resort, etc. The problem, which the roads, canals and railroads have to solve, is to put these places in connexion with each other, and with other places of commerce in the shortest, most certain and cheapest manner. I place here the railroad lines together, which are necessary to furnish our native country with the means of supplying the present demands of commerce.

Their railroads are—1. From Eirenach to Bamberg, in length 18 miles.

2. From Frankfort, on the Mayne, to Bamberg, in length, 20 miles.

3. From Heidelberg, to Heilbrum, in length, 7 1-2 miles.
4. From Ulm, to Augsbourg, in length, 9 miles.
5. From Prague, to Vienna, in length 40 miles.
6. From Prague, to Nuremberg, in length, 34 miles.
7. From Prague, to Freibourg, in length, 26 miles.
8. From Stockerau, to Salsbourg, in length 34 miles.

Making 139 miles of railroad, which would cost $42,864,000.

When we now bring together the expenses and the length of all German railroads, we find the following results.

1. Finished railroads		175⅓	German	miles	in length,	which have cost	Ger.	$38,940,000
2. Constructing	"	166⅓	"	"	"	"		43,357,000
3. Chartered	"	124½	"	"	"	"		27,240,000
4. Projected	"	363	"	"	"	"		80,586,000
5. Junction	"	193	"	"	"	"		42,846,000
		1022⅙	German miles.				Ger.	$233,969,000

The Prussan railroads are comparatively the dearest and most extravagantly constructed. It appears, also, that most faults are committed there. The Prussian engineers have, among other things, constructed the Berlin and Anhalt railroad, 1 1-2 inch too wide to unite with the railroads from Magdebourg and Leipzick. All merchandise coming from Berlin or Leiprick must be reshipped at Koethen.

For those who might be astonished at this number, or who believe the expenses to be estimated too high, permit me too remark, that in Great Britain the railroads, 382 miles in length, have required a capital of 404,000,000 dollars, and that in the United State 745 German miles are completed, and 1,300 contemplated.

The population of Germany amounts to	39,000,000
Of Great Britain,	18,000,000
Of the United States,	17,000,000

CIRCULAR.

Sir:—I respectfully beg leave to introduce to your notice my new method of using the common flat bar rail with a cast iron chair (which I have recently invented) in the construction and repairs of railroads, with some few remarks on the expenses of repairs of railroads having the flat and edge rails. Also, the advantages of certain kinds of railroad superstructure—*entire* wooden railroads, etc., etc.

It is as follows, viz: A piece of live oak, white oak, or other solid timber is prepared termed a ribbon 5 inches less in length than the plate rail which is to be used, 5 inches wide on the bottom, and 3 inches wide on the top by 2 1-2 inches thick; each end of this ribbon is dove-tailed 2 inches long, by 2 inches wide on the top, and 2 1-2 inches long by 3 inches wide on the bottom. The ribbon is to be mineralized to increase its hardness as well as to prevent it from decaying. The plate rail is then riveted to it (the ribbon) three inches from each end, also at intervals of 8 inches for its whole length.

To secure this rail and ribbon at the *ends*, cast iron chairs are placed in the centre of the string pieces, the required distance apart. The following is the plan of the chair, for a rail 2 1-2 inches wide; length, 9 1-4 inches, 4 1-2 inches wide on the bottom, with a wing on each side 3-4 of an inch wide, the whole length of the chair 3 inches wide on the top, with a ledge or projection 1-2 inch wide rising nearly to the top of the rail to prevent the flange of the car wheel from moving the ends of the rails horizontally. The thickness of the chairs is the same as the ribbon. Through each wing, are holes to receive the spikes or screws required to secure the chairs to the string pieces. In the chair are openings at each end to receive the dove-tailed ends of the ribbons. The chair being fastened to the string pieces or longitudinal sill, the ribbon, with the plate rail riveted to it, is forced into the opening in the chair, leaving the iron rail projecting 2 1-2 inches over the end of the ribbon, and laying on the top and solid part of the chair, and against the ledge or upward protecting projection. It is there secured by a half inch screw with a head similar to a bedstead screw, running through a hole in the plate rail and also through a corresponding one in the chair (a little oblong to allow for expansion and contraction of the rail,) the screw turning into a nut inserted in an opening running horizontally through the chair.

Thus you will perceive that the ends of the *ribbon* being firmly dove-tailed in the chair, with the rail riveted to it, the projecting end of the rail screwed to the chair will effectually prevent the ends of the ribbons from spreading or sinking with the weight of the car wheels, or rising or moving horizontally, also prevent the *end of the rail* from turning up, which often causes much damage and alarm and is a strong objection to the use of the plate rail.

Timber can be selected and mineralized of a size and quantity that would be required for the ribbons of a road, but would be too expensive for longitudinal pieces; the advantage, however, of the plate rail being well secured to ribbons of solid timber, such as live oak, or the better kinds of white oak, must be very apparent, as there would not be that sinking or yielding of the rail and wood, to the weight of the locomotive and cars as is the case on common timber, such as white pine, and other soft woods frequently used with the plate rail, thereby answering in a great measure all purposes of the expensive edge rail. The ribbons and iron rail are to lay on a continuous surface, secured with spikes or screws, at intervals of about 18 inches, to prevent them from spreading *on the curves*, iron dowels, or pins, will extend from the string pieces into the ribbons. The superstructure best adapted to this rail is described in the report of L. O. Reynolds, Esq., Engineer of the Georgia Central Railroad.

The cost of chairs will be about $200 per mile. White oak ribbons, mineralized, with the plate rail rivited to them with spikes and screws, ready to lay down, $300 per mile. Ribbons made of live oak would make an additional cost of $200 per mile. The iron plate rail, 2 1-2 inches wide by 5-8 of an inch thick, at the present prices of iron, would be $1,100 per mile.

Objections have been made against the use of the plate rail, supposing that a road constructed with it costs more for repairs than one with the edge rail. In a published report of the Baltimore and Susquehanna Railroad Company, I have been informed on that part of their road having the plate rail the repairs are said to have been $700 per mile per annum. William E. Bloomfield, Esq., in a recent communication in the American Railroad Journal, has the following: "The Utica and Schenectady railroad has the disadvantage of the light flat bar, which during the last year in *part* caused the extravagant outlay of $65,279 for the repair of roadway, and fixtures equal to $860 per mile." This statement really makes the flat bar rail appear bad enough, without such an assertion as the former; but one moment's reflection with persons having the least experience in the construction or repairs of railroads must make it appear fallacious. To say that there is a difference of $600 per mile per annum, between keeping the plate and edge rail in order, is too absurd for one moment's belief. Why did not this report explain and let the public know that the plate rail, the repairs of which were $700 per mile, was laid on a superstructure that had been built 9 and 10 years, and the edge rail, the repairs of which were only $100 per mile, was laid on entire new superstructure?

One writer in the Journal says, "the transition from the flat bar to the T rail is instantly perceived by all persons in the train as it passes over." I have not the least doubt but such was the fact, and had the new part of the road, alluded to as having the edge rail, been laid with the plate rail, in a proper manner, there would have been the same "transition perceived," for it is very clear that traveling over an old and decayed superstructure, there will not be that uniform and easy movement as over a new and solid one. It should be recollected that all our first railroads being laid with the plate rail, when we had little or no experience in making a superstructure best adapted to it, and which are now nearly decayed, accounts for the great expense of the repairs of this kind of road, and which is very unjustly attributed to the use of the plate rail. Having some experience in building railroad superstructure, and having closely observed the many plans on which they are built, I feel well convinced that the plate rail laid in a proper manner on a superstructure which experience has proved to be the best, need not cost any more for repairs than the edge rail.

I will now make a short extract from the report of Mr. Reynolds, Engineer of the Georgia Central Railroad, and see how the expense of repairs of that road compares with the others above mentioned. He says, "The cost of maintaining the road, as regards repairs and renewals, is a subject of much interest to all persons interested in its success. For the last half year the expenses of this department have been $50 per mile, which will amount to $10,000 per annum for 100 miles. That part of the repairs comprising the preserving of the arrangement of the part of the superstructure, which on most wooden roads forms a very important item in the expenditure, is with us a mere trifle. On ordinary wooden roads the string pieces require renewal as soon as they exhibit symptoms of decay. With our plan they may be suffered to remain with perfect safety until they are almost entirely decayed; as the iron rail and ribbon are placed along the centre; and the string pieces, firmly bedded in the earth, will support the weight of the engine until they absolutely crush under it. But if the flat bar were applied directly to the surface of the string pieces, that surface would require to be kept always sound and solid. This is effected in our plan by replacing the ribbon, which is done at a trifling expense." So it would appear that the cost of the repairs of this road with the plate rail is only $100 per mile per annum—truly some difference between this sum and $700 per mile, the cost of the repairs of the Baltimore and Susquehanna Railroad.

One other objection has been raised to the use of the plate rail, which is, that it requires more power to move a train over this kind of road, than over one with the edge rail. This is certainly true, that is, as that kind of rail has been used, no kind of care being taken to select timber, when it is well known that some kinds of the same timber have a great deal more solidity than others.—In many roads, white pine string pieces and ribbons have been used to lay the plate iron on; timber of this kind must give to the weight of the locomotive and cars, and consequently require more power to propel a train. But select the most solid kinds of oak, hickory, or maple, and secure the rail well to it, and the difference in power required will be so trifling it can hardly be told. The expense, however, in the two kinds of rails, will be very easily perceived, especially when the proposed tariff goes into operation, which will make an additional cost of $3,000 per mile for the edge rail.

The plan of superstructure adopted by Mr. Reynolds, I have been informed, is in use on some of the graded parts of the New York and Erie Railroad. The advantages of this kind of superstructure, in the repairs of railroads which are much decayed, are very great; for when repairs are made on this plan, it is so much new road or superstructure. The common way in which they are made, continually renewing timber "whenever symptoms of decay occur," without any such advantage, always having an indifferent road. A superstructure of this kind can be rebuilt, and the track being kept in use at the same time, passing trains morning, noon, and night. Further, it can be done by contract, which is admitted by all to be the most economical way of having any kind of labor done.

There are many sections of country where roads with this kind of superstructure might be used to great advantage, without iron, except on curves and inclinations, the locomotives and cars running on the bare wood; and ninety per cent. of the amount that might be expended in their construction would be so much judiciously invested in a proper railroad. Between Chicago and the Illinois river, and between Milwaukee and the lead mines of Wisconsin, they might be made very profitable to the proprietors, and a general benefit to the country, by reducing the present price of transportation two-thirds or three-fourths. Roads of this description are now in use at the coal mines in the western part of this State, and were in general use at the coal and iron mines in England for near a century before iron railroads were introduced. The Penny Magazine has the following on this kind of road: "The regular load of a horse with a cart along the common road was 17 cwt., while on this railroad it was 42 cwt. The advantages so gained appear to have been thought sufficient, and no further economy of power was for some time sought to be obtained. When there were any acclivities or abrupt curves, thin pieces of wrought iron were nailed over those parts of the rail to diminish the resistance opposed to the wheels, and so that one horse could draw 42 cwt., the required maximum of power. No further effort was considered necessary.

To put a railroad on this plan in operation, from the amount of money that could be obtained a sum should be reserved to build the wooden superstructure, and to purchase iron for the curves and inclinations, two or three cheap locomotives and cars; the residue applied to having the best location made that the ground would admit of and the grading of the road. Wherever light cutting or filling occurs, have the grading complete, and the superstructure finally laid. Where there are deep cutting and filling, and timber is convenient, have bents or trussels of any kind of round timber set up on the exact line of the road, and the superstructure placed upon them. Near the cutting have the ground leveled, and a superstructure laid down with iron, (on that part having much ascent or decent, or curves,) such as is eventually intended to be generally used, connecting with the superstructure on the main line of the road. The money applicable to grading should, if possible, be so expended as to leave the inclinations and cuttings together on some one part of the road, having in view, however, to have the longest level on the end of the road where the greatest amount of tonnage would arrive and depart from. As soon as the road is thus completed, have light locomotives placed on the levels of any length, and use horse power on the short levels and inclinations, and as soon as the resources of the Company will allow it, have the inclinations reduced near the business end of the road if there was none more objectionable. The excavations to be carried by cars into the fillings on a permanent track laid down as the cuttings advance. When completed, remove the iron from the temporary superstructure on the inclinations, and have it permanently laid at the termination of the level, also on the most business end of the road, which will make a proper railroad as far as it will extend. The timber dispensed with on the first inclinations removed may be used in other cuttings as they progress.

Where timber is convenient, this kind of superstructure with ribbons of common hard timber can be well laid down for $1000 per mile. It will last, by the renewal of the ribbons, which is done at a trifling expense, ten years. Lest, from its partial description, it may not be fully understood, I will explain it. Flatted timbers, 12 inches wide on the bottom, 8 inches wide on the top, and 10 inches deep, are bedded in the ground, lengthwise of the road, the requisite distance apart, with flatted cross ties, the ends dovetailed or framed into them, from 4 to 5 feet apart; in the centre of these timbers is placed the ribbon, about 4 inches square, on which the car wheels are to run.

It must be very clear that a work of this description could not be long in operation, more especially between Chicago and the Illinois river, or Milwaukie and the lead mines of Wisconsin, before its profits and credit would be such that all the grading could be completed, and the iron rails laid down, on the most approved plan for the whole distance, and the light locomotives disposed of to companies about building wooden roads, or might be used on branch roads where there was not business or capital to justify or make an iron railroad. I am aware that this plan or project will have its opponents, who will contend that there is more economy in expending whatever amount of money can be obtained for a railway in making it complete as far as it will extend. To this kind of argument I would answer, that $200,000 will make a wooden railroad between the two first points above mentioned, which will reduce the present cost of transportation, as above stated, two-thirds or three-fourths, as one horse can not draw on our common roads more than 10 cwt. That amount of money would not make any thing like a perfect railroad for more than half the distance, consequently would not reduce the present cost of transportation that proportion or anything like it; and it is very questionable whether such an investment would be profitable, or the road in such credit as to procure the necessary funds to complete it for the whole distance. As cheap railroads complete are also objected to, for many contend that no railroad is worth having unless it is constructed at an expense of $15 or $20,000 per mile, I will make an extract from a writer in the Philadelphia American Sentinel, a few weeks since, on the light railroad, who says, "I am informed, from undoubted authority, that the first railroad for coal made in the United States is the one at Mauch Chunk, of nine miles in length, which cost about $3,000 for the superstructure, over which have been transported, at least, 1,200,000 tons, which is perhaps a greater business than any other road in the United States, and on this light road it has been as fully proved that velocity can be as greatly extended as if it had been ever so heavy, and that was the first road in this or any other country that effected a motion of thirty miles per hour."

Yours respectfully,

M. J. Clark.

Athens, Pa. July 27, 1842.

[From the Civil Engineer and Architect's Journal.]

MR. VIGNOLES' LECTURES ON CIVIL ENGINEERING, AT THE LONDON UNIVERSITY COLLEGE.

Second Course.—Lecture vi. On the Gauge of Railways.—After some preliminary observations, illustrating parts of the last lecture, and particularly in reference to what was stated respecting the Brighton railway, Mr. Vignoles proceeded to enter on the subject of the breadth or gauge of railway, which he explained to denote the distance between the iron bars which form the track or way. The definition of the gauge of the old tramways, introduced the observation that, from their form being as it were an artificial rut, they were styled by the French *ornieres*, of which the literal translation was, "wheel-rut." The present ordinary railway gauge was 4 ft. 8 1-2 in., and some speculations were made as to the choice of such a particular breadth; and quotations were made from Mr. Wood's *Treatise on Railways* to show that it had been owing to an accidental circumstance—viz. that the first conclusive experiments on the principle of the present locomotive engines had been made on the Killingworth Colliery railway, which was laid to that gauge. In some of the first of the Acts of Parliament for modern railways, it had been made imperative by a special clause to adopt this particular gauge, and many companies submitted quietly to the enactment, thereby preventing all chance of improvement in what was assumed to be perfect *ab initio;* but about six years ago much discussion having taken place as to the proper gauge, this decree was altered, and there is now no limitation in the width of the gauge, which is left entirely to the discretion of the engineer. Now, the consequence is, that although it would be desirable that there should be a standard gauge fixed, yet, so divided have the public been as to what is the right one, that we have at present no less than seven different gauges used throughout the United Kingdom; some of the Scotch lines, for instance. have a gauge of 4 ft. 6 in., and others of 5 ft. 6 in. The Eastern Counties Company have adopted 5 ft. The gauge of the railways in Russia is 6 ft. On the recommendation of the Irish Railway Commissioners, the Belfast and Armagh Railway Company have made their gauge 6 ft. 2 in. On the Great Western Railway the gauge is 7 ft. Now, as much as 18 years ago, Mr. Tredgold, a celebrated and scientific engineer, made the following observations:—"The width between the rails being dependant on the height of the centre of gravity of the loaded carriage, and this again varying with the nature of the load and the velocity, it will be obvious we cannot do better than make the breadth between the rails such, that by disposal of the load, the centre of gravity may be kept within the proper limit in either species of vehicle, whether swift or slow, and it would be desirable that the same breadth and the same stress on a wheel should be adopted on all railways. We would propose 4 ft. 6 in. between the rails for heavy goods, and 6 ft. for lighter carriages to go at greater speed." Now it is remarkable that, during all the discussions that took place with regard to the gauge, this observation was never referred to. When Mr. Brunel broke through that fixed number for the gauge, and adopted another, he gave very strong and sound reasons for so doing; whether he was right in assuming so high a number as seven is questioned by many, but the principle upon which he went was this,—"I have, said he, laid out the line as nearly level as possible; the curves that I have adopted are nearly equivalent to straight lines; I keep the centre of gravity low, by placing the body of the carriage within the wheels, and anticipating greater stability and steadiness, I shall be able to go at a much higher speed, and with much more assurance of safety."—The Irish Commissioners argue thus,—"From the nature of the locomotive engine, its power is so great in proportion to the friction it has to overcome, that it is capable of drawing a load which (even with a greatly increased breadth as compared with common road carriages) extends to a very considerable length, and, in order to reduce this length as much as possible, it is necessary with the present breadth of way to make the wheels run within the frame which supports the carriages; the seats of the passengers are, therefore, placed above the periphery of the wheel, which for the sake of lowering the height of the centre of gravity, is made as small as possible."

One great theoretical objection, therefore, to the narrow gauge, is the increased friction consequent upon the reduction of the diameter of the wheel, since besides what is due to the load, the friction of a wheel, at the axle, may be said to depend upon the proportion of the diameter of the wheel to the diameter of the axle; but, in attempting to carrying out this principle in practice, the axle has sometimes been turned down so small as to produce much greater and more positive inconveniences, and it is very questionable if it be prudent or desirable to make the proportion between the wheel and axle greater than 15 to 1, and which proportion can be obtained with 3 feet wheels. Now, with a 4 feet wheel and a 3 inch axle, the proportion being 16 to 1, it may be well doubted if, on this account alone, the large wheels are worth their greatly increased cost. The commissioners, however, urged that the same carriage room may be preserved, by extending the breadth of bearing of the rails, so as to allow the wheels to run outside the frame, instead of running within it, in which case we can bring the body of the carriage down to the axletree. The gauge may be thus increased from 4 ft. 8 1-2 in. to 6 ft. 2 in.—thus arguing for an increased breadth, that the centre of gravity may be lowered, and the diameter of the wheels thereby reducing the friction, and increasing the power to overcome the "surface resistance." This is, in other words, getting more leverage: but such an advantage, however, does not apply so much to railways as to common roads, for, on the railway, there is little or no obstacle to be found in the shape of surface resistance, except what are as a few grains of dust compared with the obstacles to be found on the common road, or the deep ruts in a wood, which require very large wheels for the timber wain. "At the same time," continued the commissioners, "the load itself may be reduced in height, the bottom of the carriage, or truck frame, being, in this case, limited by the axletree of the larger, instead of the periphery of the smaller wheel, and, with this reduction of height, the wear and tear will be reduced, and the ease of the motion increased. Moreover, the force to be overcome being less with the same load, we may, by retaining the power of the engine the same, carry a greater load than at present with the same velocity, or, retaining the same load, carry it at a greater velocity by increasing the diameter of the driving wheels of the engine; or, if it be not desirable to increase the velocity, the speed of the piston might be reduced, which would be a great practical advantage; or, lastly, preserving the same load and velocity, the form and weight of the engine may be made less, and, probably, the one or other of these arrangements would be adopted, according to the nature of the traffic on the railway. Thus, in passenger and mail trains, it might be desirable to increase the velocity, whereas, in the carriage of heavy goods, it would be most economical to increase the load." "But (say the commissioners) there is a point which must be attended to, and that is, that the whole of the advantages apply only to level lines." Now the Great Western was thus susceptible of having a wider gauge, since the line was made nearly level, for, as the commissioners observe, "in ascending the various gradients and inclined planes, the load has to be raised in opposition to gravity, and the power necessary to effect this is frequently equal to, or exceeds, that which is employed to overcome the friction, and will remain the same to whatever extent the friction is reduced. To avail ourselves fully of the reduced friction, those planes which cannot be worked by assistant power require to be reduced in their slopes, in the same proportion that the wheels are increased, or, otherwise, that assistant power be applied on proportionably less slopes than according to present practice"—that is to say, that the power of the engine is employed in overcoming the friction of the load, and in raising it up several ascents, and what is gained by increasing the breadth of the railway and making the wheels run outside the frames, is only applicable to the former, the latter remaining the same as before; "and the advantage of the alteration would be overated if this circumstance were not taken into consideration." Thus it is that the additional advantage arising from the diminution of friction is so small, when you come to other than nearly horizontal lines, that the advantage is lost. There is yet another reason for increasing the gauge—viz. that we are enabled to construct the machine without being cramped in space for the moving parts, and affording a larger diameter for the boiler; it was this consideration, probably, which first induced practical engineers to pay attention to increasing the gauge above 4 ft. 8 1-2 in. If we had to begin railways again, we should certainly make the gauge wider than 4 ft. 8 1-2 in. In laying out future lines, particularly where the traffic is not great, the point of consideration will be to obtain the greatest advantage at the least expense, and to determine how much the gauge ought to be increased; and Mr. Vignoles stated, that, after having paid a deal of attention to the subject, he gave it as his opinion, that a gauge of six feet would be amply sufficient to satisfy all reasonable conditions. The Irish railway commissioners had observed, "that, at present, the load is seldom equal to the power of the engine, and, this being the case, but little would be gained by a greater breadth of road," with a view only of reducing the resistance, already much inferior to the power by which it is to be overcome, except by allowing an increased speed on the line generally, and on the level planes in particular. With a full and overflowing traffic, there is no doubt it would be advisable to employ the greatest possible breadth of bearing; but, it is useless, or worse than useless, to incur a present expense for a benefit which it is not likely that there will ever be the means of taking advantage of, so that, unless under the circumstances just mentioned—viz. an incessant traffic, Mr. Vignoles thought that a seven feet gauge was over the mark. Mr. Vignoles stated, that the consideration of curves was connected with that of the gauge, that it was a most important element in the consideration of railways and would be taken up in another lecture. The rule given for raising the outer rail, on curves, required the gauge to be included as one element in the calculation, as also the height of the centre of gravity above the rails, which was also contingent on the gauge, as before explained.

[From the Civil Engineer and Architect's Journal.]

INSTITUTION OF CIVIL ENGINEERS.

"*Description of the Iron Skew Bridge across the Regent's Canal, on the Eastern Counties Railway.*" By Edward Dobson, Assoc. Inst. C. E.

This bridge is built with a direct span of 54 ft., at an angle of 79° with the centre line of the canal. The level of the rails is 14 ft. 6 in. above the water, and it is constructed to have a waterway of 44 ft. with a clear headway of 10 ft. above the towing path.

The dimensions of the several parts of the bridge and the mode of putting them together, with the masonry and the cost of the construction, are described in detail, and illustrated by an elaborate working drawing.

As an appendix to this paper a description is given of a bridge over the same canal, on the line of the London and Birmingham railway, on account of the similarity of its construction. The span of this latter bridge is 50 ft., but being made for two double lines of rails, it was thought expedient to have three main ribs instead of two, as in the former. The details of construction of this bridge are also given, with a drawing of one of the main ribs and its tie-bar.

"*Remarks on the Ravages of the Worm* (*Teredo Navalis*) *in Timber.*" By Robert Davison, M. Inst. C. E.

This communication describes the ravages committed by the "Teredo Navalis" upon the fir piles of the foundations of the old bridge at Teignmouth, five arches of which, after having been built 12 years, fell suddenly; the construction of a new bridge thus became necessary, and it is now in progress under the direction of Messrs. Walker and Burges. The worm is described as entering the wood through a hole not larger than a pin, and perforating the timber in all directions, but chiefly in the direction of the fibre, at the same time increasing the size of the holes even sometimes to an inch diameter; a few of the worms had been found of the extraordinary length of 3 ft. They confine their operations between low water mark and the bottom of the river, showing that they cannot exist out of water.

A specimen of part of a log picked up off Jersey was as much perforated, but in a different manner, the worms having penetrated the wood indiscriminately all over the surface; in some cases leaving in the holes a coat resembling the tail of a lobster about 3 in. in length, which showed that the ravages had been committed by the "Lymnoria Terebrans."

The paper was also accompanied by a specimen of wood sheathing charged with nails, from the bottom of a vessel believed to be about 100 years old, together with some of the worms ("Teredo Navalis") for the purpose of showing the peculiar shape of the head—resembling a pair of forceps, with which they cut away the wood.

"*Description of the Roof of Messrs. Simpson and Co's. Factory.*" By John Boustead, Grad. Inst. C. E.

The truss of this roof is double, consisting of two frames of Memel timber. The principals are fitted into cast iron shoes resting on the walls, with projections let into the wall plates; they taper towards the ridge, and there abut against a cast iron ring piece, through which a wrought iron bolt 1 1-4 in. diameter passes, and answers the purpose of a king-post in supporting the collar-beam. To the under side of this beam is attached a heel and eye-plate, to either end of which are linked bolts passing between the principals, and secured by nuts at the backs of the shoes, thus forming efficient ties to resist the thrust of the principal rafters.

The slate boards are supported by five purlins 4 ft. apart, and abut against a ridge piece resting on the kings.

The span of the roof is 34 ft. 3 in. The pitch is about 3 to 1, and the principals are placed 9 ft. apart.

The scantlings of the principal timbers are:—Principals 9 1-2 by

2 1-2 in., tapering to 6 1-2 by 2 1-2 in.; collar beam 7 by 3 1-2 in.; purlins 6 by 4 in.; wall plates 6 by 4 in.; slate boards 1 in. thick; ridge piece 10 by 2 in.

The principals were sawn out by a template, so as to insure the given taper and the accuracy of the angles of the ends; they were then laid on a horrizontal position placed at the required angle, and the collar beam inserted 1-2 in. deep into each principal, and secured by bolts 7-8 in. diameter; the mode of raising the roof is then described.

Some of the advantages of roofs of this construction are stated to be, economy in materials and workmanship, with lightness and simplicity, and that all sagging of the timbers may be rectified by screwing up the nuts of the kings and shoes.

The truss is recommended for building where lofty apartments or coved ceilings are required, and also for its presenting so few points for the suspension of heavy weights that may subject the timbers to strains for which no provision has been made.

From the examinations that have been made, this roof seems to answer satisfactorily; it has been erected three years and a half, and has sustained heavy falls of snow, but the ridge and rafters have preserved their lines perfectly, and the walls show no signs of having been subjected to undue pressure. The design of the roof is simple, its appearance light, and it may be considered an interesting specimen of the art of simple carpentry assisted by iron work.

A drawing of the truss accompanied the paper.

SUGAR FROM INDIAN CORN.

The Agricultural Society of Ontario county has offered two premiums to induce the trial of making sugar from Indian corn, pursuant to instructions given by a Mr. William Webb, of Wilmington. Del. It is stated that 800 to a 1000 lbs. of good sugar can thus be made from an acre. If so, it would be exceedingly profitable business. The material instructions are as follows:—

"I have felt considerable interest in the plan for the cultivation of sugar in temperate climates and have made many experiments; first upon the beet, and recently upon maize, or Indian corn, in the hope of discovering some mode by which the desired end might be attained. The results from the latter plant have been extremely encouraging. The manufacture of sugar from it, compared with that of beet, offer many advantages. It is more simple and less liable to failure. The machinery is less expensive, and the amount of fuel required is less by one half. The quantity of sugar produced on a given space of ground is greater, besides being of better quality.

The raw juice of maize, when cultivated for sugar, marks 10 degrees, on the saccharometer, whilst the average of cane juice, (as I am informed,) is not higher than 8 deg., and beet juice not over 3 deg. From 9 3-4 quarts (dry measure) of the former, I have obtained 4 pounds 6 ounces of the syrup, concentrated to the point suitable for chrystalization. The proportion of chrystalizable sugar appears to be larger than is obtained from the cane juice in

Louisiana. This is accounted for by the fact, that our climate ripens corn perfectly, while it but rarely if ever happens that cane is fully matured. In some cases the syrup has chrystalized so completely, that less than one-sixth part of molasses remained. This, however, only happened after it had stood one or two months.—There is reason to believe that if the plant were fully ripe; and the process of manufacture perfectly performed, that syrup might be entirely chrystalized without forming any molasses. This perfection in the manufacture cannot, however, be attained with the ordinary apparatus. Without any other means for pressing out the juice than a small hand mill it is impossible to say how great a quantity of sugar can be produced on an acre. The experiments have been directed more to ascertain the saccharine quality of the corn stalk, than the amount a given quantity of ground will produce; but the calculations made from trials on a small scale, leave no room for doubt that the quantity of sugar will be from 800 to 1000 lbs.

Another mode of cultivation to be employed in combination with the first one proposed, consists simply in raising a greater number of plants on the same space of ground. By this plan, all the unfavorable results above mentioned, were obviated, a much larger quantity of sugar was produced and of better quality.

The juice produced by this mode of cultivation is remarkably pure and agreeable to the taste. Samples of the sugar yielded by it are now in the Patent Office, with a small hand mill, by which the stalks were crushed."

* * * * * * *

"The following mode of cultivating the plant, and making the sugar, is the best that can now be offered:

"The kind of soil best adapted to it is so well understood, that no direction on this point is necessary, except that it should be rich, the richer the better; if not naturally fertile, manure must be applied either ploughed in or spread upon the surface, or used both ways, according to the ability of the owner. Nothing can form a better preparation for the crop, than a clover sod well turned under, and harrowed fine immediately before planting.

"Select for seed the largest and best ears of any variety of corn not disposed to throw up suckers, or spread out in branches; that kind most productive in the neighborhood, will be generally the one best adapted to the purpose. The planting should be done with a drilling machine. One man with a pair of horses, and an instrument of this kind, will plant and cover in the most perfect maner, from ten to twelve acres in a day. The rows, (if practicable, let them run north and south.) two and a half feet apart, and the seed dropped sufficiently thick in the row to insure a plant every two or three inches.

"A large harrow made with teeth arranged so as not to injure the corn, may be used to advantage soon after it is up. The after culture is performed with a cultivator, and here will be perceived one of the great advantages of drilling: the plants all growing in lines, perfectly regular and straight with each other, the horse shoe stirs the earth and cuts up the weeds by every one so that no hand-hoeing will be required in any part of the cultivation.

"It is part of the system of cane planting in Louisiana, to raise as full a stand of cane upon the ground as possible; experience having proved that the most sugar is obtained from the land in this way; as far as my experience has gone, the same thing is true of corn. This point must therefore be attended to, and the deficiencies, if any occur, made up by timely replanting.

"The next operation is taking off the ears. Many stalks will not produce any, but wherever they appear, they must be removed. It is not best to undertake this work to early; as when the ears first appear, they are tender, and cannot be taken off without breaking, which increases the trouble. Any time before the formation of the grain upon them will be soon enough.

Nothing farther is necessary to be done until the crop is ready to cut for grinding. In our latitude, the cutting may commence with the earlier varieties, about the middle of August. The later kinds will be in September, and continue in season until cut off by frost. The stalks should be topped and bladed while standing in the field. They are then cut, tied in bundles, and taken to the mill. The tops and blades, when properly cured, make excellent fodder, rather better it is believed, than any hitherto used; and the residium, after passing the rollers, may be easily dried and used the same way.

"The mills should be made on the same general principle employed in constructing those intended for grinding cane. An important difference, however, will be found both in the original cost, and in the expense of working them. Judging from the comparative hardness of cane and corn stalk, it is believed that one-fourth part of the strength necessary in the construction of a cane mill, will be amply sufficient for corn; and less than one-fourth part of the power will move it with the same velocity. It may be made with three upright wooden rollers, from twenty to forty inches in length, turned so as to run true, and fitted into a strong frame work, consisting of two horizontal pieces sustained by uprights. These pieces are morticed to admit wedges on each side the pivots of the two outside rollers, by which their distances from the middle one may be regulated. The power is applied to the middle roller, and the others are moved from it by means of cogs. In grinding, the stalks pass through on the right side of the middle cylinder, and come in contact with a piece of frame work called the dumb returner, which directs them backwards, so that they pass through the rollers again in the opposite side of the middle one.

"The modern improved machine is made entirely of iron; three horizontal rollers arranged in a triangular form, one above and two below, the cane or stalk passing directly through, receiving two pressures before it escapes. The lower cylinders are contained in a small cistern, which receives the juice. The latter machine is the most complete, the former the least expensive. These mills may be moved by cattle, but for large operations, steam or water power is preferable. When the vertical cylinders are turned by cattle, the axis of the middle one has long levers fixed across it, extending from ten to fifteen feet from the centre. To render the arms firm the axis of this roller is carried up for a considerable height, and oblique braces of wood by which the oxen or horses draw, are extended, from the top of the vertical axis to the extremities of each of the arms. When horizontal cylinders are propelled by animal power, the upper roller is turned by cogs at one end, which are caught by cogs on a vertical shaft. It is said that in the West Indies, the purest cane juice will ferment in twenty minutes after it enters the receiver. Corn juice has been kept for one hour before boiling, without any apparent injury resulting; but so much delay is not desirable, as it may be attended with bad effects.

LONG LINES OF RAILROAD, AND THE CENTRAL RAILROAD.

It is important to chronicle the growing success of every long line of railroad communication, as thereby affording an encouragement, and inspiring hope to those engaged in similar enterprises. The Western railroad, running from Boston to Greenbush, near Albany, is, we believe, the longest continuous road in the country, and its success was at one time deemed so improbable as to excite for its supporters, ridicule and almost opprobrium, as wasters of public and private means. But what is the result, now that it is completed? Entirely successful! Where are its opponents? They have been constrained to join the number of its friends. The road is 200 miles long, and cost $9,000,000, or on an average $45,000 per mile. To show somewhat of the business done on this road, and its value, we clip the following items from two or three papers before us, which merely give detached views of the success of this enterprise.

From the Boston Daily Advertiser.

Western Flour.—The morning freight train on the Worcester Rail Road, brought 25 long eight wheeled passenger cars, loaded with 1000 barrels of flour. It left Greenbush on the preceding day, and was brought through that day to Worcester, 155 miles.—The evening train also brought a quantity of flour. The passenger train on the Boston and Worcester Railroad, which left town for Worcester after the fire works, carried out 25 cars conveying about 700 passengers.

The following appeared in the Boston Transcript of July 9th.

Extract from a letter dated Springfield, July 6th.

"I have just seen a gentleman from the West, this evening, and from him I learned that the freight train came from Albany this day with 1,668 barrels of flour for the Boston market. The whole weight of the freight, including other matter besides the flour, is 200 tons."

And what has been the effect of this road on Boston? A letter written to one of the New York papers dated Boston, July 9th, 1842, thus speaks of her rail roads, and their influence:

The population is increasing with rapidity. There was a time when it appeared to me that the glory of Boston was departing, and that her streets would soon be like those of old Salem, overgrown with grass. But a change has come over her, and she is now making rapid strides to come up with her sister, New York! What has produced this change? What has made New York what she is? No one can be at a loss for an answer. It is internal improvements, added to her regular intercourse with Europe. Look at Boston—her line of steam packets—her rail roads to the East, West, North and South. Let any one, for a single day, watch the arrival and departure of the cars on the great Western route—thence let him pass to the Eastern depot, and see the intercourse of that direction. Let him then go to the Stonington and Norwich cars; and last, although not least, let him look at the Northern depot and see the trade through Lowell, to the States of New Hampshire and Vermont; he will not then be surprised at the growth of Boston.

As I passed over the line of the Western rail road the other day, I was surprised to see the quantities of merchandise and live stock which we passed from Springfield to this city, while the store houses at the depots on the route were crowded with country produce in like manner as you find them on your noble Hudson.

We cannot, at present, expect like advantages from our railroad. It passes through a different kind of country, a sparse population, through no large towns or villages, and cannot, therefore, for some time, be made as profitable as the Boston and Albany rail road.

We have often heard the doubt expressed as to the ultimate success of the Central Rail Road; we have even heard it condemned as a failure; but such remarks are grossly invidious and unfounded. The affairs of the company are indeed embarrassed, but the road is daily progressing to its completion. It cannot be expected that it would be very profitable until it reached its terminus; because then only would it tap the principal growing and trading portions of the State. We believe that if the road can but be run up to its next station, before the fall, that the freight will be astonishingly increased, and that most of the crop in its vicinity will be sent to market upon the cars. It is unfair, therefore, to pass judgment on this road, until the nearer completion of the work shall have tested its value.

Before it reaches the richer districts of the interior, and until it fairly enters and taps that more fertile and productive region, and makes it tributary to its channel, we cannot tell its value. When it reaches Macon, it will there meet the Monroe Rail Road on the other side, and when that shall be joined to the Western and Atlantic road, and we hope it ere long will, then we shall begin to realize the value of this great and important link, in that great chain of communications, by which, so large a portion of the West and South-west, shall find its sea-board outlet in the port of Savannah. The friends of this enterprise should not suffer themselves to despond; for if they can, as we know they will, surmount present obstacles, they will surely reap a rich reward at last, in the increasing and valuable business of the road, and in the prosperity and advancement of Savannah! It has been well said, and it should ever be borne in mind, that "the tributary sources of a rail road increase, in a ratio much greater than in proportion to its length, because the longer the road is, the wider the strip of the country whence it draws its tributary sources of revenue. A man will travel 30 miles on the common road out of his way, for the sake of going 100 miles on the rail road, while he would go only 10 miles out of his way, on a common road, for the sake of using 33 miles of rail road. Thus the strip of country tributary to the rail road, increases in length with the length of the road, and in addition to this, it increases in width."—*Georgian.*

RAIL ROAD TOPICS.

Dividends of Massachusetts Roads in July.

	Capital.	Dividend.	Amount.
Worcester,	2,400,000	4 pr. ct.	96,000
Lowell,	1,800,000	4 "	72,000
Nashua,	400,000	4 "	16,000
Taunton,	250,000	4 "	10,000
Eastern,	1,600,000	3 "	48,000
Providence,	1,842,000	3 "	55,260
New Bedford,	400,000	3 "	12,000
	$8,692,000		$309,360

Averaging nearly 7 1-8 per cent. per annum.—*Transcript.*

European Rail Road Items. The emperor of Russia is constructing a rail road between the two principal cities of the empire, St. Petersburg and Moscow—a distance of 500 miles.

The great rail road which is constructing in Austria by a company chartered in 1830, with a capital of seven millions, at the head of which is the Baron Rothschild, of Vienna, is gradually progressing. The work was commenced in April, 1837. In November of that year the first trip was made from Vienna to Wagram, a distance of seven miles. In July, 1839, it was opened as far as Brunn, in Moravia, 91 miles. There are now 180 miles in operation.—Fifty-three miles are now in progress of construction, and the locations are extended many more miles. Few difficulties are found in the route; neither tunnels nor inclined planes have been required to surmount summits;—the steepest grade is 17.6 feet per mile, or 1 in 300, which is their maximum. The curves have no radius shorter than 1.500 feet. The width of the road 12½ feet, the slopes 1½ to 1. Single track, except the first seventeen miles from Vienna. The iron T rail of 40 lb. per yard is used which cost $135 per ton. The superstructure is not let to contractors for fear of not obtaining solid work, but the residue, after the plans are completed, and estimates made, are set up in sections and bid for by contractors, at *so much below the estimates.* The sub-contractors employ females to do a great part of the work, at very low wages.

The cost of this road, single track, has averaged $29,800 per mile, or $33,000 including outfits. The amount expended so far, six millions of dollars. In 1840 the income of the part between Vienna and Brunn, $294,172, averaging $3,333 per mile, or ten per cent. on the capital of construction; 228,368 passengers paid $201,561, and 32,180 tons of goods paid $90.063. The expenses were $225,547 or $2,478½ per mile, leaving $68,625, or 2½ per cent. profit.—The number of miles travelled by all the engines, was 188,100,—at an expense of $1,25 per mile,—of which 52.4 cents was paid for fuel, which has to be brought from a great distance;—coal and coke are used.

The rate of passenger fare, has been 3.16 cents for first class 2.01 for second, 1.58 for third class—and the average 1.77 cents per mile. The charge is now increased one-fourth.

The first 91 miles required 6,012,500 cubic yards of excavations and embankments; 3,708 feet of wooden bridges, the one over the Danube at Vienna being 1,960 feet long, with spans of 60 feet, 488 feet wooden bridges, with stone piers; 24 stone bridges and viaducts having 228 arches of different spans; 116 culverts, 198 road crossings, of which 31 were under, 6 over, and the remainder level with the rail road.

It is estimated that 90,000 oxen, (*cattle we presume is meant,*) are driven annually from the interior of Galatia to market, upon the transportation of which this company calculate, as well as vast travel and traffic from the interior. Experiments have shown that from 100 to 180 oxen can be carried by a train, each car containing 6 to 8, standing sideways, secured by their cars. In this way they are conveyed from Hardish to Vienna, 83 miles, in 7 or 8 hours, without food.

Since sketching the above we have met with the following article from the *Courier Francais.* It affords so comprehensive a view of the progress of rail roads in Central Europe, that we have had it translated.

From the Courier Francais.

An extraordinary emulation has seized upon the German and Sclavonian population beyond the Rhine, in regard to the rapid progress which the construction of rail roads has made in England, Belgium and the United States. The governments of Austria, Prussia, Russia and Central Germany have applied themselves to work, drawing after them the zeal of a population which cannot be estimated at less than 60,000,000. In these countries the projects have not to undergo the tardy movements of representative bodies, and the financial resources not being absorbed by a multitude of contingent or separate schemes can be concentrated upon a single object; in fine, the lines being traced with great economy, and generally on a single track, do not require any great outlay of their capital. These causes must in a few years give to Germany, Poland and Hungary a great net work of railways.

In Austria, Bavaria, Baden and Hanover, the lines which are to traverse their territories are placed under charge of the governments. Saxony and Bavaria have signed a convention, which has for its object, the execution of a line traced across the centre of Germany from Augsburg to Leipsig, and 85 millions of francs have been appropriated to that purpose by the two governments. Prussia on her side has treated with Brunswic and Hanover, for prolonging to Cologne, the line from Berlin to Magdeburg, and thus to connect the Elbe with the Rhine.

Germany has not a centre to which all the radii of her united schemes might converge and unite (as France has in the city of Paris,) and hence, each of her great powers wishes to have its own separate system, to which the works of the secondary states shall attach themselves. It is thought however of creating an artificial centre, where the great line which shall join the Baltic to Switzerland, in passing from north to south will cross and exchange its transports, with that which will pass from east to west to unite the Danube with the Rhine, and Vienna with Rotterdam. This intermediary point will be Cassel.

The railroad lines executed comprise 1,225 kilometres or 306 leagues, which have cost 144 millions, (470,000 francs per league.) If the line from Leipsig to Dresden and a part of that from Vienna to Brunn be excepted, the German railways have yet but one track; and some of them even, among others the 206 kilometres from Budweis to Gemunden, do not admit locomotives and are subserved by horse power only.

The extent of the lines in the course of construction is estimated at 1,162 kilometres, and their expense at 160 millions francs. There are besides 4,750 kilometres of additional roads projected, The whole system, comprehending thus the Prusso Saxon, and the Austrian projected towards Poland and Lombardy, would thus compose 7,147 kilometres or 1,786 leagues and would cost 852 millions.

The Austrian system has been prosecuted at the north, from Vienna to Olmutz, and at the south from Vienna to Neustadt; it is to be prolonged to Peth by the left bank of the Danube, to Prague via Brunn, and from Prosan where it is arrested, it is to connect with Cracow. Austria intends to extend it moreover towards the Adriatick and also towards Bavaria—but to attain this immense developement, a financial power would be requisite which this government is not at present endowed with.

In northern Germany, there exist only the roads from Francfort to Mayence, from Manheim to Brucksall, from Augsburg to Munich, and from Nuremburg to Furth. Wurtemburg is discussing the construction of a road from Ulm to Heidelburg, and from Ulm to Augsburg; but her project has not yet led to any measure indicative of its execution; and the government seems to be waiting for France to decree the construction of the road from Paris to Strasburg, before entering decisively upon the undertaking.

IRON STEAMBOATS.

A correspondent of the New York Courier furnishes the following notice of the new iron canal steamboats, constructed with Ericson's propeller, which have just been completed:

Captain R. F. Stockton with his characteristic enterprise, has started a new project, in connection with the great work of transportation; He has had built, in this city, four Iron Boats of about *two hundred and eighty tons burthen*, to go by steam, upon the *Erricson* propeller principle. The boats are, however, rigged schooner fashion, so as to avail themselves of the less costly power of propulsion, whenever the wind shall come in aid of this old fashioned method of getting along. Two of these boats, the *Black Diamond* and the *Vulcan* left the wharf on the North River, opposite the Phœnix works, last Friday, 12 o'clock. Their appearance excited great attention. It fell to my lot, (somewhat accidentally,) to be one of the party on board. The Black Diamond, on board which was Capt. Stockton, (Capt. Erricson being in charge of the Vulcan,) put off, first; and while the steam was being got up in the latter, a circuit was made by the Black Diamond up the North River, when returning the two boats joined company, and amidst the greeting of the bells of steamboats, which was responded to by the letting off of *jets* of steam; and in view of crowds that lined the wharves, and shipping, we ran up the East River a couple of blocks above the Fulton Ferry. Our speed, I estimated at the rate of about six miles the hour, (only about one half of the propellers being submerged,) operating. On our return we ran under the stern of the ship of the line North Carolina, whose ports were filled with the crew; and on whose quarter-deck were the officers and the band of music, the latter playing "Hail Columbia," as a greeting to this new developement of genius and of enterprise.

The impression made upon the thousands who witnessed the movement of these (as to size and color) *brig-of-war* looking boats, was one of force and wonder. They saw the boats dashing the foam up in their prows, their sails brailed to the masts, and the jack flying, but could see no cause for this onward and steady motion, until a sight of the stern was had, when the propellers being half out of water gave signs that they were the instruments of the power, and to them belonged the agency by which this onward motion was given; and the water thrown into foam, testified that no ordinary power was busy with it.

Passing round the North Carolina, a boat was sent off, which took a few of us to the shore, when these boats continued on to Brunswick *en route* to Philadelphia.

The whole of the machinery is at the stern, and occupies not much more space than would an ordinary dining table. It is as simple as beautiful, and sufficient as it is harmonious. There was not the slightest jar felt. In the bow of the boat is the cabin, it is quite a home for a gentleman. *Multum in parvo* would seem to have been studied out to perfection. All the rest of the boat is for stowage.

The advantages that struck me, as peculiar to this contrivance were—the buoyancy of the boat—its durability and strength; the celerity with which coals and produce and merchandise, &c., may be conveyed; its peculiar adaption to canal duty; and its adaption also to river or sea navigation. I shall remark upon but one of these its *peculiar adaption to canal duty*. I noticed the boat in company, and when in our rear, could see that instead of the water being thrown out, latterly, from the sides, it fell in upon the boat, right and left. This was caused by the action of the propellers, which threw the water backwards in the boat's wake, making a trough or hollow, in the water, at the stern. Upon the known principle that "water will find its level," the tendency of the water forward, and right and left, is to *fall into the cavity at the stern of the boat.* This effectually secures the banks of the canal from the usual action of the water driven forward, and right and left of the bow, in the horse-towing, or any other mode of passing through a canal.

It appears to me that this propeller, for this reason alone, will be adopted in the navigation of all the canals over the whole country. But, through the canal, these boats keep on, indebted to no external aid, to their destination, and when there, should occasion require it, they can move from dock to dock; from one river to the other, or from one port to the other, and that too by the simplest machinery —(for a boy can work it) in the world.

I presume some one will state the draught of water made by these boats when loaded, and enter into other like calculations, such as the cost of fuel per mile, of labour, of ware and tear, &c.

These boats appear to me to do the business at stroke, of just doubling the capacity of the canals—for a canal may be considered as being doubled in its width, when by any arrangement, a boat can be constructed to carry through it, double the tonnage of any other. Capt. Stockton's triumph is complete—and he will be regarded as a public benefactor for this successful experiment. These boats will ply between Philadelphia and New York; New York and Albany: and New York and New Haven.

Artificial Ice.—There was yesterday opened to the public, at the Colosseum, in the Regent's park, an exhibition of the artificial ice, by means of which skating may be enjoyed in all weathers.—The summer's sun cannot melt the patent ice, over which the skater can glide and figure in a ball room costume. The ice glen in the Swiss cottage of the Colosseum is tastefully arranged. It is surrounded by snow clad cliffs and corresponding scenery. The artificial ice is composed of a mixture of salts, which possess the property of quickly crystalizing into a hard body; so that whenever the surface becomes cut up a new face may be made by pouring on a solution of the salt.—*Courer.*

Four passenger cars from the manufactory of Messrs. Davenport and Bridges, at Cambridgport, (Mass.) arrived at Albany, last week, by the Western Railroad. The cars, omnibuses, &c., from the establishment of these enterprising gentlemen, are considered we believe, fully equal to any others in the country; and we are glad that orders are coming in from a distance.

Am. Traveller.

A steam engine was invented by the Marquis of Worcester in 1655.

AMERICAN

RAILROAD JOURNAL,

AND

MECHANICS' MAGAZINE.

No. 4, Vol. IX. New Series.] AUGUST 15, 1842. [Whole No. 413. Vol. XV.

For the American Railroad Journal and Mechanics' Magazine.]

Ohio Railroad Office,
LOWER SANDUSKY, Aug. 6, 1842.

Much has been written upon the subject of "the failures in the construction of Railways." But, in my opinion, the failure of many Railways is more to be attributed to a failure in their laying out than in their construction. If a road is injudiciously located a heavier expense must necessarily be incurred in its construction as well as in its repairs. All will admit that the construction and repairs are much augmented by deep cuts and heavy embankments. My opinion is, that if Engineers would be governed more by the natural surface of the ground, and run lighter and more frequent trains, an increase of dividends would be realized, and that, too, by a reduction of tolls, and at the same time be better adapted to the wants of the public. The improvements in motive power will go far to strengthen this position. It is now established beyond a doubt that gradients of 60 or even 80 feet in the mile may be introduced with success. Then why not adopt the principle at once of vertical as well as horizontal curves, whether for short or long grades. If an elevation of 80 feet in the mile can be overcome for successive miles, it requires but a "schoolboy's sagacity" to see that a very short one can. I have adopted the maximum of departure, whether for ascending or descending grades at ,015 in 15 feet or 1 to 100, and any maximum grade at 60 feet per mile. A road located and constructed upon this principle can be built with an edge rail for $7,000 per mile, excepting over a very rough and broken country, and where heavy viaducts are required. To run light and frequent trains over a road would increase the expense, but it would be more than met by a decrease in the cost of the repairs of the road and machinery.

Very respectfully yours,

C. WILLIAMS,

Chief Engineer O. R. R.

[For the American Railroad Journal and Mechanics' Magazine.]

We have much pleasure in presenting the following data, from the operations on the *Philadelphia and Pottsville* Railway for the year 1841, while open only to Reading, a point of no moment as compared with the mass of business which now awaits it at Pottsville, the centre of the Coal Fields, and which it is now making preparation to accommodate.

The details here furnished in regard to the expense of working this Road afford the amplest evidence of the cheapness with which it can be operated, and its ability to compete with the Canal and the Freighters on it is fully sustained. It brings the miner in immediate contact with the dealer, and even consumer, whom he will always be prepared to supply, without regard to seasons, at comparatively low and steady prices which heretofore have encumbered with too many intermediate agencies and other clogs.

This Report goes to show—

1st, That this Road has been adjusted and repaired at a cost for 56 miles of $17,400, or $310 per mile per annum.

2d. That 31,500 thro' passengers were carried, including all expense save repairs to Road and interest on capital, for $13,600 or 43 cents each.

3d. That 28,500 tons of merchandize and road material were transported in like manner for 31,600, or $1,10 per ton—$62,600.

4th. That the machinery for engines, passenger and burden cars have been repaired at a cost on their value of about 5 per ct. pr an.

5th. That the consumption of oil and grease on the burthen trains for a distance of 116 miles has been at the fraction, per ton, of 3-4 of a cent.

6th. That the whole cost in wages, repairs, fuel, oil, etc., of an engine over this road per an., running daily has been about $4,000.

7th. That the average loads, net freight, down the road, by one engine, have 201 tons.

8th. ditto up the road, 129 tons.

9th. That the entire cost of running an engine 116 miles, including the train capable of accommodating 150 passengers each way but of which the average number between Reading and Philadelphia was only 87 per day—43½ up and 43½ down, amounts to $18,84

This last item shows how very cheaply passengers could be carried were it possible to obtain always *full loads*, as will be the case with coal, and which is justly grounded the claim of carrying this latter so cheaply, and so much to the astonishment generally of the unitiated part of the community.

Further economy also will hereafter be practicable on this road, in the fall of labor and of every article necessary in the maintenance and repair of road and machinery. By opening to it the forests above Reading, wood, for which they have heretofore paid $3 per cord can be had for $2⅓; and while this is the case, it will be cheaper than coal, seemingly the most natural resort for fuel in this case, but which will remain for the present as a grand resort for it as wood shall grow dearer, and when the most economical mode of burning coal will be better understood. It should be borne in mind that the expense of adjustment of the track would not be materially increased, by the addition of 10 to 15 trains at moderate speed to the 2 or 3 which have so far passed over it at high velocities, and that the item of $310 per mile would nearly suffice for at least the next 5 or 6 years, before which period few renewals could be required. This would only be the natural effect of good and efficient machinery well attended to and kept constantly braced up.

As a temporary and extraordinary measure, during the remaining half of the boating season on the Canal, to induce the trade to seek the Road more quickly, the rates on coal per Railway have been reduced to $1 per ton from Sch. Haven, and 1,10 from Pottsville, but so soon as this transfer is effected, these rates will revert to 1,50, and to 1,75 per ton, at which the road can easily retain the trade, and at which it will in due time be able to make remunerating dividends.

As an auxiliary to the Coal trade, and consequently to its extension on this road we may note the introduction of the large 200 ton iron Steam Barges with Erricson's propellers, by which the freight to New York and the eastern ports will be materially reduced. Already are these boats on the Lakes and rivers of Canada, and they will soon be running between Philadelphia, Baltimore, Richmond, etc., through the Delaware and Chesapeake Canal, capable of accommodating a boat of near 200 tons of the iron kind.—This revolution in inland coastwise navigation should be carefully noted.

The Pennsylvania Railways have till now been pointed at as remarkable only for *bad location, inefficient construction,* and *unfaithful management*; in future, however, the *Philadelphia and Pottsville* railway will redeem her on these three counts, and in *general benefit,* it will be without a rival. New York, more fortunate in having most of her flimsy roads (but of which even her canals are afraid) on a great thoroughfare of business and travel, their profitableness has silenced reproach; and she yet needs a railway worthy of her and the age, which we trust she will soon have in the completion of the New York and Erie, and New York and Albany roads, now indispensably required by the rivalry with which she is encompassed from this improvement in other states,

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For the American Railroad Journal and Mechanics' Magazine.]

GEORGIA RAILROAD.

We have been again favored with the annual report of the Georgia railroad for the year 1841, under the management of Mr. J. Edgar Thompson, to whom the curious in railways owe much for his intelligible and instructive statements, as throwing much light around the mysteries of this fruitful, but as yet but poorly appreciated source of wealth and prosperity in a community.

The line of this road in the last year has been greatly extended and is now composed as follows:

Main line, Augusta to Madison, 104 miles,

Branch, to Athens, 40 miles.

Do. to Warrenton, 3 1-2 miles; 147 1-2 miles, the whole of which is a flat bar of 29 lbs, per yard, except 29 miles of the main line which has a T rail of 46 lbs per yard. The shortest curve on the road is of 1,000 feet, and throughout its course to the Tennessee river, the grades will be no higher than from 33 to 37 feet per mile.

The receipts for 1841 were for 22,784 passengers, averaging 3 1-4 each,	$73,492	
11,000 tons goods averaging 11 or 11·14 per ton,	122,705	
Mail, etc.,	28,055	
		224,252
The expenses for 1841 were, say 40 per cent. on gross receipts,		90,578
Nett receipts,		$133,734

or about 6 per cent. on the whole cost of $2,363,000, equal $16,000 per mile.

An increase on the previous year's business of $60,000 is exhibited, spite of the depressed state of trade, and while the branches, as yet, yield but little or nothing compared with the expense of maintenance, although they are looked too as being soon important sources of revenue.

On the subject of increasing the rates of passenger fare from 5 cents per mile, as now charged, to 6 1-4 cents, deemed by Mr. Thompson as the most profitable *for this line of road*, he justly remarks:—

"There is doubtless a medium rate which will give to the company the largest profits, and this rate, instead of being uniform and applicable to all roads, as generally supposed, is controlled by the amount and character of the travel on each road. In Europe, and the more densely peopled sections of our own country, where in addition to an amount of travel proportioned to the greater population, there is a class of mechanics and laborers who would not use Railroads at high fares, low rates are no doubt both politics and profitable."

There are 12 locomotives of Baldwin's make on this road, of the 2d and 3d classes, or light and adapted as far as practicable to a flat bar road. These engines have mostly been now 5 or 6 years in use, and are returned as good, if not better than when new, after having run in that time over this trying description of road, 519,-000 miles, at an expense for repairs of $27,500, or at an average of 5 1-4 cents per mile, run at a speed of about 7 miles per hour for freight and 18 miles for passengers; and the whole expense of motive power for 1841, is here stated to have been 19 2-3 cents per mile, which corresponds nearly with the results on English roads, using coke as fuel, where it generally averages 20 cents per mile run. If, in England, the roads are better, the velocity, the source of most of the wear and tear, is at the same time much higher.*

The repairs and maintenance of road are also on a moderate scale, averaging for 1841, $265 per mile, increased in this year by the usual amount of timber requiring renewal. In this southern latitude Mr. Thompson fixes the duration of the wooden structure in contact with the earth at 5 years only, but with this, the nature of the soil, the drainage of the road-bed, and description of wood must have much to do. In the north, with cedar and oak, 7 to 8 years, and if 9 and 10 years on favorable soils and *good drainage* might be given as an average. Tho kyanising preservative, will

* "Again, referring to the table with reference to the difference between carrying slowly and carrying quickly, we find that the total expense of carrying goods on the Liverpool and Manchester railway, at high velocities, is 2 1-2d per ton per mile, while on other roads, at moderate speeds, it is only 1d per ton per mile."—*Vignoles' Lectures.*

for a long time, in this country, be too costly in proportion to the cheap price of wood; but Dr. Earle's process, now on trial, promises to do something, at a suitable cost, towards lessening, hereafter the expense of renewals to the wooden portions of the railway; but, in fact, the perpetuation of the entire road and its machinery is now nothing so onerous, requiring only 30 to 40 per cent. on the gross receipts where they are at all commensurate to its cost, and leaving a fair dividend on its capital. The *uncommonly* perishable nature of the railway, so long a bug bear with the community, is thus fast losing its terrors with it, or at least, with that portion of it which has no adverse interest to blind them to the truth. It is believed by us, moreover, that all that could be desired for the economy of transportation on railways, is about being accomplished in new plans of engine, by Mr. Norris and Mr. Baldwin, by which the pressure on the rail from its drivers, with a large increase of power will not be greater than that of the wheels of the car behind it, say 1 1-2 to 2 tons; and on this subject Mr. Thompson remarks:—

"*Light engines have hitherto been so inefficient*, that until the late improvement of Mr. Baldwin, by which the whole adhesion of the engine is obtained, and at the same time the track left free to adapt itself to the curves and undulations of the road I had despaired of their success, under any circumstances."

The subject of unguents has lately received much attention on most railways, and on the Georgia road this expense has been, at the very moderate average of 2 1-4 mills per mile, run by the trains, and one cent per mile of oil for the locomotives, owing, as Mr. Thompson adds—" to the adoption and adherence to the use with the freight trains of tallow instead of oil, using but a small quantity of the latter in cold weather. During the past winter we have been induced by the low price of lard to make trial of its properties, which has great satisfaction. Tallow, however, is to be preferred in warm weather." It is further said that "*lard oil*," a recent invention, can be profitably used on fine machinery, and consequently answer for the locomotives, the price now asked being 75 cents per gallon, and is likely to be much cheaper. These economies, together with the introduction of Babbitts white metal for journal Boxes, and in different parts of the locomotive, are doing much towards exterminating friction, the great enemy of railways, and give much greater force to the following remarks of Mr. Thompson:—

"It has been but 12 years since the introduction of railways as avenues of general commerce, and in that short space they have grown so rapidly in public estimation that now the most sceptical on the subject are constrained to admit, that they are in almost all cases, greatly superior in point of economy for the transportation of passengers and freight to their former rivals, canals, or any other artificial way, in which the amount of trade to be accommodated is sufficient to authorize their construction in a substantial manner."

When we look at the liberal manner in which railways are treated in England and on the continent, by the different governments, owing to their *great services* in the transmission of the mail, it is mortifying to find our Post Office Department, driving hard bargains with our yet poor and struggling roads, to perform a duty which above all others, should not be allowed to fail for want of the requisite stimulus of a just remuneration. In this case it appears, that the department was unable to get a lower offer than $350 per mile, by the stage coaches, at 7 miles per hour, and although the law of congress allowed an advance of 25 per cent. over and above the tender by stage coach, which would have given the railway $437 per mile—it was unable to obtain more than the *legal rate* as interpreted by the department of $237 per mile, and this for performing night service. When the Postmaster General can be brought to understand more fully this subject, we believe, he will find, that as a minimum, $125 and $300 per mile as a minimum, will be no more than a fair remuneration to railways in the majority of cases for a daily mail.

We already owe much to Mr. Thompson, but it would still add to one debt in railway details, if he would in his next year's report, when the wooden structures of his road will have been nearly all renewed, furnish a tabular statement (as in the case of the performance of locomotives) of the whole expenses from the opening of his road, by which an average could be made of each department for the whole period, something by which he could judge of a southern road, as compared with a northern road, say the Utica and Schenectady, of which we annex a statement for his guidance, and which is about similar in character to the Georgia road, also a parallel case for vigilant management and good economy. Such examples give encouragement to the cause.

This road is connected with the Atlantic by means of the Charleston and Augusta railroad, and its great purpose is now to unite itself with the western water of the Mississippi and Ohio, at a point on the Tennessee river, which, once reached, would fix its prosperous destinies and make it difficult to give them a limit.

Statements of the results on the Utica and Schenectady Railway, 78 miles long with 22 miles turnouts, total cost $1,968,000. Grades 25 feet per mile. The rail is a flat bar, and the wooden structures were principally of western and southern pine, and some red cedar. Its business is exclusively travel.

	1836 5 months.		1837		1838		1839		1840		1841		To'l in 5 1-2 years.
Gross receipts.	$176,547		$317,177		$337,709		$106,674		$380,411		$388,461		2,019,979
Transportation,													
Wages of collectors, breakmen, attendants, etc.	4,387		9,726		10,284		9,145		9,684		9,904		
Repairs to cars,	748	5,135	4,439	14,165	4,887	15,171	9,624	18,769	7,112	16,796	6,612	16,516	
Motive power,													
Wages of enginemen, firemen, station attend'ts etc.	4,892		13,316		13,033		10,400		9,165		8,956		
Oil for engines, Cars, and station houses,	1,355		4,447		3,100		2,557		2,268		3,714		
Fuel for engines, station houses, etc.	17,699		36,853		22,007		13,874		18,934		11,262		
Repairs to locomotives,		23,946	7,724	62,340	11,214	49,348	15,143	41 968	9,992	40,359	9,573	33,455	
Maintenance of way,													
Repairs to road and fixtures,	"		"		"		"		"		"		
Management,				27,590		25,704		35,221		48,192		65,276	
Salary of superintendent.	820		4,667		6,000		6,000		6,635		6,000		
Damages, salary of clerk, treasurer, printing, etc.	1,380	2,210	11,357	16,024	14,094	20,094	11,703	17,70.	7,887	14,522	5,109	11,106	
Charges extraordinary,													
Repairs to Mohawk turnpike,	1,305		2,001		2,228		4,187		3,691		5,427		
Taxes in poor rates,	902	2,207	2,264	4,265	13,367	15,595	13,736	17,923	13,660	17,351	23,322	28,749	
Total expenditures, 35 per cent. on receipts, or less extraord'y expenses 30 per ct. on ditto,		33,498		124,384		125,912		131,584		137,220		155,096	707,694
Net Receipts, -													$1,309,286.

The following letter from Mr. Trautwine we give immediately on its receipt to our readers. It was furthest of all things from our intention, that any thing disrespectful or unfair, either to Mr. T. or any one else should appear on our pages, and we did not think the article contained any thing of that nature; we thought so at the time we first read it, and on a re-perusal we think so still. The quotations give a fair view of Mr. Trautwine's article which we had intended giving entire, but having no room to do so, we would not venture to make any other selections than the one relating to a collateral subject. As the right understanding of the matter is of some consequence, and as one party feels aggrieved, we shall publish the papers of Mr. Trautwine as rapidly as possible. A part will probably appear in this number.

Mr Schaeffer,

Dear Sir—Your Journal of July 1, contains a criticism on an article of mine which appears in the Franklin Journal of the Institute for the month of May, on the injudicious construction and machinery of many railroads in the United State. The author of the criticism alluded to, has a peculiar faculty of handling such subjects, which renders the task of rejoinder one of no ordinary labor; and therefore, as your Journal does not contain my paper, I must avail myself of the medium of your pages to request no one who reads the criticism will pass judgment upon my article, until he has read it also. Your correspondent would be much more likely to attain eminence as a critic, and as authority in disputed cases, were he to select as the object of his labors, such papers as appear in your Journal. His readers would thus be enabled to judge to some extent for themselves; and could not fail to be struck with the profundity of his remarks, and the astounding force of his arguments.

I am very respectfully yours, &c.

John C. Trautwine.

It was not in our *power* to avail ourselves of the polite invitation of the New York and Albany Railroad Cmpany to be present ato the ceremony of breaking ground upon their line.

The following letters from the New York Courier and Enquirer seem to give the best description of the ceremonies. We give them with a few notes of our own supplying one or two omissions.

NEW YORK AND ALBANY RAILROAD.

Pawlings, August 2, 1842.

J. W. Webb, Sir:—The first step towards the commencement of the important railroad communication between Albany and New York, was taken on Monday morning.

We left the city at 7 A. M. on Monday, in the Columbus, having on board the boat a party of fifty-seven gentlemen, among whom were Mr. Delafield the President, and Josiah Rich, Esq. the Vice President, with Mr Bloomfield, the Secretary of the Board of Directors. To these gentlemen, all of us were much indebted for many acts of attention and courtesy, rendering our situation perfectly agreeable. On reaching Sing Sing, we found vehicles ready to convey us to Somerstown, where we dined. The procession was accompanied by a band of excellent music, furnished by Dodworth, and as we passed through the various towns, all the inhabitants were drawn out by the sound of the music.

At many places as we passed, the men at work in the fields, knowing the object of our procession, cheered us, which was returned with hearty good will by all in the procession.

After leaving Somerstown, we reached Owensville about one and a half miles distant, and struck into the valley through which the east branch of the Croton runs, and we followed this, through some of the most fertile lands and beautiful scenery in the country, till we reached Sodom, about six miles distant.

[We may here make mention of the famous Simewong ore bed near Sodom, corners on the east branch of the Croton, to which the writer does not advert. This deposit of ore has long been known as of superior quality, and for years was carried to Danbury, Ct. The facilities offered by a road at this place would be of invaluable benefit both to the vicinity and to the city of New York. As it now is, the value of this ore is far below what it would be if its products were in a position between which and the city a frequent and certain communication existed.]

Thence we proceeded over the hills leaving the valley to the right, and about dusk arrived in the vicinity of Quaker Hill, in Dutchess county, where the company were distributed around among the inhabitants, and where we were all treated with the most generous hospitality. The view from the top of Quaker Hill is one of the most picturesque I ever beheld, comprising as it does a panorama of miles and miles in extent of the most fertile and well cultivated farms in the State. The States of Massachusetts and Connecticut are also in view from this eminence, and at the base of it on the east side, is the source of the Croton, which was visited by many of the party, who drank of the water.

The ground which is to be the scene of operation to-day, is a beautiful valley near Pawling, and the projected route of the road will run on nearly a dead level for upwards of thirty miles in a northeast direction. The whole ascent from Owensville to Chatham, which I believe is the termination of this portion of the road, is only about 8 feet to the mile, and even where it is a much greater ascent, any person who viewed the fertile plains filled with produce waiting for a market, which can now only be forwarded at a very great expense, would not, for an instant hesitate to urge and assist the immediate formation of this important and necessary road.

I need hardly say that with all whom I have met, the greatest enthusiasm prevails with reference to the road, and the firm determination of all coucerned is not to pause on any account until it is completed.

The necessity of it is so thoroughly apparent, and the practicability of constructing this great work in the chain of Western transportation so feasible, I cannot doubt for an instant that the views of those so deeply interested will be carried out, and in a short time the railroad will be in full operation, through one of the richest and most productive portions of our State, not even excepting the noble valley of the Mohawk.

Among our company from New York, are Ald. Lee, Leonard and Martin, Assistant Ald. Nesbitt, Pettigrew, Brown, Atwell, Adams, Scoles, and Waterman—also Mr. Grout, and Mr. Murray of the Legislature; Judge Sherman, and Mr. Young, the contractor of this district of the road.

Every thing has been done by the gentlemen of the Board of direction to render our trip agreeable, and they have succeeded in rendering it such, in an eminent degree.

I shall write again to-night, giving an account of the proceedings of to-day. B.

[At Armenia the iron ore is so good and abundant that within a space of 12 miles 14 furnaces are to be found yielding annually, iron to the amount of half a million of dollars. Again, we may ask, how much more would these works be worth if the communication by railroad with New York city were now in existence.]

Amenia, Aug. 2.—8 P. M.

We have just arrived here from South Dover, the last stopping place between Pawling and this place. My last was hastily closed at Pawling, and I was compelled to conclude it much more speedily than I had intended, but that the mail was momentarily expected, and I now take up the occurrence of the day from an early hour in the morning.

About seven o'clock, Mr. Bloomfield, the active and courteous Secretary, to whom all are indebted for many acts of kindness and attention, collected the party from the various houses where they had been domiciled, and proceeding to Quaker Hill, the whole body moved thence, preceded by the band playing enlivening airs.

On reaching Paulings, to our agreeable surprise and pleasure, we found hundreds of vehicles lining the road, filled with farmers and their wives and daughters, who had collected to see the ceremony of breaking the first ground for the railroad, which, when completed will confer incalculable benefits on all who have taken deep interest in it.

We found here alse a party of the delegation from Troy, headed by J. C. Heartt, Esq., the Mayor, and at about eleven o'clock the procession was formed, and the band striking up a beautiful march, it moved on to the ground selected, or rather designated for the ceremony. In order to give some idea of the interest felt in the anticipated completion of this road, I will mention that the procession, though formed at a place distant from any town of magnitude, was counted as it passed over a small bridge, and was found to number twenty-six hundred and seventy, exclusive of the stragglers lining the road. The majority of these were ladies, and they seemed to take as deep an interest and to be as enthusiastic in their anticipations as were their more rugged companions.

On reaching the ground the procession filed off right and left, so as to form a large oblong, in the upper part of which were laid wheelbarrows, spades, pick-axes, crow-bars, &c. The ground was in a valley some miles across, bounded on either side by well cultivated fields, affording a truly beautiful scene.

The band was stationed in the centre of the oblong, and four spades were handed to as many *ladies* appointed to receive them, who, at a given signal handed them to the Mayor of Troy. Ald. Leonard, of New York, representing Robert H. Morris; Mr. Delafield and Mr. Rich, the President and Vice President of the Company. Ald. Leonard, Mr. Heartt and Mr. Delafield receiving them with appropriate remarks. At a word all four went into the yielding soil at once. The sod was turned up, and the first ground was broken on the line of the New York and Albany railroad. As the sods were turned the band struck up a national Air, the cannon brought to the scene for the occasion, gave forth its thundering tones, and the loud huzzas of the assembled hundreds gave token of the joy with which the ceremony inspired them, as a harbinger of future increased wealth and prosperity.

Each gentleman who chose, then proceeded to fill and wheel off a barrow load of dirt, and in a short time quite a pile of sod was collected at each side of the oblong.

The procession was then formed, and returned to Pawling, where they proceeded to an old building formerly used as a church. The ladies were first seated, and the galleries of the capacious old building were soon filled with more youth and beauty than was probably ever before seen at Pawling. When the church was filled, and order restored, Mr. Delafield, in a few remarks, introduced to the assemblage, Judge Davis of Troy, who had been requested to address them.

[The remarks of Judge Davis seem to have been rather caustic to the New Yorkers, but as they were not made in ill humor, they passed off very well. Ald. Leonard replied and urged the debt of the Croton Acqueduct, &c. as reasons why New York had not done more.]

When he had concluded a long, and in some respects, an able and effective address, Ald. Leonard arose at the request of Mr. Delafield.

When the speakers had concluded, the assemblage fell to with hearty good will upon the bounteous refreshments generously furnished by the ladies from the surrounding places. The party were soon again seated in their vehicle, and after a pleasant ride of six miles along the beautiful valley through which the road is intended to run, reached South Dover where the guests, numbering now about four hundred, sat down to dinner in the rear of the hotel, under a capacious arbor formed by laying branches of trees across posts driven in for the purpose. Thence we rode on to Armenia, where I am now writing and where we are to lodge, it being the intention of the gentlemen who control and direct our movements, to start hence at a very early hour in the morning on the route to Troy. Thus has passed the day, and thus has the first step been taken towards the construction of one of the most important schemes of internal improvement ever contemplated.

Mr. Young, the contractor of the district commencing at Pawling, has a large number of men engaged, and, as I am informed, will proceed at once with his share of the work.

I have obtained from Edwin F. Johnson., Esq. Chief Engineer of the road, a few particulars concerning the road, which may be interesting.

The commencement of the road in West Chester County, is about three hundred feet above tide water, running thence to Pawlings in Dutchess county, where ground was broke to day. The spot where the first sod was turned, is the bottom of a broad valley, on the summit between the Croton and Housatonic river, about four hundred feet above tide water. From Somers to the summit at North East, a distance of about sixty miles, the ground over which the road is to pass, nearly a continuous level, with an ascent of about eight feet to the mile.

From North East, the road passes over the summit of the Ten Mile river and a branch of the Ancram creek, which is the highest summit of the road, and from thence to Greenbush, a distance of forty miles, there is a descent of sixteen feet to the mile. The maximum ascent on the whole line of the road is thirty feet to the mile—an ascent easily accomplished.—Of the feasibility of this road I can speak, I think, confidently, from having seen so much of the ground over which it is contemplated to construct it, and it certainly seems to abound in produce, for which New York always furnishes a market so ready. Those who have never passed through this section of the country can form no idea of the beautiful scenery by which we have been surrounded throughout the whole ride from Somers, a distance of sixteen miles from Sing Sing. The views have amply compensated all for the tedium of a ride in a hot sun in open vehicles.

At Dover, where we stopped for a short time on our road to this place, we visited the Stone Church, as it is termed, one of the most extraordinary curiosities in nature. It has the appearance of an old fashioned church, formed by the throwing together of immense masses of rock, apparently by some tremendous convulsion of nature; and down these the water roars and tumbles, forming a scene at once sublime and appalling. A winding stair-case has been erected from the bottom up, and the whole party ascended to view this wonderful freak of nature.

The crops throughout the whole section of the country passed over by us, are said to be most abundant—and indeed as far as we could judge from appearances, such seemed to be the case.

We start to-morrow morning very early for Troy; and as I am very weary, and have a long ride before me for the morrow, I will now close. B.

Troy, August 3, 1842.

Amid the confusion produced by the variety of scenes through which we have this day passed, I scarcely know how or where to begin my report of the day's proceedings. Since five o'clock this morning we have ridden in wagons forty-four miles—in cars twenty-two, and on the steamboat six, and we are now in Troy, seated in a parlor of the "Mansion House," with my head yet filled with the noise of music, cheers, and the firing of cannon, with which our arrival was heralded.

At four o'clock we were aroused from our beds at Amenia, where we lodged last night, and before we were half dressed, early as was the hour, half the inhabitants of the town were out to witness our departure. As the cavalcade started, a salute was fired from a cannon which the enthusiastic friends of the road had brought out for the purpose, and in a few minutes a turn of the road shut us out from sight.

Our road lay along the western edge of a broad fertile valley, teeming with the richest products of the soil, and affording a view at once beautiful and sublime. After passing along the western edge a few miles, we turned off and crossed to the eastern side of this same valley, where the view was none the less beautiful or interesting. A delightful ride of about sixteen miles brought us to North East, which is the highest summit of the road, and at this place we again crossed over to the western side of the same beautiful valley, stopping at Copaque for a short time to rest the weary horses, and procure if possible some refreshment, for we had started without breakfast. Some few of the party succeeded in procuring something to eat, but the most of them went on to Hillsdale, a beautiful and picturesque village, situated, as its name imports, amid blooming hills and dales.

An excellent meal, which some designated breakfast and others dinner, was here furnished, and about half past eleven o'clock we again mounted our vehicles to proceed *en route* for Chatham, there to take the cars of the Western Railroad for Greenbush. Up to Hillsdale, as far back as Owensville, our whole route has been in sight nearly all the time of the valley, bounded by high mountains, through which the road is intended to pass, and I cannot forbear repeating that of this entire distance, upwards of sixty miles, there is no portion of the road so difficult of construction, as has proved many miles on the best part of the Western Railroad.

[This portion of the route has very properly been designated as the Bloomfield Pass, in honor of the successful exertions of that gentleman who discovered it in 1838. Up to that time the broad valley of the Ancram had been followed, leading to a costly summit and involving the necessity of locating some miles of the road out of the State. In 1838, Mr. B. on his own responsibility caused a survey to be made, turning to the west of Hillsdale, which entirely obviated the necessity of leaving our own State, and that too without any additional expense.]

The road for the rest of the journey was over a hilly country affording however, some magnificent views of the fertile valley which lay beneath us.

Our next stopping place was at Spencertown, in the Township of Austerlitz, one of the most romantically located towns I have ever had the good fortune to pass through.

At Greenbush we were met by a deputation of citizens and civic dignitaries from Troy, accompanied by the beautiful military company of the Troy Citizens Corps, under the command of Capt. A. Pearce, by whom we were escorted to the steamboat Jonas C. Heartt, which was waiting our arrival at the wharf. An immense concourse of citizens were also assembled at Greenbush, who seemed to hail our arrival with as much gladness as though our presence secured the completion of their road.

A beautiful sail of six miles brought us to the city of Troy, and on the voyage some minutes connected with this portion of the road were communicated to me by a gentleman from Troy, which are matters of interest as connected with this subject.

Ground is to be broken to-morrow in a beautiful meadow on the margin of the river, lying immediately below the Van Rensselaer Manor House, and the line of the road is staked out for a considerable distance. The road from Troy to a point about two and a half miles distant from the centre of the city, is to be constructed under the charter of the Troy and Schenectady Railroad Company, which is owned by the city of Troy, leaving only about four and a half miles to Greenbush to be constructed under the charter of the New York and Albany Railroad Co.—The road from Greenbush to Troy runs along the margin of the river, and with the exception of a few hundred yards of embankment, can be easily constructed.

Just before reaching Troy, the bell of the J. C. Heartt was rung to announce our arrival, and a salute was immediately commenced from the cannon stationed on the wharves near the landing. The band on board the boat struck up a national air—the thousands with whom the wharves were crowded rent the air with shouts—the cannon performed their duties admirably, and in this manner we were landed in Troy. Headed by the Citizens' Corps and followed by thousands of the citizens of Troy, we marched to the admirable quarters provided for us at the Mansion House, which we entered amid the renewed cheers of the immense assemblage.

Such has been our reception at Troy: and the remembrance of it most effectually does away all the harsh things (though good naturedly spoken) urged against New York by Mr. Davis, and proves that however the Trojans may think New York, as a city, backward is advancing her own interests, the citizens of New York were accepted and received as friends engaged in the same work. It is impossible to conceive the enthusiasm on the subject of this road, which pervaded all classes, at least as far as I have been able to judge from personal observation.

To-morrow will be a busy and exciting day. In addition to the ceremony of breaking ground below the city, it is the intention of our kind hosts to show the lions to us, and few will have during the day any moment he can call his own. The ceremony will be interesting and imposing, if I may judge of the preparations made for it, and I trust to do justice to it in my report.

Among the gentlemen added to our party are Messrs. Norris and Imlay, the celebrated locomotive builders, who are here, as are the rest of us, by invitation.

The same courtesy has been extended to the officers of the various roads throughout the State, many of whom have accepted, and will probably be on the ground; and as the delegation from Brooklyn is expected to-morrow, our party will be considerably increased. The road is contracted for by about thirty contractors, among whom are some of the most wealthy and experienced in the business. Mr. Farwell commences at the end of the work, and will go to work at once and vigorously. Shantees are already erected on the ground where we are to meet to-morrow, and more will be speedily built, so that, as far as outward appearances go to convince, there is every reason to believe that the work will be prosecuted with an energy and vigor worthy of its vast importance.

Troy, August 4, 1842.

The second and most exciting of the days set apart for the commencement of the New York and Albany Railroad has passed over, and in a manner which has afforded the highest gratification to all concerned.

At 8 o'clock, a cavalcade, consisting of twenty-three carriages, all well filled, left the hotel on a tour of inspection of the lions of Troy, and wonderful indeed, at least to many of us, did some of these lions seem. Our first halting place was the immense carriage establishment of Messrs. Gilbert & Eaton, which must be familiar to every person who has at any time ridden in a mail stage, for they have finished thousands of their commodious and substantial stages for almost every part of the Union. Their establishment occupies a space two hundred and thirty-five by one hundred and fifty feet, and is most perfect and complete in all its arrangements, every article pertaining to the coaches being made within the same walls. We were conducted to every part of the building by the gentlemanly proprietors who took pleasure in exhibiting their immense works. The machines for turning spokes, sawing felloes, and plaining huge oak boards, attracted great attention as well from the novelty of the inventions (to us) as for the perfect manner in which the work was turned out. The establishment when in full operation affords employment to upwards of two hundred persons, but at present not half that number are at work.

From this place we proceed, under the guidance of the committee appointed to receive and attend to us, who were headed by the Mayor, to the celebrated Iron Works under the superintendence of Mr. Henry Burden, about two miles as I judged, from the city. These works are all kept in operation by water power, the stream used for the purpose being Winan's Kill. To obtain the proper use of this water, Mr. Burden has cut out of the solid rock, a space wide enough to admit a water wheel, fifty feet in diameter, and twenty-four feet in width. This wheel was to all a subject of the most unbounded wonder, which was rather increased, when we were told that the wheel would hold seventy-five tons of water, each bucket being eight feet deep, giving, as Mr. Burden stated, a power sufficient to raise seventy five tons in three and a half minutes.

The immense power afforded by this wheel is made to connect by a shaft sent through a solid rock under a road, with a building where are erected the furnaces and machinery for making spikes and horse shoes. The latter article is manufactured by Mr. Burden's machine at the rate of twelve or fifteen to a minute, and he has another machine for punching the holes, and a third to make the corks.

As soon as the procession was on board the boat, (the Jonas C. Heartt,) the fasts were cast off, and amid the cheers of the immense assemblage who thronged the wharves; the music of the band, and, the roar of cannon from both sides of the river, we put out into the stream, followed by the John Mason, which was crowed almost to suffocation with citizens going down to witness and participate in the interesting ceremony.

We landed at Bath about a quarter of a mile from the spot appointed for breaking ground, and forming again in procession, with the citizens from the John Mason bringing up the rear, we marched to the spot selected, which, as I said in a previous letter, was on a beautiful meadow of W. P. Van Rensselaer, Esq., the patroon, on the east side of the river, about 2 1-2 miles below Troy.

The Troy citizens' corps, who escorted us, formed a circle round the spot staked off, into which the New York, Brooklyn, and Troy delegation were admitted, the citizens surrounding them, and looking on with deep interest as the ceremony progressed.

When all were properly arranged, Mr. Edwin F. Johnson, the

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able Chief Engineer of the corps, handed four spades to Mr. Delafield, the President. Before proceeding to use them, Mr. D. placed them on the ground, and delivered, or rather read a short, but pertinent and exceedingly interesting address, which he said he had prepared during the very few hours of leisure he had enjoyed since they left New York. Mr. D. gave a brief history of railroads, which was listened to with deep attention.

Mr. Delafield then adverted to the New York and Albany railroad, which he said could be completed in twenty-four months, and with a facility not to be found for the same distance in any other part of the state.

Mr. Delafield's remarks were received with great approbation, and when he had concluded, he handed spades to J. C. Heart, Esq., Mayor of Troy, to Mr. S. Leonard representing the Mayor of New York, Thomas G. Talmadge representing the Mayor of Brooklyn, and W. P. Van Rensalaer, Esq., the patroon on the east side of the river.

J. C. Heartt, Esq., then responded to the address of Mr. Delafield, in a very brief but happy speech, in which, after wishing all success and prosperity to the road, he pledged to that end the energy of the citizens of Troy.

He was followed by Ald. Leonard, of New York, and Ald. T. G. Talmadge, of Brooklyn, each of whom addressed a few appropriate words to the assemblage.

In a moment each gentleman's coat was off and the sod was turn ed up, amid cheers, music and the roar of cannon—W. P. Van Rensalaer taking, throughout, a most active part in it.

The procession was then formed again in the same manner, and marching back to the boat, we started on our homeward tour. As the Albanians had declined honoring the company with their presence, it was feared they had all left the city, and in order to ascertain that fact the boats were turned down the river, and we sailed along the shore. As we reached the city, the band on board the Jonas C. Heartt, struck up "Oh dear what can the matter be," the bell of that boat was rung, and was answered by all the boats at the wharves. Passing over to the landing of the Western railroad, where a large concourse of people were assembled, we saluted them with three cheers. We then returned to Troy, and marched in procession to the hotel, where a sumptuous dinner was set before the hungry guests, who did ample justice to all the good things provided by their generous hosts. The dinner was strictly on the Temperance plan, and consequently no toasts or speeches were made, but after the room had been nearly cleared, a social party was formed at our table, where wine, wit, toasts and speeches kept them agreeably entertained until evening drew on.

As I have in one part of this report mentioned the extraordinary works under the charge of Mr. Burden, which I inspected personally, perhaps a few words as to another establishment which time did not permit us to visit, may not be amiss.

Mr. Marshall, one of the wealthiest and most influential citizens of Troy, has three factories or mills in operation on the Poeston Kills, just in the rear of the city, but finding that he had room and perhaps business for more, he has bored a tunnel two hundred feet under the street, through the solid rock, through which the water of the Poeston Kills is to be conducted, and run three other establishments. The cost of this tunnel has been immense, and when we consider that it was entirely a private enterprise, conceived and conducted by one man, we could not but yield our admiration to the energy and perseverance of Mr. Marshall.

And thus has ended the second day of ceremony, as connected with the long wished for commencement of the New York and Albany Railroad. I have before given my own opinion, derived from personal observation during a ride through the country of one hundred and ten miles, of the entire feasibility of making the road, in which I agree not only with the accomplished engineer of the company, Mr. Johnson, but with all who have had the same opportunities of judging as myself. The offcers and directors under whose charge the construction of the road is placed, is composed of gentlemen well known as enterprising, energetic and persevering, as the following list will show:

President—John Delafield.

Vice President—Josiah Rich,

Treasurer—Jonas C. Heartt.

Executive Committee—George R. Davis, Charles H. Hall, A. G. Hammond.

Directors—A. Sherman, Peter Cooper, Hiram Brown, J. M. Ketcham, J. A. Taber, H. Crosby, Joel Mallary.

Agent—Joseph E. Bloomfield.

Chief Engineer—Edwin F. Johnson.

The road is needed, and that no person can deny; and if the citizens of New York would but come to Greenbush and pass a few hours at the present depot of the Western Railroad, and see the immense quantity of freight daily passing over the road, they would, I think, with one accord put their hands in their pockets and demand the immediate completion of a railroad from Albany to New York.

And now before I close this report of the proceedings of one of the most agreeable weeks I have ever passed, justice requires at least the mention of the gentlemen, to whom all are so much indebted for the pleasure they have enjoyed.

First to Messrs. Delafield, Rich, and Bloomfield, who have had the entire responsibility of providing for and entertaining the guests, is due all thanks and praise, for their kindness, courtesy and attention, and the happy hours made more happy by their efforts, will be long remembered by all who were of the party.

To the hospitable farmers in the vicinity of Quaker Hill, and for my own part to Jonathan Akin, Esq., we are especially indebted. Their doors were freely opened to receive us, and all at their command, was tendered for our acceptance, during our brief but pleasant stay among them.

To the Mayor and committee of arrangements of Troy, whose hospitality knew no bounds, we cannot tender sufficient thanks. Their reception and treatment of their guests, was such as all might expect from the well known hospitality of the Trojans.

Messrs. E. & W. Dorlon the gentlemanly proprietors of the Mansion House, where we were quartered, left nothing undone to render our stay agreeable; and I can do no less than commend their excellent establishment to the attention of all travellers.

The Troy Citizens' Corps, who did escort duty during our stay in Troy, is a beautiful, well disciplined and effective company, and should they ever visit New York, they will find that their courteous attention has not been forgotten.

This report is necessarily much condensed, but a proper appreciation of the value of your columns, and of the necessity of as much brevity, warns me to conclude, which I do with the fervent hope, that in two years hence, I may be one of the party who are to go from New York to Albany over the New York and Albany Rail Road.

Our Reporter has furnished us with an account of a dinner on board the steamer Troy, at which the Officers of the Company with the Delegates from Brooklyn and New York sat down, but owing to the crowded state of our columns, we are much to our regret, compelled to omit it entirely. We shall, however, endeavor to find room for it hereafter. Thomas G. Talmadge, Esq. of Brooklyn, presided, assisted by Assistant Ald. Atwell, and Josiah Rich, Esq. Some excellent toasts were given, and a few admirable speeches delivered. The party was kept up from 2 P. M. to the arrival of the boat at the wharf in this city. The company proceed to Westchester Co. to-day to break ground there, and the work will be at once commenced with spirit.

Errata.—The following corrections to Ellet's article in our last number were not received until after it had been printed. :—

Page 70,—after title insert No. 1; 6th line proportioned, read *proportional;* 10th line for proportioned read *proportional;* 34th line, for per ton per mile, read per ton *nett* per mile. Page 71,—8th line for How to express, read *Now* to express; 15th line, for business exists, read *consists*.

[From the Journal of the Franklin Institute.]

Remarks on the Injudicious Policy pursued in the Construction and Machinery of many Railroads in the United States. By *John C. Trautwine*, Civil Engineer.

I have read, with much pleasure, an able pamphlet, entitled "*The causes which have conduced to the failure of many railroads in the United States,*" written by Mr. Charles Ellet, Jr., Civil Engineer, of Philadelphia.

Mr. Ellet proves, in my opinion, most satisfactorily, that the cause of so many failures in railroad enterprises in the United States, is not to be traced to any defect in the system itself, but to the injudicious application of the resources of the companies, to the accomplishment of the object to be effected.

There has been much more money expended on many of our railroads, than either their present or prospective resources could possibly justify. Even admitting that the anticipations of their warmest advocates, as to their probable amouut of trade, had been fully realized, a little calculation would show that an expenditure altogether disproportionate even to *that* amount has been thoughtlessly lavished on many of our enterprises. Indeed they have, with, however, several honorable exceptions, been commenced, and carried on, with so little reference to the principle of adopting the means to the end, that it is only matter of surprise that so great a number of them sustain themselves even so well as they do.

This position is so amply supported by the numerous failures to realize the anticipated results that were to follow the construction of many of our railroads, as to need no labored arguments in its behalf. The fact speaks for itself more convincingly than any thing I could say on the subject; indeed, I am not certain that I should have ventured to enter my feeble protest against our present heedless system of railroad making, had I not been sustained by so incontrovertible an argument: for when the current of public opinion once sets strongly into a determined channel, no matter how ill directed its course may be, it is rarely that good results to him who ventures to stem it. It is only after the vessel, entrusted to its stream, has struck upon the rocks, that one may, without apprehension of censure, strive to save the fragments of the wreck, or mark out the dangerous spot upon the chart.

The chief cause of these failures has been, as Mr. Ellet remarks, our want of attention to first principles. We are too much an *imitative* people; and, in our endeavors to keep pace with England, whose vast pecuniary resources, and concentrated commerce, enable her safely to reduce to practice those abstract principles, the union of which constitutes the "beau ideal" of a railroad, we overlook the great disparity that exists in the trade and financial capacities of the two countries;—almost unlimited in the one, but comparatively restricted in the other.

The moment news reaches us of some important change in railroad policy adopted by the mother country, no matter what expense its application necessarily involves, our engineers are not content until they effect its introduction upon the several works under their charge.

Now there is certainly nothing culpable in this disposition to avail ourselves of the experience of others;—on the contrary, where a *parity of considerations exists*, it is wise to follow the beaten track. But it is equally certain that a blind adoption of every abstract improvement—without regard to any existing disparity of means or of secondary causes calculated to neutralize its beneficial effects—may be justly deprecated.

The engineer, before he can decide poperly on the details of his location, superstructure, machinery, &c., must ascertain an essential element of his decisions, not only what is the probable *amount* and *nature* of the trade which the road will be required to accommodate, but whether or not it will present itself in such quantities and at such intervals of time, as will admit of loading the engines nearly up to their full capacity of draft.

If the trade is so heavy as to require many engines, and so regular that nearly full loads may be depended on, he will of course find it advisable to encounter great expenses for light grades, heavy rails, and powerful engines; because, abstractly considered, a certain amount of power is much more economically maintained, and applied through the medium of one large engine than of two or more smaller ones; and the use of such powerful engines necessarily involves that of proportionally heavy rails and superstructures.

Again, still further to reduce the number of engines by enabling them to draw maximum loads, the grades, or acclivities of the road, must be reduced as much as possible.

A perfect railroad would be that on which the least imaginable force would draw the greatest imaginable load; such a road is evidently a theoretical one; it can never be attained in practice; but it is the duty of the engineer to approximate to it in every instance, as closely *as the trade of the road, and the interest of the company, will admit.*

It follows then, that the above considerations of grades, weight of engines, rails, &c., although not reducible to any one fixed rule for their application to practice, still have certain limits which we may not transcend with impunity. It is plain that every railroad, to some extent, constitutes a case by itself;—it requires its own peculiar calculations; and the engineer must modify, and remodify his assumed outlays for gradients, curves, engines, rails, &c. until he attains that happy medium in each, and consistency in all, that will best subserve *the interests of the company. That* must be his guiding principle; and if he hopes in every case to attain that end, by simply making for them a railroad combining in itself all the improvements of the age, the chances are greatly in favor of his being disappointed.

It is not the *best railroad,* but the *best paying* railroad, that should be aimed at; and the two are by no means necessarily associated in our country, except in comparatively few instances.

Experience has shown that we may assume the annual expense of running such engines as are now in common use on all our railroads, at about $5,000 each; and as $5,000 is the interest at 6 per cent. on $83,333, we see that the engineer may very properly incur considerable expense in diminishing the number of engines requisite for maintaining the traffic of the road. But it happens on many of our railroads that the number of engines employed, is less dependent on the grades, or even on the amount of transportation, than on the *number of trips* which the nature of the business requires to be made daily. This business may be so great as to yield a fine revenue, and yet not of such a nature as to require either high grades, heavy rails, or powerful engines; but on the contrary, such that if grades, rails, and engines of this kind be provided for it, the result must inevitably be a failure of the enterprise.

Such are the cases that constitute the numerous railroad failures in the United States. Nothing but the want of knowledge of, and attention to, the principles that influence the expenditures warrantable in each instance for the attainment of light grades, easy curves, and heavy superstructure, has led to so general a disappointment among railroad adventurers, and excited sentiments of distrust with regard to the system itself. Indeed no argument could probably be adduced, so favorable to the merits of the railroad cause, as that it has survived the horrible manglings inflicted on it ignorantly by its best friends. It has struggled through a long and well fought contest against both friends and foes; and now stands forth in its might, victorious, though wounded almost to the death.

The grounds of every expenditure on a railroad should be, that the annual saving thereby induced, shall more than counterbalance the interest on the increased cost. To this test, not only the general character of the line, but every deep-cut tunnel, bridge, and other important work along it should be submitted, before it is finally decided on; and this cannot be done, unless the engineer is previously in possession of some general data, as to the amount, nature, and regularity of the anticipated trade of the road.

It is upon this principle that the enormous original outlays on the English railroads are so willingly encountered. The English engineer first ascertains that the transportation will not only justify a first rate road; but that in order to accommodate it, with a due regard to economy, the road *must* be a first rate one.

But our American engineers, *as a class*, do not descend to first principles. It is enough for them, that such and such improvements have been introduced in England;—omitting all considerations of the premises, they look only to the conclusions; and the imitative faculties are forthwith called into requisition, without any regard to the modifying, and controlling circumstances peculiar to their own case. They dash on blindly in their operations, deluded by the impression that they cannot err, if they only adhere closely to their English copies. Deep cuts, high embankments, heavy rails, powerful engines, long tunnels, expensive masonry, &c. &c. are all decided on, as matters of course, whenever an opportunity offers, without a moment's reflection that the interest on their cost may never be repaid by their services—but that, on the contrary, they must for ever operate as drains on the annual revenues of the company.

Yet with the data of probable amount and nature of the trade, together with the expenses of transportation as now developed by experience, the adoption or rejection of all these things admit of an easy determination. But unfortunately it is easier to point towards England, than to make calculations even of the most simple character.

This servile imitation, or rather attempt to imitate the splendid practice of the English engineers, without either the motives, or the means for carrying it out, has been the source of incalculable injury to the railroad cause in the United States. All would be well, were we content to investigate the *principles* upon which their practice is founded; for by adhering to those principles, we should, (as would they also in our circumstances,) arrive at a system of construction entirely different from that which their unlimited trade, and equally unlimited finances, now warrant them to adopt. The same *principles*, lead to *totally different practice*, in different circumstances.

Having ascertained, approximately, the probable amount and nature of the trade which the road will be required to accommodate, and knowing pretty nearly the rates of carriage it will bear, we arrive at a sum which constitutes the gross annual receipts of the road. If from this amount we deduct a portion sufficient to defray the annual expenses, we have the yearly profits. These profits are the interest on the principal which we will be justifiable in expending on the construction and furnishing of the road.

Self evident as the propriety of this simple precautionary process of calculation is, and impossible as it would appear to be, (and actually is,) to decide properly on the character of the contemplated road, and its machinery, without it, yet it has not probably been resorted to by the engineers of one road in ten that has been constructed in the Union. When the engineer commences his location, his aim almost invariably is, to obtain the *best* abstract line; and whether his road is to obtain 5,000, or 50,000 tons annually, the character of his grades, curves, superstructure, machinery, &c., will be precisely the same. His standard of propriety is an invariable one; it adapts itself to no contingencies; it admits of no accommodation to difference of objects to be effected. It is summed up in the brief sentence, "the English do so."

The usual routine is pretty much after this manner, viz: the survey is made; the map drawn; and the grades and curves laid down *without any reference to the object or cost of the road*;—then the calculations of costs are made;—and finally, to make both ends meet, an exhibit of probable revenue is concocted, *to suit the Report!*

The road is made; it does not pay; the railroad system "won't do." I do not mean to insinuate that this mode of proceeding is resorted to with the intention to deceive; but that it does deceive, and that ruinously, is undeniable. We are apt to be led astray by our prejudices in favor of any project in which we are personally interested. Every engineer considers his road to be a little more important than any other in the world; and under the influence of such feelings, imaginary freight flows to it, from all quarters, without limit. Like the Legislator's conscience, it is "equal to any emergency;" and it is unfortunate that it is so. Were it otherwise, reports and profits would coincide much more nearly. Now, most of our railroads that have failed to pay well, have been constructed principally for the purpose of accommodating, from two to four times a-day, the passengers, baggage, and freight brought to them either by some other connecting line of railroad, or by stages, or steamboats. But few, if any, of those connecting large cities may be considered as failures. I hope to show that to conduct such a business as that represented in the first case, does not, as is generally supposed (and practiced on) necessarily involve a company in enormous expenses, for easy grades, powerful engines, and heavy rails. In attempting this, I shall, for the sake of illustration, suppose a case, and carry it through.

The amount thus to be transported, say only twice a day (once in each direction) may, generally speaking, be carried by a single light engine, weighing, with her complement of fuel and water, not more than six tons, over grades as high as sixty feet to a mile, by merely slacking her speed at such points.

Let us suppose that an engine of this light weight, would take, over such grades, a gross weight of only thirty tons, exclusive of her tender; and let us see how much business one such trip daily, in each direction, would amount to in a year, of 300 working days. At first sight, this may appear to many of my readers, like taking a very contracted view of the subject; but before we conclude, it may, perhaps, assume a somewhat more imposing aspect. The six ton engine is assumed merely to show how small a power can, on a railroad, satisfy a considerable business. In practice I should recommend, for such a superstructure as is hereafter described, eight ton engines.

Gross load of an engine weighing six tons, with her compliment of fuel and water in the boiler, but exclusive of her tender, over grades of sixty feet to a mile.

	Tons.
40 passengers and their baggage,	4
Passenger cars, - - - - -	7
Freight, - - - - - -	12
Preight cars, - - - - -	7
Total, - - - - - -	30 tons, gross load.

Now if we suppose only one such trip daily in each direction, and assume 300 working days to the year, we have annually,

24,000 passengers.
7,200 tons freight.

Let our road be fifty miles long;—the charge for passengers $2.50;—and for freight $4 per ton. Then we have for the gross income of the road,

24,000 passengers, at $2.50,	$60,000
7,200 tons freight, at $4,	28,800
	$88,800 gross annual receipts.

And this, it will be remembered, may be accomplished by two engines, (one for each direction daily) so small in comparison to those which are now coming into favor for *all* roads, as to appear like models: and over grades of sixty feet to a mile, with an eight ton engine, an addition of about fifty per cent. might be made to the above amount of trade and income, with but a trifling increase of expense. But now let us see whether so small an income as $89,000 per annum, would justify the construction of a railroad fifty miles in length.

Experience has shown that the annual expenses of our railroads, generally range within from thirty to fifty per cent. of their income; varying, of course, with many circumstances, which it would not be to our purpose to expatiate on in this place. There can be little doubt that these expenses would be materially diminished on most of our roads, by the use of lighter engines and cars, lower rates of speed, and Kyanized timber for the superstructure; but, although our road contemplates all those conditions, still we shall assume fifty per cent. of the gross receipts, as necessary to defray the gross expenses.

If then from the $89,000 of gross income of our road, we deduot fifty per cent. (say $45,000,) for expenses, there remains the sum of $44,000 of clear annual profit. Now $44,000 is the interest at eight per cent. on a capital of $550,000; which amount, and no more, we would be justifiable in expending in the construction, and equipment, of a railroad fifty miles in length, intended to accommodate so small a trade as we have assumed, in our example; and required to realize dividends of eight per cent. per annum.

If from this capital of $550,000, we set aside $50,000 to cover the expense of furnishing our road with engines, cars, water-stations, depots, &c., there still remains $500,000, for the construction of the road itself; which in this case, is equal to $10,000 per mile.

Here then it is evident, that if we wish "to keep up with the age," and to build a road of the best *abstract* character, our project must be abandoned; because the sum of perhaps from $20,000, to $30,000 per mile, would be required to construct such a one. And although we should even be convinced that at some future day, distant perhaps ten or twenty years, the road would, by the gradual accumulation of business, be able to realize profitable returns on this large investment, still adventurers could scarcely be found so confiding in these prospective advantages, as to embark their capital in it.

But in the case before us, I should certainly advise not to keep up with the age; but to go back to those ancient times, some five or six years past, when flat bar roads were in fashion; the old flat bar road, that has been so unmercifully crushed out of existence by our mammoth engines, of the present day. I entertain a high regard for the flat bar road; and conceive that the odium which is now attached to its memory, has not been justly incurred. Does it follow, as a matter of course, that because it is not adapted to very heavy trades, necessarily involving the use of powerful engines, and a resort to high velocities, that therefore it may not be very serviceable, nay, more serviceable than any other, in cases where the limited business admits of lighter engines, and does not justify the construction of a more expensive road? The outcry against the flat bar road, has, in my opinion, but little foundation in justice. It is, like our more permanent structures, good in its place; and its place is, where light engines, moving at moderate velocities, can satisfy all the demands of the trade at less expense than heavy engines on the more permanent roads can do. And such cases are very numerous. The reader cannot, I presume, infer from this, that I should recommend to substitute the flat bar for the 75 lb. rail on the Liverpool and Manchester road; in that event, I should, beyond all controversy, be "behind the age;" but, by inversion, I conceive that any one who should advise to employ the 75 lb. rail, at its enormous expense, upon a road on which the cheap light bar would answer every purpose, would be equally open to censure. However, we are digressing from our subject; let us see what kind of railroad we can construct for 10,000 per mile.

In the first place, I would limit the weight of the engines to the maximum of eight tons; and would allow no greater weight on any one engine or car, than one ton. The speed of passenger trains should not exceed twelve or fifteen miles per hour; nor that of freight trains seven or eight miles. The grading, it is needless to say, should be for a single track; the acclivities should coincide as nearly with the natural surface of the ground as the maximum would admit of, provided said maximum did not seriously interfere with the time of making the trip, or render assistant power necessary. Sudden changes of grade should of course be eased by vertical curves. But trifling expense should be incurred, for horizontal curves of greater radius than about 1500 feet; and should any very serious object require it, I should admit of radii as short as 300 feet.

The superstructures if not piled, should consist of log cross-ties, and of six by six inch strings, supporting a flat bar, or rather *flanched* bar, similar to that on the South Carolina railroad; but smaller.

Finally, the whole of the timber should be thoroughly Kyanized, or otherwise protected from decay.

Now, so far from expecting this superstructure to be knocked to pieces in a few years, as the old flat bar roads generally were, I should calculate on its annual repairs being less than on perhaps any railroad in the United States: and that, not from any inherent virtue in the road itself, but from the simple fact that *all its parts are fully proportioned to the offices they have to perform.* We should have no crushings or deflections here; but with its light engines, it would be one of the stiffest roads in the Union; and moreover, a much more agreeable one to ride on, than any of those of more permanent construction. Beside which, it would annually yield eight per cent. clear profit in its cost, when doing only the moderate business of one trip daily in each direction, with a small *model* engine, over grades of sixty feet per mile; or, should the business require the use of eight ton engines, it would yield twelve per cent. profit on the same number of trips: or should two trips daily in each direction be necessary with such loads, it would yield twenty four per cent. profit.

Below is an estimate of its cost. If the professional reader should think the item of grading too low, (and it is, I suspect, the only one on which he will have any doubts) let him take the profile of almost any road in the United States, and relocate it, in imagination, so as to adapt it to sixty feet grades, and he will find the allowance to be ample.

Estimate per mile, single track, of such a Railroad as the foregoing.

Grading, culverts, drains, road-bridges, &c.,	$4,000
Fencing, (1400 panels at 50 cents, $700; but allowing fencing only half way,)	350
Land damages,	400
Cross-ties—1760, at 25 cents,	440
String timbers, 35 thousand feet board measures, at $25,	875
Iron flanched bar—24 tons, at $65,	1,560
Splicing plates,	30
Spikes,	100
Workmanship, 1760 lineal yards, at 50 cents,	880
Surveys, engineering, instruments, &c.,	800
Earle-izing, 13,000 cubic feet, at $2\frac{1}{2}$ cents,	325
Incidentals,	220
Total,	$10,0000

In northern climates, a small addition to this sum would be advisable for broken stone under the cross-ties.

Thus we see, that such a road as we speak of, can be constructed for the moderate sum of $10,000 per mile. Yet how many railroads are there in the United States, not enjoying even the limited business to which this road is adequate at two trips daily, on which not only thousands, but tens and hundreds of thousands have been thoughtlessly squandered for light grades, heavy rails, and powerful engines.

[TO BE CONTINUED.]

At the request of a friend we insert the following portion of Mr Herapath's observations upon four and six wheel engines, which relate to cross sleepers and longitudinal bearings.

CROSS SLEEPERS AND LONGITUDINAL BEARINGS.

On this railway I had an opportunity of making some observations, which it may not be amiss here to record. In our travels from Nottingham to Leicester, on Wednesday morning, there having been previously a little rain, I was struck with observing the rails which lay on cross sleepers hold their wet and dampness much longer where the ballast came up to them and was within two or three inches of the top of the edge of the rail; and to part with it much earlier when the ground was hollowed out, and clear of them, to drain the surface. This was not universal, but it was so very general for nearly the whole distance, as obviously, to make it, where it was not, the exception to the rule. What may have been the cause, unless it being a mild morning the ballast was much colder than the atmosphere, and communicating that cold to the iron in contact with it, prevented the quick evaporation of the wet, I am unable to explain. Mr. Kearsley, whose attention I called to the phenomenon, at first thought it might be owing to the air having a freer circulation round the rail where the ground was hollowed out, which caused a quicker evaporation; but I was not satisfied with this explanation, and I do not think he was at last, inasmuch as there was little or no current of air, and the appearance was observed in nearly all situations.

The next day we had an opportunity of traveling over stone blocks, cross sleepers, and longitudinal bearings, the two latter in an instructive variety near Rugby. The unpleasant rigidity and harshness over the stone blocks were very sensible, but our attention was chiefly drawn to the comparison of cross sleepers with longitudinal bearings. I had previously mentioned some experience on the Hull and Selby Railway (which I shall hereafter detail,) of the greater draught over longitudinal bearings than over cross sleepers, with which he said his observations agreed, and now we endeavored to appreciate the comparative effects of the two as we traveled along. It appeared to me, and I believe to him, that the train ran much heavier on the longitudinals, which, like traveling over a heavy road, one easily feels; and between the sounds over the two there was no comparison. Over the cross-sleepers the train run with comparative silence, but over the longitudinals there was a constant heavy murmur and noise. These phenomena of draft and noise happened not in one place, or change, only, but in every one—of which we had a much greater variety than I could have expected to meet with on any line. *To me the observations on this line are satisfactory in favor of cross-sleepers, as to lightness of draught and absence of noise.*

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In the early part of this article I have hinted at some curious facts mentioned to me by Mr. Gray, *relative to longitudinal bearings and cross-sleepers.* The difference of draught in hoar frost and wet weather, Mr. Gray affirmed—and the affirmation was borne out by the testimony of one or two of their men, to whom I spoke on the subject—*was as much as 50 or more per cent. against longitudinal bearings*, the draught being as much greater upon them than it was upon cross sleepers. For instance, they assured me that oftentimes when the engine could with difficulty draw its load upon a level, over longitudinal bearings, it would trip up easily enough a rise, which they called their "bank," of 14 or 16 feet a mile, in which the rails were laid upon cross-sleepers.

To me, at first, this was a poser, the solution of which I could not so much as guess at. Being, however, informed that the hoar frost seized the rails on the longitudinal bearings earlier, and left them much later, than it did those on cross-sleepers, I immediately divined the cause, and saw a beautiful, because an altogether unexpected, illustration of the truths of natural philosophy. It is known to philosophers, that before dew can be deposited on any body, this body must become colder than the atmosphere around it, and that hoar frost is nothing but dew, frozen, by the temperature of the body on which it is, having sunk below the freezing point, that is, below 32° of Fahr. It is also known, that the temperature of the earth, a little distance below the surface, is, at night generally higher than that of the atmosphere. Wood is comparatively a non-conductor of heat. Therefore, and because the rails, where there are cross-sleepers, are embeded in the ballast to within an inch or two of the top of the rail, and iron is a good conductor of heat, whatever heat the rails lose by radiation, on account of their rough surface, is quickly and wholly, or in a great measure supplied from the sub-soil, where there are cross-sleepers, while it is not so where the rails are kept from a communication with the subjacent ground, by the broad and deep wood of the longitudinal bearings. The consequence is, that the rails on the longitudinal bearings lose more heat, and faster, and of course become colder earlier, and continue so longer, than those on cross-sleepers. Of course the deposited moisture from the atmosphere is earlier and more copiously condensed, and quicker and harder frozen, upon those than upon these. Hence the whole phenomena of heavier draught, arising from longer and greater slipperiness, upon the longitudinals, and, perhaps, at times of their being slippery when the cross-sleepers are wholly dry, and free from hoar frost.

As a confirmation of this, I may here mention what I observed Tuesday morning, Dec. 21st, upon the Bristol and Exeter Railway. It had been a calm and clear night, for the whole surface of the vegetable country was covered with a thick and heard hoar frost, which can take place in such circumstances only; and the stagnant water was everywhere covered with a thick coat of ice. The rails themselves were so covered with hoar frost, that we were obliged to have the assistance of a pilot engine; and yet with all the united power of two Great Western engines, our speed was comparatively slow. Being upon the platform of the engine, my attention was quickly caught by here and there perceiving patches on the rails, of one to one and a half feet, or perhaps more, perfectly dry and free from hoar frost, amidst the all but universal white which prevailed. Struck with the phenomenon, I looked more closely for something which might develop the cause, and soon saw that these exceptions to the hoar frost invariably appeared over the places where the longitudinal bearings abutted against each other. I called the attention of a relative of mine, who was upon the engine with me, to it, and we observed it for many miles together; so that I am quite satisfied it was owing to no local or accidental circumstance.

The explanation of this—which I call singular and important phenomenon, as bearing upon the relative advantages of two modes of constructing the upper works of railways—is simple and easy. The space betwen the ends of the longitudinal timbers is too small, and the timbers themselves too large, and maintain too high a temperature, for the hoar frost to affect the ground between them; the consequence is, during the still and clear night, heat is constantly communicated to the rail above by radiation, but chiefly, I apprehend, by the conduction of the atmosphere; by which means it is kept at a temperature that prevents the deposition of dew, and consequently the formation of hoar frost. This effect is of course not confined to a point, but by the conducting power of the metal, diffused some little distance on each side the joining of the timbers.

Thus, if phenomena and circumstance were carefully attended to, many a lesson might be learned which would lead to improvement, and save hundreds of thousands in the construction of these costly undertakings. But to do it effectually, men must have courage to resist the allurements of comfortable carriages, and travel upon the engine—the only place where observations can efficiently be made—in all seasons and in all weathers. But our philosophising has carried us for the present too far from our friends on the Hull and Selby Railway.

Mr. Gray observed that frosty mornings were not the only times at which they found longitudinal bearings of much heavier draught than cross-sleepers. In wet weather it was the same, and the longitudinals much the heavier to travel over. As it had happened that rain to some extent had fallen, in the night preceding the morning on which we were out, we had an opportunity of witnessing the effect near one of the stations. A train was coming up, and we walked some little distance down to meet it. On its passing, I observed, even under the nail which fastened the rail to the timber, that water was expressed from between the timber and metal, as the engine passed, and re-absorbed the moment after. The same phenomenon, but in an inferior degree, occurred as the carriages passed. Hence, as Mr. Gray observed, "wherever the wheels are, in wet weather, it is a valley, and they are in the position of constantly ascending a hill," which of course much increases the draught.

In very dry weather, Mr. Gray does not think there is much difference between continuous bearings and cross-sleepers. From what I observed on the Midland Counties Railway, I am somewhat sceptical upon this. *I fear the draught is greater, under all circumstances, upon continuous bearings*, and, if I understand them rightly, I think Mr. Kearsley, the superintendent of the locomotives, and Mr. Woodhouse, the engineer of the Midland Counties Railway, are of the same opinion. It is, however, a matter well worth trying, and one which I should like much to put to the test of accurate experiment.

[TO BE CONTINUED.]

EXTRAORDINARY RACE.—On Monday morning, at five minutes past five o'clock, thirty two carrier-pigeons, belonging to different persons at Brussels, were let loose at Liverpool, and started off with the swiftness of wind on a race to the Belgian capital. They had been brought over to this place covered up in a basket for a grand trial of their swiftness and sagacity in returning to their homes, and the winner of the race will carry off a handsome sweepstakes. They were set at liberty in the neighborhood of St. Luke's church, and immediately rose to at least double the height of its tower, after which they all started off to the southeast, the direct route to Brussels, with incredible rapidity. When they were let loose the morning was bright and beautiful, but if the rain should have been as heavy in the southeast during the day as it was here, their flight will have been greatly impeded, and some of them will be likely to lose their way across the channel. We shall be curious to hear the result of this extraordinary race.

Spontaneous Combustion.—A case of spontaneous combustion occurred in Hartford, Connecticut, recently. In drawing linseed oil, some of it was spilt on the floor: it was absorbed by a coarse sponge, and placed on a shelf. The smell of something burning led to an examination of the premises, when the sponge was found in a state of combustion, and just ready to burst into a flame. Only about two hours had elapsed between the time of using the sponge and the discovery.

Railway and Steamboat Travelling.—From a report made to the London Board of Trade on the comparative safety of steamboat and railway travelling, it appears that from the first of January to the first of July, 1841, but thirty lives were lost by railroad travelling. Of these, three passengers lost their lives from causes beyond their own control; two suffered from their own folly and negligence; five were trespassers on the road; and the remaining twenty were engineers, laborers, and workmen on the line of the railway. The number of passengers travelling was nine million one hundred and twenty-two thousand, distance travelled one hundred and eighty two millions four hundred and forty thousand miles, and the number of persons killed from causes beyond their own control was three, or one out of three million forty thousand six hundred and sixty six passengers; or, in other words, one passenger lost his life for each sixty millions eight hundred and thirteen thousand three hundred and thirty three miles travelled.

The author of the report, Mr. Lang, shows by a number of facts that railways are the safest of all modes of conveyance, and more particularly safer than steamboat travelling.

Her Majesty's steam frigate Penelope, now fitting at Chatham, is ordered to be rigged with Andrew Smith's patent wire-rope. The experiment made at Portsmouth on this rope a fortnight since, in the presence of Admirals Codrington, Bouverie, and Percy, and many other officers of high rank and experience, were highly satisfactory, both in proof of its immense strength and the facility of splicing.

The new canal steam packet Gallant returned to Georgetown on Saturday from a trip to the Great Falls of the Potomac. This trip, it is said, has dissipated every doubt upon the subject of the application of steam power to the navigation of the Chesapeake and Ohio Canal.

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COST OF TRANSPORTATION ON RAILROADS. *By* CHARLES ELLET, *Civil Engineer.*

(No. 2.)

On the value of Gradients.--In the preceding number I proposed a formula for the determination of the cost of transportation on railroads. I am aware that that expression is not in accordance with the opinion which now prevails in regard to the economy of railroad conveyance; and that there are many gentlemen of experience and reputation who are prepared to adopt a much lower estimate than mine. But, until some road can be adduced on which the experiment has been tried long enough to exhibit a result which can be received as a fair average, and which authorizes ower constants, I cannot consent to the reduction of the formula. In its present state it gives a result below the actual performance on any road in the United States.

I am aware that in not presenting the actual cost of freight in any particular number of cents per mile, or in any particular sum per mile travelled by the locomotive engines, I have deviated from the popular and most approved methods of treating the subject. But I regard the aggregate cost per mile run as no guide whatever to the economy which characterizes the management of a railroad; and deem it an unauthorized assumption that because this sum is, in any instance, unusually low, the work is conducted with more than ordinary success. The fact, where it exists, can only be used to prove, if other circumstances remain the same, that the engine have taken smaller loads, and made a greater number of trips, and run more miles, than was absolutely necessary. In fact, if we admit—what cannot well be denied—that under similar circumstances, and with engines of the same class, the cost of locomotive power is proportional to the distance run—or that the cost of running one mile is not *diminished by increasing* the load, it follows as a consequence that, caeteris paribus, *The more economical the administration of a road the greater will be the aggregate cost per mile run by the locomotive engines.*

Neither is the circumstance that the aggregate expenses of a line for one year dividend by the number of tons conveyed, exhibits a low average per ton per mile, any test of good management. The fact, by itself, is more likely to prove that the tonnage was great than that the administration was judicious.

I shall now proceed to deduce from this general expression of the cost of freight, certain consequences of the utmost importance in the location and establishment of railroad lines, which I believe have hitherto been little, if at all, repeated.

What is the value of gradients? I mean by this question, how much more is a railroad having grades of 30 feet to the mile worth than the same road with grades of 40 feet per mile? Or, how much would good economy authorize an engineer to expend, in the construction of his road, in order to reduce the limited gradient any given amount? I have seen various intricate and laborious solutions of questions which involve the loss of *time* and the consumption of *steam* in the ascents of gradients, but I have never yet met with any examination of this interesting and all important problem. The loss of time, in this country, is usually a matter of little consequence in the transportation of merchandise; and experience teaches that the cost of motive power is very nearly proportional to the distance travelled by the engine, and very little affected within the limits which ordinarily occur in practice by irregularities in the tractile power. It is no doubt true that if we were to make observations under extreme circumstances, as where the engines move on a perfect level, and where they frequently mount the steepest grades they can possibly ascend without loads—the cost of motive power, per mile run, would be considerably increased by the increase of the acclivity of the gradients. But we have no such extreme cases in practice; and the following investigation is based on the perfectly authorized assumption, that the cost of running the locomotive engine, with its tender, is proportional to the distance run, and independent of the variations of the tractile force consequent on the ordinary irregularities of grade.

In the preceding number, the aggregate annual expenses of a line of railroad, under good management, were represented by this formula:

$$\frac{3}{10}\text{N}+\frac{14\text{ T}}{1000}+500\text{ h}, \qquad \text{(A)}$$

in which N is put for the number of miles travelled during the year, by the locomotive engine, T the number of tons, nett, carried one mile, and *h* for the length of the line of the road. This formula, it will be observed, expresses the cost of transportation without any direct computation of the effect of the grades over which the tonnage is carried. Nevertheless, the result which it yields is not independent of the grades; for they enter into the value of N, and control the number of miles travelled by the engines. The variation of the maximum gradient will not cause a sensible variation of any item of the aggregate cost of transportation excepting that of the locomotive power.

Now, in deducing the changes in the cost of locomotive power consequent on changes of grade, I shall assume that the circumstances of the trade are such as will permit that the machine be always started with a full train—that is to say, with the heaviest train which it is certain to control on the limiting grade. In many instances this assumption is not strictly in accordance with the facts; since it is frequently advisable—particularly where the grades are light and the trade inconsiderable—to effect a portion of the transportation with imperfect loads. In such cases greater ascents might obviously be encountered without increasing the cost of carrying every train; and the effect of assuming that the trains are all full, when a portion af them is not full, will evidently be to render the estimated increase of cost consequent on the gradient somewhat higher than it really is. The formula is intended to give *a limit* within which the actual value of the gradient must always be found; and as it should be the object of every company to do their transportation with the least possible labor, and at the least possible cost, the number of miles actually travelled ought to approach very nearly the number corresponding with the assumption of full trains; and, consequently, except in extreme cases, the estimate should not be much in excess.

Now, if the limiting gradient of the road be changed, the number of miles travelled by the locomotive engines will also be changed. If the load be reduced one half by the introduction of any plane, the number of trips, and, consequently, the cost of locomotive power, will be very nearly doubled by the admission of that plane.

The number of miles travelled by the engines in the course of a year, snpposing them to convey full loads, and the transportation, accordingly, to be effected with the greatest possible economy of power, will be expressed by

$$\frac{2\,T'}{n}=N,$$

where n is put for the average *gross* load in tons, up the limiting grade, and T' tor the *gross* weight in tons carried one mile in the direction to which that gradient is opposed.

We know from satisfactory experiments, that an inclination of 20 feet per mile, on a road in good adjustment, requires for its ascent a power nearly double, and one 40 feet per mile, a power treble, and one 60 feet a power quadruple, (or, for grades under 80 feet, very nearly in this proportion,) that which is required to draw the same weight on a level. In other words, if W be the gross load an engine is capable of drawing with safety and certainty on a leve, road, and x the inclination in feet per mile of the gradient which limits the road, then

$$\frac{20}{20+x}W=n$$

will be the load, near enough for our object, with which it can ascend the plane rising x feet in a mile.

If we now designate by C the cost of running the engine with its tender only, one mile; by c the additional cost of motive power per mile, due to each ton gross added to the load,—then $C+cn$ will be the whole cost of motive power per mile run. This sum may be written

$$C+c\frac{20\,W}{20+x}$$

by substituting for n its value expressed in terms of the grade and the power of the engine.

If we now multiply this sum by $2\ T'\ \frac{20+x}{20\,w}$, the number of milo that ought to be travelled by all the engines in the course of a year, we shall obtain for the whole annual expense of motive power

$$2\,T'\,(C\frac{20+x}{20\,W}+c)$$

and for the whole annual cost of maintaining the line and accommodating the trade which it receives

$$2\,T'\,(C\,\frac{20+x}{20\,W}+c)\;+\;\frac{14\,T}{1000}+500\,h \qquad (B)$$

in which we have the cost of transportation, with the greatest attainable economy of power, eleared of the number of miles traveled by the engines, and expressed in terms of the particular grade which controls the cost of power.

In order to determine the sum which we might expend for the reduction of this limiting radient, which is the problem under consideration, we must ascertain the value of this formula for different values of x, and take the difference between those values.

Let us now suppose x to assume the new value x'; the correspondihg difference produced in the aggregate annual expenses by the change of gradient, supposing still that the trains are full will be

$$C\,T'\,\frac{x'-x}{10\,W} \qquad (C)$$

The increase of of expenses is proportional to the increase of the sine of the angle of inclination of the gradient; and directly proportional to the aggregate gross tonnage which ascends the limiting gradient; and reciprocally as the power of the engines capable of runing one mile at the assumed cost of locomotive power.

The value of gradients, or the expenses whice they produce on railroad lines, will diminish, therefore, proportionally to the improvement in the power of the engines.

Let us now substitute for C its value—$\frac{3}{10}$ of a dollar—and put $x'-x=1$; and we shall obtain

$$\frac{3\,T'}{100\,W} \qquad (D)$$

for the increase of the annual expenses of a road consequent on the addition of one foot per mile to the acclivity of the limiting slope.

It is not easy to assign the proper measure of the power of the freight engines now in use; but if we assume 300 tons gross for the maximum load on a level at all seasons of the year, of engines of the medium class—from 9 to 12 tons weight—we shall not be too low for the present condition of the machine, and the average power of all good engines of that class. With this addition to the *data* of theproblem, we shall have

$$\frac{T'}{10000} \qquad (E)$$

for the an nual value, in dollars, of one foot in the acclivity of the maximum, or limiting gradient. If we now capitalize this quantity, or determine from it the original outlay of capital which would be justifiable in order to avoid an increase in the ascent of *one foot per mills,* we shall find it to be

$$\frac{1}{600} \text{ of a dollar,}$$

or $1\frac{1}{3}$ *miles for each gross ton carried one mile*—the value of money being taken at 6 per cent.

In other words, to find the value of any reduction of the acclivity of the limiting grade, on ordinary railroads, *we multiply the number of tons gross carried* UP *that gradient, by the length of the line* (*or by the distance seen by the engines which cross the grade in question*) *and by the number of feet per mile in the ascent which it is proposed to save, and divide by* 600. The result will be the value of the reduction grade, in dollars.

There is one point in this enumeration, worthy of remark, and which, I believe is never regarded in the consideration of such subjects—if, indeed, this question itself has ever received any consideration. The amount which may be paid, or ought to be expended for the reduction of the maximum gradient, *is proportional to the length of the road,* if the engines run "through," or proportional to the length of the "stage" on which the gradient is found if the line be very long and divided into stages. And this law will continue to apply until it becomes more economical to employ one or more assistant engines to aid in the ascent of such grades, in which case the value of these auxiliary engines, or the expenses which they involve, limiting the sum which may be expended in the reduction of the acclivity.

For the purpose of an application of the rule which I have announced, let us suppose that the road is 30 miles in; that the duty to be exacted of the engines is 20,000 tons gross conveyed "through" in the direction to which the limiting gradient is opposed and that the cheapest admissible line would prevent a gradient of 50 feet per mile. How much could we afford to expend, in the construction of the road, in order to reduce this summit to 40 feet? By the formula (F) we have

$$\frac{20000 \times 30 \times 10}{600} = \$10,000$$

The comparison of this result with the cost which would be actually required, under the circumstances, controls the location.

But if the trade in this instance had been assumed at 200,000 tons gross, the length of the line 60 miles, the value of 10 feet per mile in the limiting gradiant would have been

$$\frac{200000 \times 60 \times 10}{600} = \$200,000$$

The magnitude of this last result would, of course, bring up the question of the relative economy of auxiliary power, which would be wholly inadmissible in the former case. Should the comparison determine in favor of assistant engines for the limiting gradient our equation then becomes applicable again to the determination of the value of the next highest gradient, or the sum which may be expended in its reduction.

STATISTICS OF THE SOUTH CAROLINA AND GEORGIA RAILROAD COMPANIES.

The following carefully prepared comparison of the statistics of two important parallel lines of railroads will prove highly instructive and needs no other remark than that due to the industry and accuracy of the gentleman who has so kindly communicated the result of his labors to the pages of the Railroad Journal.

Receipts on the South Carolina Railroad from January 1st 1836, to December 31st, 1841.

Year.	Number of passengers.	Amount of Receipts for Passengers.	Number Bales of Cotton.	Amount of Receipts for Freight.	Amount mail storage etc.	Total Receipts.
1836	39,216	$129,982	28,497	$140,034	$ 1,598	$271,614
1837	41,554	131,283	34,395	138,269	10,663	280.215
1838	44,487	148,926	35,349	163,422	11,033	323,381
1839	37,283	190,249	52,589	204,323	28,269	422,841
1840	29,279	168,316	58,496	186,328	28,551	383,194
1841	35,141	137,928	55,665	156,328	29,475	322,741
Total.	$222.594	$905,694	261,987	$988,704	$ 109,589	2,003,986

EXPENSES

of Maintenance of Way, per Mile of Road and of Motive Power per Mile, run by all the Engines on the South Carolina Railroad, from July 1st, 1836, to December 31st, 1841.

Year,	Maintenance of Way per mile of Road				Motive Power per mile run.					Ms. run by all the engin's.	Total rec's pr mile run.	Tot. expenses per m'le ruu.	Ratio of expen's to rec'ipts.
	Timber,	Spikes,	Lab'r,etc.	Total,	Repairs of Engines& cars.	Oil and Tallow.	Fuel.	Engine and firemen.	Total.				
					cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	
1836	$238 16	$ 20 53	$ 611 06	$ 869 75	74 69	6·19	12·36	11.35	104 59	121,720	217·78	240·58	114.1
1837	262 75	55 52	561 20	870 48	73·20	1·53	9·89	11.81	96 43	172,456	162·48	212·67	134·5
1838	328 97	66 35	644 53	1039 85	53·60	3·35	6·87	10.55	74 37	210,400	153·70	181.04	117·8
1839	227 23	136 93	618 04	982 20	42·74	2·38	5·57	8·81	59 50	253,104	167·06	147·39	88·2
1840	140 72	23 03	420 36	593 10	33·34	2·15	4·35	8·10	47 94	251,764	152·20	111·04	73.0
1841	168 50	13 61	365 36	347 47	27.35	1·00	3·92	7 84	40 11	253,560	127.28	96·40	75·7
Av'ge.	$227 72	$ 52 66	$ 538 26	$ 818 64	49,60	2.48	6.17	9·42	65 27	211,001	158·39	155·22	98·1

EXPENSES

of the South Carolina Railroad, from June 1st, 1830, to December 31st, 1841.

Year.	Maintenance of Way.				Motive Power.						Trans-porta'n depart-ment.	Salar'es interest etc.	Total expenses.
	Timber for track.	Spik's	Superin. labor etc.	Total repairs.	Repairs of egines and cars.	Oil & tallow.	Fuel.	Engine & fire-men.	Inclin'd plane.	Total.			
	dol.	*dol.*	*dol.*	*dol.*	*dol.*	*dol.*	*dol.*	*dol.*	*dol.*	*dol.*	*dol.*	*dol.*	*dol.*
1836	32,390	2,792	83,105	118,286	93,151	7,723	15,408	14,154		130,436	17,330	43,933	309,985
1837	35,734	7.551	76,324	119,609	126,290	2,643	17,058	20,375	9,091	175,457	24,799	57,284	377,149
1838	44,739	9,024	87,656	141,419	112,784	7,049	14,463	22.199	10,671	167,165	35,339	36,994	380,917
1839	30,904	18,622	84,053	133,579	108,181	6,031	14.086	22,306	6,670	157,274	53,732	28,454	373,039
1840	19,138	3,131	58,393	80,662	84,039	5,404	10,958	20,389	6,255	127,044	52,388	19,463	279,557
1841	22,915	1,851	49,689	74,456	69,352	2,535	9.948	19.866	4.834	106,537	42,254	21.173	244,419
Total.	185,820	42,971	439,220	668,011	593,797	31,385	81,921	119,289	37,521	863,913	225,842	207,301	1,965,066

The South Carolina Rail Road extending from Charleston South Carolina to Hamburg, a distance of 136 miles, consisting originally of a light flat oar iron lrid on a superstructure supported, except in cuts, on piles. This construction proving insufficient, after two or three years trial, the whole was rebuilt between the years 1835 and 1839; the piled portion of the road embanked, and a flat bar having a flangh projecting downwards on the inside and weighing 20 lbs. per yard substituted for the old.

Ti e expenses in the above statements, include, the relaying of the road and the timber and spikes necessary for that purpose, but not the iron rails and embankment, for which the following sums were expended in

	1836	$138,891	
	1837	221,629	
	1838	216,290	
	1839	165,171	including $10,806 paid for land.
Total		$741,981	

The repairs of Engines and Cars include the cost of all new cars and ten or twelve new Locomotives, besides the reconstruction of five or six old ones. On 1st January 1836 the company had

16	Efficient Engines
4	Needing considerable repairs
20	in all

They have now about the same number besides such as may be reconstructing in their shops. In addition to repairs of Engines and Cars the shops do work for the road of which there is no account in the Report. All the Oil, Tallow and wood for fuel used in the shops is included under these heads in the statement, the report not furnishing the means of separating them.

RECEIPTS

On the Georgia Railroad, from May 1st, 1838, to April 1st, 1842.

Year.	Number of Passengers.	Amount receipts for Passengers.	Weight of Freight.	Number of Bales of Cotton.	Amount of Receipts for Freight.	Amount Mails, etc.	Total Receipts.
		Dol.			Dol.	Dol.	Dol.
1838	28,001	66,141	7,817,927	25,613	60,984	7,805	134,929
1839	22,632	63,505	8,818,060	47,235	101,420	19,678	184,003
1840	22,910	66,262	9,667,706	20,878	66,427	25,536	158,225
1841	22,784	71,461		40,616	118,969	33,826	224,256
Total,	96,417	267,369		134,342	347,800	86,845	702,013

EXPENSES

on the Georgia Rail Road, from the 1st. May 1838, to April 1st. 1842.

Maintenance of Way.				Motive Power.								
Year.	Lumber &c. for track.	Labor &c.	Total.	Repairs of engines.	Repairs of cars.	Oil and packing.	Fuel.	Engine and Fire-man.	Contin-gencies.	Total.	Transpor-tation. Depart.	Total Expenses.
	Dol.	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*
1838	589	21,654	22,244	5,044	4,193	1,489	4,051	4,913	472	20,164	20,954	63,362
1839	1,285	15,887	17,171	4,733	4,965	2,850	6,269	8,275	4,013	31,106	21,969	70,246
1840	5,446	16,390	21,837	6,792	4,924	1,177	5,403	6,755	2,525	27,577	17,870	67,284
1841	11.933	26,759	38,692	9,611	6,115	1,539	7,187	8,815	2,861	36,126	22.700	97,518
Total.	19.253	80.691	99.944	26,180	2,0197	7,055	22,910	28,758	9.871	114.973	83,493	298,410

EXPENSES

of Maintenance of Way, per Mile of Road and Motive Power per Mile, run by all the Engines on the Georgia Railroad, from May 1st, 1838 to April 1st, 1842.

Year,	No. of mil's of road in use.	No. of miles run by engine.	Maintenance of Way pe mile of Road. Ti'ber etc	Lab'r.etc	Total,	Motive Power per mile run. Rep's of engines.	Rep's of cars.	Oil and pa'king.	Fuel.	Engine and fire-men	Total.	Total rec'ts pr mile run.	To. expenses pr. m'le run.	Ratio of expenses to r'cts.
			Dol.	*Dol.*	*Dol.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	
1838	70	89,701	8 42	309 36	317 76	5.62	4.68	1.66	4.52	5.48	21.95	150.42	70.64	47.0
1839	88	110,842	14 60	180 53	195 12	4.27	4.48	2.57	5.66	7.47	24.44	166.55	63.38	38.1
1840	105	110,540	51 87	156 10	207 98	6.15	4.45	1.07	4.87	6.11	22.66	143.14	60.87	42.5
1841	140	152,520	85 24	191 14	276 38	6.30	4.07	1.01	4.74	5.77	21.81	147.03	63.94	43.5
Av'ge.	99½	115,901	40 38	213 38	253 17	5.65	4.36	1.52	4.94	6.20	22.67	151.43	61.37	42.5

The Georgia Rail Road extending from Augusta Geo. to Madison on the main line a distance of 104 miles, has 75 miles laid with a flat bar weighing about $18\frac{1}{2}$ lbs per yard and the remaining 29 miles with a T rail weighing 46 lbs. per yard. The Branches to Athens and Warrenton 43 miles in length are laid with the flat bar weighing $18\frac{1}{2}$ lbs. per yard. Upwards of 30 miles of the oldest portion of the road is said to have been completely renewed in consequence of the decay of the timber. The cost of this is included in the above statements.

The Receipts for the year 1839 are only for eleven months and in the average at the bottom of the statement, of "Maintenance of way per mile of road," $\frac{1}{11}$ of the cost for this year is added. In the other parts of the statement this correction is not necessary.

The Georgia Rail Road Company, have 12 Locomotives made by Baldwin, Vail & Hufty of Philadelphia, which it is believed are all that they have ever owned. The oldest of these Engines has cost in repairs $3500 and is now said to be as good as new. There are other Engines on the road that have run twice the distance that this one has at no greater cost for repairs.

For the American Railroad Journal and Mechanics' Magazine.]

Mr. Editor,—Having received the annexed *Official Report*, from Major Baker, Commandant of the U. S. Arsenal, at Watervliet, I offer it as an article that may prove acceptable for your Journal; and will feel obliged, too, by your insertion of it.

Your obedient Servant, Edward Earle.

To Major R. L. Baker, *Watervliet, June* 6, 1842.

REPORT

Of the Comparative Strength and Elasticity of *Mineralized* Timber, and that in the *Natural State.*

I have submitted to the proving machine 12 pieces of each kind, comprising oak, maple, birch, whitewood or tulip tree, and pine. The principal data recorded were—

1st. Deflection with the constant weight of 383 lbs. (weight of apparatus.)

2d. Greatest deflection and weight while the elasticity was perfect.

3d. Ultimate deflection and *breaking weight.* The deflection was also generally taken for every additional weight.

Five minutes were allowed for a *Set,* five minutes for a *Resili-*

ance, and five minutes between each 20 lbs. added near the breaking point.

The proof pieces were two inches square, and 48 inches of effective length, prepared in November 1840, by sawing blocks of large timber lengthwise into battens, which were carefully finished by the plane to a square of two inches, and the weight of each taken to within three grains. One half of the battens, from each prism of timber, were selected for mineralizing by taking from a map of the end every second piece over the whole area. They were mineralized in November 1840; and since that date both kinds have been constantly in store, and seem *absolutely dry*, many of them having lost from 1-6th of a lb. to 1-5th of their original weight. It is somewhat remarkable that birch has lost less than other kinds; and some pieces have increased in weight from a few grains to more than a pound.

In the oak, pine, and whitewood, the average of the breaking weight was greatest in the mineralized pieces;—equal in those of birch,—and a little less in maple. Being called to other duty, the number of proofs in maple and birch were too few to be satisfactory. But thus far, the results led to the decision that Dr. Earle's process *does not reduce the strength* of timber. The elasticity seems a little diminished in several, and, perhaps, further experiments may show some corresponding increase of strength.

TABULAR COMPARISON.

—	MINERALIZED.		UNPREPARED.	
	Greatest Deflection.	Breaking Weight.	Greatest Deflection.	Breaking Weight.
Oak	2.37	1256	2. 6	1226
Maple	1.50	1469	1.36	1617
Birch	1.00	808	1.15	1014
Whitewood .	1.55	965	1.95	931
Pine	1.25	729	0.82	589

Two contiguous battens on the map were selected,—one cured, the other raw,—and each reduced 1-8th of an inch on each face, to remove the part, if any, injured by the heat, and to render them of one size. The cured broke with 1022 lbs., the other with 988 lbs.

A number of pieces of different kinds of timber were intentionally operated on *excessively* by *repeated* and long boilings. In *all* *of these* which have been tried, the strength *appears diminished* in a slight degree.

All my observations, thus far, tend to corroborate the suggestion that *boiling heat is not necessary;* and that long* digestion is important: and, to prevent checking when taken out, that the timber ought to be *cooled in the tank.*

Respectfully submitted,

(Signed) R. M. Bouton.

Extract from the last semiannual Report of T. Tupper, Esq. President of the S. S. C. and R. R. Co., who has, since last year, been using this process on the R. R. between Charleston and Hamburgh, S. C. Referring to a late advantageous purchase of timber for the road (*at one half the usual price*), he says :—

"This timber is obtained at a reduced price, as the sap is embraced in the square of the piece, and consquently taking a much less tree than when the heart only is retained.

"The advantage of this process will be felt at once in the lower price at which the timber is contracted for; and, should it only last as long as ordinary timber, no expense will have been incurred, as the difference in the price of the timber will pay the expense of preparation.

"The timber prepared four years ago with corrosive sublimate, is still sound, the sap of which has already shown a durability of double that of unprepared wood, and, from all appearance, will be sound when the unprepared is so rotten that it cannot be separated from the earth in which it is buried."

☞ Here is a most important fact ascertained,—the effect of corrosive sublimate on the sap-wood of timber;—from which President Tupper derives the practical and useful inference that the sulphates of iron and copper—which have been fully proved to affect timber in the same manner as corrosive sublimate—must also render sap-wood at least as durable as the heart is without them; and, by thus reducing the price of timber *one half,* annihilate the cost of the process. E. Earle.

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* By "long digestion" is meant a more protracted digestion than has been hitherto employed; that is, from one to two, three, or more days, according to the size, length, and kind of timber; and at a temperature short of the boiling point, or at 170 to 180 degrees F. A short boiling, of an hour or two, however, is recommended for timber of great size and length. E. E.

[From the Civil Engineer and Architect's Journal.]

MR. VIGNOLES' LECTURES ON CIVIL ENGINEERING, AT THE LONDON UNIVERSITY COLLEGE.

Lecture 7.—On curves of railways.—This lecture was devoted to the consideration of curves upon railways, and Mr. Vignoles pointed out the principles on which should be compared the economy and advantages to be obtained by the adoption of curves, with the inconvenience attending on them; the saving of expense in formation, earthwork bridging, &c., by curving round natural obstacles; the advantages of attaining a more level line, avoiding interference with valuable property, or approaching towns, mineral or manufacturing establishments, &c., all entering into the former—the practical inconveniences of additional resistance to motion and retardation of velocity to ensure safety being the set-off; and, among other elements, it was stated that the breadth or gauge of the railway affected the calculation. The Professor then showed that along very wide valleys, through champaign countries, and where the grounds undulated, so that the ridges, dividing the water courses, were successively crossed by the railways at right angles to their general direction, the saving by lateral deviation would seldom be material, and consequently, that the curves may be laid out so flat as to be practically equivalent to straight lines—the "*accidens de terrain*," to use a French phrase, being, in such districts, to be overcome by cutting and filling, to the extent justified by the importance of the line and traffic, or by the introduction of undulating gradients, somewhat approximating to the natural surface of the country. But in tracing a line of railway along the sides of hills bounding narrow valleys, particularly where the main valley is broken by lateral rivers, then the economy from curing becomes very great, and ihe introduction of curves to the greatest possible extent, consistent with safety, is allowable.

Mr. Vignoles then went on to consider the various means employed to obviate the practical inconvenience arising from curves on railways. He began by explaining the peculiar distinction in make between carriage-wheels and axles constructed for running on railways and those for common roads—in the former the wheel being keyed fast to the axle, and both moving round together—in the latter the axle being fixed to the carriage, the wheels only moving round. Many attempts had been made by engineers to give the railway vehicle the advantage which the road carriage had of turning with facility and safety round sharp bends, but in vain, as the wheels always got off the rails laterally, at even moderate velocities; it was only on the old tramroads that the wheels were loose on the axles. Railways wheels being thus fixed to the axles have the tendency to move on a straight line, so that on the occurrence of a curve the effort to continue in motion in the direction of the tangent of that curve creates a certain degree of resistance, as the wheels are only kept upon the rails by the flanges pressing against the inside edge of the outer rail of the curve. The professor then entered into a number of technical details, which he illustrated to the class by diagrams, explaining why the flange of the wheel had now, by common consent, been placed on the inner side or the periphery of the wheel rather than on the outer side; and also the reason for allowing a certain amount of play, being the difference between the gauge of the rails and the gauge of the wheels, and the manner and cause why the rim of the railway wheel is made somewhat conical—that is, the wheel, instead of being quite cylindrical, is really the frustrum of a cone—stating at the same time, the rule for giving the proper "cone" to the wheel, being dependent on the *minimum* radius of curvature on the line to be travelled over, and the *maximum* velocity. In general, the "cone" was stated to be about one-seventh of the breadth of the rim of the line, giving about one inch for the difference of diameter of the wheels at their inner and outer edge, for, when carriages are passing round a curve, the wheel and axle, being connected, roll together as a rigid body, and require the contrivance of the "play and the cone" to prevent too much lateral friction of the flange, and to get the wheel round the curve without dragging. Mr. Vignoles then showed that on the ordinary railway gauge of 4 ft. 8½ in., and in the 3-feet wheels, the above amount of cone and play would be sufficient to meet a curve of only 200 yards radius, which is greater than any which ought to be laid down on a travelling line for high speeds.

The centrifugal force due to the velocity of the carriage was next to be considered. As before stated, its tendency in moving round a curve is to keep a tangential course; this force may be accurately computed (being dependent on the velocity of motion, weight of the carriage, and the radius of curvature) by well-known formula, whence is deduced the fractional part of the weight of the carriage, representing the contrifugal force. The Professor gave the formula, and worked it out on a supposed velocity of something more than 17 miles per hour, or about 25½ ft. per second, on a curve of 200 yards radius, whence the centrifugal force was found to be 1-30th of the weight of the carriage. Mr. Vignoles quoted the following rules—viz., "multiply the square of the velocity in feet per second by the gauge of the railway, and divide the product by the accelerating force of gravity, multiplied by the radius of curvature in feet," which gave an expression, which, though not the fraction of the weight, was what would do very well for practical and ordinary purposses; it was the height which the outer rail of the way should be elevated, to counteract the centrifugal force, and prevent the wheel flying off at a tangent to the curve. He then stated M de Pambour's more strictly mathematical, but more complicated, rule for obtaining the same amount of elevation of the outer rail, and showed the table of results calculated by that engineer and by Mr. Wood, of which we only give the extremes, by which it appears that, supposing it safe to encounter so sharp a curve as one of 250 feet radius, at the rate of 30 miles an hour, the outer rail of the way must be elevated 12 inches; but for a radius of 5000 feet, or nearly a mile, at the rate of 10 miles per hour, the requisite elevation is only 1-16th of an inch. Having elevated the outer rail, the axle of the carriage, resting on the two rail, gets such an inclination as will produce on the load a gravitating force inwards equal to the centrifugal force outwards; and there will neither be any tendency in the carriages to upset or to press the flanges of the wheels against the rails. The rails once laid, if the carriages run slower than the calculated rate, the centrifugal force is overbalanced by gravitation, and the flanges of the wheel press the inside rales; if quicker, the contrary effect takes place, and the flanges press against the outer rails, so that some medium rate of travelling must be fixed on; and, as the slow trains are in general most heavily laiden, any increase of friction has a more powerful effect of retardation than will occur to lighter loads moving at greater speed. Mr. Wood, therefore, advises that the outer rail should not be elevated more than will compensate the centrifugal forçe produced at the slower rates of motion with heavy trains. Mr. Vignoles then forcibly illustrated the practical effects of neglecting these rules.

He then entered on the subject of laying out curves on the ground by a succession of set-offs at the end of each length of any given measure—the set-off being calculated from the radius of curvature considering the given measure (say a chain length) as the side of a circumscribing polygon; and, on the large scale, and practically, a number of these sides of a polygon become the segment of a circle. Mr. Vignoles gave a simple approximate rule for finding the set off from the radius, or the reverse, by "divide the number 792 (the number of inches in a chain) by the radius in chains—the quotient is the set-off per chain in inches." Thus, the set-off per chain for a curve of a mile radius is 9.9. or, in round numbers, 10 inches. When the curve is of less than one mile radius, it is advisable to make the sets-off by half-chains. It was observed incidentally by the Professor, from the same rule, she set-off due to the curvature of the earth was, in round numbers, about eight inches per mile, and hence had arisen formerly some curious engineering mistakes, from supposing that a horizontal line was a tangent to the earth's surface; and, in setting out canals, an inclination of eight inches per mile had more than once been given to the water line, while it was imagined it had been laid out for a dead level. In conclusion, Mr. Vignoles mentioned that some further observations on curves would occupy the next lecture.

Lecture 8.—*On curves.*—In continuation of the subject of curves, Mr. Vignoles explained that in many cases it was impracticable or inconvenient to apply, on particular ground, the approximate rule given in the last lecture, of setting out curves chain by chain, or other short lengths, making each the side of a regular polygon, the set-off being constant. In that method the given length was strictly a secant, and not a tangent, to the curve. Another formula was more generally applicable, and sharp curves on hill sides, through thick woods, had been quickly and accurately set on therefrom. It was this; *offsett*=*radius*—(*radius*—*tangent*)$^{\frac{1}{2}}$; the demonstration of this was given, and illustrated by a diagram. For the field tables calculated beforehand, for the greatest number of usual curves should be prepared; but, on the occurrence of any peculiar cases, the calculation could be very readily made, with the help of a pocket table of natural sines. The Professor then recapitulated some of the leading points that had been gone over in detail at the last lecture observing that on the three principal expedients for counteracting the injurious effects of curves, the usual measurements might be easily remembered—viz., half an inch for the "cone" of the tread of the wheel; one inch as a *maximum* amount of "play" of the wheels between the rails (it being disadvantageous to allow too much play;) and one inch for the extreme elevation of the outer rail in laying the way, that being the measuredue to a velocity of 25 miles an hour, on a curve of half mile radius. Mr. Vignoles then observed that the "cone" being given to the wheels, on account of the curves, when the line of road was perfectly straight, this conical formation of the tuyere was not required, and the general disadvantage of such a form of wheel, not bearing upon the whole face or upper bottom of the rail, preponderated. It had, therefore, become customary to incline the rail, to meet the cone of the wheel, and this should always be done, both, on straight lines and on curves whose radil are not small. This inclination of the surface of the rail is obtained by casting the receiving chair accordingly on rails; having a continuous bearing on longitudinal sleepers, or bearing direct on cross timbers, without the intervention of chaies, the wood is cut to the requisite angle; or the inclination is sometimes given to the rails in passing through the rolls. Without this precaution of inclining the bearing surface of the rail to meet the cone of the wheel, the edge rapidly wears, and the laminæ of iron peel off in strips, more or less, according to its quality, and there is no more critical test of the perfection of rolled iron rails than the manner in which the bottom edges go through this ordeal. With the above precautions of "cone," "play," and elevation of the outer rail, the resistances opposed by curves to a single carriage may be considered to be practically annihilated; but when the trains become very long, there must, of necessity, be a considerable lateral action and grinding, from the change of direction of the original drawing force through a number of carriages; but Mr. Vignoles stated that although no conclusive experiments had been made to show the exact amount of resistance from this cause, his own observations and experience led him to conclude that the degree of curvature on railways might be safely extended further than they have hitherto been laid down on principal lines.

Mr. Vignoles referred to former observations of his, that the public would be better accommodated by more frequent departures of smaller trains, and that with such trains the curves would be of still less importance, adding that it could only be by the introduction of greater curvatures to save expense; and, as he had repeatedly argued for the same reason, by the adoption of steeper gradients, that the benefits of railway communication could be extended through many districts, and to the more distant parts of the country, as on the most economical principles of construction. Mr. Vignoles referred to the report of the Irish Railway Commissioners, and to the works of Mr. Wood, M. de Pambour, Lieut. Lecount, and other writers, for further details on curves, observing in conclusion of this part of the subject, that where curves are so quick as to require it, especially in crossings, the additional precaution of guard rails becomes expedient.

In adding a few words on the subject of coupling carriages together in a train, the Professor insisted strongly on the draw-boys being always in the centre, and observed that, as a general rule, the connecting links should be screwed up as stiff as possible consistent with the curves of the railway, as otherwise the carriages are apt to swing. He mentioned that the best coupling was that of Mr. Henry Booth, the talented manager of the Liverpool and Manchester Railway from its very first origin. But, as a general form of combining the draw-boys and buffers on a central rod or tube with spiral springs acting solely from the centre, Mr. Vignoles spoke in the stronges terms of the apparatus of Mr. Thomas F. Bergin, the manager of the Dublin and Kingstown Railway, on which line they had been used with advantage for a number of years.

Lecture 9.—on tunnels.—In proceeding to treat of the subject, which might be termed that of the great works of art, to be introduced in the formation of roads or canals, but particularly of railways, Mr. Vignoles said that it would not be possible in the lecture-room to go into the details of the constructions, but that he must limit himself to general principles. The rules for consideration when such works ought to be adopted were sufficiently simple; for example, to determine where tunnels should be substituted for open cuttings. or viaducts for embankments. The French engineers who are in general very much better mathematicians than we are and probably, from that very circumstance, more inclined to be theoretical, are much in the habit of introducing formulæ which, often very useful, are not always readily applied by the practical men of this country. Supposing it to be required to determine at what point on a longitudinal section (for road, railway, or canal,) it is advisable to begin to tunnel, instead of continuing a simple excavation—that is, the point where it becomes as cheap to tunnel as to cut open—for such a case the following formula is given by an eminent French engineer :—Let x=depth of cutting ; l=breadth of road, railway, or canal, on the travelling surface; a=depth of bed, of road, or railway, to be first excavated, and afterwards filled with road material or ballast ; or depth or canal below the water-line ; $\frac{x}{m}$=slope of excavation ; p=price of the cutting per cubic yard. The expense of excavation per yard forward of the sectional area of any cutting will consequently be $a p+p$ (l x $\frac{x}{m}=x$; and, when this price exceeds the price per lineal yard forward of tunnelling, the latter is cheaper, supposing the given prices to cover all risk and contingencies in each case. But, as circumstances are continually varying, the English engineer so repeatedly finds that he has to modify—and perhaps finally abandon—the general theoretical rule, and fall back on his own experience, and that of the contractor he may be disposed to employ, that, although he may occasionally resort to such a formula as an approximation, he ceases to employ it in practice, and obtains the sectional area of the given cutting in superficial yards, by simple mensuration, and multiplies it by the price. All the complex condition involved by slips, faults, water, and the numerous incidental occurrences in great works, to occasion unforeseen expenses, render prices uncertain, and prevent any fixed general rule; and it is only when the materials and probable contingencies are perfectly well known, that the element of cost can be safely introduced into the mathematical formula. For dry indurated sands, gravel, sandstone rocks, &c., calculations may be made within probable limits or error; whereas, in many instances where the theoretical rule and general opinion, even of those sufficiently experienced, would recommend tunnelling, it has been tried in vain, abandoned after great expense in contending with water, and recourse had after all to open cutting The average cost of tunnelling upon the principal railway lines, as actually executed, appears to be about 60*l.* per yard forward, in some instances as much as 100*l.*, especially when driven forward in reckless haste, and in attempting to sink shafts or drive driffs, without due consideration as to the quantities of water in the various strata, or the means of at once grappling with the difficulties of drainage or pumping. With great facilities, favorable material, and not too much hurried, the same area of tunnel has been driven for so little as 20*l.* per yard forward. In round numbers, and on an avarage the sectional area of the ordinary tunnel for a double line of railway, to be worked by locomotive engines, may be called 50 superficial yards when finished, or within the ring of brickwork or masonry, if lining were required; in this latter case, the sectional area of the opening to be assumed as about 80 superficial yards. Mr. Vignoles observed that, for future tunnel operations, with the benefit of past errors and experience, by avoiding undue haste in execution, and with sufficient caution and activity, 40*l.* per yard forward for tunnelling may be taken as an avarage approximate fair price. Now if it were wished to compare this expense of tunnelling with the cost of open cutting, the Professor observed that, from his experience, which had been very considerable, in removing earth in large quantities, he was not disposed to put a less price than that of 1*s.* per cubic yard for removing materiel for deep excavations, especially when this price is to cover contingencies of slips, &c.; with such a price, then, an open cutting 55 ft. deep, roadway 24 ft. wide, and soil requiring slopes of two horizontal to one perpendicular, would give a sectional area of 800 yards—that is, the expense (in estimate) would be the same as that of tunnelling. But Mr. Vignoles observed that, in addition, the future maintenance of the tunnel should be taken into consideration, as well as whether the material from the cutting could be disposed of with advantage; the nature of the soil, and a varity of other circumstances which he stated, all of which would influence the decision. In soft rock, which would work with facility, and yet stand nearly perpendicular, the depth might be very much greater than 55 ft. before tunnelling would be cheaper. In such cases, a depth of 80 ft. and upwards had been resorted to. In chalk the proper slope to be given. which was very variable, would greatly alter any elements of calculation, while, on the other hand in forming tunnels through chalk, experience had shown that water was the great enemy, and had entailed enormous expenses. The Professor went into a great many other points for comparing excavations with tunnelling, but they appeared too technical to be satisfactorily explained in a brief abstracts such as this.

On Viaducts and Aqueducts.—Mr. Vignoles next proceeded to the consideration of viaducts and aqueducts, into which, he observed, a totally different set of conditions enter, the cost varying from 20*l.* per lineal yard to the price for which no rule could possible be laid down. Viaducts such as that of which the London and Greenwich Railway wholly consists, may, probably, be executed for 20*l.* to 30*l.* per yard, including the foundations. Of course, the foundation entered materially into the calculation, and where water had to be crossed, largely increased the expense. In some peculiar instances, a large river viaduct, or bidge, has cost as much as 200*l.* per lineal yard. The Professor instanced a viaduct he had built over the river Ribble, at Preston, for the North Union Railway. The length was 300 yards, the height about 45 feet above the water, and the whole mass, including concrete foundations (where the rock was not attained,) comprised about 25,000 cubic yards; coffer-dams were used for the piers, and for one abutment. The bridge consisted of five arches, each of 120 feet span, batiring on the face and spandrils from the parapet to the impost course—roadway about 27 feet wide; the total cost, including all contingencies, was £45,000, which is 150*l.* per yard forward, or 36*s.* per cubic yard on the whole solid contents; this might be considered a low price, inasmuch as an ordinary brick bridge, of twenty to thirty feet span only, and with facilities for construction, can seldom be built for less than 20*s.* per cubic yard. Where no water or expensive foundations are to be encountered, and where the spans of the brick or stone arches do not exceed about 60 or 70 feet, 1*s.* per cubic foot on the solid contents of the viaducts may be put as a good covering price. Mr. Vignoles stated that, for such viaducts, about 60*l.* or 70*l.* per lineal yard might probably be taken as the average approximate cost, and the additional expense, from a considerable increase of height, does not become so very great, as it chiefly affects the piers only. The Professer then enlarged much on adopting timber arches with piers of masonry, for viaducts of large span and great height, and produced a number of drawings of such bridges, some actually constructed, and some only proposed. The heights were from 70 to 150 feet, the *minimum* price being 35*l.* and the *maximum* 80*l.* per lineal yard. He further pointed out that high embankments should be avoided, and timber viaducts substituded, as a mere point of economy, even without taking into consideration the risk and danger of slipping in such great masses of earth. In an embankment only 40 feet high, an occupation bridge for a farm would often cost nearly £1000; it was, therefore, only in crossing a very narrow valley or ravine, where no bridges under would be called for, and no masonry—except perhaps a culvert of the very smallest dimensions—that very high embankments should be made. Mr. Vignoles alluded to several such, varying from 70 to 90 feet high, which he had made, and pointed out a terrible failure in one case although in other instances success had followed. In passing through hilly countries and along mountain sides torn by ravines, the introduction of the timber-tod viaduct, with stone piers, to overcome points of great but partial difficulty, was strongly recommended, especially as great additional height of virduct could be given at small expense, and thus excavations on each side saved.

REPORT

To the Stockholders of the South-Carolina Canal and Rail-Road Company:

In conformity with the rules and usage of the Company, we present to the Stockholders the accounts for the half year ending 30th June, 1841, with such remarks on them, and the general interest of the Company, as seem necessary to give the most correct understanding of its affairs.

Soon after the annual meeting and semi-annual report in January last, the Board thought proper to reduce the rate of passage on the road from 7½ cents per mile to 6 cents per mile as an experiment, believing an opinion very generally held, that reduced rates would increase the receipts of the road; but thus far it has not produced that effect, although a greater number of passengers have passed on the road in this than in the same months of last year—the receipts have been $19,000, or 21 per ct. less.

The rate of freight too, has been reduced, to accommodate the public, to about three-fourths of what was charged the early part of last year, which accounts for the small amount received, compared with that period. The accounts of the Secretary and Treasurer herewith marked (A.) show that the receipts from 1st January to 1st July, instant, amount to - - $158,992 12

And the expenditure, - - - 124,743 55

$34,248 57

Making the nett income less 1⅓ per ct., notwithstanding the expenditure is $27,470 25 less than

the corresponding months of last year. But, had the receipts of this six months equalled that of last year for the time, say 1st January to 1st July, 1840. $223,295 46
And the expenses the same as now, 124,743 55

The nett income would have been $98,551 91
Nearly 5 per ct. for six months, or 10 per ct. per annum.

A reduction of rates below that which will yield a fair remuneration for the out-lay of capital in an institution of this kind, is not only injurious to the parties immediately concerned, but does injury to other establishments in the same business, and thereby produces mischief to the whole carrying trade of this section of country.

No corporation can be considered as well managed, where the public or individual interests are made paramount to that of the corporation.

We think it proper, therefore, that such tolls be charged as would return a fair interest on the capital employed, calculating an ordinary amount of traffic and tarvel, and trust to the good sense of the community to give a generous support, especially where it can be made to appear, it is their interest to do so.

An opportunity lately occurred, which proved to this city the value of our road, which could not be felt so sensibly by the continual use of it. We refer to the late freshet, when the trade was broken off with the country about one week. During this time the business of the city was almost entirely suspended, and animation only returned when the road was re-opened for transportation.

Early in March last a flood came which stayed the transportation for several days, and so injured the road that the repairs are not yet fully made in a perfect manner, having been first done in a temporary way to prevent a delay, as far as possible, of passengers and goods. The expense of these repairs will not be heavy—say about $5,000, which leaves the expenditure of this half year considerably less than the same period of 1840, viz:

January 1, 1840 to July same year, $152,213 80
The same time this year, - - - 124,743 55

Leaving, - - - - - - $27,470 25

This saving has been in reduced wages and lower price for supplies, and a less amount of machinery and materials required.

By a comparative statement appended, marked (F.,) it will be seen that many of the items in the expense accounts are lower this year than in the last; and that all of those higher, are swelled by the extra repairs of the road after the late freshet, except coal, of which we had purchased largely at a low rate.

Wages for the road, notwithstanding the large number of hands replacing embankment, (about 80,) for the last three months, is $925 less than last season.

The additional force will be contined some time in refilling the road where the embankment has settled since first made, and would have been done before this, were it not that before the repairs of the effects of the great freshet of May, 1840, were fully completed the freshet of last March made a demand for a large amount of labor. The whole surface of the road will soon present a more perfect finish than at any time past, and will, before October next, if not interrupted, by any extraordinary occurrence, be completed agreeably to the plan contemplated for the general improvement of the road resolved upon in 1836.

Great facility of repairs has been obtained by the use of the locomotive engine in removing earth; where the haul is more than half a mile, the saving is fully one half. The Four Hole Swamp has been refilled near the centre, where the haul was about one mile, for not over ten cents per yard, by the application of steam power, saving more than double the cost of the wooden road over the swamp, had the whole been originally filled in the same way. It was calculated by the contractor who constructed the embankment over this swamp, that the use of the *road on piles* was equal to the cost of it, ($4.500,) merely in filling the track by horse power and barrows; and by steam power double that amount is saved.

The hauls on the whole road would average much less, but it is safe to say, that more than half the whole cost of a wooden road on piles through a route like ours, would be repaid by the advantage gained in using it with locomotive power in filling the embankment. But the greatest benefit from a piled road is the preservation of a perfect level, and sustaining the rails when the embankment is washed.

The advantage of substituting locomotive for stationary power at the Inclined Plane is now fully developed The saving cannot be less in fuel, labor, superintendence and interest on capital employed, than $3.000 per annum.

The superintendent and labors are not employed in passing trains more than three or four hours in the day—the remainder of the time they are repairing road, cars, &c.; and the engine, when required to do so, takes passengers and freight to and from Hamburg. Five negroes and three white men, including master carpenter, have been dispensed with from 1st July, employed before in repair of buildings, &c. A brick building for work-shops, with tin roof, has been completed there, which is quite fire proof, and two large wooden buildings, taken down; another, the last of wood, to be taken d wn in the ensuing year.

There is no subject of higher interest to this Company, and others owning rail-roads, than that of preserving timber from rot, There are two modes that have particularly claimed t'e attention of the public within the last three years.

The first is that of Kyan in England, called Kyanizing, which process we have experimented upon the three years past, and reported the progress semi-annually, which will continue here.

"On the 9th day of July, 1838, four pieces of rail timber, all cut from one stick, each six and a half feet long, and about nine inches square, were put in the road as rails. Two of these pieces were prepared in a solution of corrosive sublimate about fifteen days. The other two pieces were not prepared," These four pieces were all nearly covered with the earth to the top surface, where they remained, daily passed over by trains of cars, till July 1st, 1841, when they were taken up and examined by a Committee of the board consisting of the president Col. Gadsden, and Dr. Johnson; and Mr. Ross. Master of the Workshops. Mr. Lythgoe Superintendent of the road, Mr. Jas. F. Edwards and Dr. A. Gadsden, were also present.

The Kyanized pieces were perfectly sound, the sap as well as the heart, the former retained a strength and elasticity equal to a green piece of timber. The unprepared sticks were quite rotten. The sap of one, and the sap and part of the heart of the other, so much decayed, that it was believed they would not answer to remain in the road another year; consequently, the four pieces were all removed and placed in the ground at the west end of the pattern shop, the unprepared pieces nearest to the shop, there to remain for future annual examinations.

We have been thus particular in stating the above facts, and mentioning the persons present, that they, as well as others, may feel curiosity enough, or, we should say, sufficient interest in the experiment to attend the examinations as many years as they may, by circumstances, be permitted to do so.

One hundred and thirty pieces of prime timber, all twenty feet long and ten inches square, and Kyanized as above, were placed as cross-ties under both tracks of the Inclined Plane, at Aiken, supporting joints of the rails, laying about twenty feet apart the whole length of the plane. They were put in the road about two years ago, and to this time are perfectly sound.

Fifty other pieces Kyanized at Summerville, were the same year 1839, put in the road as ties on the 23d mile, and the old ties left by the side of them that they might be the better designated.—These also are yet perfectly sound. The sap of pine generally thus exposed, shows signs of decay in eighteen months or two years. There are some exceptions, however. Where the timber is put in the ground quite green, and the earth rammed about it firmly, it will remain sound four or five years, and perhaps much longer.

In March, 1837, about three-fourths of the 129th mile of our road was broken up to change the grade, and re-built with green timber, the cross-ties entirely covered, and the rail imbedded in the earth to the top, and the earth well rammed. This timber was generally quite sound, especially the ties. The sap of some decayed—none, so much so, as to require removal. One of the rails which appear to have a wind shake when put in, was condemned; the first piece removed for the four years and four months, since laid to the day examined by Mr. Lythgoe, Superintendent of the road, and myself, on the 10th instant. But it will be proper to state, that none of these pieces showed that perfect, sound surface, which the Kyanized wood presented. On the contrary, the outer surfaces were generally cracked as if burnt about half an inch deep which was no where discovered on the prepared pieces.

The other mode of preserving timber from rot, has been introduced by Dr. Edward Earle of Philadelphia, formerly of Savannah. Dr. Earle's process which he has had patented, we will call *Earlizing*. It is much cheaper than Kyan's mode, and, if equally effectual, has everything to recommend it in preference to the other process. The cost will not be more than one-quarter or perhaps one-fifth that of Kyanizing--and it is an American invention. These secure interest and patriotism to our countrymen. We have been some time in correspondence with this gentleman, endeavoring to persuade ourselves of the propriety of inviting him to visit this State for the purpose of preparing timber for our road.

The Doctor has presented such evidences as he possesses of the value of the preparation he uses—and, as far as time admits, they are very satisfactory; but the experiments have only had about two years trial. The most important one is the pavement in two streets in Philadelphia—one prepared with sulphate of copper and iron, (Dr. E's process,) and the other unprepared. In a report of the Commissioners of the streets, it is stated, that all the prepared pieces perfectly sound; but that many of the unprepared, are quite rotten, requiring to be replaced with new.

The timber in these pavements are of Hemlock, a kind of wood that rots very soon when exposed to the weather.

A Committee of our Board have this subject under consideration and are collecting information from abroad. Col. Gadsden, one of the Committee, is promised the result of experiments making by the Ordnance department, which we hope soon to be in possession of.

If this process would preserve the timber in our road ten years, Mr. Lythgoe the Superintendent calculates there would be a saving of over sixty-six thousand dollars in the first five years, beyond the extra labor and materials required to rebuild the road in three years, usually done in five years. This sixty-six thousand dollars would more than pay the cost of Earlizing; and after five years, the saving in labor and materials would be over forty-five thousand dollars per year, as long as the timber remains sound.

Could our *pines* be made indestructible in exposed situations certainly for ten years, with the prospect of greater durability, at a rate so cheap, about two dollars and fifty cents per M. board measure, or three cents a cubic foot, our forests would be more valuable than the iron mines of any country. We say, the pines, because they can be more readily procured than any other timber, particularly when great size and length are required; and when prepared, would be at a less cost than any other timber used for building—for the land or sea service.

We have to congratulate the Company, that the expense account of each department of our establishment, is considerably less than by the report of last July, and all in better condition for effectual operation.—

The road acc't less by,	$5,188 09
The Machinery,	12,366 24
Transportation,	7,448 58
Contingent expense,	2,467 35
In all,	$27,470 25

All of which is respectfully submitted by

T. TUPPER, *President.*

Charlestown July 19, 1841.

NOTE.—In the printed report for July 1841, statement D the number of passengers for the 1st half of 1841, is printed 13,611 in place of 17,977,—and in the two succeeding reports for Jan. and July 1842 statement D the number of passengers for 1841 is printed 30,775 in place of 35,141. This will explain the difference between the original report and the tables now given.

THE RAIL ROAD WESTWARD.—Two of the seven ship loads of rail road iron required for the completion of the Baltimore and Ohio Rail Road to Cumberland, have very recently reached this port. The quantity embraced in these two cargoes is upwards of thirteen hundred tons; the five cargoes yet to arrive comprise an aggregate of some twenty seven hundred tons—making, with those just received, an aggregate of over four thousand tons. The rails are of the heavies and most durable of the kind, and of a form much approved. A gratifying evidence of the earnestness of the company to complete the road to Cumberland as speedily as possible, is shown by the fact that in twenty-four hours after the first cargo reach the wharf, a portion of it was in the hands of the contractors beyond Hancock, about 130 miles from this city. Since the rails have been sent to the western terminus of the finished road at the rate of what is equivalent to about a mile of track per day, and as the entire line to Cumberland is ready for the reception of the rails, they are in the course of being laid down very nearly if not quite as fast as they reach their destination. If no unforeseen occurrence interferes, the important object of opening the Road for travel and transportation to Cumberland will be achieved in all the month of October. In anticipation of this event it will be seen by the annexed paragraph that preparations are being made on an extensive scale for an active and efficient prosecution of the enlarged transportation business which will be then carried on between Baltimore and the West.

From the Cumberland Civilian, August 19.

WARE-HOUSES.—Four extensive brick buildings are now under construction at the Depot of the Blatimore and Ohio Rail Road, at Cumberland. They are severally intended for forwarding and commission merchants, under the following firms:—Talbot Jones & Co., Hollyday & Edgerton, Atkinson & Templeman, and Dilly & Edwards. The completion of the road to this point, this fall, is confidently calculated upon, by which time it is intended to have these ware houses finished, to accommodate the anticipated trade which this great work will afford.

The results which have been realized in the few months since the Railroad has been in operation to Hancock, have been of the most gratifying character. The travel to and from the West has been doubled, having been attracted to this route by the superior advantages of comfort and expedition which it presents over others; and there can be no doubt that when the Road is open to Cumberland, so that the trip between Baltimore aud Wheeling or Pittsburg can be easily made in twenty four hours, or probably less, the question of the course of travel between the East and West will be settled definitively and permanently in favor of this Great Central Route: There is no other that can come into competition with it in any one of the prominent particulars of expedition, comfort or economy, and it must therefore *command* the travel between the Atlantic States and the vast valley of the Mississippi.

Correspondence of the Savannah Georgian.

LEBANON, COBB COUNTY JULY 14.

To the Editor of the Georgian—

SIR,—Major Bulloch has requested me to send you some particulars concerning the mineral resources of this section of country. My attention was first attracted by the abundance of *iron ore* I soon found in Cass county, and to this my remarks will now be confined.

The Allatoona hills mark the boundary between the primary rocks of the gold formation and the great limestone formation to the north west. The situation therefore of this range of hills bordering on granite and calcareous rocks shows at once that veins of different ores are likely to be found along and near the line of contact of the two rocks; and in no place have I ever seen this observation more strongly confirmed. On the north east side of these hills is the range of the gold veins running north east and south west, in a belt of country of unascertained width; while on the north west side, nearer the limestone, are huge beds of brown hematite iron ore running in the same direction. The extent of these beds of iron ore, as far as they have co[me] under my observation, are at least forty miles; they are seen crossing Sharp Mountain and Long Swamp creeks, in the northern parts of Cherokee county, and thence passing to the south east, cross the Etewah river, in the neighborhood of the rail road, and so into Paulding county, and how much further in that direction I know not. At several points in this range I have carefully examined the beds to ascertain their thickness and the quality of the ore, which is found to vary very much. Much of it is a rich brown hematite, occurring in the various forms that ore is well known to take, stalactical, mammillary, botryoidal, &c., and this passes into a silicious ore, and thence to quartz rock, which is the formation comprising the veins. A grey specular iron ore also occurs, and some which is volitic, and some micaceous iron ore. The hematite is well known as the ore which makes both the Salisbury iron and the Juinata iron, both of which are the most highly esteemed for bar iron of any metal manufacture in the United States. The varieties of ore will enable the manufacturer to obtain any quality of iron desired either for castings or bar iron, and in some localities there may be obtained on a single lot, on others the greatest abundance of the rich hematite, this latter ore I have seen in beds that from surface indications, (that is the whole surface on their outcross being entirely covered with loose masses of ore along the range of the bed,) I am satisfied must be at least one hundred and fifty feet thick; they pitch at different degress of inclination between the quartz rocks, and are *beds* (not nests or pockets) in that formation of unknown depth. Where the beds have been uncovered the ore is wrought by blasting, like an open quarry. This is for one little furnace near the Etowah, the only furnace in operation in the Cherokee county.

I have examined the iron mountains of Missouri, have traced out the beds so boastingly described by Featherstonhaugh as "sufficient to supply a nation's wants," but can truly say I was much more struck with the importance of these vast mineral beds, which contain a rich and easy ore to work, situated in a fine farming country in the immediate neighborhood of a great limestone formation, of good water power, extensive and almost untouched forests, and yet on rail roads, and on water communication into the southern parts of Alabama and Georgia.—The Iron Mountain ore is a very difficult and refractory ore to work, and though it yield seventy per ct. of metal it is never found so profitable as a lighter ore like the hematite yielding from forty to sixty per cent. It is in a barren country thinly timbered, very rough, near no water power, and eighty miles from the Mississippi river. *This* is in the midst of a fertile country fast settling up, where the demand for iron is now great, and rapidly increasing and possessing every facility desirable for the profitable manufacture of iron. Bituminous coal is found on the line of the rail road in Tennessee about sixty miles from the Etowah river. If that prove of a suitable quality for coking, it may some time hence be advantageously transported to the furnaces but for a long time to come it will be more profitable to use the timber so abundant near the oar. particularly as the iron made with charcoal is always of a superior quality to that made with either coke or anthracite coal.

The furnace now in blast cannot supply the demand for iron. Much is brought in wagons from the furnaces in North Carolina, and sold at a price which would afford great profits to the smelter in Georgta.

I have thus given you a rough sketch of the advantages this country promises for carrying on the manufacture of iron on a large scale; and so well am I convinced of their importance that I have determined on that account to remain some time in this country to aid in developing these resources. The details I have collected of most advantageous situations, I may at some future time communicate to one of the scientific Journals for publication, or make known to individuals able and willing to embark in the business. In such a communication an account of the various other veins and beds, such as the little veins of Galena (lead ore,) the immense beds of sulphate barytes, etc., will find a more proper place than in the pages of a daily paper.

With respect, I am yours &c.

JAMES T. HODGE.

THE TRAFFIC ON RAILWAYS.—The Railway Magazine, published in England, gives the following calculation of the last weekly returns of forty railways, 1428 miles in length; Number of passengers on 25 railways, 329,039, consequently the total for the week must be about 500,000. The receipts for passengers on 39 railways, £88,588 12s. 6d.; ditto for goods on 34 railways, £20,411 3s. 8d.; total, £108,999 15s. 11d. This is an average of £76 1-4 per mile per week. The traffic therefore, is certainly at the rate of about four millions a year, and carrying fifteen millions of passengers.

Perhaps few of our readers know that in the neighboring town of Franklin, Ten., six steam looms are in active operation, and about *seventeen hundred yards of domestic shirting are turned out weekly*. This machinery also embraces carding and spinning gear, so that a bale of cotton put in at one end comes out quickly at the other converted into a bale of excellent cloth. We are informed by the enterprising proprietors, Messrs. Parks and Campbell, that the number of spindles now running in Tennessee is estimated at *sixteen thousand.—Rich. Banner.*

INTERESTING TO TOBACCO MANUFACTURES.—A bill is now before Parliament containing the following clause:—And be it enacted that no manutacturer of tobacco shall receive or take into, or have in his custody or possession any sugar, teracle, molasses or honey, (except for the necessary and ordinary use of his family, the proof whereof shall lie on such manufacturer,) nor shall any manufacturer of, or retailer of tobacco, receive or take into, or have in his custody or possession any commings or roots of malt or any ground or unground roasted grain, ground or unground chickory, lime, sand, umbre, ochre, or other earths, sea-weed, ground wood, peat or other moss, or any leaves or any herbs or plants (not being tobacco leaves or plants,) or any syrup, liquid substance, material, matter or thing to be used or capable of being used as a substitute for, or to increase the weight of tobbacco or snuff, on pain of forfeiting the same and two hundred pounds.

PHILADELPHIA, READING AND POTTSVILLE RAILROAD.—"We understand that the Engineer sent by the Emperor of Austria to examine the various Railroads of the United States, has fixed upon the Philadelphia and Reading Railroad as the best made road in the Union. The engineers of this road at the various stations are busily engaged in making drawings of the most important works on the road, for the use of the Austrian Government, some specimens which we have seen are highly credible to the gentlemen engaged, and will no doubt be duly appreciated by His Imperial Highness.

AMERICAN

RAILROAD JOURNAL,

AND

MECHANICS' MAGAZINE.

No. 6, Vol. IX. New Series.] SEPTEMBER 15, 1842. [Whole No. 413 Vol. XV.

For the American Railroad Journal and Mechanics' Magazine.]

DUTY ON RAILWAY IRON.

We are favored with a copy of the following letter sent to a distinguished member of the Senate of the United States to lay before the Secretary of the Treasury. It was prepared by a member of a firm largely interested in the iron works of Pennsylvania, also as importers of railroad iron. That there should be a reconsideration of the vote of the last session, relative to the duty on the *edge* rail, every friend of internal improvements and the defence of his country, must admit.

We should suppose the iron masters, would desire to promote and facilitate railways up into the secluded iron districts, to get their iron to market. The cost of transportation, even in Pennsylvania, where there are many facilities, we understand amounts to $8, or $12 per ton—in fact a prohibition to the manufacturer of the article.

As many railroads have been projected and commenced under the old law, we would give them three years to import their iron free of duty; aud then for each successive year for four years, increase the duty to the present rate, which amounts to a prohibition to its importation. We have not a single establishment in this country capable of rolling the *edge* rail,—the machinery for which is very costly—added to all, we should inflict great injury to the public, in parallizing many important railways, without any substantial benefit to the iron master and iron trade of this country.

PHILADELPHIA, JULY 18, 1842.

The subject to which I beg to call your attention, is *railway iron*, which I observe in your tariff bill lately presented to the House of Representatives it is proposed to charge with $30 per ton duty, being almost equivalent to its first cost in England; and if to this be added the expenses of inspection, export duty from England, the freight, insurance, merchant's commission, cartage and all other charges, independently of the expense of transportation to the line of railway, will amount to at least 33 per cent more, will make the cost of the material so high as to interrupt very seriously the importation, and thus interfere most essentially with the further construction of railways in this country, which for the rapid conveyance (at all seasons of the year) of intelligence, travellers and merchandize, as well as for the defence of the country, and to secure domestic quiet, may be considered indispensable, and ought by all means to be encouraged by the federal government. If however the manufacturer of railway iron in this country could be effected within a reasonable time, there might be some inducement for endeavoring to encourage the home production of it, but from the fact that the importation of merchant iron and even pig iron, notwithstanding the high duties on them, I conclude there is not capital and skill enough in this country engaged in making them to supply the demand. This supposition is based on the fact, that for the last five years the annual average importation of these two articles, (pig and bar iron) has been about 100,000 tons. But there has been *no edge railway iron rolled in this country*, and it is not reasonable to expect that any will be until the manufacture of these comparatively raw materials shall be made in sufficient quantity to shut out their farther importation. The cause of no edge railway iron being made here, and why none ought to be expected to be manufactured for some years to come is that it requires more manipulations, more experience, and very much more heavy machinery, more skill and experience in rolling, and is altogether a more expensive article than merchant iron, and cannot be made even in South Wales, under 40 shillings per ton, advance over the price of bar iron, and if our people in Pennsylvania (where iron can be made cheapest in the United States,) were to attempt it, they could not succeed in making it at less than 20 to 25 dollars per ton over the price of bar iron. The manufacture of flat bar railway iron with countersunk holes, and united or square ends, has been attempted in this country, but only at 3 establishments in Pennsylvania, which however have not made exceeding 400 or 500 tons. As the flat bar railway has been made in this country, I suppose the manufacture may be extended, and therefore I would encourage domestic production, but it being impossible to make *edge rail* for some years to come, I propose to allow edge rail of 40 lbs. and upwards per yard in weight, to be imported free of duty for 6 years, say up to the 4th of July, 1848, by which time I hope our establishments will have acquired sufficient extension, as well as capital and skill to undertake the manufacture of edge rails. To show what I mean by edge rails, I send you the enclosed sheet containing tracings of sections of the different patterns of rails in use in the United States and in Europe. But under this denomination I class all rails that are rolled and *are not flat bars*, whether they be after the T pattern, the L pattern, ⌶ pattern, or the bridge pattern, or any other pattern that ever has been rolled. My reason for restricting the minimum weight, to 40 lbs per yard, is that the heavier (within reasonable bounds) the rail, *the more perfect the railway will be.* Most of the railways in the Eastern States have iron weighing from fifty five to sixty five lbs. per yard, and the flat bar is going out of use wherever the parties are rich enough to replace it with the edge rail. The use of the flat bar is most inexpedient, and though less in the first cost of the railway, ends in being far more costly, as the expenses of repairs, cost of transportation, and danger of throwing the trains off the track, renders it in every point of view excessively inferior to the edge rail. In new and poor districts of country, the flat bars may be used until by establishing channels of trade, sufficient capital may be accumulated to justify the cost of replacing them with heavy edge rails. This has been done in several parts of the country already, and will become universal whenever railway concerns can bear the cost and inconvenience arising from a change. I might give many other reasons for keeping the duty off edge rails for a few years longer, but fearing to intrude too much on your time, I will only mention one other reason and that affects the interests of the American iron master himself. The principal expense of making iron in this country arises from transporting materials to the place of manufacture, and afterwards the manufactured article to market. For example, the iron stone and fuel (wood) are generally in the same neighborhood, but limestone and bog ore may be ten, fifteen, or twenty miles off. The furnace for smelting the ore into pigs is generally many miles distant from the forge, or rolling mill, for converting them into merchant iron. So, also the rolling and slitting mills for the manufacture of rails etc. are usually still more distant from the smelting furnace. Therefore until all these establishments or the elements (the fuel, limestone and iron ore) for the manufacture of iron are concentrated, as they are in Wales, Staffordshire, Stropshire and other parts of England—and also in Scotland, the iron masters (and also the consumers) are interested to have the importation of Railway Iron continued free of duty. Besides the construction and use of railways calls for a very enlarged consumption of iron (every pound of which must be made by American iron masters,) in making locomotives, tenders, wheels, axles, spikes, screws and a great many other articles of iron which are to be furnished exclusively by the home producer.

I will not trespass more on your time, but conclude by reiterating the hope expressed above, viz.: that all edge rails of 40 pounds per yard and above that weight may continue to be imported free of duty for six years up to 4th July, 1848.

I am with great respect,

Your obedient servant,

GERARD RALSTON,

Of A. & G. Ralston, & Co.

P. S. The Liverpool and Manchester Railway began with rails 34 lbs. per yard, but through successive changes, going higher and higher, it now has rails of 70 lb. per yard. The heaviest iron used on any railway in England, is on the London and Brighton road which weighs 76 lbs per yard. On the Philadelphia and Columbia Railroad, the rail imported 10 years ago was only 41 1-2 lbs. per yard, but recent importations for this road weigh 56 lbs. per yard. So also on the Philadelphia and Reading Railway, the *first* rails did not exceed 42 lb. per yard, but the recent importations weigh 55 lbs. per pard, and this must give place in a few years for rails of 70 to 75 to accommodate the heavy trade in coal and iron on that road. If a duty edge rails be imposed, the importation will cease altogether, or the rail will be rolled lighter and lighter instead of as experience has taught they should be, heavier and heavier than they have been. G. R.

For the American Railroad Journal and Mechanics' Magazine.]

WORKING OF ENGLISH RAILWAYS.

We have much pleasure in presenting our readers with the following specimens of the working of English railways, as affording means for useful comparison with those of our own country. They have been compiled from Herapath's Railway Magazine of 13th August, 1842.

The "London and Birmingham" Railway is the great Leviathan as a road for travel, as the "Stocklin and Darlington" is for the passage of tonnage. On the former, for the week ending 6th July, the total receipts were 103,360. At the present quotation of £180 for 100 of this stock, the value of these 113 miles of double track railway, is equal to the enormous sum of $53,100,000. It will be observed that the ratio of expenditures to the gross receipts have been reduced in the last returns to 25 1-4 per cent. and that as a consequence of the increasing magnitude of their business, still furt! er economy is expected.

If our post office department is at any further loss as to what is paid in England, under this head, they can be referred to

The "London and Birmingham" which receives at the rate of $637 per mile per annum, for 113 miles.

The "Birmingham and Derby Junction," which receives at the rate of $554 per mile per annum for 48 miles.

The highest rate fixed by law of Congress of the United States is $300 per mile, per annum; a rate even, much complained of by the Department, and the necessities of our railways have been used by it to obtain much lower rates, in many cases not affording a just remuneration for the services performed. Taking into view the immense mass of circulation in this country of newspapers, pamphlets, etc., the size and weight mailed by railway in either country, is not materially different, as we have been assured by parties who have looked into the subject.

Our best American Railways are worked quite as cheaply as those in England, but unable generally to make as good a show of business, are not as yet in as good credit. In both countries the improvement is still progressive.

London and Birmingham Railway, opened throughout in 1839,

Capital stock,	18,400,000	
Loans,	9,730,000	
Locomotives,	647,000	
Carriages and wagons,	744,000	
Total cost for 113 miles double track, or per mile, $261,200	$29,521,000	

Receipts for six months, ending 30th June, 1842,

From Passengers,	$1,324,000	
" Mail, equal to $637 per mile per an.	36,000	
" Merchandize, parcels, cattle, etc.	582,000	1,942,000

Disbursements for same period.

Maintenance of Way.			
Repairs to permanent way, per contract for 6 months,	96,000		
Repairs to bridges, fences, drains, turn tables, engines, and other salaries,	16,000	112,000	1,042,800
Locomotive Power.			
Wages to enginemen and firemen,	24,000		
Coke fuel,	71,000		
Repairs to engines and tenders, equal to 5 3-4 per cent on cost,	36,000		
Laborers, cleaners, oil, stationary power,	39,000		
Salaries of superintendent, clerks, etc.	15,600	185,600	
Transportation Account.			
Wages to policemen, coach guards, &c., gratuities to switchmen,	66,800		
Salaries to various clerks,	14,600		
Salaries of Secretary, office rent, travelling expenses, etc.	32,000		
Repairs to carriages and wagons equal to 6 1-2 per cent on cost	48,800		
Compensation for damages, oil, signals, clothing, etc.	10,400		
Gas at stations,	5,300		
Carriage and wagon grease, stationary waste, etc,	12,200	190,100	
		487,900	
Charges Extraordinary.			
Mileage duty to government, 4 3-4 per cent on receipts from passengers,	106,400		
Parish rates	43,600		
Reserved fund for depreciation of locomotive and carriage stock,	71,600	221,600	709,500
			$1,232,500
Interest Account.			
Interest on loans for six months,			255,500
Dividend Account.			
Half yearly dividend declared on capital of 5 per cent,			$977,000

Remarks of the Chairman from the Report.

"The increase of nett profit for these six months, as compared with the corresponding half year of 1841 will be found to be $128,700.

And the most pleasing feature of this increase is, that it chiefly results from a progressive decrease in the charges on the company revenue, and particularly in that portion, which immediately attaches to the working of the traffic, and which, as appears from the June half yearly statement has been successively reduced from 34 3-4 per cent, to 29 1-2 per cent, and lastly to 25 1-4 per cent on gross receipts.

In travelling this year from John o' Groats to the Lands End, I heard nothing but commendations, nothing but uniform praise of the London and Birmingham. Long may we continue to go on in this progressive state."

Birmingham and Derby Junction Railway, opened throughout in 1842.

Capital stock	$3,903,000
Loans,	1,268,000
Locomotives,	166,500
Carriages and Wagons,	230,000
Total cost of 48 miles of double track $116,000 per mile,	$5,567,500

Receipts for six months, ending June 30th, 1842.

From Passengers,		83,400	
" Mail, equal to $554 per mile, per annum,		13,300	
" Merchandize, parcels, cattle, etc.		51,900	148,600
Disbursements for same period.			
Maintenance of Way.			
Per contract for 6 months,		18,800	
Locomotive Power.			
Wages and salaries,	8,800		
Fuel, coke,	10,400		
Repairs of engines, etc. eqnal to 6 per cent on cost,	9,500	28,700	
Transportation Account.			
Salaries and wages,	17,000		
Depairs to coaches and wagons, equal to 3 1-4 per cent on cost,	7,300		
Advertising, insurance, damages, clothing, travelling expenses, etc.			

Toll to London and Birmingham Railway,	5,700	37,200	
		84,700	

Charges Extraordinary.

Mileage duty, rates and taxes,	8,700	93,400
		$55,200

Remarks of the Chairman from the Report.

"This line has been in full operation for only a few months, and both the business from merchandize and travel continues to improve as well by the increase of the original, as by the addition of new branches of trade.

Reductions in working the line are also progressive—the most important being in that for maintenance of way—the average contracts hitherto having been at $900 per mile, but which have now been taken at $585 per mile, including sleepers and all materials except rails."

Northern and Eastern Railway, opened throughout in 1842.

Capital Stock,	$4,135,000
Locomotives, Carriages and Wagons,	237,000
Total cost of 29 miles double track, $150,000 per mile,	$4,372,000

Receipts for six months, ending 30th June, 1842.

From Passengers,	142,800	
" Parcels,	2,200	145,000

Disbursements for same period.

Maintenance of Way.

For six months, per contract,		5,700	
Locomotive Power.			
Salaries and wages,	13,900		
Fuel, Coke, etc.	13,900		
Repairs to engines,	1,300	29,100	
Transportation Account.			
Wages to conductors, guards, etc.	9,700		
Salaries, stationary, printing, etc.	7,600		
Repairs to coaches,	2,500		
Toll to Eastern counties railway,	13,700	33,500	
		68,300	
Charges Extraordinary.			
Mileage duty,	7,300		
Rates and Taxes,	2,200	9,500	77,800
			$67,200

Remarks of the Chairman from the Report.

"This line has been open throughout but eleven weeks, and from the result we may anticipate a period of prosperity. The expenses thus early of working this line have been only about 41 per cent, which is a gratifying circumstance, because it is allowed that on an average receipt of $7,500 per week, the average expenses should be $2,500, or about 33 per cent.

I consider that we shall very soon have a goods traffic, and while at present we fire every day seven engines, I think with the same extent of power, we might carry goods affording an increased recept of $1500 to 2000 per week without any additional expense."

REPORT OF THE SOUTH CAROLINA CANAL AND RAILROAD COMPANY,

To the Stockholders of the South Carolina Canal and Railroad Company:

In accordance with the general usage of this company, a statement of its affairs are herewith presented, showing the business, and receipts, and expenditures for the six months, ending 31st. December, 1841; by which it appears the gross income has been $163,748 83

And the expanditure for repairs and improvements. 119,675 69

Leaving a nett income of $44,072 94

Nearly the rate of 4½ per cent. per annum—

Showing a gain over the corresponding months of the year previous, of $11,517 13

Viz.: in increased receipts,	3,849 80	
And in less expenditures,	7,667 33	

The most remarkable saving in the ordinary expenses, is in the article of oil—and has been produced by the use of palm oil and tallow, instead of limpid oils.

The cost in the last year of this item, has been less than the average of the five preceding years, $3,234 93

The average cost of oil and tallow for 1836, '37, '38, '39 and '40, per year, is	5,769 90	
And for 1841 only,	2,534 97	

The saving in wood for fuel, in each of the last two years, has been greater than that of oil for the last year, though not so much in proportion to the whole amount used.

The average cost of wood, for the years 1836, '37, '38 and '39, was, per year, $15,253 83

In 1840,	$10,957 54,	saving	4,296 29	
" 1841,	9,949 29,	"	5,304 54	

As the cost of these items have been reduced without any great decline in the price of either, it will be proper to explain how the result has been effected.

After several years trial of palm oil, with good effect, the hardest tallow has been substituted for oil, on all the journals where boxes are fitted to receive it—Boxes are required under the journals as well as over them, and both must be crowded full of firm tallow, so as to exclude the air.

The rust of the iron incorporates with the tallow, and forms a preparation equal to plumbago, in which the journals literally float, and prevents any contract of the metals—consequently no heat is produced, no wear of the journal of steel, or the *bearing* of chilled cast-iron, and scarcely any consumption of the tallow, where the boxes and bearings are properly fitted.

The chilled bearings must be cast at least 1-8th of an inch larger in diameter, than the journal, to admit the tallow between them on the sides of the latter.

When the frames of all our cars and engines are fitted with *chills* and bottom cups or boxes, there will be a further saving. The change of steel for iron journals, and cast iron chilled bearings for brass, is made as fast as practicable, and has been in progress over three years. In proof of what we have stated above, the following fact is presented.

On the 16th, 17th and 18th of July last, the boxes of all the cars in the passenger trains, say ten cars on 8 wheels,—were supplied with tallow in the manner above stated, requiring about three fourths of a pound to each journal, or in all sixty pounds—and they are now all in the same order—though not more than half the same quantity has since been added, say thirty pounds, or ninety pounds in all for six months; each having performed about the average run of one hundred miles per day, for the whole time, without the least perceptible wear of either journal or bearing. The same can be said in the use of palm oil, for over three years past; but the expense of the oil is much greater than the tallow.

The saving in the cost of wood, for fuel, has been in contracting for it, cut in lengths proper for use, and corded by men in the employ of the company: thus obtaining better measure—and the increased speed of the trains, keep them out a less time, and a less quantity is supplied to the furnace; it having been found that the practice of filling the furnace with wood, did not answer so well as feeding more lightly, making a freer fire, and consequently a less consumption of fuel. One thousand dollars of the cost of wood in the last year, has been saved by the application of locomotive power for stationary, at the Plane.

The timber account, for the last two years, has been reduced each year, about ten thousand dollars below the cost of previous years—as less has been required, since the road has been so much improved by a firm embankment, and new iron.

It is believed, however, that a greater reduction in the cost of this article is to be obtained by mineralizing it with a preparation recommended by Doctor Edward Earle, of Philadelphia, and mentioned in our last report—called *Earlizing*. If the expense does not exceed his calculation, say 2 and a half to 3 cents per cubic foot, or if even four cents, the timber may be put into the road at no increase on the present cost; as an inferior timber of small trees, embracing the sap, as well as the hearts of the wood, would answer equally well, and be obtained at a price, which with the preparation, would not exceed the present cost of heart timber; and if the durability is only doubled, the saving in material and labor, would be fully $30,000 per year.

It is believed that timber made of pine saplings, would receive the mineral better, and be equally serviceable, and as durable as the timber entirely from the heart of the tree; so, with any confidence in this process, it would be criminal to neglect it—especially as a test has been made in the wooden pavements of Philadelphia, which have been in use two years and a half, and a recent examination, reports the timber, Earlized in these pavements, perfectly sound, while that unprepared of the same kind of timber, (Hemlock) is quite rotten.

We have commenced this process, in a small way, in timber to be used for revolving sections, and turn out gates, etc., the durability of which is of more importancce than the main track, and in such places can be better kept in view, as an experiment.

After better ascertaining the actual expense, it is hoped that it will warrant a continuance of the work, till the whole road is renewed with mineralized timber.

The machinery account has been greatly reduced; (except $7,333 worth of chilled wheels and axles,) the account for the last twelve months is very small, not half the average of former years. The machinery that was formerly charged, is now produced in the workshops of old materials as well as new—by this the workshop wages are gradually increased, although not in proportion to the reduction in the amount of machinery—having the satisfaction of making, in our own shops, with our own men, nearly every article of machinery which we formerly imported.

The Master of Machinery has been very successful in casting chilled wheels—has about thirty pair made, and some of which have been in use long enough to prove them equal to any that have been ordered from other works. Having arrived at this fact, we shall go on with confidence, and endeavor to supply ourselves with new wheels as fast as they may be required, for the future.

The company is much indebted to the aid of such of the officers and men, who are exerting themselves to reduce the expenses in every department—and it must be a great satisfaction to those, who are thus engaged, to reflect, that they are saving to the company, more in this way, than double the pay they receive for their services—and although the business of the road does not yet yield an adequate return to the stockholders, for their investments, it is believed that with a steady perseverance in the economy of its affairs, it will soon do so.

The interest, on the amounts borrowed, from time to time, from the Louisville, Cincinnati and Charleston Railroad Company, to complete the improvements of this road, amounting to $37,869 70, has been lately calculated, and placed to the credit of that company and charged to construction and outfit. It is expected the present year will enable this company to pay this, as well as the balance of principal due, amounting in all to $57,388 56, after which, the nett income will be paid over in dividends, instead of the liquidation of debt.

The larger receipts of 1839 and 1840, over other years, as shown in comparative statement (D) is accounted for, by the higher rate of tolls in those two years.

We also present a paper, showing the cost of each item of expenditure, for each half year, from 1835 to date. The summing up of which, will show a gradual decrease in the total expenditure for the last five half years—and for the last year, $132,000 below the average of 1837, '38, and '39, being about $376,000
And that of the year 1841, 244,000

This calculation does not embrace the amount paid for embankment, rail iron, or land. but includes all other improvements now covered by current expenses. It is proper to state, however, that in the three years mentioned above, the railroad was literally rebuilt.

A further reduction of the expenses is expected, provided there is no increase of business to prevent it, which would be more desirable. The proposed reductions are in the timber, by mineraliz ing it—and in the machinery, by making all at home, instead of importing it, to which we are fast approaching.

The difficulty of apportioning the machinery, to an uncertain amount of business to be done. with a liability of having a superabundance of power, and consequently, a waste of capital, must be apparent to all who have considered the subject. This is explained in a correspondence with Col. Gadsden, President of the L. C. and C. R. R. Company, and is as follows:

Office of the L. C. and C. R. R. Company.
Charleston, October 23, 1841.

To T. Tupper, Esq., President, &c.

Dear Sir:—I have been under the impression, that the motive power, burden and passenger cars, belonging to the S. C. C. and R. R. Company, with the ability of the work and carpenter's shops, to keep them in repairs, and to increase them if necesary, would be, or could be made equal to the business and travel on that road, as well as on the L. C. and C. R. Road. As the latter progresses, and new sections are opened, increased facilities for transportation will be required, and pursuing the plan which has been adopted, of devolving on the S. C. C. and R. R. Company, the furnishing of the power, and the managing of the transportation on the road to Columbia, from Branchville, it becomes necessary to ascertain from you, whether there will be any difficulty in the accomplishment of this object, so that the subject may be submitted, if necessary, to the Board, and provision be made accordingly. I am more than ever satisfied, that after the road crosses the Congaree, and a depot is opened on the north of that river, that the freight business, even this season, will be considerably enhanced; and the progress of the road, and its near approach to Columbia, even if not completed to that point, will devolve on us all the spring travel and transportation of that city. It is important, therefore, that arrangements be made in advance, so that our roads be found fully equal to all that may be offered. Respectfully,

Your obedient servant,

JAMES GADSDEN, *President.*

Office of the S. C. and C. R. R. Company.
Charleston, October 28, 1841.

To Col. JAMES GADSDEN, President.

Dear Sir,—On my return from the country, Monday, the 25th inst., I met your favor of 23, making inquiry respecting the ability of this company to do all the transportation on this road, and on the L. C. and C. Railroad, as the latter progresses, and new sections are opened, increased facilities would be required, etc. I have felt much anxiety on this subject, for months past, as in former years, when the time approaches for the winter business; not for want of ability to provide power, but the difficulty of proportioning the supply to the uncertain demand for it. Last fall the power was more than required all the season. The year before, was deficient with press of business for one month only, when the income from that month was over $65,000. and thirteen engines only were employed in all that month. Now, as the business of that month was much greater than any, before or since, and about double that of ordinary business months, it might be supposed, an equal provision of power would be sufficient for the business of the present winter. But instead of thirteen engines, the number used in November 1839, Mr. Ross informs me, he has in running order, fifteen engines, and three that will be out in about three weeks, and three more in February next, and three others rebuilding, probably in all next year.

With the cars now in order, and those that are finishing daily, we hope to be able to perform, as much as has been done, in any former season—and probably more should the business increase, as we hope it will.

I have sometime past requested Mr. Ross and Mr. Hacker, to employ all the hands they could to advantage, in our own shops, and procure the aid of other establishments, if necessary, to keep on the road, all the machinery, that might be required. We are casting and importing wheels and mounting cars, as fast as the wheels are ready, so that should the produce press upon us at any time, by suspending the transportation of materials for the L. C.

and C. R. R. Company, for a little time, I have no doubt, we may be able to keep the stations clear of cotton, or nearly so.

Very respectfully,

Your obedient servant,

T. Tupper, *President.*

The connexion between the L. C. and C. R. R. Company and this, will be better understood, by reference to a letter from Col. Gadsden, the President of that company, with the reply, which are annexed, turning over to the officers of this road the Columbia branch as fast as completed and received from the contractors for transportation and repairs, of which a strict account is to be kept, and that company charged and credited, as the case may be.

Extract from a letter of the President of the L. C. and C. R. R. Company, to the President of the S. C. C. and R. R. Company, and dated 24th November, 1841.

"By a resolution of the Direction of this company, the preservation of the track, and the furnishing the necessary motive power, burden and passenger cars, etc., together with the direction and management of the transportation on the sections of the road, between Branchville and Columbia, has for the present, been devolved on the officers of the S. C. C. and R. R. Company. You will be good enough, therefore; to assume the duties, and give the necessary instruction for carrying the same into effect. As previously advised, the road has been opened for freight and passage as far as Lewisville. As the contractors are bound to keep that portion between Orangeburg and Lewisville in repair, for three months from the 5th of October last, your attention will for the present, only have to be directed to Orangeburg."

Extract of a letter dated on the 29th Nov. 1841, from the President of the S. C. C. & R. R. Company, to the President of the L. C. & C. R. R. Company, in reply to the foregoing extract.

"Your letter of the 24th inst., duly received, turning over to the officers of this company the keeping up, and the transportation upon the Columbia branch road, so far as opened and received from the contractors. I have extended the order in conformity, and will do all in my power, to comply with the wishes of the L. C. and C. R. R. C., in the extra duties required of me, in common with those on the main stem of our road to Hamburg."

It is about time that those interested in these companies, should look to see on what ground they are standing, to know the value of the respective charters—to preserve that which is good, and reject that which is worthless. That the business of the two companies may be so arranged as to be conducted by one board and one set of officers, as required by the stochholders of that company at its last meeting.

Having by authority of the board, attended a meeting of delegates, from the several railroads in the United States, by invitation of the Post Master General, on the 1st. of January, 1842, at Washington, where they received a communication from that officer, respecting the difficulty of regulating the mail connexions at different points—not having the power to control the hours of arrival and departure of the cars on the several railroads.

A committee of six was appointed to reply, in behalf of the convention, to this communication, and the following members appointed on the committee—Louis McLane, of Maryland, Chairman; Dr. Shepherd, of Virginia; Gov. Dudley, of North Carolina; J. P King, of Georgia; R. L. Stevens, of New York, and George Bliss, of Massachusetts.

It was proposed, that the members of the convention send to the chairman, any facts they might deem proper, to be in the reply, to be used or not by the committee.—The following is the communication by this company:

Office of the S. C. C. & R. R. Company.
Charleston, January 8, 1442.

My Dear Sir,—Enclosed, are some facts connected with our establishment, which will show how much we are disposed to take advantage of the department, or on the contrary, how much we have suffered by our connexion with it. I am sorry to say my experience teaches me, that any thing given to the public is seldom acknowedged, and only increases the demand for something further.

With full recollection of the last clause of the resolution, which induces this communication, (the right to reject it)

I am, with great respect,
Your obedient servant,
T. Tupper.

To the Hon. Louis McLane,
Chairman Committee R. R. Committee,
Baltimore, Md.

Office of the S. C. C. & R. R. Company.
Route 2214.

Before the great mail was conveyed upon this route, a six days service, per week, in winter, and three days service in summer, with a speed of 10 to 12 miles an hour, was only required. Then freight could be taken with the mail and passengers, exceeding in amount four times that now received for the mail, which cannot now be done and performed in contract time.

By such an arrangement, particularly in summer, a freight train could be saved, and all the year the Sunday service avoided; the cost of which approaching nearly one seventh part of the whole expense of the company, say $240,000 making $34. 285, or at least the full amount received for transporting the mail, $27,600.

The facilities given to business, by the establishment of railroads, letters and papers have been much increased—say three fold, since the contracts were first made, and no additional pay to the companies, when, if continued in stage coaches, a correspondingly increased pay would have been incurred.

On this road, an engine at ten miles an hour, would carry freight with the mail and passengers, amounting to at least *one hundred and fifty dollars* each way, and frequently double this sum westward— when the same engine, with the mail at twenty miles an hour, now required, conveys no freight, and only receives each way, *thirty seven dollars* for the mail, a clear loss of *one hundred and thirteen dollars* per trip, or, *two hundred and twenty six dollars* per day— Making in a year, a certain loss of *eighty one thousand three hundred and ninety dollars*, by the speed necessary to carry the mail in contract time.

In the event of a war, this company will be found ready to make further sacrifices, to serve our country, and for a moderate pay transport men and munitions of war, in preference of all other business.

By order of the Board,

TRISTRAM TUPPER, *President.*

Charleston, Jan. 8, 1842.

REPORT OF THE SOUTH CAROLINA CANAL AND RAILROAD COMPANY, FOR JULY, 1842.

To the Stockholders of the South Carolina Canal and Rail Road Company:

In conformity with a rule of this company, and the general usage, we herewith present the semi-annual accounts of the Secretary and Treasurer, from the 1st January to the 30th June, 1842, both included; showing the whole income, for these six months to be $167,156 39

And the expenditure for the same time, 115,657 40

$51,498 99

Being over the rate of 5 per cent. on the capital of $2,000,000, and $17,250 42 more than the nett income of the first half of last year—

By increased receipts, $8,164 27

And by decreased expenditure, 6,086 15

Had the improvements in the road, machinery, and buildings, with the increased amount of materials on hand, in the last three years, been paid for by the increase of capital, as is the practice of other companies wishing to make a good showing, the nett income of each half year would have been fifteen to twenty thousand dollars more than has been represented by our accounts, as it is, the property of the company has been improved and should have a relative increased value to the stockholders, as in this way, the nominal capital is less than the actual amount invested in it. For the ensuing half-year, the expenditure may be much reduced from the last, if the business should not be much increased, as the improved state of the road and other property of the company, with the ability of the shops to turn out any new work that may be required, a less outlay will be called for. The *machinery* is now in better order than ever before, as will appear by the return of the Master of Machinery. There are seventeen engines and tenders, in good order, and seven others building, re-building or repairing. These, with the cars, many of which have been supplied with wheels from our own shops, will be equal to transporting a larger amount of goods and produce than on any previous year.

The wheels that have been cast in the foundery of the company, in the last twelve months, and have been fairly tried under the engines, tenders, freight and passage cart, in all about one hundred pair, have proved better than any before used on the road, and are substituted for the cast iron wheels with wrought iron tire. These cast iron wheels with the steeled journals and chilled iron boxes, all made in our shops, will result in a saving of eight or ten thousand dollars per year. *Tallow* in the place of oil is also working well. Nearly all the journals are supplied with it, and in all the year the advantage of the change will be further seen, as a small quantity will be required to replenish the boxes when once filled.

In the road department, some progress has been made in the preparation of timber, with the sulphate of iron and copper, as will be seen by the report of the superintendant of the road. About 100,000 lineal feet of rail timber have been contracted for at 2 1-2 cents per foot, being about half the average price usually paid. About 50,000 feet have been delivered, and 12,000 feet have undergone the process of Earlizing in tanks prepared at the 58th mile, and 5,000 feet have been put in the road, 2,000 of which was used to renew the turnout on the 8th mile about the middle of April last. This timber is obtained at a reduced price, as the sap is embraced in the square of t'e piece and consequently taking a much less tree than when the heart only is retained.

The advantage of this process will be felt at once in the lower price at which the timber is contracted for, and should it only last as long as ordinary timber, no expense will have been incurred, as the difference in the price of the timber will pay the expense of preparation.

The timber prepared four years ago with corrosive sublimate, is still sound, the sap of which has already shown a durability of double that of unprepared wood, and, from all appearance, will be sound when the unprepared is so rotten that it cannot be separated from the earth in which it is buried.

The state of the land of the company, as far as there is any difficulty connected with it, is explained by Capt. Robertson. Land Agent, in his report marked (3.) There are some points in this, that require attention. This report will give the company some idea of the importance of the office, and enable them to determine whether it shall be continued or not—at any rate, it would seem, that as the whole of the year cannot be employed, the pay might be reduced, if the office is not abolished.

An increase in the cost of wood for fuel will be perceived over that of the last year. This is produced by the increased trips on the Columbia road, and the higher price paid for it on that line. The cost of the wood for that branch will be more than one third of the whole, from the fact stated above. Deducting that used on the branch, would exhibit a further reduction in the cost for the main stem of the road than that shown in our last report.

The wages of negroes will be further reduced, and will be more felt in the next year's account; already, however, some are hired at from nine to ten dollars, giving rations only, and deducting sick runaway time, as in all former contracts.

The arrangements for business are now so complete, that if no farther movement is made in the reduction of rates, the current half year will, no doubt, on both roads, furnish a nett income of not far from $100,000.

The number of passengers that have passed on the main stem of our road the last six months, are only 20 per cent. less than in the corresponding months of the year 1839, but at the higher rate then charged, our receipts were $107,933 against $65,866 this year—over 6 per cent.

The Columbia branch road having been extended to Columbia, though not quite completed, was opened for passengers and freight on the first of July instant.

The transportation upon, and the keeping in repair, of that road, as fast as turned over by the contractors, was assigned to the officers of this company by the order of Col. Gadsden, President of the L. C & C. R. R. Company, in November last, and these duties have been attended to by Mr. Lythgoe and myself, in common with the same duties on the main road. It is now found, that the expenses of both roads have not exceeded $125, 000 for the last six months, being the lowest amount ever suggested by the most rigid economist, and if there be no increase of business to demand a great outlay, can be further reduced after the Columbia road is fully in order, now made otherwise by the washing and sinking of the embankment and tho giving way of some of the culverts, caused by heavy rains.

The superintendant has taken the floating gang from this road, and hired others, in all about forty hands, to make these repairs, and when done, if no further effects of storms, the force can be much reduced. The police of that road is not fully organized, but will be so, as soon as all parts of it are turned over by the track-layers.

It is believed, that no increased power or cars will be required to do the business on that road, as the transportation of the iron and timber, while building, was equal to the ordinary traffic which will be offered on it when the road is in full operation. To provide, however, for a press of cotton in the fall, eighteen platform cars are building, which, with twelve of the same already made, will make three trains that will carry 500 bales each. These alone would take to market more than has ever before been brought in, for any extent of time, from all points on the Hamburg line.

The receipts of the Columbia road, for the six months, ending 30th June, were,

For Freight and Passengers,	$12,050 98
The expenses charged,	7,520 43
Nett receipts,	$4,530 55

The average distance passed over in the six months was about forty miles. But as passengers are now landed in Columbia in about eight hours from Charleston, and the freight in about twelve hours, it is believed that a large proportion of the business heretofore carried through other channels, will now be diverted to the railroad.

Respectfully submitted.

T. Tupper, *President.*

Charleston, July 20th, 1842.

MR. VIGNOLES' LECTURES ON CIVIL ENGINEERING.

Lecture 10.—*On the upper works of railways.*—This lecture was on the upper works of railways, which term, the Professor stated, was intended to comprehend everything above the bed or formation level of the roadway—viz., the gravel, broken stone, or other road material, technically called the "ballasting;" the stone blocks or wooden cross sleepers, laid thereon; the chairs and rails, and their fastenings, as attached to the stone or timber supports; and the boxing or filling up of the road material around these supports, when the railway is finally laid to the proper gauge, range, and level—the whole of the materials and adjustment forming the "upper works"—an expression borrowed from the German *oberwerke*. The depth from the road-bed to the level of the rails, of all these parts, as permanently laid together, is seldom less than two feet, when a good way is to be insured; the principle to be observed being to have the ballasting of such a material and nature that water will percolate freely through, as clean gravel, cinders, quarry rubbish, coarse sand, etc. The word "ballast" is a northern provincial term. Some of the first railways were introduced into the vicinity of Newcastle-upon-Tyne, Shields, and the neighboring coal shipping ports, and in being found necessary to have a bed or layer of some material, to receive the railway track, the same not to be retentive of water, the gravel brought by the colliers from London as ballast, and accumulated in hills or spoil-banks near the side of the harbours, was found to answer the purpose very well; the expression has since become common for whatever other material was similarly used for laying railroads. Mr. Vignoles observed that a great number of other technical words now in common use, when treating on railway works, were provincial terms, chiefly from the north of England. When the bottom of cuttings, or top of embankments, are of soft material, it was recommended to make a kind of pavement or hard layer, on the forming level, below the ballast. On embankments, until the became well consolidated, this pavement would not perhaps he conveniently put in; still means should be contrived to carry off the water quickly from the surface and the Professor insisted much on the free introduction of blind, or French drains, of brokon stone, among or under the ballast, connected with the open side drains, which should never be omitted in cuttings; on embankments these cross rubble drains should go free of the road-bed, with water channels down the slopes, of sods, or more substantially formed if needful.

The bed of the railway having been prepared on the above principles, next came the consideration of the railway itself. The substance first used for this trackway was wood, and afterwards a metal rail, plated on the wood; after 200 years' trial of different systems—for so long was it since the first colliery wagon-ways were introduced—the Professor observed, we are just coming back to the original form and material as best adapted for the purposes of a railway—viz., timber laid longitudinally. When blocks of stone are used to support the chair and rail, weight seems to be sought for as desirable, and the general cubic contents of such blocks as are considered proper for a good way are about five cubic feet—viz., 27 inches wide, and a foot thick. When cross bearers of wood are the supports, each sleeper, as it is termed, contains about two cubic feet of timber, being about seven feet long, with a transverse section of 40 square inches, being full eight inches broad and averaging five inches thick. The intervals at which the blocks or sleepers are placed vary from three to five feet, according to the weight of the rail or of the load. With these descriptions of supports becomes generally necessary that a chair or saddle be attached thereto to receive the rail, which is seldom fastened directly either on block or sleeper, without the intervention of this contrivance of a chair, unless when the rail is made wide and flat at the base. Such shaped rail is now much used on cross bearers of wood for temporary railways, by contractors, while executing works. Mr. Vignoles said this form of wrought iron rail was first introduced nearly 12 years since on the St. Helen's Railway. by some contractors. at his suggestion, and the same rails were lately in use by the same persons, and still good and serviceable, after continued use. Of late it had been recommended by many engineers—among which Mr. Vignoles believed he was among the first—to lay down the railway bars on bearings of timber, disposed lengthways in the direction of the way, and upon which the iron had a continuous bearing, instead of having it supported at intervals (either with or without chairs,) as was the case when blocks or cross timber bearings were used. In describing the different modes of laying rails, the Professor observed that the heavy stone blocks being packed around, or boxed up with ballast, kept the rails in place—that the cross sleepers having both rails attached thereto, the gauge or breadth was preserved; with the longitudinal system of bearings, the parallelism was retained by cross ties of wood, with tenons, and sometimes by rods of iron with screw-ends and nuts, and occasionally with both. It was necessary thus to provide for preserving the breadth of the railway, for, as the carriages and engines work along the rails with a wriggling motion, there is always a tendency, by the lateral action of the flanges of the wheels, to push the road out of gauge. Mr. Vignoles mentioned the two new lines added on the south side of the London and Greenwith Railway as the latest examples of longitudinal timber bearings; but he observed that, as the great point in this system was to insure that the rail be firmly attached to the wood, to prevent any vertical play, he consideied a more effectual method might have been there used, so as to have the iron continually united to the timber, on a plan which he had tried with success, and to which he would presently advert. When iron was first introduced for railways, it was for a long time merely a plating of metal on the edge of the wood rail, on which plan, with iron bars of greater or less weight, many of the lines in America had been laid. Cast iron being next introduced, the system of fastenings was necessarily changed, and the original longitudinal timbers abandoned for cross sleepers, or isolated stone blocks. The rails being cast in lengths of three or four feet, it was found expedient to prepare some contrivances to receive and fasten the ends together, and this was the saddle or chair. Some of these iron rails were cast deeper in the middle, and, from their shape, got to be termed "fish-bellied." this form being probably adopted with the idea of obtaining uniform strength; though, for railway purposes, the position of this increase depth was the reverse of that given to bearers intended to resist quiescent weights. From the action of the moving weight, however, upon rails with so many joints, they soon got out of order. Wrought iron was then introduced, to get greater lengths; the first of these were rolled at a considerable expense of useless ingenuity into the same form as the fish-bellied cast iron rails, the length of 15 to 18 feet being divided into five or six flat ellipses. On most of the lines where this description of rails was first laid, it has been found necessary to take them up, and replace them, as they were found to break at a short distauce from the points of support. Mr. Vignoles stated that he had, from the first, decidedly set his face against this form of rail, and argued for and introduced rails with the same section throughout their length—since commonly styled *parallel rails*, as distinguished from the "fish-bellied rail," adding 10 lb. to the original weight of 35 lb. to the yard, by putting on a lower rib or web, on the principle that gave such additional stiffness to all beams; this lower web was increased in size from time to time, until, in a special report to the London and Birmingham Railway, Mr. Vignoles recommended that the upper and lower webs, or buttons, should be made precisely alike, to allow the rail to be turned up or down, or in either direction. This form was, however, first actually laid down by him on the North Union Railway, and its advantages in the above respects have already been appreciated and applied: these rails are about 65 lb. to the yard. The Birmingham Company decided finally on adopting this form, increasing the weight to 75 lb.; and, where chairs are used, it is now almost exclusively employed, the weight being sometimes increased to 78 or 80 lb. per yard. With the increase in the weight of the rail, the intervals between the supports also gradually increased from three to five feet, but with bad effect, as the expense of keeping a railway in order with the longer bearings (as the technical phrase is) was very much augmented; and, on the London and Birmingham Railway, intermediate supports had since been introduced, where the original bearings were five feet. Mr. Vignoles stated it as his opinion, deduced from considerable experience and observation, that where chairs and supports, at intervals, were used, he considered a 60 lb. rail, with a 3-feet bearing, better than a heavier rail with a longer bearing. Blocks, he observed, were, however, nearly exploded as supports; the cross sleepers and chairs were still preferred by many engineers, but it was certain that the closer the supports—that is, the shorter the bearings—the less the cost of maintenance, and hence the inference, which experience every where confirmed that the continuous supports were best of all. In respect of fastening the chair to the block or sleeper, and the rail to the chair, it was now almost universally admitted and acted upon, that compressed wood was much preferable to iron spikes, bolts or keys. Mr. Vignoles introduces a number of drawings, and described a variety of diagrams, illustrating the various shaped rails and chairs, and modes of fastening adopted, and drew comparisons as to the advantages and cost of each. In reference to what he had before stated of the disadvantageous method hitherto pursued in fastening rails with flat bases to continuous timber barings, by spikes or screws, the Professor said that such a mode seldom continued to hold the rail close down to the timber, and there ensued a certain quantity of vertical play of the rail on the wood, often accompanied with a good deal of rattling, and in the end, the head of the bolt or spike was absolutely jerked off. Mr. Vignoles said that the only effective fastening was that used with Evan's patent rails, which had a slit or grove of a dove-tail shape (in cross section) rolled for the whole length of the rail in the bottom; bolts, with similar-shaped heads to fit, were passed into this groove, and dropped at the necessary intervals, through holes in the longitudinal timbers; the bolt termined in a screw, and a washer and nut being put on, by means of a spanner, the nut drew down the rail closely to the timber. Mr. Vignoles stated that he had had a considerable length of railway thus laid, which had been done some time, and the rail had remained close down at the wood without any play, or getting at all loose. He concluded this lecture by stating that in the next he would endeavor to draw a comparison between the modern heavy rail and chair and fastening, as used with cross timbers laid at internals, and the rail and fastening as above described, to be laid on longitudinal timbers, and having a continuous bearing thereon.

Lecture 11.—In resuming the subject of the Upper Works of Railways, the Professor said he would enter briefly into the consideration of the strongest form of rail, after explaining those points applicable alike to cast and wrought iron bars. First, a certain breadth was required for the bearing surface of the rail, for the wheel to run upon, and this breadth should be such as not to be likely to produce improper action or grooving, in the tire or tread of the wheel, and, at the same time, not to be increased so as to make the rail needlessly heavy; there must also be a sufficient depth or thickness of that bearing surface, to make it strong enough to withstand abrasion, and render the rail sufficiently stiff, and capable fully of sustaining the action of the driving-wheels of the locomotive engine. Hitherto the established breadth seemed to have been about two and a half inches on the top web, or button, and Mr. Vignoles thought, from experience, that that breadth should be considered the *minimum;* however, the strength of this bearing part of the rail, being as the breadth and square of the depth, a greater breadth than absolutely necessary to prevent the tire of the wheels being grooved, would add to the weight of the rail, without increasing the strength more than in the direct ratio of the breadth whilst the same quantity of material, disposed in terms of the depth increases the strength in the duplicate ratio. Considering the great increase of weight in the locomotive engine of late years, and the continued wear and tear on the rail, from the action of the driving-wheels, and looking to the state of the iron of the upper works of those railways which have not very heavy bearing surfaces, it would seem that, while two and a half inches is a *minimum* of breadth, the chief attention is now required to the proper depth, to resist abrasion and exfoliation which takes place, especially if the iron is not perfectly well rolled. Railway bars are compounded of fagotted iron, and if the pieces are not properly welded the bearing edge is broken down, and peels off; but, supposing the iron good, and the manufacture perfect, the heavy effects of the engine must be provided against, and experience shows that an inch and a half is not too much for the depth of the top web, or bearing part of the rail, and two and a half inches being the breadth, then three and three-quarters—or, say four square inches—should constitute the sectional area of the part that is exposed in receiving the direct action of the driving-wheels; this is the section actually requisite, and the greatest additional strength being to be obtained by increasing the depth, if possible, this is the point to be attended to. It thus appears that a weight of 36 lb. per yard is required to sustain the engine, and all beyond will belong to the mode of attaching the rail to the support below.

In treating of the wear and tear of rails. Mr. Nicholas Wood has given some curious and interesting results of experience: but the weight of the locomotive engines used is stated to have been only 10 tons, and of this the weight on the driving-wheels would probably not exceed six or seven tons. The result of a variety of experiments on the malleable iron rails of the Stockton and Darlington Railway gave one-tenth of a pound per yard as the absolute amount of fair abrasion; some statements, however, made it much higher, being one-sixth of a pound. On the Killingworth

Colliery it was one-eighth of a pound. On the Liverpool and Manchester Railway, some years ago, three rails were taken up, carefully cleaned and weighed, relaid, and taken up again at the end of one, and again at the end of two years: the wear was found constant, and about one-tenth of a pound per yard per annum. If we were to take this to be the true wear, and suppose it to arise wholly on the upper surface of the rail, the result would be but the 84th part of an inch in depth, and it might be supposed to take 100 years to wear away a rail from mere abrasion. But later experience shows that the increased weight of engines acts very destructively on rails whose upper webs are not sufficiently strong, and of the best manufacture. We may take 10 tons as the present average weight on the driving-wheels of a locomotive engine; and, if this is to be effectually provided for, the button, or bearing part of the rail, must not be less than 40 lb. to the yard. Now the form of the remaining part of the rail will depend upon the manner in which it is to be fastened down to the support below, either by being fixed in a chair, which is itself to be again fastened to something else, or by being screwed down, as the rails on the Great Western, Croydon, and the new part of the Greenwich railway; or, finally, secured in the simple manner described in the last lecture. A comparatively very small addition to the theoretical form of rail to be sustained in a chair, gives a section which has the advantage of being capable of being turned in either direction, or vertical position, and hence the top and bottom of the rails have, of late, as previously stated, been made equal and similar, connected by a neck of proportionate dimensions. With the present heavy rails, of nearly 80 lb. to the yard, the average weight of the chairs, including the joint chairs, may be taken at 20 lb. per yard, reducing the intervals of support to that constant distance. Thus, we have an aggregate of nearly 100 lb. weight of iron per yard of each single rail. If, then, we could in any way get rid of the extra weight required to fasten the rail into the chair, and dispense with the chair altogether, it seemed to Mr. Vignoles to be desirable to do so, provided the object in view was equally well attained; and he contended that such would be the case with a 50 lb. rail attached, in the mode before described, to a longitudinal bearing of timber; for the whole strength of the upper or bearing part would be retained, that being as the breadth and the square of the depth; thus, with a weight of iron just one-half, would be equally efficacious, and it only remained to compare the supports in either case. Now, as stone blocks seemed to be discarded by universal consent, the question of the supports below is narrowed to that of *transvers* or of *longitudinal* wood sleepers. Sufficient experience had been obtained to warrant the conclusion that, for the purposes of this argument, the cost of fastening and of laying the rails, ballasting, drains, etc., taken as a whole, were nearly the same for both systems, and it only remained to contrast the quantities of timber, and always considering a locomotive line to be the one to be made, it may be stated that this cubing was about double for the longitudinal system to that in the transverse method of laying the sleepers. In short, looking at first cost only, there was a saving of 100 lb. of iron, and an increase of two cubic feet of timber in each yard of single trackway of the former over the latter mode, so that strictly the longitudinal system was the cheapest; but to avoid minor objections, let the cost of each be taken to be the same, which was given a decided concession in favor of the transverse system. But this was a very narrow view to take of the question, which wholly omitted the economical results from diminished wear and tear of the engines, of the railway, and of the carriages, as had been most especially exemplified on the Dublin and Kingstown Railway where the massy granite blocks originally laid down had been all replaced by longitudinal sleepers, and though the old light 45 lb. rails and 15 lb. chairs were retained, the diminution of the annual maintenance was most remarkable, though there was not a railway in the United Kingdom where so many passengers were carried daily throughout the year.

The expense of keeping up the double way, now that the system of longitudinal timbers has been quite carried out, is less than one-third of the corresponding expense per mile per annum of maintaining the London and Birmingham Railway. Mr. Vignoles then read a variety of tabular results of the cost of the three various systems, going through all the details, and pointing out the exact measures and quantities, and stating the actual expenditure on the upper works of various lines of railway. The result seemed that the bed of the road was duly prepared, including all the items under that for a double line of railway—upper-works, properly laid after the head, which were enumerated in a former lecture, and calculating, for the present heavy and powerful locomotive engine, that no less a sum than £5000, and, in most cases, £6000, per mile was necessary, and that, in many instances, it had reached nearly £7000—the market price of iron and timber, also the quality of the latter, the greater or less facility of obtaining materials for ballast, etc., affecting the amount, and these large sums were independent of the earthwork, masonry, land, fencing management, stations, carrying establishments, etc.

Mr. Vignoles also gave a number of drawings and diagrams contrasting the three systems, and exhibiting, in a very explanatory manner, the modes of laying and fastening. He also exhibited the rail, chair, and fastenings, for the transverse method, with all the recent improvements introduced by Mr. Cubitt on the South-Eastern railway, and as manufactured by Messrs. May, of Ipswich, and then produced the rail with the dove-tailed slot, and the mode of attachment to longitudinal half baulks of timber, repeatedly alluded to in this and the preceding lecture, observing forcibly, that, if the same effective results were obtainable by the latter simple method as by the former complicated one, it was not only to be preferred in this kingdom, but was peculiarly eligible for such countries as Russia, Poland, Germany, in general, France, and America, where wood usually in great abundance, and where iron is comparatively scarce especially in the form required for railway bars. and, of course, the prices became in proportion. Mr. Vignoles quoted largely from the works and reports of Tredgold, Barlow, and Lecount, and stated a number of mathematical and empirical rules laid down by those authors, which, he stated, were chiefly relating to rails supported at intervals, but, though he felt it right to lay them before the class he considered that further experiments and investigations were requisite, and particularly in reference to the perfect combination in one support of the iron and timber in the longitudinal system, as explained and advocated by him. of which the Professor insisted, the great advantage and peculiarity was that of obtaining a perfect fastening, independent of the fibre of the wood, or the tenacity of the screws or bolts therein, and of obviating the hitherto well-founded objections to the mode of attaching rails having a continuous bearing, which had not been able so prevent a vertical play of the iron on the timber.

CHASM IN THE PRAIRIES.

The last number of Kendall's interesting sketches of incidents connected with his Santa Fe Expedition is as follows:

The morning of the 3d September broke bright and cloudless, the sun rising from out the prairie in all his majesty. Singular as it may appear nearly every shower we had, came in the night from the time we left Austin until we reached the Mexican settlements. Again we spent a couple of hours drying our blankets, then saddled up and pursued our journey. and still in a northwest direction.

We had scarcely gone six miles before we suddenly came upon an immense rent or chasm in the earth, far exceeding in depth the one we had so much difficulty in crossing the day before. No one was aware of its existence until we were immediately upon its brink when a spectacle, exceeding in grandure any thing we had previously witnessed, came suddenly in view. Not a tree or bush, no outline whatever marked its position or course, and we were all lost in amazement and wonder as one by one we left the double-file ranks and rode up to the verge of the yawning abyss.

In depth it could not have been less than eight hundred or a thousand feet from three to five hundred yards in width, and at the point where we first struck it the sides were nearly perpendicular. A sickly sensation of dizziness was felt by all as we looked down, as it were, into the very depths of the earth. Below an occasional spot of green relived the eye, and a small stream of water, now rising to the view then sinking beneath some hugh rock, was bubbling and foaming along. Immense walls, columns in some places that appeared to be arches were seen standing, worn by the water undoubtedly, and so perfect in form that we could with difficulty be brought to believe that the hand of man was not upon them. The rains of centuries, falling upon an immense praric, had here found a reservoir, and their workings upon the different veins of earth and stone had formed these strange and fanciful shapes.

Before reaching the chasm we had crossed numerous large trails leading a little more to the west than we were travelling, and we were at once convinced that they all centered at a common crossing close by. In this conjecture we were not disappointed, for a trot of half an hour brought us into a large road, the thoroughfare along which millions of Indians, buffalo. and mustangs had travelled for years. Perilous as the descent looked we well knew there was no other near. The lead mule was again started ahead; the steadier and older horses were next driven over the sides, while the more skittish and untractable brought up the rear. Once in the narrow path which led circuitously down the deep decent there was no turning back, and our maddened animals finally reached the bottom in safety. Several large stones were loosened from their fastenings by our men during the frightful decent. They would leap, dash and thunder down the precipitous sides and strike against the bottom far below us with a terrific crash.

We found a running stream at the bottom, and on the opposite side a romantic dell covered with short grass and a few scattering cotton woods. A large body of Indians had encamped on this very spot but a few days previous, the wilted limbs of the trees and other "signs" showing that they had made it a resting place. We too, halted a couple of hours, to give our horses an opportunity to graze and rest themselves. The trail which led up on the opposite side was discovered a short distance above us, to the south, winding up the steep and ragged sides of the precipice.

As we journeyed along this dell all were struck with admiration at the strange and fanciful figures made by the washing of the waters during the rainy season. In some places a perfect wall formed of a reddish clay, were seen standing, and were they any where else it would be impossible to believe that other than the hand of man had formed them. The vein of which these walls were composed was of even thickness, very hard, and ran perpendicularly; and when the softer sand which had surrounded them was washed away the veins still remained standing upright, in some places one hundred feet high and three or four hundred in length.

Columns, too. were there, and such was their architectural order and so much of chaste grandeur was there about them that we were lost in wonder and admiration. In other places the breast-works of forts would be plainly visible, then again the frowning turrets of some castle of the olden time. Cumbrous pillars of some mighty pile raised to religion or royalty were scattered about, regularity was strangely mixed up with ruin and disorder, and Nature had done it all. Niagary has been considered one of her wildest freaks; but Niagara sinks into insignificance when compared with the wild grandure of this awful chasm. Imagination carried us back to Thebes, to Palmyra. and to ancient Athens, and we could not help thinking that we were now among their ruins.

Our passage out of this place was effected with the greatest difficulty. We were obliged to carry our rifles, holsters and saddle-bags in our hands, and in clambering up a steep pitch one of the horses, striking his shoulder against a projecting rock, was precipitated some fifteen or twenty feet directly upon his back. Although he must be killed by the fall; but singular enough he rose immediately, shook himself and a second effort in climbing proved more successful—the animal had not received the slightest apparent injury!

By the middle of the afternoon we were all safely across, after spending five or six hours completely shut out from the world. Again we found ourselves upon the level prairie, and on looking back, after proceeding some hundred yards, not a sign of the immense chasm was visible. The waste we were then upon was at least two hundred and fifty miles, in width, and the two chasms I have mentioned were the reservoirs and at the same time the conductors of the heavy quantity of rain which falls upon it during the wet season to the running streams. The prairie is undoubtedly the largest in the world, and the chasms are in perfect keeping with the size of the prairie.

ON PAINTING TIMBER.

We extract the following observations on painting timber when exposed to damp, by Mr. Lander, from the Professional Papers of the Royal Engineers.

"I beg leave to lay before you a few observations which I have made on the construction and causes of decay in bridges, on the works at Devonport, having been employed on the erection of the bridge at the north-west barrier in the years 1812 and 1813, and also on a large repair in 1837: and I am now employed on a similar repair at the north-east barrier bridge, which, I think, was built in 1816, which has induced me to make the following remarks;—

"1st. These bridges were paved with Guernsey pebbles, which I think, was one cause of decay, as the wet constantly dripped through the joints; an evil which may be avoided by macadamizing, by which such a compact body is formed that the wet cannot get through, and the joists and girders, etc., are thereby kept perfectly dry, besides the advantage of the vibration being very much reduced, as is the case now at the north-west barrier.

2nd. The whole of the wood-work below, as well as the under side of the flooring, was frequently payed over with coal tar, which forming a thick body on the surface, was another, if not the greater cause of decay, as it completely prevented the air from acting on the wood, thereby keeping all moisture within, which of itself is sufficient to decay it. It must be observed that the plank or flooring was so rotten, that in many places it would not bear the weight of the men to work on it, and many of the joists and girders broke into two or three pieces in removing them; some of them were found to be quite dry, and in a similar state to snuff.

3d. As a further proof of the bad effects of paying and paving bridges, I may state that the bridge at the south-east barrier across the old works leading to Stonehouse, the girders, joists, etc. of which have never been payed or painted, and the road above always macadamized, remains sound and good at this time; and I know this to be a much older bridge than either of the former.

4th. I should state that the timber alluded to above is oak, but I think the same observations will apply to other timber, and in other situations, such as fences; for many posts and rails of the stockade fence here have frequently been found decayed, while in other and older fences, although much worn by time, yet not having been payed or painted, the fibre of the wood remains in a healthy state.

5th. I am also of opinion that skirting to walls, and linings to storehouses and other buildings, if not painted, would last much longer, as the damp from behind would then be allowed to evaporate by the action of the external air.

FRENCH ACADEMY OF SCIENCE.

May 30.—The reading of papers connected with the *accident on the Versailles Railroad* occupied a great portion of this sitting. One of the most interesting was by M. François, an engineer of mines, on the means of preventing the crystalization of iron used in machinery. On the examination of the raptured axle of the engine, which was the cause of the calamity on the 8th ult., the conclusion come to was, that the rupture had been caused by this crystalization, the iron being of the best quality, and of a volume more than sufficient for the purpose to which it was applied. Similar results on other railways have been ascribed to the same cause; but no person has been successful in the means of preventing the recurrence of accident by an improved mode of manufacturing the iron, and all that could be done in the way of precaution was, not to permit iron axles to remain in use for so long a period as to undergo the crystalline change which is so fatal, and of which external appearances give no indication. M. François informs us, that, in a long continued series of experiments, he has observed that a magnetic action upon iron when in a state of fusion, will produce the change alluded to, causing the small and closely adhering grains to crystallize into coarse and larger grains, depriving it of its compact character; and it is inferred that the action of heat upon axles employed in machines, subjected to great velocity, will produce the same effect. This can only be prevented by diminishing the volume of silicate in the iron, by carefully sweating the coal employed in melting, and above all, by the use, in the manufacture of axles, of iron which has already undergone a partial change in its vitreous character, and which, on being reworked, is much less susceptible of crystalline change than new iron. Another communication on the same subject, by Colonel Aubert, was also read. He agrees with M. François as to the cause of the imperfection complained of, but appears to think that the only real precaution is to change the axles employed in railway locomotives so frequently as not to give time for them to undergo the crystalline change, which is found to be so destructive. Another paper, by Mr. Manby, on the causes of railway accidents, and the means of preventing them excited much attention. This engineer recommends the use of four-wheeled locomotives, but with some important modifications in the construction of them, both as regards the axles, so as to expose them to an inferior degree of stress than upon the present system, and the frame-work of the wheels, which should, he says, be within the wheels, and immediately under the boilers. He also lays down some practical rules for counteracting the liability of locomotives to run off the rails, and mentions several facts in support of the correctness of the various portions of his system.

A paper, by M. Pambour, on the means *of checking, or rather equalizing the velocity on railways, by the use of fans*, deriving a force of resistance in the precise proportion of the velocity communicated by the impetus of a train, was next read.

ON THE ACTION OF AIR AND WATER ON IRON. *By* MR. MALLET.

This is the third report for which the association is indebted to Mr. Mallet. The object of former tabulated rusults was to determine the actual loss by corrosion in a given time, and the comparative durabilities of most of the principal kinds of cast iron of Great Britain, and to discover on what durability depended. The tables of experiments now presented show that the rate of corrosion is a decreasing one in most cases, and that the rapidity of the corrosion in cast iron is not so much dependent upon the chemical constitution of the metal as upon its state of crystalline arrangement and the condition of its constituent carbon. The present report, too, extends the inquiry to wrought iron and steel, of which between thirty and forty varieties have been submitted to experiment. The results show that the rate of corrosion of wrought iron is in general much more rapid than that of cast iron or of steel. The finer the wrought iron is, and the more perfectly uniform in texture the slower and the more uniform in its corrosion. Steel corrodes in general more slowly, and much more uniformly, than wrought or cast iron. The results of the action of air and water in the several classes of iron have been examined and chemically determined. The substance spoken of as plumbago was next described. It is produced by the action of air and water on cast steel, especially that in the raw ingot, in the same way as it is in the case of cast iron.

A quantity of plumbago, found in the wreck of the *Royal George* absorbed oxygen on exposure to the air with such rapidity, that it became nearly redhot. Mr. Mallet next described a method of protecting iron by a modification of the zinc process. It was found impossible to cover the surface of iron with zinc, to which it had no affinity. The first process was to clean the surface of the iron, taking off the coat of oxide, and then immersing it in double chloride of zinc and ammonium, which covered it with a thin film of hydrogen, by which its affinity for the zinc is much increased. The iron was then covered with a triple alloy of zinc, sodium and mercury. Mr. Mallet produced several specimens of his alloy, one of a bolt to be driven into a ship's side, and another a cannon shot covered with his preparation, and exposed to the weather on the roof of a building, and which was perfectly preserved. Cannon balls were so much oxidised by exposure to atmospheric influences that in five or six years they became useless. The French Institute had been engaged in experiments to protect these, and had been compelled to abandon it. Mr. Mallet also brought under the notice of the section a method of preventing the fouling which takes place on the bottoms of iron ships, especially in tropical climates, by means of which new invention he had ascertained plants and animals were prevented from adhering to the ship's bottom.

Another series of experiments related to the rate of corrosion of cast iron, wrought iron, and steel, exposed to atmospheric influences—a matter of great importance to the engineer. The characteristic form of corrosion in air, as contradistinguished from that of water, was also pointed out. This series of inquiries was now complete. The next matter which had engaged his attention was the rate of corrosion of rails on railways. The general opinion was, that the rails travelled over were not corroded at all. He had been enabled to lay down three sets of rails on the Dublin and Kingstown Railway: one not travelled over, the second in use and not exposed to corrosion, and the third also in use, but made impervious to moisture. The loss of the first was 2·555 of the second 2·344, and of the third 2·650.—results which seemed to indicate that the rail travelled over does corrode more slowly than that out of use. Mr. Mallet concluded by referring to Mr. Nasmyth's theory, that corrorion is checked by the trains passing over the rails always in one direction, and takes place wher, as in the case of the London and Blackwall, trains pass both ways.

The Vice-President paid a high compliment to Mr. Mallet on the value of his investigations, and the success which had attended them. The cost to the association of these inquiries was far less perhaps than that incurred by Mr. Mallet in addition to the sum voted him: while the results might have been made more conducive to his private purposes, had Mr. Mallet chosen to conduct them for his private advantage. In reply to a member, Mr. Mallet said that his preparation for the bottoms of iron vessels lasted for about two years and a half in Kingston harbour, in a vessel exposed to a rapid tide-way. He did not think his preparations would answer for copper sheathing. Nothing but copper would protect wood; but he looked forward to the time when the greater proportion of our vessels would be constructed of iron.

ACADEMY OF SCIENCE.

June 20.—A paper by M. Vicat was read, "*On the nature of Pouzzolanes.*—M. Vicat, having discovered the nature of the substance, has been able to compose a sebstitute with pure clay, calcined whilst exposed to a dead heat, so as to get rid of eight or nine-tenths of the water combined with it. The best clay for the purpose, says this gentleman, is pipe-clay; and in proportion with the admixture of iron, manganese, carbonate of lime or sand, is the defect of quality.

M. Degousee gave an account of some recent results in the making of *Artesian wells.* He states that he has bored for water in the plateau which extends from Lagny to the forest of Arminvilliers, at the height of 11 metres above the Marne. In one spot an abundant supply of water rushed out, although he had gone to a depth of only nine metres. With M. Degousee's report he forwarded to the Academy a letter which he had received from Aime-Bey, the director of the mines of Egypt, who announces his intention of re-opening some of the bored wells of the ancients, at the foot of the Libyan chain, and requests that the necessary instruments may be sent out to him for that purpose.

July 25.—A paper was read by M. Vallee. "*On the mode of rendering the Lake of Geneva subsidiary to the Rhone.*" Amongst the phenomena presented by the Lake of Geneva is one which has particularly attracted the attention of M Vallee, viz: the sudden changes of level which in the country are called *seches.* He attempts to account for this phenomenon by supposing the existence of a subterranean lake, communicating on the one side with the Leman. and on the other with the high valleys by means of natural wells, which are nearly vertical. In this way he endeavors to explain the rising and falling of the waters at Geneva, which have been frequently noticed to vary as much as two metres at a time, and to account for the rapid and extensive changes which occur in the temperature of the lake.

August 15.—M. Dumas placed before the Academy some specimens of the power of *the newly-invented roller*, by M. Schatteamann which, according to a former report, has been used with great effect in compressing together into one solid mass the fractured portions of the stones used for macadamizing roads. The specimens now submitted to the Academy are of two kinds. In the one the interstices of stone are filled with sand, so compressed as to become as solid as the stone itself: in the other. fragments of stone are rolled together, and form the most complete cohesion.

AMERICAN

RAILROAD JOURNAL,

AND

MECHANICS' MAGAZINE.

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NEW EXPERIMENTS ON FRICTION, MADE AT METZ, 1831, 1832, AND 1833, BY ARTHUR MORIN, CAPT. OF ARTILLERY.

[Concluded from page 69.]

The third memoir of M. Morin, embraces several distinct objects of inquiry, viz., the friction of building materials—the transmission of motion by a blow—the penetration of certain media by projectiles—the same while the body struck is in motion, in a direction perpendicular to that of the blow—and the friction of surfaces as modified by sudden pressure or by a blow. The whole memoir is concluded by a notice of the application of the peculiar apparatus employed, to various other physical enquiries.

It is that portion only which treats of the first named subject that we propose condensing into the present article. The latter subjects although highly interesting referring rather to military engineering or being of less general value. The friction of building materials of different kinds, was as might have been anticipated from the previous experiments, precisely in accordance with the three general laws of this species of resistance, viz.:

In proportion to the pressure.

Independent of the velocity.

Independent of the extent of surface.

A few words may be necessary in explanation of the nature of the material experimented upon. The *soft limestone*, or limestone of Jaumont is an oolite being of medium hardness, of a yellow color and having a very even texture.

The *hard limestone* or limestone of Brouck is the muschel kalk of geologists. It is the hardest limestone of the department—takes a fine polish—is of a light green color and exceeds the last in specific gravity by a little more than one third.

The bricks used were of the common kind, well baked, red without any signs of vitrification and very homogenous.

It might be thought that the limestones mentioned, being without representatives in this country, are not proper subjects of experiments, the results of which are to be used in this country, but it will be seen that their nature is such that they may fairly be taken to represent the extremes between which all our serviceable building stone may be found. As in the previous experiments it was found that the powder arising from abrasion of the surfaces did not interfere with the fixed laws of friction. The hard limestone seems to have abraded but little, and when two pieces were rubbed together, a fine polish resulted.

The tables are constructed in all respects as before.

Friction of surfaces after having been in contact for some time.

New experiments are given in the table, upon cast iron, as being the most frequently used in machinery. The set is otherwise parallel with the one on friction during motion. The author has also added an experiment on the friction of limestone with mortar interposed—the mortar being composed of one part lime and three sifted river sand. The duration of contact varied in each series from 5 seconds to fifteen minutes, the results in no case varying to any extent from the mean of the whole.

TABLE III.

Friction of Surfaces in Motion. Building Materials.

Nature of the surfaces in contact.	Condition of surface as to unguent, etc.	Arrangement of fibres.	Proportion of friction to pressure.
Soft limestone on soft limestone.	none		0.64
Hard limestone on soft limestone.	"		0.67
Common brick on do.	"		0.65
Oak on do.	"	vertical.	0.38
Wrought Iron on do.	"		0.69
Hard limestone on hard limestone.	"		0.38
Soft limestone on do.	"		0.65
Common brick on do.	"		0.60
Oak on do.	"	vertical.	0.38
Wrought iron on do.	"		0.24
Wrought iron on do.	water.		0.30

TABLE IV.

Friction of Surfaces which have been for some time in contact. Building Materials.

Nature of the surfaces in contact.	Condition of surfaces as to unguents, etc.	Arrangement of fibres.	Proportion of friction to pressure.
Cast iron on cast iron.	lard.		0.10
Oak on oak.	none.	vertical.	0.43
Soft limestone on soft limestone.	"		0.74
Hard limestone on do.	"		0.75
Brick on do.	"		0.67
Oak on do.	"	vertical.	0.63
Wrought iron on do.	"		0.49
Hard limestone on hard limestone.	"		0.70
Soft limestone on do.	"		0.75
Brick on do.	"		0.67
Wrought iron on do.	"		0.42
Oak on do.	"	vertical.	0.64
Soft limestone on soft limestone.	mortar.		0 74

For the American Railroad Journal and Mechanics' Magazine.]

CONFUSION WORSE CONFOUNDED.

There are few subjects of general interest on which the public mind is less enlightened, than on that of "*railway expenses*," and such attempts as have been made to render it clear, have had for the most part the contrary tendency, of only mystifying it the more. So much of extraneous expense, *that for which the railway is in no way accountable*, has attached itself to many of our principal lines, and gone in partial or entire destruction of their profits, that this bewilderment is not so surprising, particularly when professional men lend their aid to entangle it the more, in essays similar to that found in the September number of the Journal of the Franklin Institute, by Charles Ellet, Jr. Civil Engineer.

In classifying these expenses on railways, under distinct heads, he accompanies them with the following vague qualification.

"This formula takes proper account of the difference of grades, but is not applicable to very short roads—to roads doing a very inadequate business—by which I mean a less business than can be accommodated by one engine—nor to the first four years operations, while the road, cars, and locomotives are yet all new."

We propose to show, that if this formula is not applicable to *short* roads, and roads doing a *small* business, still less is it so, to *long* roads doing a *large* business. This can be done by taking the Philadelphia and Pottsville Railway, say 100 miles long, and which will shortly be in a position to do a business of at least 500,000 tons of coal per annum, and comparing it in order with his classification of expenses.

I. *Repairs of road. That repairs of a road consist of two distinct divisions; the first of which is nearly independent of the amount of the trade, and may be estimated on the average, at about $500 per mile. The second division is dependent on the amount of the tonnage, and represents the injury done by the passage of one ton of freight. I estimate this wear and tear at .35 of a cent per ton per mile.*

The wear and tear independent of trade, would of course be from the beginning, while that dependent on trade, would be entitled to the allowance for new—but let us charge the whole from the start, thus:

100 miles, wear independent of traffic, $500 per mile,	50,000	
500,000 tons of traffic, wear thereby, $\frac{35}{100}$ of a cent per ton, per mile,	175,000	$225,000

Now the entire cost of superstructure to which this wear is applicable, at present prices of materials, may for 100 miles be given as follows:

Iron rail, 8,500 tons for 100 miles, at $35 per ton, landed free of duty, is	297,500	
Spikes and chairs for 100 miles, at $450 per mile,	45,500	
Wooden oak sleepers, 170,000 for 100 miles, at 30 cents each,	51,000	
Labor of relaying track at $400 per mile,	40,000	434,000
Allowing therefore the iron rail to be rendered useless, (not destroyed) in two years, and that an entire new superstructure would be required in that time, the old materials would certainly go in reduction of the loss, and which may be estimated to produce at least, say		
2200 tons of iron rail left, being fair bar iron, and worth as such at least $60 per ton at present duty of $27 per ton; but say it sells only for good pig, at $30 per ton, is	24,600	
Spikes and chairs, as old iron, at 50 per cent. of cost,	22,700	
Wooden oak sleepers, as cord wood, worth at least	15,300	284,000
Loss in two years,		$150,000

Thus at this annihilating and improbable rate of wear even, the loss could only be $75,000 per annum, while by Mr. Ellet's formula, it is made triple that sum, or $225,000 per annum.*

What then is the probable truth in this respect?

For righting and adjusting track.

This must be comprised in Mr. Ellet's item of $500 repairs, independent of trade—is however a mere matter of labor and is covered by almost $350 per mile, and serves as well for ten as for one daily train over the track; for 100 miles is	35,000
For slight repairs.	
Such as spikes, broken chairs, an occasional defective rail, etc. at say $150 per mile, per annum,	15,000
	$50,000

* It may be remarked that if the iron rail brought the ordinary price of bar iron, and it is so credited when defective rails are used in the workshops of railways, that a superstructure thus sold at the end of two years would realize a handsome profit!

being $500 per mile, per annum, for the first 6 to 7 years, after which, allowing an average duration of 25 years to the iron rail and stone work, 7 years to the cross ties and 12 years to the wooden portion of the bridges, $250 additional, or $750 per mile, per annum, average, would maintain and entirely renew the track *doing any amount of business.*. This is of course applicable to roads of *good materials well put together*—and these expenses will be always in an ascending and descending scale, never exceeding an average of $750 per mile, per annum, which would at ordinary prices refurnish all the materials and pay the labor of always keeping up the entire track to the *standard of new.*

II. *Expense of cars. The expense of repairing and renewing the burthen cars is proportional to the distance which they run, or to the tonnage of the line; and may be estimated at* .45 *of a cent per ton, per mile.*

A car, carrying 3 1-2 tons of coal, (the capacity of those on the Pottsville road) would therefore at .45 of a cent per ton per mile, cost $1 57 per trip, and performing in the year 125 trips, woulld in all expend in repairs per annum, $197 per car.

The entire cost of a coal car is about $250 consisting of wood or perishable material, say	80
Iron or comparatively imperishable materials, in axles, wheels, bolts, etc.	170
	$250
Deduct for old iron,	80
	$170

being the amount left to be ultimately provided in renewal of the car, while according to the formula of Mr. Ellet, it would more than eat itself up annually, by expending $197 in that time.

What then is the probable truth in this respect? According to the experience on the roads in England and this country, the wear and tear on passenger and burthen trains is found to be nearly equalized—the lower speed of the latter nearly compensating for their rougher usage, and about ten per cent. per annum on their cost is admitted to be a competent average to replace them. But as a coal car may be supposed to be subject to more than ordinary hard usage, a charge of 15 per cent. per annum is allowed in its case, and according to which it would be consumed in 6 to 7 years, instead of being more than used up in *one year*, according to Mr. Ellet.

III. *Expense of agents, conductors, force at depots, breakmen, and contingencies of all sorts, is likewise nearly proportional to the business of the road, and cannot be assumed at less than six mills per ton, per mile.*

On a business of 500,000 tons, the expense annually at 6 mills per ton, would be only $30,000.

What then is the probable truth in this respect? In this item, the allowance is as much under, nearly, as the others are over the bounds of reasonable probability, and may be stated as follows.

Agents, such as president, clerks at depots, book keepers, etc. $150 per mile, per annum,	15,000
Conductors and breakmen on trains, say 100 men at $300 per annum,	30,000
Force at depots, say 30 men, at $300 per annum,	9,000
Contingencies of all sorts, such as pensions from accidents, fire from locomotives, etc.,	12,000
	$60,000

The first and last of these items appertain to "Management of Road," the second and third to "Transportation or Freight Account."

IV. *Locomotive Power. The expense of renewals and repairs of locomotive engines and tenders, the cost of fuel, and the pay of enginemen and firemen, are nearly proportional to the distance run, and may be estimated at 30 cents per mile travelled by the engine*

To do a business of 500,000 tons, it would require 25 engines, of which 20 would be in constant use, each being required to travel 25,000 miles per annum, at 30 cents per mile, is per engine, $7,500.

What then is the probable truth in this respect? In this item, the allowance is nearer the mark than any of the others. The amount of motive power is dependent on the gradients of the road, and the total cost, on its favorable position or otherwise, for cheap fuel, good track, facilities for repair, and on the skill and economy of the enginemen. In these particulars, the Pottsville road stands pre-eminent, and although $5000 is a fair charge per annum for an engine on most roads, it could here be made to do all that is required of it at per annum, $4,500
making a considerable saving in the nett result of a business of such magnitude, the circumstance which most elicits the economy of a railway—its expenses being always in an inverse ratio to its business.

substantial and level railway, doing exclusively a freighting business of 8 to 10 trains per day, or say 500,000 tons per annum, the expenditures would be annually about as follows:

Repairs of Road.

At $50 per mile, per annum,	50,000	
Attendance on water stations,	2,400	52,400

Motive Power.

25 engines, of which 20 would be in constant use, at $4,500 each, per mile,*		90,000

Transportation.

Repairs to cars, 1500, cost $375,000 at 15 per cent. per annum,	56,000	
Oil and grease for cars per annum,	11,000	
Conductors and breakmen, 100, at $300 per annum each,	30,000	
Laborers at depots, 30, at $300 each,	9,000	106,000

Management.

Salaries to president, clerks at depots, etc.		20,000

Contingent Fund.

For accidents by fire, pensions, etc.		11,600
		$280,000

This divided on the tonnage transported, would give for each item the following proportions, and exhibits the favorable effect of doing a *large business* on a well appointed railway.

Repairs of road, etc.		10.50 per ton
Motive power,	18	
Transportation,	21 1-4	
Management,	4	
Contingent fund,	2 1-4	45.50
		56 cts. per ton

or taking the gross receipts at $750,000 at $1 50 per ton, it gives a per centage thereon, of 36 1-2 per cent., or at most could it reach 40 per cent. or 70 cents per ton. This rate of expenditure moreover, is fully sustained by the experience in this country and in England, and on the London and Birmingham, doing a mixed business to the extent of nearly four millions of dollars per annum, it has by the last returns been reduced to 25 per cent. thereon, and the received average for roads in England doing a respectable business, is about 35 per cent. on the gross receipts.

Thus is Mr. Ellet's formula found particularly inapplicable to the working of a railway doing a large freighting business. In forming it he has undoubtedly been misled, by the insufficient data generally supplied by railway reports, and by the little affinity or analogy between the roads themselves, not admitting of deductions from their operations, certain enough to be of any use in forming particular or separate averages. We think, however, the following extract from his essay, shows Mr. Ellet to be wanting in a true perception of the great purposes of this invaluable improvement.

"In course of time, when the velocity of burthen trains is reduced to 3 to 4 miles, and companies learn to know where and how to economise, it is probable that some of the items may be reduced; but time and experience have yet to determine how much."

Under such a restriction as to speed, why incur at all the great expense of a railway, when the turnpike and horse team would accomplish as much or more? The cost of a locomotive railway is nearly repaid, and its economy principally derived from the speed and then to couple it in that particular with the gate of a dray horse, strikes us a very incongruous association of ideas.

[From the Journal of the Franklin Institute.]

FABRICATION OF GAS FOR LIGHTING FROM SOAP SUDS EMPLOYED IN CLEANSING STUFFS. *By* M. HOUZEAU MUIRON.

A few years ago the immense quantity of soap suds employed in the city of Rheims in preparing woolen stuffs was entirely lost. M. Houzeau Muiron conceived the idea of extracting from them the fatty matter, and of making an important application thereof. In fact, by submitting them to a regular purification, he has obtained a limpid oil, with which he succeeds in preparing the soaps in demand in commerce, while the residue of this purification serves for the advantageous production of a gas for lighting a part of the city.

The soap suds collected in the shops, where they have become saturated with grease and the impurities of the tissues, are poured together into a large basin which is capable of containing about 3,000 gallons. To decompose them, there is poured upon them 308 pounds of muriatic acid, or 154 pounds of sulphuric acid, first diluted with its own weight of water, and the mass is rapidly agitated, until the decomposition is complete.

Shortly afterwards a froth is seen to form, which at the end of twelve or eighteen hours is sufficiently well separated from the water upon which it floats. Four fifths of this water is then run off, containing about one per cent. of sulphate of potassa which is utilized either by evaporating it in drying houses, or by running it off upon dry earth exposed to the air, which when sufficiently charged with the salt is washed. Directly after this operation, the basin is filled again with a fresh portion of soap suds, which float the fatty matter and permit it to be run off into a side tub. The product obtained is a mixture of unaltered oil, the acids, animal matters and a large quantity of water, which forms with them a species of hydrate. This water is disengaged by injecting several times into the mass a current of steam which heats it and facilitates its evaporation. The fatty matter is then run off into a boiler where it is submitted to a rapid ebullition, aided by continual agitation, which drives off the last portions of water. The product contains twenty or twenty-five per cent. of impure matters which color it and render it turbid. To purify it, it is poured into basins of copper and mixed with two per cent. of concentrated sulphuric acid. After two days the limpid oil comes to the surface, while the impurities are precipitated to the bottom.

The oil is carefully separated, and the deposit, when filtered through cloths in a press, gives still a large quantity of oily products, which are added to the preceding and made into soap by treating them with common soda.

The residuum is black and very thick; from it M. Houzeau produces the gas for lighting, but before introducing it into the retort, he liquifies it by means of the empyreumatic oil obtained in the preceding operation.

The gas thus prepared is purified by lime, and the water from the washing contains sufficient cyanide of calcium for the preparation of Prussian blue from it, by treating it with sulphate of iron and washing the precipitate with muriatic acid.

This gas possesses a considerable lighting power, and in order to apply it to the lighting of the establishments scattered throughout the city of Rheims, M. Houzeau has contrived a manner of transporting it, at the same time simple, economical and from danger.

F. Boudet.

Jour. de Pharm, et de Chim., May, 1842.

MR. VIGNOLES' LECTURES ON CIVIL ENGINEERING.

Lecture 12.—*Railway Estimates.*—This lecture had reference to the consideration of estimates, as applied to railways—that is, to ascertain lineal dimensions, superficies, and cubic contents, and, affixing the proper rateable prices, to work out the monied results. The professor said, that, probably, the most ready way to give a general idea on this subject would be to go briefly over the several heads to be considered in framing an estimate. It was assumed that proper plans and sections of the work had been prepared in a skilful manner beforehand, Mr. Vignoles strongly insisted on the necessity and importance of having all such documents furnished on a much larger scale, and with vastly more attention to accuracy and detail, than had often hitherto been the case, particularly for parliamentary estimates, observing, that erroneous data and calculations could not but result from a neglect of this rule; and he stated, that, although many of the standing orders of parliament were annoying in some respects, yet the principle on which they were framed, went to compel a compliance with forms, in doing which, greater previous investigation and accuracy of plans and sections, became absolutely indispensable.

The *quantity of land* required formed naturally the first item of an estimate. It was but seldom, indeed, that the very small economy of taking land for one line of railway only was adopted. To a given breadth, therefore, for a double line—say, from eight to ten yards—must be added the necessary allowance for fencing and ditching—say, three yards on each side—making a constant breadth of fourteen to sixteen yards of land throughout, independent of the necessary slopes in excavations and embankments: the additional quantity for these, depends, of course, on the depth of the cutting, or height of the bank, in the various places, and on the ratio of the slopes of the earthwork. Suppose, in a cutting or banking of ten feet, this ratio to be one horizontal to one perpendicular, then, such slopes of one to one require ten feet additional breadth of land on each side—together, twenty feet—viz., twice the depth or height to be added as a further breadth, beyond the constant one for the railway and fencing. In like manner, for slopes of one and a half, two, two and a half, or three to one respectively, multiply the varying depths or heights of cutting or embanking by three, four, five or six, as the case may be, for the necessary augmented breadth of land due to the slopes, along their several extents; and thus, from the lengths measured, and the heights figured, on the section, the varying quantities of land are obtained, multiplying length by breadth, and reducing the areas to acres and parts for agricultural districts, and to square yards for land in towns and their immediate vicinities. For the prices to be assigned to these superficial quantities, the engineer must depend on the land valuer, who is also to judge of the amount of contingent damages. On an average, the actual quantity of land for a double line of railway, including the slopes of earthwork, may be taken at ten acres to the mile, but the precise areas must be ascertained in detail in the way explained. The cost of land for many of the leading lines of railway had been as much as £5000 per mile for the whole of their length. The cost of land for lines at a greater distance from the metropolis was less—still, from the numerous contingent after-charges, in respect of land, the sums were large, and had often far exceeded the original estimates.

The *fencing of the land* comes within the province of the engineer, though it is sometimes comprised in the item of land. The mode of fencing must always be regulated upon the custom and materials of the country. Dry stone walls, earth mounds with furze hedges, posts and rails, quickset hedges, and broad side-ditches or drains, are the principal kinds of fencing through agricultural lands; walls of brick or masonry, set in mortar, are generally called for through towns or building land. The several lengths of each of these are ascertained from the plans; the prices are obtained in the localities. Including farm gates, the cost of fencing varies from 1s. 6d. to 3s per yard lineal in the country. In the vicinity of towns, for stations, etc., the price will vary from 5s. up to 10s. per yard, according to circumstances, which it must be the business of the engineer to ascertain.

The third item is usually that of *earthwork*—that is, to reduce the undulating natural surface of the ground to the railway level or gradient, by cutting through hills, and filling across valleys. Mr. Vignoles having, in the first course, entered at large into the consideration of earthwork, thought it unnecessary to say much here. The price of the earthwork depends abstractedly on the average work that an able-bodied man can perform in a day, in various soils —this it should be the study of the engineer to determine. The mere price to the workman, for getting and filling, may be taken at from 2d. to 5d. per cubic yard, for the various kinds of sands, gravels, or clays; and from 6d. to 2s. for harder materials, rock, etc., but, in addition, various other matters are to be provided—barrows, planks, wagons, temporary railways, etc.—the present modern practice in moving large quantities of earth is vastly different to what it was in this country thirty years ago, or to what it still is on the continent, more particularly in the greater distance to which the material is carried; these several distances between the excavations and the points of depositing them, either into embankment or to spoil, must be ascertained from the longitudinal section, and a careful examination on the ground—these distances are technically called *the lead*; for distances under a quarter of a mile, the prices are higher, in proportion, than for longer distances. Taking the average description of soils, and the average distances, 1s. per cubic yard may be taken as a covering first estimate, upon the whole number of cubic yards of excavation or of embankment, whichever may be the larger quantity shown upon the section. The quantities of earthwork in a railway, on an average per mile throughout the whole distance, might be taken as a characteristic of its cost, so far as mere construction went, independent of carrying establishments, stations, and land, over which items the engineers seldom had control. Mr. Vignoles said it would be very interesting to have an abstract of the quantities and cost of the earthwork, distances carried, etc., on all the railways, and indeed, of all the other items of the works, as actually executed; they would become valuable precedents for future estimates, particularly if accompanied by explanations of the circumstances under which the operations were carried on. The great haste with which many of the railways were executed, while the late powerful excitement lasted, had added greatly to the cost, by raising the price of labor. Mr. Vignoles stated that he had already given some such abstracts of the railways that had been executed by him, or under his directions, and he was prepared to give more, and he hoped that other engideers would follow his example, as it could not but be very satisfactory to the proprietors of the different concerns, as well as a justication to the engineers themselves, and to the directors, that they could go into the minutest detail of expenditure. The professor then gave abstracts, in round numbers, of the quantities of earthwork on many of the principal lines of railway, as well as could be ascertained from the sections. He mentioned the North Union railway, twenty one miles long, with 125,000 cubic yards of earthwork per mile, at an average cost of 10¾d. per yard, including all extras and contingencies. The Midland Counties, 57¾ miles, with 100,000 cubic yards of earth per mile, at an average cost of 13d. per yard, including slips and all charges, the soils nearly the same in each, and the average lead nearly alike—viz., one mile—attributing the difference to the great haste and great demand for labor in the latter. The mean of these would be now a fair estimate.

Having estimated for the cost of obtaining the artificial bed of the railway, the next item would be the *Bridging and Masonry*—that is, to restore the previously existing communications of roads, canals, or other railways, the passage of rivers, watercourses, etc. etc., by viaducts, aqueducts, ordinary bridges, culverts, drains, etc., and often by heavy retaining and breast walls. Under this head came the bridges of brick, timber, or iron;—in very marshy countries, where the foundations are likely to be bad, and the drainings liable to be affected, timber may be resorted to, and used in the shape of piling, with cross beams to sustain the rails across the openings, avoiding thus the cost of arches, abutments, and wing walls. The ascertainment of the several superficial or cubic quantities in each of these different constructions, is a matter of simple mensuration from the working drawings. The attachment of prices to these, in all their various details, with sufficient accuracy, depends on the mature judgment and experience of the engineer; and it is by a long course of careful study and observation that the young student, in his employer's office, and on his works, can alone hope to acquire this knowledge. It was but too common, in making estimates, to fall short in this item, particularly in the number of occupation bridges, which, owing to the complicated holdings, improvements, etc., had to be provided for to a vexatious extent, or bought off. The masonry is generally in proportion to the earthwork, and in many cases has happened to be of nearly the same amount of cost. The average number of bridges on a main line of railway might be taken at five for two miles. Diversions and embanked approaches of roads, gravelling or metalling the new surfaces, and the contingent operations, should be separately calculated. They are included under the head of fencing, of earthwork, or of bridging, or kept as a distinct item, according to the practice of the engineer, but they form a large sum, varying from 100*l.* to 500*l* per mile, according to circumstances, and, in preliminary estimates, are too often omitted, or are put into that refuge for all deficient items—contingencies.

The item of *Upper Works* in general, or *permanent way*, had been gone into so fully in the recent lectures, that it was not necessary here to do more than mention it, as forming a leading point in considering estimates. It is usual to add 10 per cent. upon all the items of the estimate, properly belonging to the engineer. Besides these were the preliminary expenses of surveys and Act of Parliament. The management, including cost of conveying, etc., and all salaries and expenses of direction, office, engineers, solicitors, etc., etc. Then came the expenditure on the stations, engines, carriages, repairing and building shops, fittings, and all the carrying establishment necessary for passengers, also for goods and for warehouses, wharfs, and other accommodation. It was in them the heavy extra expenditure of railway capital mostly went, and which, in the early stages of the railway system, could not be properly judged of. By way of summary, Mr. Vignoles said he would give, in his next lecture, the actual cost of one or two lines of railway which had come under his direction, and which might be useful by way of reference in making out estimates on other occasions, though the construction and working of railways must be regulated on much more economical principles than had hitherto been the case, or no more of them would be undertaken.

Lecture 13. In continuation of the observations on *Railway Estimates*, which had been commenced in the last lecture, Mr. Vignoles observed that, having therein gone fully into the items of *construction* of railways, he had only glanced at the very necessary provision to be made for the efficient *working* of them—viz., the *Stations and Carrying establishment*, upon which he would say a few more words, for it was mostly under this head that the chief causes—or, rather, the chief excuses—for extra expenditure, or excess of estimates, had arisen. Properly speaking, this item, so costly, and yet so indispensable, should be taken as falling on a railway company, not as proprietors of the road, but as carriers—the distinction being, that if the railway was let on lease, as canals have been, or if every body could carry on the railways, as they do on the canals—if, in short, public safety and public convenience, and generally necessary arrangements, did not make it imperative, or, at least, highly desirable, that the railway companies should be carriers (of passengers, at all events,) the expense of stations and carrying establishment would not fall on them, though they must still be incurred by some parties, before the railway can be brought into profitable operation; nevertheless, the public, who are to use and be benefitted by the road, having, after all, to pay in one shape or another, are greatly interested in a proper expenditure, any excess of which is sure to be felt in increased charges or in diminished accommodation, until the grievous expenditure of a rival line is introduced. In analysing the cost of *Stations*, it is obvious that the land always forms a prominent item, for, being near towns and populous places, it is to be bought by the yard, and not by the acre—

building land, villa land, etc., instead of mere fields. Hence, it will not be surprising, if it is found that the cost of the land, for the stations only, on many of the great lines, has amounted to as much as one-third of the whole cost of land for the railway. The *buildings* erected at stations may be divided into three classes—those for the accommodation of the passenger trffiac—those for the goods, minerals, etc.—and those for the repair and maintenance of the engines, carriages, etc. At principal towns, therefore, large and distinct establishments must be erected; and, on long lines, a principal central depot for the engines, is often required in addition. At the minor and road stations the whole may be grouped together under one roof. In no department of expenditure have so many differences, and so much useless extravagance in construction and arrangement been displayed, as in the buildings at stations: and hundreds of thousands of pounds have been absolutely thrown away from want of sufficient forethought and consideration, and by erecting enormous masses of buildings, either at the wrong places or in an injudicious manner. It was better to wait until the character of the traffic was ascertained, before making such expensive permanent establishments, and then to increase the accommodation by degrees. As an example of a moderate expenditure under this head, Mr. Vignoles mentioned some particular instances, and went somewhat into detail. At the terminus of a railway in a manufacturing town with 80,000 inhabitants, there had been an expenditureof £9,500 for the passenger buildings, sheds, etc.; £5,500 for goods' warehouses; about £2000 for the mineral traffic; and about £3000 for fixtures, turnplates, etc.—say, in all, about £20,000 exclusive of the land, which had amounted to a very large sum, upwards of £13,000, including a good deal of spare space, existing buildings, etc. At a smaller town on the line, but with some extent of goods' traffic, the cost for passenger buildings, sheds, etc. was £2500; for merchandise accommodation, £3500; turn-plates, fixtures, tools, etc., £1000; land about £3000. On the same railway the cost of six or seven various minor road stations, including water tanks, coke and engine sheds, tools, etc., was £3500; land about £1500; sundries on the whole line about £1000—being a gross expenditure of £50,000 on station, land, and buildings, for a line of about twenty two miles, which is at the rate of £2273 per mile; and the corresponding carrying establishment of engines tenders, etc. (for passenger traffic only), was about £10,000; for passenger carriages of three classes, horse-boxes, trucks, etc., about £13,000 (the wagons for merchandise, coal, etc. as well as the engines, etc., being provided by carriers on the line, who provided their own carrying stock); and the necessary buildings for repair and maintenance of engines, carriages, etc. with tools, fixtures, etc. about £12,000—making a gross cost of £44,000, or £2000 per mile. The whole of this concern having been arranged with the strictest regard to economy, may be taken as a fair average, and it will be safe to say, that £4000 per mile for an effective carrying establishment, with the necessary stations, is a moderate sum. For lines of less traffic, if of considerable extent—as, for instance, say for some of the long lines from the present railway termini in the north of England, to either of the principal towns in Scotland, a smaller amount might be sufficient; but Mr. Vignoles considered that it would be unwise to estimate a smaller expenditure than that of £3000 per mile for *Stations and carrying establishments*, on a line to be worked by locomotive engines, and it would be much safer to take £4000; on either of these sums, £1500 per mile for the locomotive stock and buildings must always be estimated, and about £500 per mile for the carriage department—leaving from £1000 to £2000 per mile for the stations, according to the extent of accommodation; keeping the instances of extraordinary outlay on some of the principal railway lines as examples to be avoided, and not to be imitated, or referred to, as necessary.

Under the last head of *Management*, came all the various and miscellaneous items of expenditure, between the first concoction of the project, to the closing of the capital account. The preliminary expenses of examining the ground, levelling, surveying, maps etc., and all the formalities in the engineer's department, to enable application to be made to Parliament; the ascertainment of the traffic, revenue, travelling and other expenses of various kinds, etc., generally undertaken by the secretary; the valuation of land, etc. by the surveyor; the collections of the names of owners and occupiers, notices to them, applications for their assents, etc., and the management of the Bill throughout all its stages, falling to the charge of the solicitor. All these must be incurred before a spade was put into the ground, and had heretofore varied from £500 to £1000 per mile, according to the facilities afforded, the opposition encountered, the length of the line, etc. In future estimates, it was to be hoped this item might fairly be put, as not exceeding the smallest of these sums. Then came the setting out of the line, the detailed levels and surveys, and all the office work of the engineer, until the works are put into the hands of the contractor. The minute valuations of the property to be taken, and the juries, references, conveyancing, stamps, and all the various legal steps until the company are put into full possession. Then the office establishment for regulating all the financial and ministerial affairs, and the temporary arrangements, police, lawsuits, and legal and illegal charges of all kinds, taxes and rates, interest and commission to agents and brokers, travelling expenses, salaries, and a great variety of disbursements of a miscellaneous kind, which, in the aggregate amount to a large sum. The whole of the outlay thus coming under the head of *Management* has varied from 5 to 10 per cent. on the gross cost of the railways hitherto executed, according to their extent, and the amount of capital embarked, and especially according to the degree of vigilance exercised to keep down expenses, which depends chiefly on the director or secretary, or under whatever name the acting manager of the company may superintend. Judging from the examples past, and the deep impression which has been made on the public mind of the necessity of economy in every department, Mr. Vignoles thought 5 per cent. might be estimated hereafter, unless the lines were very short, and the capital small.

In recapitulation, the Professor observed, that the young engineer should always keep in view, for his estimates, the preceding great divisions of the cost—viz.; *land*, including the damages and fencing—*earthwork*—*works of art* (bridging, masonry, etc.)—*upper works* (the permanent railway proper)—*stations and carrying establishment*—*management*—and having, in his first estimates, allowed amply for each of those items under their several heads, he should add at least 10 per cent. for unforseen contingencies. Some of the preceding items would be common to almost all railways, and others, of course, would vary greatly, according to local circumstances, chiefly regulated by the amount of earthwork; for as that is heavy, so the works of art become costly, since the works of art are merely to restore the existing communications of the country, and the natural or artificial water courses and drainage to their state before disturbed, or as near as may be, and that to an extent in exact proportion to the civilization and improvement of the country, to enforce all which stringent clauses are inserted in the acts of parliament, and plenty of persons are always on the watch to enforce them. Mr. Vignoles observed, that the land, levelling of the ground, and restoring of communications, might, on the average, including contingencies, extra land, etc., be taken as forming about 50 per cent on the total outlay of railways hitherto executed. But, referring to the items the professor had gone over in detail in previous lectures, it appeared that, when proper economy and circumspection was used, the necessary cost of the railway proper—that is, the necessary quantity of land for the road only, a good substantial set of upper works for a double way, and a complete and effective carrying establishment—might, and had been, obtained for £10,000 per mile. All beyond is expenditure to obtain gradients, more or less perfect, and Mr. Vignoles thought that the great error all engineers had hitherto committed, the cardinal mistake—of which he himself was far from guiltless—was, seeking to make railways, intended, as they were chiefly for passengers, *too perfect*—that is, of cutting down his, and filling up valleys to too great an extent, on the erroneous supposition that the engines were always to carry *maximum* loads, which was very seldom the case, and never would be so on lines at a distance from the metropolis, particularly such as the lines into Scotland, previously mentioned. In short, the Professor insisted that the engineer should, in such instances, and for the cross railways, which he yet hoped might be introduced, make the gradients and curves much less theoretically perfect; and that the amount of expenditure, beyond the above stated necessary one of £10,000 per mile, should be reduced to the very *minimum*; and he considered that henceforth an average of £15,000 or £16,000 per mile, and a *maximum* of £20,000, or, in very extraordinary cases, indeed, £25,000 should be looked to for the construction of double lines of railway in any country, but that most cases, of light traffic, and consequent adaptation of gradients, for single lines, a sum of from £7000 to £12,000 per mile would be the limit of total expenditure. Mr. Vignoles concluded by observing, that the preceding abstracts were deduced from very detailed accounts, which had been arranged on a uniform system, and kept from the very commencement of each undertaking, so as to be available, at any time during the progress of the works, to show the exact state of the expenditure; and had been finally wored out to the nearest thousand pounds, as above. And the professor expressed his great hope and expectation that this example would be followed, and that similar accounts would shortly be forthcoming, of the corresponding items of cost on all the principal railways in this and in other countries, more especially where complaints of improper excess of expenditure over estimates (well or ill-founded) had been charged, for the publication of such accounts—and the more in detail the better—would be the most complete defence of the directors, and the most satisfactory explanation from the engineer, and alike valuable, as statistical information, to the country—as salutary guidance to the capitalist and speculator—and as valuable information and warning to the old as well as to the young practitioner.

The preceding is a very brief outline of this interesting lecture, and following, we believe, is a correct abstract of the cost of the two railways quoted by Mr. Vignoles.

Comparative abstract of the cost of two principal lines of railway, under the general heads of expenditure, as deduced from the very latest accounts of actual expenditure, brought out to the nearest round numbers.

MIDLAND COUNTIES RAILWAY. [57¾ miles.					NORTH UNION RAILWAY. [25 miles.]			
Pr. cent whole cost.	Cost pr. mile. £	Total cost. £		Heads of expenditure.		Total cost. £	Cost pr. mile. £	Pr. cent whole cost.
12	3463	200,000	(190 acres)	Railway land, and damages	(320 acres.)	50,000	2000	8
3 1-2	1004	58,000		Fencing, gates, roads, etc.		20,000	800	3 1-2
18 1-2	5455	315,000	(5,700,000 cubic yards)	Earth work	(2,900,000 cubic yards)	125,000	5000	20 1-2
15	4364	252,000	[tons	Works of art, of all kinds		125,000	5000	20 1-2
23	6822	394,000	Upper Works £215,000—(17,670) 179,000	Iron rails and chairs All other materials, and labor	(6885 tons) £68,000 62,000 Upper works	130,000	5200	21
21	6147	355,000	Stations and carrying establishment £51,000 168,000 75,000 61,000	Station land and damages Buildings, fittings-up etc. Engine, etc. stock Carriage, etc. stock	£18,000 48,000 20,000 14,000 Stations and carrying establishment	100,000	4000	16 1-2
7	2182	126,000		Management, law, interest, etc.		60,000	2400	10
100	29,437	1,700,000		Totals.		610,000	24,400	100

ON STRAIGHT AXLES FOR LOCOMOTIVES. By Prof. Vignoles.

The fatal results of the late terrible catastrophe on the Paris and Versailles Railway (rive gauche) has drawn the attention of the public in general and engineers in particular, to the causes which produce such fearful effects; and the breaking of the axle having been prominently put forward as the original occasion of this and many other railway accidents, it seems desirable that a dispassionate inquiry should be instituted, and an endeavor made by calm discussion to elucidate truth.

It is not intended, in the present note, to allude, except in general terms to the above accident. It is clear that the breaking of the axles in this case was not of itself sufficient to produce such a disaster. It was not the driving axle that broke, but the fore axle of the small four-wheeled engine; and it was with great regret that I perceived the cause of the accident attributed to the principle of construction of the machine. It must be quite evident to all engineers who have attentively read the details of the accident on the Versailles Railway, and of the one that occurred on the London and Brighton Railway soon after the first opening, that the same causes were in operation, and greatly aggravated the sad results in both instances, viz. the coupling together of two locomotives engines of unequal power and of different constructions, the smaller in advance:—On both occasions a long train of heavily laden carriages were moving at very high velocities on a falling gradient; on the occurrence of the accident to the smaller engine in front, the diver suddenly turns off the steam; the man on the larger engine behind, from whatever cause, does not act simultaneonsly, and a few seconds continuance of the vast unchecked momentum of the heavy engine with the steam on, overwhelms the smaller machine, and the whole train is overthrown. It is scarcely possible to regulate this unity of action, more especially in the locomotives of unequal size and construction. Why are engines propelling from behind objected to? Evidently because, in the event of any obstacle occuring in front, a simultaneous check cannot be given to the rear engine, and it drives the carriages forward upon each other, at the very moment when the opposite effect is required.

There is, therefore, quite sufficient to account for the accidents in both cases, without raising the ridiculous and exaggerated cry against the fourwheeled engine *per se*. As respects safety to the travelling public, I believe, and I venture to say, in common with a great many engineers who are not manufacturers, that there is no material difference between the four-wheeled and the six-wheeled locomotives; but that the consideration most generally influencing the selection is that of the distribution of the weight of the machine so as to impinge less injuriously on the rails; and it is well understood that the system of the double trucks, or eight-wheeled supports for locomotives, tenders, &c., as adopted on the American Railways, has been introduced on this principle, the rails and upper works in that country being in general much lighter than with us.

The real and important point, and which seems to have been quite lost sight of in the vivacious discussions on what I would call the minor question of the number of wheels, is, whether the *cranked axles* for the driving wheels of locomotive engines ought not to be abandoned, and whether driving axles should not be always made straight. The extent of prejudice in favor of cranked axles is most extraordinary. The very great increased expense iucurred in making and strengthening them, the additional complexity and cramping into narrower space of all the moving parts of the machinery, and the consequent wear and tear and inconvenience involved by their use, to say nothing of the augmented risk, far overbalance, in my opinion, any theoretical advantages alleged in their favor, but which advantages and superiority, in practice, over the straight axle engine, I could never discover and wholly deny. Eight years since, after a hard struggle with the manufacturers, straight driving axles were adopted for the locomotives on the Dublin and Kingstown Railway. On that line, especially on Sundays and on holidays, the traffic is quite equal to that on any railway yet open. Trains of from 12 to 15 carriages (but with one engine only) are at such times sent every quarter of an hour from each end of the line; and there has been no instance of accident from any cause connected with the form of engine or axle, or with such frequent departure of heavily laden passenger trains; and the finance accounts of the Company show that the cost of locomotive power, repairs, etc. is below that of other lines using cranked axles; nor do I know of any cause of objection to the straight driving axle, after seven or eight years experience of their use, without, I believe, a single instance of failure which fully justifies my opinion of their superiority.

On other railways I have been connected with I have not always been so fortunate as to have succeeded in banishing the cranked axle. As sometimes happens in Governmental and political struggles, the votes of the controlling body have overpowered the opinion of the executive, where a difference among members of our profession have given opportunities for Directors to exercise their own discretion; and cranked or straight axles, four-wheeled or six-wheeled engines, have been alternately adopted according to the prevailing ideas of the majority of the several railway boards.

I have, however, reason to believe that several engineers of high standing are becoming converts to the straight axle, and I congratulate the public on it, as a very important step in the right direction.

In respect to the attention to be given to the manufacture of axles it is impossible to pay sufficient regard to the importance that the scrap iron should have gone through the same processes in its previous different stages. On this subject I hope some of the experienced manufacturers who are present will throw some light, especially on the details, for on the abstract principle there can be no dispute, although I suspect it is greatly neglected, in particular for ordinary carriage axles, and probably only scrupulously attended to in forming the driving axles of locomotives.

Some of the French engineers, however, have, within a very recent period, suggested that we must seek for the causes of the often unexplained rupture of axles in another way. M. François and Colonel Aubert have both lately read, at the Royal Academy of Paris, papers on the subject, and attribute the cause of the fracture of the axle of the engine on the Versailles Railway to the iron having been crystallized from the action of heat or magnetism. In support of this opinion it is stated that the axle broken was formed of the best iron, and was of sufficient dimensions; and that the fracture had a decided crystallized appearance: and I have indeed myself often observed the same character in broken axles, so much so as to induce me to fancy sometimes that they had been formed of cast iron.

M. François stated in his paper that he had made a long continued series of experiments, and had observed that a magnetic action on iron in a state of fusion will produce similar effects, and change the small and closely adhering particles into coarse and large crystallized grains, depriving the iron of its compact character. This talented mineral engineer inferred that the action of heat upon axles moving at high velocities might produce the same effect. Both M. François and Colonel Aubert seemed to be of opinion that the only real precaution was to change the axles of locomotive engines so frequently as not to give them time to undergo the crystalline change; suggesting. however, that iron that had been previously worked up should alone be employed for axles, and not new iron, which had more of a vitreous character, and was more susceptible of crystallization.

Since this paper was prepared, I have reason to believe that this crystallization of wrought iron has been noticed by some of our eminent manufacturers, whose opinions there may be an oppartunity of obtaining; and if it be, as Mr. Fairbairn informs me, that cold swaging will crystallize hammered iron, the shocks that locomotive engines sustain in their rapid transits may well be put as a great cause of this remarkable change.

It is, however, clear, that to remedy and replace straight axles is much easier and cheaper than to deal with cranked axles, and I venture to state it as my humble opinion, that as much ingenuity and talent is thrown away in arranging locomotive engines with cranked axles, and in perfecting the manufacture of those "crooked billets," as there was in rolling iron into undulations for fish-bellied rails; which are now almost as much forgotten as, I doubt not, the cranked axles for locomotive engines will one day be.

Remarks.—Mr. Hodgkinson was certain, from the results of his experiments, that a succession of strains, however slight, would produce a permanent deterioration of the elasticity of the iron.—Mr. Fairbairn had been told by the engineer on the Leeds line, that he considered all crank axles to be constantly deteriorating from percussions, strains, etc., and that they should be removed and replaced by new ones periodically, to avoid danger of fracture.—A discussion arose as to whether the crystaillized appearance observed in fractured axles arose from defects in the manufacture, in the quality of the iron, or from the effects of working, either by percussions, strains, or magnetic action.—Mr. Grantham, although a manufacturer of cranked axles, admitted that straight axles were less liable to break. Cranked axles, from the way in which they were welded together and shaped, were rendered weak and liable to fracture. On other grounds, however, he believed that the cranked axles were preferable, as they produced a steadier motion, and much heat was saved. Mr. Garnett believed that more straight axles had broken than cranked one.—Prof. Willis showed the effect of vibration in distroying molecular arrangement, by reference to the tongues in musical boxes, etc.—Mr. Nasmyth believed that the defects in axles etc., arose in the manufacture, especially from cold swaging and hammering, and also from over-heating in welding, all of which causes injured the toughness of the iron. In small articles he found great advantage from annealing; and he believed that axles might be annealed very cheaply, and would be more serviceable. He disliked the fashion of referring all unaccounted phenomena to magnetism and electricity, although he was convinced that very singular electric phenomena accompanied the transit of locomotives and the rapid generation of steam. With this was connected the non-oxidation of rails, where the traffic was in one direction, and the rapid oxidation when the same rails were travelled over in both directions, as in the Blackwall railway. He had also observed that brasses, in some cases, had from friction entered into *cold fusion* —that is, at a heat not perceptible to the eye, a complete disintegration of the molecular structure had taken place. and he had seen the brass spread as if it had been butter or pitch. He had no doubt that this arose from electricity, but had not ascertained the fact from experiment.—Mr. Fairbairn stated, that in hand-hammered rivets the heads frequently dropped off, and presented a crystallized appearance, while those compressed by machine were sound. He found that repeated percussions, from the rivetting, hammering plates, etc., induced magnetism in iron boats.—Mr. Vignoles could not, from his experience, agree to Mr. Nasmyth's theory of the oxidation of rails by single traffic, as the railway from Newton to Wigan had been single for a long time, and was as bright as the Manchester and Liverpool. The Blackwall railway was not an analogous case, as no locomotives were employed.—Mr. Roberts disbelieved the deterioration of axles by work; he would rather trust an old axle than a new one. He believed cold swaging and hammering to be the chief causes of mischief. In fact, if axles were sent out sound and well manufactured, they would rather improve by working.

Mr. Nasmyth at a subsequent meeting gave some valuable practical suggestions on the cause of breaking of axles, which we purpose noticing next month.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

TWELFTH MEETING, 1842.

We are indebted for the following report partly to our own correspondents, and partly to the *Athenæum* and the *Manchester Guardian*—the latter paper gave a very copious account of the whole of the proceedings, including the speeches delivered at the dinner.

REPORT FROM THE COMMITTEE ON RAILWAY SECTIONS,

presented by Professor Vignoles.

A grant of 200*l.* from this Association was made at the Glasgow meeting in 1840, on a joint application from the Geological and the Mechanical Sections, towards obtaining profiles of the various railways, chiefly with a view of putting on record (before the slopes of the excavations become soiled over and covered with vegetation) the geological appearances and strata developed in the many vast openings made through the country by the operations of modern engineering. At the Devonport meeting last year a renewal of the unappropriated balance of the first grant was made; the whole sum has since been expended, and the results are now laid before the Sections originating the subject, in the shape of the numerous working plans and sections of several of the railways, and of the enlarged parts of the profiles of the excavations.

In obtaining these the Committee appointed by the Association have great pleasure in reporting, that they have been aided in the most effective and satisfactory manner by all the railway companies to whom they have applied, and also by their several officers; the engineers in particular having taken extreme pains and great interest in forwarding the views of the Association. When so many parties have thus zealously co-operated, it might be almost invidious to name one without specifying all; but in particularly mentioning Mr. Swanwick, the engineer of the North Midland Railway, the Committee wish to do so for the purpose of remarking on the great pains taken by that gentleman in marking, as his works went on, all the geological details of the cuttings, which pass through so interesting a region, and which has put into the possession of the Committee a vast extent of most valuable records of the kind sought for, and which at the same time forms a most striking example, well worthy of imitation, of the combination of engineering and geological information, applicable for economic purposes.

The Committee were not at first able to organise a system of working the grant to their entire satisfaction; but they found after some experience that with the favorable disposition shown by all the railway companies, they might (without increasing the expense,) by degrees and in no great time, be able to form an interesting and valuable collection, not only of the sections of the excavations of the railways, but of the whole of the plans and profile of all the lines, which, concentrated in one public depository, and open to the inspection of all scientific and literary bodies and individuals, and to the public in general, under proper regulations, would be of high interest. In fact such documents were almost necessarily required, as the mere indices wereby to identify the particular geological profiles; and so useful and important is such a collection likely to become, that it is not unreasonable for the Committee to hope and believe, that after another year's experience shall have matured their arrangements and perfected their proposed system of records, and brought down the expense to a certain and moderate rate per mile, the subject may be taken up by Her Majesty's Government, and made to form part of the great geological survey of the United Kingdom, conducted by Sir Henry de la Beche, in connection with the trigonometrical survey now carrying on by Colonel Colley and the officers of the crops of Royal Engineers. The committee, therefore, are not without hopes that the geological and mechanical Sections will again unite in applying to the General Committee for a further grant of 200*l*. at the present meeting, to enable them to complete the organization they have began.

The documents which the Committee have to submit are the following:—

1st. Plans and sections of the whole of the Midland Counties Railway from Rugby to Derby and Nottingham, about 58 miles. Enlarged sections of the cuttings on that railway, prepared to be filled in geologically. The chief characteristics of this district are the gypsum beds, commonly called plaster of Paris, and the hydraulic lime, well known to engineers as the Barrow lime.

2d. Plans and sections of the whole of the North Midland Railway, from Derby to Leeds, about 72 miles. The entire of the geological details have been laid down on the working sections of the cuttings; but as it has been considered by the Committee that a uniform system should be observed enlarged sections have been prepared, on which, as on the similar sections of the other lines, the strata should be delineated. It may be observed here, that these enlarged sections are on the natural scale of 40 ft. to an inch, that is, the vertical and horizontal scale are alike, which is not always the case in ordinary geological sections, and very seldom so with the working sections, for earth work and similar engineering purposes. This railway intersects the coal districts for many miles, and is replete with interesting objects.

3d. Plans and sections of the Manchester and Leeds Railway, from Manchester to Normanton, about 50 miles. These latter are not quite finished, but will be so before the close of this meeting. Enlarged sections of a considerable portion of the excavation on this railway, are filled up with the geological details.

4th. Enlarged sections of the excavations on the Glasgow, Paisley, and Greenock Railway, about 22 1-4 miles, with the geological details.

5th. The same for the Manchester and Bolton Railway; about 10 miles containing full details of the strata where the remarkable fossil trees were found, and of the trees also, models of which are in the exhibition room at the Royal Institution in Manchester. The liberality of this company will afford several opportunities for the members of the Association to visit these trees, and the particular profiles of the excavation where they are, will remain in the Geological section, or in the Royal Institution, where the models are.

6th. Enlarged sections of the Hull and Selby Railway, about 30 1-2 miles, with the geological details.

Some other enlarged sections are stated to be preparing for the Committee, but they have not come to hand in time for the present report.

These records, according to the directions of the Association, will be deposited in the Museum of Economic Geology, in London, where they may at all times hereafter be usefully referred to.

In conclusion the committee cannot refrain from observing that the documents thus collected are equally important and interesting to the philosopher, the geologist, and the engineer. To the philosophical or theoretical investigator they present the curious and varying features of the crust of this portion of the globe; to the practical engineer they offer a memorial of the experience of the profession, whence many a serviceable lesson for future operations may be learned; whereby difficulties and expense may be hereafter avoided and diminished, and from which valuable information may be derived for the appliance of materials in constructions, it being one of the great arts of the engineer to avail himself of the most immediate natural resources which he has to displace in one instance, and to apply them usefully in another, when in juxta-position. And, on the other hand, the minute variations of strata and soil thus accurately delineated, and referred to well defined altitudes with respect to the general surface of the ocean, become of the very highest interest to the geologist, and no less so to the mining engineer, more especially on the lines of railway intersecting the coal and mineral districts, where, in numerous instances, labor, directed by science and sustained by commercial enterprise, has laid bare in deep chasms the secrets of Nature, and the stores whence this country has derived so many advantages, and whose well-directed energies have drawn from our mines of coal and rude metals that abundant wealth and prosperity which the more splendid productions of Potosi and Mexico have failed to bestow on their possessors.

INSTITUTIONS OF CIVIL ENGINEERS.

April 26.—The President in the Chair.

"*A description of a new arrangement for raising Ships of all classes out of water for repair, proposed to replace the Graving Dock or the Patent Slip in certain situations; with observations upon the other methods used at different periods for this purpose.*" By Robert Mallet, M. Inst. C. E.

This communication describes an apparatus proposed by the author as a substitute for the graving dock or the patent slip, in situations where such constructions would be too expensive, or an inappropriate locality prevents their adoption. It reviews the principal methods hitherto in use—such as stranding by bilge-ways, careening or heeling over, lifting by the camel, the graving dock, the floating dock or caissoon, the screw and the hydraulic docks (both American inventions,) and Morton's patent slip; it enumerates the localities for which each of these inventions is most applicable, and then gives the objections to them. The author then describes the general principle of his invention to be, the diffusion of the the load or strain over the greatest possible number of fixed points avoiding casual and unequal strains; that there should be uniform motion, with a power proportioned to the resistance. In providing for this, the joggle-joint is used throughout. The machine consists of a platform, supported upon a series of frames with joints at each end, attached at the lower extremities to fixed points in the foundation, and at the upper ends to the under side of the platform, which is traversed by a series of beams, to the ends of which are fastened rods connected with rollers, working in grooves along a suspended railway on the cantilevers of two jetties, which are built to form the sides of the aparatus. A chain connected with all these rollers traverse in each suspended railway groove, and the power of a steam-engine and wheel-work, being applied after the vessel is floated on the platform and made fast, the frames raise the platform and vessel together gradually out of the water, permitting free access all round the ship; and when the repairs are completed, the whole is again lowered into the water. It is contended that many practical advantages would arise from this system—that the ship would not be strained, that time would be gained, and that it is superior to the ordinary methods now practised. The calculations of the leverage, the division of the load over the fixed points, etc., are given in detail, and the paper is illustrated by a series of elaborate drawings and a complete model of the apparatus.

Remarks.—Mr. Rendel thought that credit was due to Mr. Mallet for the science and the practical skill combined in the production of the contrivance under discussion; it was perhaps imperfect in some of the details, but he was inclined to believe that, in certain situations, and for vessels of moderate size, it might be adopted. Its construction would certainly be more expensive than that of a patent slip, but it would be less costly than a graving dock, and not liable to injury from hydrostatic pressure, to guard against which frequently constituted a main portion of the expense of a graving dock. The foundation of this structure might be simple, as the weight was distributed over so many points; he conceived, however, that unless it was established where the rise of tide was considerable, the foundation must be laid at a depth of 5 or 6 feet under low-water mark, to allow for the thickness of the frames and the platform beneath the ship's bottom. He was of opinion that a modification of the plan might be advantageously employed for canal lifts.

Mr. Hawkins agreed with Mr. Mallet that a ship must be strained while on a patent slip, because the timbers were all bearing a weight at an angle; but more particularly when leaving the slip, as the stern floated whilst the stem was still on the cradle of the slip.

Mr. Palmer did not admit the advantages of the proposed plan over graving docks, for, as they are now constructed, they possess every requisite convenience for examining the repairing vessels; the gates are made to exclude the water perfectly, and the machinery for pumping is so effective, that a very short time suffices to lay the dock dry. The plan might possess some advantage over Morton's slip in retaining the vessel in a vertical position, but it would be more expensive to construct, and he was not at all convinced that the objections urged against the patent slip were well founded.

Mr. Gordon observed that the position of a ship upon a patent slip was exactly that in which it was built; he could not therefore understand why it should be so very injurious; besides, if the stern cradles were elevated, as was the case on some of the slips proposed by Captain Brown, the vessel remained nearly on an even keel. Another improvement introduced by Captain Brown was, substituting solid rollers for the wheels of Morton's slip, the axles of which frequently twisted and prevented the progress of the vessel. Among the modes of examining the bottoms of vessels enumerated by Mr. Mallet, he had omitted the "gridiron," which consisted of a strong frame of horizontal timbers resting upon the heads of piles a little above low-water mark; over this frame the vessel was moored, and on the tide receding was shored up, resting upon chocks. When it was dry the bottom could be examined, and any slight repair made before the returning tide floated the ship off. "Gridirons" existed at Liverpool, at Havre, and at many other ports.

The President observed, that, like the form of breakwaters, much depended upon locality. Where timber was cheap, and the rise of tide considerable, the plan might be applicable; at Liverpool, where the tide rose 30 feet, and in the Channel Islands, where the rise was 40 feet, the platform might be 10 feet above low-water mark, and still accommodate any ordinary vessel. It certainly appeared to avoid some of the main expences of the graving dock, in which so many precautions must be taken for preventing the springs rising and blowing up the bottom. The Institution was much indebted to Mr. Mallet for the great pains he had bestowed on the communication, for the complete drawings and model illustrating it (which were presented to the Institution,) and he deserved credit for the ingenuity displayed in the contrivance.

May 3.

"*Description of the Tunnels, situated between Bristol and Bath, on the Great Western Railway, with the methods adopted for executing the works.*" By Charles Nixon, Assoc. Inst, C. E.

The works described in this paper comprised a large quantity of heavy earth-work in tunnels, etc.; they were commenced in the spring of the year 1836, and terminated in the year 1840. The whole of the tunnels are 30 feet in height from the line of rails, and 30 ft. in width; they are curved to a radius about 120 chains; the gradient of that part of the line is 4 ft. per mile. The strata through which they were driven consisted generally of hard gray sandstone and shale, with the gray and dun shiver, etc; in a few places only, the new red sandstone and red marl were traversed. Every precaution was taken for securing the roofs, by lining them with masonry where the nature of the strata demanded it, and in some places invert arches were turned beneath. Driftways were driven before the tunnels were commenced, and shafts were sunk to enable the work to proceed at several points simultaneously. The modes of conducting the works by these means are fully described, with all the difficulties that were encountered. The construction of the centres is given, with the manner of linning the arches with masonry, which is stated to be what was termed "coursed rubble;" but was of a very superior description, and in every respect similar to ashlar-work. The author offers some remarks with regard to the expense of working tunnels by means of centre driftways. He states this plan to be costly, and in many instances without corresponding advantages, on account of the difficulty of keeping the road clear for the wagons. He recommends that when driftways are used, they should be on the lower side of the dip of the strata, as the excavation would be facilitated, and the road would be kept clearer. In long tunnels he has found the cheapest and most expeditious mode of working to be by excavating the centre part from shafts, and both the ends (together if possible) from the extremities after the open cuttings are made. The drawing accompanying the paper gave a longitudinal section of all the tuunels, and showed to an enlarged scale several transverse sections of them, where the variations of the strata rendered either partial or entire lining necessary.

Remarks.—In answer to questions from Mr. Vignoles and other members, Mr. Nixon explained that the extra number of shafts had been required in order to enable the works to be completed within a given time; there had not been any accidents during his superintendence, but subsequently one of the shafts had collapsed. The cost of driving the driftways, the dimentions of which were 7 feet wide by 8 feet high, was ten guineas per yard lineal. He then described more fully his proposed plan of cutting the driftways on the lower side, instead of the centre of the tunnel, and stated the advantages chiefly to consist of a saving in labor and gunpowder, as a small charge sufficient to lift a considerable mass of rock when acting from the dip; the road was also less liable to be closed by the materials falling into it when the enlarged excavation proceeded from one side instead of upon both sides.

Dr. Buckland, after returning thanks for his election as an honorary member of the Institution, expressed his gratification at the prospect of a more intimate union between engineering and geology which could not fail to be mutually beneficial, and cited examples of this useful co-operation in the cases of railway sections, and models that had recently been furnished by engineers to the Museum of Economic Geology. He then proceeded to remark upon the geological features of the South-Western Coal Field near Bristol and Bath, which had been described by Mr. Conybeare and himself, in the Transactions of the Geological Society of London (1824.) Some of the tunnels near Bristol are driven in the Pennant Grit of the coal formation. Where it is thrown up at a considerable angle and composed of strata yielding slabs and blocks of hard sandstone used extensively for pavement. In traversing such inclined and dislocated strata, the engineer's attention should, he conceived, be especially directed to the original joints that intersect the beds nearly at right angles to their planes of stratification, and also to the fractures produced during the movements they have undergone. These natural divisions and partings render such inclined stratified rocks unworthy of confidence in the roof of any large tunnel, and liable to have masses suddenly detached. Inclined strata of a similar sandstone are perforated by many tunnels on the railway near Liege, in nearly all of which the roofs are supported by brick arches. It has been found impossible to make the tunnels through Lias and Red Marl without continuous arches of masonry. In any of the tunnels which have been carried through strata of the great oolite, the parts left unsupported by masonry would, in his opinion, be peculiarly liable to danger, because even the most compact beds of oolite are intersected at irregular intervals by loose joints at right angles to the planes of the strata, and occasionally by open cracks; and it is to be feared that the vibration caused by the railway carriages would tend eventually to loosen and detach these masses of stone. He apprehended still greater danger would exist in tunnels cut through the loosely jointed strata of chalk, unless they are lined throughout with strong masonry; and even that, in a recent case, had been burst through by the weight of the incumbent loose chalk coming suddenly upon the arch. In open cuttings through chalk, where the numerous interstices and the absence of alternating clay beds prevent any accumulation of water, there is little chance of such frequent landslips as occur where beds of stone, gravel, or sand rest on beds of clay; but until the side walls of chalk are reduced to a slope at which grass will grow, they will be subject to continual crumblings and the falling down of small fragments, severed by the continual expansion and contraction of the chalk, under the destructive force of atmospheric agents, and chiefly of frost. In open cuttings, where the inclination of the strata is towards the line of rails, the slope should be made at a greater angle than if the strata inclined from the rails; if this be done, fewer landslips will occur from accumulations of water between the strata thus inclined towards the rails; and such slips may be further guarded against by minute and careful observation of the nature of the individual strata and a scientific application of subterranean drains at the contact of each permeable stratum with a subjacent bed of clay. Tunnels can be safely formed without masonry in unstratified rocks of hard granite, porphyry, trap, etc., and in compact slate rocks; also in masses of tufa, such as cover Herculaneum, and are pierced by the grotto of Pansilippo near Naples; but in his opinion, wide tunnels driven in stratified rock could not be considered secure unless they were supported by arches.

Mr. Sopwith confirmed the remarks on the importance to the civil engineer of a knowledge of the geological character of the strata through which tunnels or open cuttings were to be made; the cost was materially affected, as well as the stability of the works. The angle of inclination and the lines of cleavage should be carefully studied; on one side of a cutting the slope might be left steep, and all would be firm and dry; whilst on the other, if the same slope was adopted, all would appear disintegrated and wet, and a series of accidents would be the necessary consequence. He could not sufficiently urge the importance of a more intimate connexion between the geologist and the engineer.

In answer to a remark by Mr. Farey on the apparent advantages of Frazer's centres for tunnelling, Mr. Bull promised to procure for the Institution an account of the execution of some work with them.

"*Account of the Machinery and Apparatus for compressing and using Gas for Artificial Illumination at the Portable Gas Works of London, Edinburgh, Manchester, and Paris.*" By Charles Denroche Grad. Inst. C. E.

This paper gives an account of the improvements introduced by Mr. David Gordon into the syphon forcing-pumps, reservoirs, etc., whereby the requisite degree of compression was obtained for rendering gas portable for the purposes of illumination, and of the arrangements adopted in the works at Edinburgh, Manchester, London, and Paris. A description is given of the various kinds of apparatus which were tried before a pressure could be obtained of 30 atmospheres, or 450 lb. per square inch. The portable lamps, with their ingeniously contrived graduated cocks are also described with the several parts composing the apparatus. It appears that, owing to the cost of compression, which was 3*s.* 6*d.* per thousand cubic feet, and that of delivery, which amounted to 10*s.* per thousand cubic feet, the speculation was unsuccessful in a mercantile point of view, although most of the mechanical difficulties were overcome. The paper was accompanied by a series of detailed drawings of every part of the apparatus.

In a paper lately read on some remarkable circumstances connected with the *Daguerreotype*, it was stated that a cameo having been suspended so as to hang near, but not to touch, a polished plate in a box from which all light was excluded, the engraving of the cameo was clearly and distinctly marked on the plate. M. Breguet, the celebrated watchmaker, has addressed a letter to the Academy, in which he states that he has frequently seen, on the polished inner surface of the gold cases of his flat watches, the name of his house plainly and legibly marked, the impression having been received from the engraved letters of the covering of the works, which did not touch the case.

AMERICAN

RAILROAD JOURNAL,

AND

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The present period of the history of railroads seem to be distinguished in a remarkable degree by the general discussion of the economical relations of the system. This is owing partly to the universal stagnation of business in its usual channels—partly to the cessation of construction on most works and the natural diversion of the attention of professional men to this particular subject—and partly to the efforts of those companies who, wishing either to commence or complete their works, are urging their claims individually and those of railroads generally, upon the attention of capitalists.

That the proper discussion of this subject is of the greatest importance, no one doubts. Mere empty assertion or even careless investigation of facts, is not only useless but positively injurious. Discerning men have therefore directed their attention to the collection of strict and authentic statistics, and also to the rigorous analysis of the information already collected, with a view to its application to future undertakings. Although a great improvement has already been made in the form according to which railroad statistics are published, there remains much to be done before the documents shall possess that clearness and distinctness of detail upon which all strict and rigorous calculation must be based. In the proper place we shall endeavor to point out these desiderata. Meanwhile it may not be curious to remark that imperfect as these data may be, they still contain nearly if not quite all the items, although not properly separated and distinguished—and from these we may derive tolerably correct approximations to the cost of railroad management, even somewhat in detail.

Our object at present is to give an outline of the errors and difficulties which have operated injuriously upon some railroads—and to make an abstract of the information derived from well established lines, with a view to determine as nearly as possible the cost of management.

In doing this no claim is made to infallibility—nor is any reflection intended upon those who entertain different views. It is only from the comparison of opposite opinions that the truth can in most cases be arrived at, and improper warmth in criticising the opinions of others, as well as over sensitiveness in bearing the examination of our own—are alike unfavorable to fair discussion.

The errors which have produced such unfortunate results in some public works, have commenced at the very outset, and were probably contained in the very germ of the enterprise, we shall therefore consider, in the first place,

Errors in Location.—These have been generally committed by those who have conceived the project—and not unfrequently before professional advice has been taken. In the enthusiasm with which public works are nndertaken certain plans are frequently laid which are improperly considered as identical with the work itself, and urged with such feeling that when it is discovered that they are inexpedient, it is too late to abandon them. The conceits of a railroad with so many miles in one straight line—of a tunnel under this hill, or a bridge over that river, or the imposing entrance into this or that part of a town, having once turned the heads of a whole district, are apt to end in emptying their pockets. That these are not mere pictures of fancy, every one knows who has been familiar with the commencement of such works—we need not alludo to particular cases, as every one's experience will supply enough of them.

A more culpable error of location, is that in which the terminus of the road, or its intermediate points are placed with distinct reference to private interest, and in direct opposition to the general interests of the company. These most mischievous mis-locations have been so common and glaring as almost to have passed into a byeword. Paper cities to be built up and new avenues to be opened, and a host of similar projects have generally resulted in serious loss to companies. We would not however wish to include in this censure, those locations where no natural or other difficulty existed, and the general interest has been consulted—even though certain individuals may have procured such a line as might result in their benefit *as* individuals. The endeavor should be to accommodate the greatest number without compromising the company.

Under this same head we might mention those instances in which the whole work has been undertaken as a matter of sheer speculation. Most of our abortive or unsuccessful railroads came under this class—but they are no more to be adduced as examples of railroads, than the South Sea bubble as an instance of legitimate commerce.

Other errors of location are those which are exclusively the fault of the engineer, and these are by far the least both in number and importance. There are not many cases in which such mistakes have been detected, and many which are supposed to exist turn upon disputed professional points. Some of the earliest locations have been re-examined. But these are hardly fair cases, for so little was then known as to the capability of locomotives, that we may consider that under existing circumstances the best was done that could have been done.

Before dismissing this branch of our subject, we will allude to a difficulty often encountered in the commencement of a railroad project—we mean the interference of persons ignorant not only of matters exclusively professional but very often of the principle of what is called common sense. Every engineer must recollect some director or stockholder who imagined himself quite an engineer—and whose ignorance might generally be measured by his conceit. Such men have been so often encountered and so often described, that we need say no more of them. We might however safely say, that these and other evils of a like nature cannot be avoided until the profession of engineering in this country stands upon the same basis and organization with the other professions.

TO ENGINEERS, DIRECTORS AND STOCKHOLDERS OF RAILROADS.

The commencement of the session of Congress renders it necessary that all those who feel an interest in railroads should bestir themselves to obtain a repeal of that portion of the tariff bill passed in August last, which relates to railroad iron.

At the time of the passage of that bill, no attempts were made to obtain an alteration until it was too late, and in fact few persons had any idea that such a strange restriction would become a law.

The arguments on this question need not now be given in detail; they are briefly these.

Under existing circumstances no railroad iron can be imported with the duty—the law in fact amounts to a prohibition.

No railroad iron can be made in this country at as low a price as it can be imported, even with the duty. No orders can then be expected for home manufacture.

The result will then be that neither railroads now in construction nor those projected can be built at these high prices for iron.

The demand having ceased no iron will be rolled in this country, and as not any of the more complicated patterns have been rolled, in regard to experience in manufacture, things will remain as they now are.

The consequent fall of price in England will draw orders until the maximum is again reached.

But how shall we do without railroads—how are our iron mines to be approached, or our coal—what is to become of the large orders for railroad castings—which were more proffitable to our iron masters than rolled iron ever can be?

The evidences against this restriction for the present at least, are so strong that we need dwell no longer upon them. We may however remark in conclusion, that the importation of locomotive engines ceased and the exportation commenced under the free law. No one can feel more interest in the protection of our iron trade than we do—but the present law in relation to railroad iron is rather for destruction than preservation.

The following memorial has been sent to us, and although late in in the date we wish to urge upon all our readers the necessity of pressing it with all their might. As soon as a few subscribers are obtained it may be forwarded to the member of Congress for the district petitioning.

To the Senate and House of Representatives of the United States, in Congress assembled.

The undersigned would respectfully represent to your honorable body, that owing to a succession of untoward events incident to season, distance, unavoidable delays in the execution of orders, etc. etc., instances exist where railroad iron now imported and intended *to be laid down on railroads* before the 3d of March next, will not, in consequence of circumstances above alluded to, be able to reach that position entitling it, under existing laws, to exemption from duty—and the imposition of a duty of *twenty-five dollars per ton* will fall peculiarly hard on parties already sorely oppressed by the onerous undertaking of constructing roads at a period of peculiar embarrassment. Some of which roads being in an unfinished state, and awaiting the return of a better condition of pecuniary affairs, must, with the money already expended in surveys, grading and superstructure, become a complete and total loss, if subjected to an additional burthen.

The iron now most approved in the construction of railroads, is of a description that requires much time and labor in making, and will not probably for many years to come be manufactured in this country. To secure such iron, your memorialists, interested in the construction of railroads, have been induced to send their orders to England, where alone such description of iron is as yet exclusively made. Some of these orders were executed under the law of 1832, which authorized exemption from duty if laid down within 3 years after its importation; other orders were executed under the law of 11th Sept. 1841, which law confined the *exemption* to iron imported before 3d March, 1843, and for roads *then* under construction at the passage of said last mentioned act, and "for such iron as was necessary to complete said roads," evidently thus intending not to confine the exemption to the fact that it should be *laid down* before 3d March, 1843, but that it should be *imported* before that period.

The unexpected passage of the Tariff Act of August, 1842, essentially altered the act of 11th Sept. previous, and now renders it necessary that the iron should not only be *imported* before 3d March next, but *laid down* permanently for use before that period; the consequence of which will be to expose some portions of iron to a heavy and unexpected duty, which iron will be found impracticable to be laid down before 3d March, 1843. Under this state of things your memorialists would respectfully urge on your honorable body so far to alter and modify the act of 30th August, 1842, as to authorize an extension of time to three years, within which iron, imported for railroads, shall be laid down on any railroad or inclined plane, provided said iron be necessary to complete such railroads as were commenced before 11th Sept. 1841.

Your memorialists would also respectfully represent to your honorable body the vast importance of railroads to the best interests of the country, and although it may be said that the interest of our own iron mines would be promoted by the imposition of a heavy duty on imported railroad iron, yet it is capable of demonstration, that owing to the peculiar localities of our iron regions, it is first highly important, for their own interest, that accessibility should be controled as far as practicable, and under the least burthens and obstructions, as one of the indispensable means of rendering our iron mines valuable or available; and as it will require years, and vast capital, to construct works capable of manufacturing the Heavy Edge or H rail, which is now most approved for durability and strength, the question is, Whether it would not be nationally beneficial to allow this description of iron to be imported as under the law of 1832, for a period of three or five years, leaving the *flat bar*, which is capable of being made here with facility, subject to existing duty?

Your memorialists are not unfriendly to the iron interest of the United States, but they can see no injury to that interest by the modification of the act of August, 1842, as set forth in this memorial.

And your memorialists as in duty bound, will ever pray, etc.

The following remarks upon the annual railroad table published in our Journal, are attached to a copy of that table appended to the report of the select committee of Board of Aldermen, upon the New York and Albany Railroad.

The practical deductions from this table are so much to the purpose that we trust our readers will refer back to it while reading this paper.

REMARKS RELATIVE TO THE RECEIPTS, EXPENSES AND DIVIDENDS ON RAILWAYS IN MASSACHUSETTS AND NEW YORK.

It will be perceived, by a table from the Railroad Journal, that the railway *system*, as a *whole*, has been eminently successful in Massachusetts, and that the Boston and Lowell, a freight railroad, for the bulky article of cotton, and its produce manufactured, has paid the largest dividends, to wit: The average of 7¾ per cent. per annum for five years.

It will be noted, that the income from passengers, on this road, advanced from $117,642 in the year 1837, to $145,953, a fraction under 5 per cent. per annum; while the freight was increased during the same period from $63, 137 to $121, 588, or at the rate of 19 per cent. per annum. The increase in the item of freight on the extension of this road to Nashua, is in a much greater ratio —to wit: from $18,406 to 56,764 in three years; increase in freight equal to 70 per cent. per annum; and this too over a short road of

14 miles, that is now further extended, and opened to Concord, in New Hampshire.

The receipts and expenses on three of the principal roads for five years (although too short for economy in their management, and built at a great cost compared with present prices,) should satisfy any person, that an investment in railway shares—"*judiciously located and constructed*, between *desirable points*," must be an investment equal to profitable real estate. This view is now taken in England, as will be perceived by the following extract from the Bankers' Circular of the 6th Feb. 1841:

"Regarded as property of permanent investment for income, and not merely as speculative things, to be bandied from hand to hand on the faith of names and exaggerated representations, we have a higher confidence in railway shares generally, than we had when we wrote two years ago on the subject. Therefore, viewed as valuable annuities, investments in the leading lines must be considered safe. We are giving no opinion of the present marketable value of shares that may be more or less than the annuity is worth, but merely asserting that the system is so far in advance of the experimental stage in which, on former occasions, we considered it, as to warrant the description, that it has worked out a *valuable property*; which, as such, may now be set down as *being permanently established*."

It will be perceived by the table, that nine railroads in Massachusetts, radiating from Boston, and in length 392 miles, cost up to Jan 1, 1842, the sum of		$16,300,937
The receipts on these roads from 2 to 5 years since their completion, is		
From passengers	$3,525,804	
From freight	1,816,422	
	———	$5,342,226

The receipts on the Western Railroad, from Worcester to Albany, 157 miles, for the last ten months, up to the 1st October, 1842, is $424,010. As the receipts for passengers and freight have steadily increased, and in the month of October had reached $59,141, it is therefore safe to estimate the gross receipts on this road at above half a million of dollars for the year 1842, with an insufficient number of locomotive engines and freight-cars. This $500,000 is exclusive of the earnings on the Boston and Worcester Railroad of 44 miles, which for 1841 was $310,807. This year the receipts will exceed $400,000, or say $900,000 for 201 miles of road.

That our capitalists have been unfortunate in their first investments, in *short* and *experimental* railroads, in and near this city, injudiciously located and constructed, is to be regretted.

It can in part be accounted for, and every candid inquirer after truth will discover, that every railroad in England and in this country, on *long lines*, between places of business or thoroughfares, have been eminently successful. Our capitalists have suffered in the following pioneer railroads, from their not being well considered, and costing too much. On the *Long Island Railroad*, via. Jamaica towards Greenport, there is to be a direct competition with steamboats on the Sound, which is open nearly the whole year: on its completion it will no doubt do a fair and remunerating business. The *Stonington railroad* runs near and parallel to water, open nearly the whole season, with no country to support it. The *New Jersey Railroad*, with accidents from flood and fire, has entered into a successful competition with steamboats from N. Brunswick to New York, at very reduced fares, and this, too, even with the expenditure of a large capital in the construction of 34 miles of road. One item is the enormous sum of $352,727, paid for land, damages, depots, and *right of way*.

The *Harlem Railroad Company* has expended large sums on a tunnel, rock excavation, etc., on a short road, with few persons residing at its terminus. It has $1,600,000 invested in 12 miles of road. The *Patterson Railroad* is a short road, with a limited population on its line up to a small manufacturing village; on its extension it will be profitable. The *Catskill Railroad* was only partially completed into the mountains, and failed for want of means to complete it. The *Hudson and Berkshire* has very severe grades, but this road is expected to recover itself and pay dividends. The roads from Albany and Troy, built for *summer travel to Saratoga*, will prove failures, until they are extended to Whitehall. This avenue to Canada will certainly pay dividends. Other roads in which our capitalists have embarked partake more or less of the difficulties enumerated. In fact, we have to look beyond our own city and the Hudson river for successful investments in railroads. We find this to be the case on all the railroads west of Schenectady to Rochester and Batavia. The several roads on this line are now earning 6 to 12 per cent. and even the *Hudson and Mohawk Railroad* has earned 6 to 7 per cent. per annum, on an expenditure of $1,100,000 per 15¾ miles of road, operated by horse and steam power, with the expenses of two inclined planes.

The *Utica and Schenectady Railroad* has yielded, on an expenditure of $1,900,000, in 5 years and 5 months, the sum of	$2,019,979
The whole amount of expenses during the same period, besides paying for the purchase of the Mohawk Turnpike, building 22 miles of road for turnouts, and paying severe taxes, was	707,964
Nett receipts in 5 years and 5 months	$1,309,285

These remarks could be enlarged, by citing several instances of well managed railroads at the South, where the freight of cotton and *bulky* articles are among the principal items of revenue. We will, however, conclude by noticing the *Camden and Amboy Railroad.* By an *official* report from the company, it is shown that this road has earned its entire cost in seven years. It has, however, had to divide its earnings with the Deleware and Raritan Canal, with steamboats and wharves at its two extremes, costing $2,829,-797,—on which it had to pay dividends, as well as to its own stockholders, on a capital of $2,291,802, expended on the canal, and in steamboats, wharves, real estate, and coal lands, $929,055. The canal, in fact, earning only five-eighths of one per cent.

The gross receipts over the Camden and Amboy Railroad, from 1st Jan. 1833, to 31st Dec. 1839, was	$4,637,535
The gross expenditures during this period,	2,253,993
Nett receipts in seven years,	$2,383,542

Being more than the cost of the railroad; and this too with but limited accommodations for the transportation of freight, at high charges proportioned to other railroads.

TABLE, SHOWING THE LENGTHS OF RAILWAYS RADIATING FROM AND IN CONNECTION WITH THE CITY OF BOSTON.

From Boston, via Albany, to Buffalo	518	miles.
Do. Portsmouth, to Portland, Maine	104	"
Do. Lowell, Nashua, and Concord	62	"
Do. to Providence, Rhode Island	41	"
From Providence to Stonington	47	"

Branch from Andover to Haverhill	25½	"
Dedham Branch	2	"
Taunton Branch, and extension to New Bedford	35	"
Bedford and Fall River	13	"
Norwich and Worcester	58½	"
New Haven to Hartford, 36, and extension to Springfield, 24 miles, not completed	60	"
West Stockbridge to Bridgdeport	98	"
West Stockbridge to Hudson	33	"
Troy and Schenectady	22	"
Troy to Ballston	20	"
Schenectady and Saratoga	21½	"
Lockport, Niagara Falls, and Buffalo	43	"
Miles,	1,203½	

Note.—The connection of the New York and Albany Railroad with the above web of railways at or near Ghent, in Columbia county, with a distance of only 118 miles from the Harlem river will render available to the city of New York—at all seasons—an expenditure of about *thirty millions of dollars*, on 1,203 miles of railways, now connected with Boston. The city of New York has but 12 miles completed from the City Hall, in connection with the interior.

The report of Mr. Johnson will be read with pleasure by those interested in the great work which he has in charge. From it we find that $300,000 dollars subscribed in New York City will enable this company to furnish by means of intercommunications a continuous railroad to Albany, until the means shall have been provided for a *direct* one.

REPORT ON THE NEW YORK AND ALBANY RAILROAD, ETC.

JONA. J. CODDINGTON, ESQ.

Prest. N. Y. & A. R. Co.:

SIR,—In examining the map of the country through which the New York and Albany Railroad passes, it will be seen that at the distance of about seventy miles from New York city, in the town of Dover, the line of the railroad approaches within about six miles of the Housatonic railroad, at a point where there is an *open valley* between the two.

The Housatonic railroad above this point must, in the event of the completion of the New York and Albany railroad, become an important branch to the latter road, in bringing to it the business of the western portions of Connecticut and Massachusetts, which will thereby be enabled to reach the city of New York in nearly thirty miles less distance than by the way of Bridgeport, and will avoid the navigation of fifty-eight miles of Long Island Sound, a transshipment at Bridgeport, and about forty-five miles of an inferior railroad.

It will be an object to the New York and Albany Railroad Company to effect the connection of the two roads so soon as their road is completed to Dover; and when this connection is formed, a *continuous* line of railroad will exist from New York to Albany and Troy by the way of the Massachusetts and Albany and West Stockbridge railroads, etc.

This route will serve to accommodate the travel between New York, Albany and Troy, until such time as the New York and Albany road shall be completed on the *direct* route within the limits of the state, which it is reasonable to suppose will not be long delayed after the connection named is formed; for the citizens of New York will not, it is imagined, be long satisfied with the use of an inferior railroad, located upon a route which passes into two other states, over a more elevated summit, is fifteen miles longer in distance, and forty to sixty miles of it under the control of a rival corporation interested in diverting the ſtrade of the North and West to a rival city.

The object of making this communication is to call your attention more particularly to the fact, that when the New York and Albany railroad is completed to Dover, it will come into *immediate and profitable* use as a portion of a *continuous* line of railroad extending to Boston on the East, to Buffalo on the West, and North to Saratoga Springs.

It will also constitute the main trunk from which a branch of three and a half miles (if the cheapest and most direct route for the main line is adopted) will unite by a ferry across the Hudson river with the New York and Erie road at Piermont, and thus bring the travel, etc., which that road may furnish over about fourteen miles of the New York and Albany railroad.

It will also constitute the main trunk for a branch eight and one half miles, extending to Danbury in Connecticut, which there is every reason to believe will be constructed as soon as the main road shall be completed up to the point of junction.

From Danbury there will remain only about thirty miles of distance to unite at New Haven with the line of railway extending thence to Boston, Portland, and other towns, and thus bring the whole of the Eastern travel by the *best* route for a continuous line of railroad to New York city, over nearly forty miles of the New York and Albany railroad.

There is not probably in the whole 8000 miles of railroad now in operation in the United States, an extent of 62 miles of road which presents so many advantages and inducements to capitalists as the portion of the New York and Albany railroad from New York city to Dover.

At one extreme it terminates in the heart of a growing city, with 350,000 inhabitants. Through its entire length the country is rich and populous, and will have important branches connecting with it on either side.

At the northern terminus, it will connect with a line of railroad stretching 300 miles to the east, 100 miles to the north, and 400 miles to the west. The town of Dover, and the region of country in the vicinity embracing Amenia, North-east, Salisbury, etc., in addition to the rich agricultural resources, is not excelled in the abundance of its mineral treasures of iron and marble combined, by any other equal extent of country in the United States.

The face of the country along the route of the railroad from New York to Dover, is unusually favorable for the cheap construction of the road, and for cheap and rapid transportation. The line from Dover to the city has an average inclination of seven to nine feet only per mile, descending for 50 miles in the direction of the preponderance in the trade, and is very straight, with maximum grades not exceeding thirty feet per mile, and allowing of any desirable speed.

The probable cost of this portion of the road from Harlem river to Dover, if the most direct route is adopted, will not, from the knowledge derived from work already done under existing contracts, exceed the following:

Road bed complete, 62 miles, single track, at $6,400 per mile,	$396,800 00
Superstructure, single track	496,000 00
Land, fencing, and engineering	132,200 00
	1,025,000 00
Add for engines, cars, car houses, etc.	70,000 00
Total	$1,095,000 00
To complete the road bed, and pay for land, fences, and engineering, the amount is $396,800 and 132,200	$529,000 00
Deduct from this one third cost of road bed, to be paid in stock to contractors	132,267 00
	$396,733 00
Deduct available subscriptions in Pawlings, Dover, and Patterson	70,733 00
Remains	$326,000 00
If means are provided to insure the immediate grading of the road to Dover, the subscriptions along the line of the road will be increased, I believe, to the amount of	60,000 00
	$266,000 00

Leaving to be provided for by subscriptions in New York city to complete the road bed and pay all expenses of land and fencing, the sum of $266,000.

When the road bed is complete in all respects, and the right of way obtained, no great difficulty will, it is believed, be experienced in securing, by loan or otherwise, the means for laying down the superstructure, which for a substantial iron rail, (and none other should be used,) will cost as estimated about 8000 dollars per mile, or for the the distance of 62 miles 496,000 dollars.

Assuming as estimated above, that the 62 miles of railroad will cost 1,095,000 dollars, the amount to be divided annually among the stockholders, in order to give them seven per cent. is	$75,650 00
The expense of transportation, when of a mixed character, including passengers and freight, according to the experience on other roads, may amount with the repairs of road, to 40 per cent. of gross receipts, or	51,100 00
Giving for the *gross receipts* per annum, in order to realize 7 per cent. the sum of	$127,750 00

To produce this amount, if the revenue be supposed to be derived from passengers *alone*, and if *two cents* per mile, or *one dollar and a quarter* only, is charged for each passenger passing the whole distance of 62 miles, it will require 102,200 passages both ways, or 51,100 each way per annum, giving per day 140 each way, or as many only each way per day as can be conveyed in *two* eight wheel passenger cars.

The probability is, that at no season will the number of passengers be less than this, and the average will be so much greater, that the receipts, including what is derived from freight, will afford a surplus, after making seven per cent. dividends upon the capital, sufficient to complete the remainder of the road to Albany in a few years, without greatly adding to the subscriptions.

Respectfully submitted:

E. F. Johnson,
Ch. Eng'r N. Y. & A. R. R. Co.

New York, Nov. 15, 1842.

Patent Office, Nov. 1, 1842.

Having noticed in the public prints an entire misapprehension of the late act of Congress respecting the Patent Office, I hasten to say,

1. That the new law does not alter the fee or duration of patents for such objects as have been hitherto patentable; the amount of which is still thirty dollars, and the term fourteen years. The new law extends protection to a new class of cases, viz. Designs embracing patterns for silk, woolen, and cotton fabrics, for busts,

statue, or bas relief, or composition in alto or basso relievo; such protection having been granted by foreign countries, and not till the present law by the United States.

2. The new law extends the privilege of renewal of lost patents to all those granted before the fire of December, 1836; the former law limiting it to those actually *lost* before the fire; thus excluding many lost subsequent to the fire, and before recording new, leaving the inventor remediless.

3. American Ministers, Consuls, etc., residing abroad, are now authorised to administer oaths to inventors. By the former law such functionaries were not permitted to perform this act; thus subjecting inventors to great inconvenience.

4. The Secretary of the Treasury is now authorized to repay money paid into the Treasury for the Patent Office by mistake; thus precluding the necessity of making special applications to Congress for relief.

5. The new law forbids under a penalty stamping the word PATENT on articles vended where no patent has been obtained, and compels patentees to stamp on the articles vended by them the date of the patent; thus affording the public information of the duration of the patent.

☞Editors of papers or periodicals will render a public service by giving the above an insertion, as the subject matter is interesting to a large portion of the community.

HENRY L. ELLSWORTH,
Commissioner of Patents.

ENGINEER DEPARTMENT, CENTRAL RAILROAD.

SAVANNAH, NOVEMBER 7TH, 1842.

To R. R. Cuyler Esq., President.

SIR—A recurrence of the period at which a report from this department has usually been made, affords me the gratification of addressing to you, the following statement of the condition and progress of the railroad.

The grading of the line is now complete, with the exception of portions of Sections 54, 57, 58, 62, 63, 66 and 69, amounting in all to a distance of about four miles. The track has been laid, and the road completed to Station No. 15. (West of the Oconee river and 152 miles from this city,) and a further distance equal to five miles of finished superstructure has been done, leaving not more than 33 miles to be laid to reach the terminating Depot at Macon.

Timber has been furnished and delivered along the road for the superstructure, to a point within 14 miles of Macon, and the remainder will probably be supplied by the end of the present year.

We have on hand a sufficient quantity of iron, to reach within 16 miles of Macon; the remainder required to complete the road has been ordered, and is expected to arrive before the end of February: should this expectation be realized, we shall avoid the duty of $25 per ton, imposed by the late Tariff Act, which goes into effect on that article on the 1st of March next.

The Bridge, Trestle work and Embankment, across the river Oconee, and its extensive swamp, has at length been so far completed, as to permit the regular transit of our trains. The work remaining to be done at this point, is confined to the main bridge over the river; and consists of the covering, roof, and a pier of stone in the channel—the bridge being at present supported by a temporary work of timber, founded on large piles driven in the bottom of the river, of ample strength to give perfect safety to the structure until the masonry is completed.

The contractor is at present actively engaged in building a coffer dam, for the purpose of laying the foundation of the pier, and expects to accomplish it before the end of the present year. The stone for the pier has been procured, and delivered on the spot. It is granite, of an excellent quality, and was quarried about 4 miles below Milledgeville, and carried down the Oconee in boats.

The Bridge over the river is 266 feet in length, and is elevated about 30 above ordinary low water. It is constructed on the lattice plan, in two spans, and will be covered so as to be protected from the weather. The trestle bridge, which carries the road for about $2\frac{1}{11}$ miles over the river swamp, is of an average height of 17 feet. It is a frame work of great strength, no timber being less than 12 inches square, and supported by piles driven firmly in the ground. The remainder of the swamp is passed on on embankment at the west end of the trestle bridge, of an average height of 16 feet, and makes in all a distance of about three miles between the high lands on each side of the swamp. This has been a work of great tediousness, in consequence of the unhealthiness of the location in the Summer and Autumn months, and the frequent freshets in the Oconee, during the first twelve months of its progress. It is about two years since it was put under contract. We have had, during the past Summer, almost universal prevalence of fever among our operatives on that part of the line; indeed, it has been a season of unusual unhealthiness, throughout nearly the whole district of country traversed by the road. Every person attached to this department with a single exception, has had an attack of fever, and several of the assistants are still scarcely able to perform their duties.

An arrangement has recently been made with two of our most responsible contractors, which will, if carried out, effect the completion of the road in time for our trains to run through in July next; and I can see no reason why we shall not be prepared to open the business of the next season, at the Depot in Macon.

It is confidently expected also, that the superstructure of the Monroe railroad, which is now laid only to Griffin, (61 miles from Macon,) will be extended to the Western and Atlantic road at White-hall, (101 miles,) and that the State road will be in operation fifty-two miles. Making in all a distance of *three hundred and forty three miles of continuous railroad from the city of Savannah*, by the 4th of July next. Should these expectations be realized, our citizens will at least be gratified with the reflection, that they are not behind their neighbors in "*the grand march of internal improvement.*" It is quite unnecessary for me to speak of the advantages, which, a connexion with the valley of the Tennessee by the railroads now in progress will confer on this Company, and on the city; the subject has during the past Summer, been constantly presented to our citizens, and there are very few of them who are not familiar with it.

Preparations are now being made at Macon, to put up the requisite buildings at the Depot, and they will be arranged with a view to the heavy business that may be expected to flow to the road, on its reaching that point.

The grading of the road, for about 14 miles of the western end of the line, comprehends a succession of heavy cuttings and embankments, with frequent curvitures. This is rendered unavoidable, by the uneven surface of the country, and of course involves a heavier expense, than the average cost of grading the other parts of the line. The heaviest and most costly portions of this work, are completed.

The embankments have mostly been constructed by the use of horses and carts, and the material in all cases being of a character perfectly suitable to the purpose, they possess great solidity. I have adopted the plan of planting their sides with "Bermuda grass," which affords an effectual protection against washing by rains. All the culverts and drains of this portion of the line, have been built of stone, which we have been able to obtain within a few miles of the road.

The troublesome and vexatious business of obtaining conveyances of the requisite lands, and right of way for the road, has been accomplished for nearly the whole route, There are very few cases remaining unsettled, and I do not apprehend any serious difficulty in arranging them.

The feeling of opposition to, and prejudice against the enterprize which prevailed throughout a considerable portion of the country traversed by the road, is gradually subsiding, and I am confident, that as its benefits become more generally extended and felt, it will be regarded with general favor and approbation.

The business of the road since the opening of the fall season, shows a great improvement on that of last year. Cotton is flowing in upon us in great quantities, and the prospect of a profitable winter's work is very encouraging. Our present equipment of motive power is the same as the last year, with the addition of 10 eight wheel burthen cars, nearly ready to put on the track.

We could with our present number of Engines and Cars, bring in about 12,000 bags of Cotton per month, should that quantity offer; we have thus far kept the road clear, or so near it, as never to have had more than two days work accumulate; and I apprehend we shall have no difficulty in doing so during the balance of the season.

In compliance with the general desire of the citizens, and a large portion of the Stockholders of the Company, a reduction has been made in our rates of freight, compared with the tariff of last year. Whether the measure will result in increased profits to the Company or the reverse, remains to be tested. The public appear to be satisfied with the present arrangement.

The total Receipts for the year ending 31st October, are as follows;

For Freight,	$91,456,31	
" Passengers,	30,167,00	
" For transportation of U. S. Mails,	11,912,00	133,535,31
The Current expenses have been as follows;		
For Maintenance of way,	$28,377,47	
" Conducting transportation, including salaries of Agents, Conductors, Clerks, Laborers and various contingent expenses,	21,269,55	
For maintenance of Motive power, repairs of Cars, Engines, etc. including rebuilding the Engines Georgia and Tennessee,	15,188,58	
Fuel and water for Engines,	4,810,80	
Oil and tallow for Engines and Cars,	1,107,79	70,754,19
Leaving a nett profit of		62,781.12
To this amount may be added		
Transportation of materials for the construction of the road,		10,000,00
Actual nett earnings of the road,		72,781,12

This sum, if applied to the capital expended in the construction of the portion of the road in actual use, amounts to about 5 1-2 per cent.

The distance performed by all the Engines during the year, is as follows, Atlantic 21,065, Oconee 19,792, Macon 17,129, Savannah 17,941, John Bolton 9,818, Oglethorpe 8,469, Tennessee 3,723, George 3,509. Total miles run 102,145. The quantity of fuel used in performing this service is, 1358 cords, or an average of one cord for every 75 21-100 miles run.

The aggregate amount of the expenses of working and keeping in repair, the road and machinery, with the transportation expenses, being as before stated, $70,754,19, gives us the rate of 69 26-100 cents per mile as the average cost of running a train for the last

31

year. The investigations of the Chevelier de Gerstner on this subject, show, that the average of all the railroads in the United States, in operation at that time, (1840,) for this item, was about $1,00 per mile. It should be borne in mind that a much larger business might be done on our road, without a corresponding increase of expense. The present number of superintendants, agents, clerks, etc. would not be materially increased, if the business were doubled.

It is proper to remark in relation to the maintenance of way however, that we have not yet felt the full expense of renewing decayed parts, for more than half of our line. The average cost per mile, for this branch of our expenses, has been about $200 for the last year, on the part of the road in operation. We may expect, that whenever the wooden superstructure reaches the maximum of decay, the expense will be double this amount. We find no difficulty in making contracts with persons along the line, for the supply of timber for keeping the superstructure in repair, on favorable terms; and in all cases where it can be done at a reasonable cost, we are substituting cypress timber, for the pine which was used in the original construction, as the latter decays. My observation on the subject of the decay of timber in our road, has led me to the conclusion, that the renewals of decayed parts will be equivalent to an entire reconstruction of the wooden portion of the road, once in six years.

There has been much written and said on the subject of preparing the timber by the use of mineral substances, so that it may resist the ordinary causes of decay; and many experiments are in progress, in various parts of the country, to test the efficiency of the several modes proposed to effect this most desirable object.

The plan which appears to find most favor in England, where it has been very extensively adopted, is the process of saturating the timber with a solution of corrosive sublimate, termed "Kyanzing." There have however, been various other modes proposed, which if found successful will be much less expensive, and better adapted to the circumstances of the public works in this country. Among these, the process employed by Dr. Earle of Philadelphia, appears to have taken the lead. He uses, instead of corrosive sublimate, a combination of the sulphates of Iron and Copper. Public opinion appears to be much divided on the merits of this "process." My impression is, that so far as our own work is concerned, the best policy is, to await the result of the experiments that are being made, on a very extensive scale on the Western and Atlantic road in our own state, and to a considerable extent on the roads of a neighboring state. The abundance of excellent timber throughout the whole district of country traversed by our road, confirms me as to the propriety of such a course.

The subject of "maintenance of way," is one of the most important of all the matters connected with the management of a railway.

It is a great error to suppose it the best policy, to cut down the expenses of repairs of road to the lowest possible sum that will keep the road in operation. A proper investigation of the subject, will in most cases, show that an over-strained economy in this branch, will result in constant derangement of machinery, involving increased expenses in the mechanical department, more than equivalent to the apparent saving. To this may be added the vexatious delays of passenger and mail trains, resulting from trifling accidents to the machinery.

From the best information I have on this subject, in relation to the railroads in the southern states, it appears, the force required to maintain the roads, is an average of about one man to a mile, while we have for a distance of 147 miles only 60 men; we must therefore, as the wood work advances in decay, look forward to this number being doubled at least.

There are no means so effectual in regulating and controling the expenditures of a railway as a system by which each item of the multitudinous expenses may at any time be exactly known, and each individual in the service of the company, be at all times made accountable for the particular branch of outlay under his charge, from a spike to a Locomotive Engine.

It is difficult to perfect such a system while the work is in an unfinished state, but we have endeavored to approach as near as possible to it, and in another year, every branch of the service will be brought under systematic regulations.

The following is a list of the persons in the service of the company, on the part of the road in operation.

Transportation Department.	
Superintendent,	1
Agents,	7
Clerks,	4
Conductors,	3
Laborers,	21—36
Road Department.	
Road Master,	1
Carpenters,	9
Laborers,	50—60
Mechanical Department.	
Principal Machinist,	1
Master Carpenter,	1
Finishers,	3
Engine Men,	5
Apprentices,	3
Smiths,	2
Strikers,	2
Fire Men,	5
Jobbers,	2
Carpenters,	5
Pattern Maker,	1—30
Total,	126

It is intended to provide an ample supply of Engines and Cars in anticipation of the probable amount of business that may offer, during the next Season, when the road shall have been extended to its terminus.

Our present Engines are what are termed the *third class*, that is, they are of the lightest description usually made at the manufactories where they were obtained. Their maximum nett load at ordinary speed on our road is about 65 tons or 350 bales of cotton of medium weight. It will be necessary to have Engines of greater power, when a further number is ordered, and I feel confident that among the several improvements that have been made recently, with a view of increasing the power without adding materially to the weight on each driving wheel, we shall be able to select such as will draw at least twice the burthen of our present ones, without materially increasing the stress on the road.

In conclusion, I think I can with confidence congratulate the stockholders, and the citizens, on the favorable aspect of our enterprize; and its obvious beneficial effect on the business and prosperity of our city in particular. I think we may venture to say, that there is not a city south of the Potomac, which has, during the unprecedented pressure of the times for the last two years, shown so decided indications of improvement as Savannah; there has been a greater number of buildings erected during that time, than for the same period in many years—our population is rapidly increasing, while that of neighboring cities is declining, and our citizens are animated with the brighest hopes of the future.

It is true, our city and its citizens have taken on themselves heavy burthens for the attainment of this object, but it is equally true that by a little further exercise of the extraordinary patience with which they have borne these burthens, they will reap a full harvest to reward them for their sacrifices and efforts.

I cannot close this communication, without alluding to your lamented predecessor in office whom it pleased Divine Providence to remove from us in the early part of the present year.

The example he has left us, of entire devotion to the duties he had undertaken, his untiring perseverance and inflexible integrity in the performance of them, should be emulated by every person in the service of the company—few will be able to come up to such a standard—none to surpass it.

The steadiness and determination with which he pursued the great object of benefiting his native State, and this city, and promoting their prosperity, ought to give his name a place among the most distinguished of public benefactors. It was an object which was remembered in his latest aspirations to Heaven, but a few moments before he yielded up his spirit to him who gave it.

I am sir,

Very respectfully,

Your ob'dt ser'vt.

L. O. REYNOLDS,

Chief Engineer.

MR. VIGNOLES' LECTURES ON CIVIL ENGINEERING.

Second course–Lecture 14.—*Working expenses of Railways.*—Mr. Vignoles commenced by reminding the class, what he hoped they duly felt, that the great object he had in view during the present course was to consider, in every bearing, the proportion between the cost and expenditure upon any work, as compared with the probable profitable returns. Although this consideration, and that of the good result of any such speculations, might be thought not to come strictly within the duties of an engineer, and until of very late years had been neglected, and, in some striking cases, absolutely repudiated, by eminent men, yet Mr. Vignoles was of opinion that it must ever be kept in view, and should absolutely form a branch of the engineer's study, for he ought to feel that any works he may be called on to construct should not only be such as will reflect credit on him, as a professional man, for design, arrangement and execution, but, as the Professor had often urged, such as, in this commercial country, where private enterprise and speculation attempts and effects so much, will, by their success, prove the accuracy of his judgment, and his capacity, as an adviser, to lead spirited undertakers into future operations of the same kind. In short, that the success of an engineer depends, perhaps, more on the beneficial results of his works to the proprietors, as commercial speculations, than on his own masterly conquest by art over natural difficulties. But the engineer should further look at this subject in a higher point of view, and consider that all unprofitable expenditure is so much waste of the resources of a country, and that, of all professions in society, his is the one most called upon to direct the laying out of large sums on what may truly be considered national objects, for the judicious and beneficial results whereof he is responsible, and consequently, whereon his reputation must ultimately depend. Referring to an expression in a late lecture, the Professor observed, that he by no means intended to represent that it was not necessary in the construction of railways, to reduce the natural undulations of a country to uniform inclinations, but that it was to be maturely considered at what cost such advantage is to be acquired, keeping constantly in view a comparison of this cost with the working expenses of a line more or less perfect. It was the investigation of these *working expenses* that was now to be entered on. In proceeding to do this, Mr. Vignoles observed that he considered it by far the best way to reduce to a mileage not only their gross sum, but also each of the items, these being again subdivided as far as possible. By a "mileage" he understood the result arising from dividing the periodical amount of the expenses by the total number of miles run by locomotive engines *with trains after them.* The Professor insisted that this was the proper way, and gave a number of reasons for his opinion, and for not at all considering the expenses with reference to any proportion they might form of the gross receipts—the two sources of income and expenditure being perfectly independent of each other; and Mr. Vignoles further thought this mileage comparison was the only one from which correct results could be drawn, and whereby materials and experience might be collected, so as to result in the practical benefit of companies being able, before long, to enter into contracts for most of the items of expenditure at given rates. Some companies had already contracted with each other for the supply of locomotive power, carriages, etc. at a mileage; the maintenance of the way was now almost universally paid for by the lineal mile of rail, and he had no doubt but that, after a little more experience, other of the working expenses of railways would form subjects of such a kind of contract.

Mr. Vignoles then proceeded to enumerate the general heads of these expenses, viz. 1, *locomotive power*, subdivided into drivers' wages, fuel, oil, hemp, etc. ordinary repairs, water and fuel stations, reserve fund; 2, *carriages;* 3 *maintenance of line;* 4, *police;* 5, *conducting traffic and stations;* 6, *rates and taxes;* 7, *Government duty;* 8, *miscellaneous charges;* 9, *management.* These were the proper items, exclusive of interest on loans, which, although to be deducted before a dividend could be made, of course formed no part of the positive working expenses of a railway. The Professor then went into a minute analysis of these several items, as actually disbursed on certain railways of various lengths, and particularly of various gradients, explaining the reasons of excess or of diminution in one or other item on the respective lines, exhibiting also comparative tables, and making many valuable observations upon abtaining the best attention and greatest economy from the servants of a public company, by instituting premiums graduated in proportion to the diminution of annual working expenses.

Locomotive power.—In considering this item, Mr. Vignoles showed, from an average of a number of lines, where the arrangements were properly established, and the railway had been long enough at work to have got all matters systematically arranged, the subdivision per mile per train might be taken as follows—viz. wages, 2*d.*; fuel, 4*d.*; oil, hemp, etc., 1*d.*; making 7*d.* per mile as the mere cost of motion, exclusive of repairs of any kind. This might be considered as applicable to an average of six or eight carriages per train. Heavier trains only came occasionally in the course of the 24 hours, and unless upon lines having exceedingly favorable gradients, auxiliary engines were then applied, the cost and mileage of which being included in the annual accounts, the above rate of calculation would still apply. On railways not having a very considerable traffic, the number of carriages, on the average, were fewer than above stated, and the engine and tender might be fairly taken as constituting half the gross load of each train. The items of wages and oil, hemp, etc. would not materially vary on different lines, except, perhaps, the first, or on short lines with very great traffic, with quarter or half-hour trains, such as the London and Greenwich railway, the Dublin and Kingstown, etc. The fuel would be a variable quantity, but it would rarely exceed 6*d.* Next must be taken the ordinary repairs, and the Professor stated that in no case was the old adage of "a stitch in time" so applicable as in a constant vigilance and daily inspection and remedy of the smallest defect in locomotive engines. A plentiful stock of engines of the very best materials and workmanship, and an efficient and roomy repairing establishment, though somewhat costly at first, would be found to be the means of keeping down the expense of repairs to a low figure. The amount of this item spread over a year's working appeared to average, on well-regulated lines, about 7*d.* to 8*d.* per mile; some instances had been as low as 6*d.* The expense of water and fuel stations varied from ¼*d.* to ½*d.* per mile. The reserve fund was an arbitrary charge; Mr. Vignoles assumed that about 10 to 15 per cent. on the ordinary repairs would be sufficient—say 1½*d.* Thus it would seem that the total cost of locomotive power ought to be about 15*d.* to 16*d.* per mile per train. In some instances it had been reduced so low as 1*s.*; in others this amount had swelled to 18*d.* and even up to 2*s.*

Mr. Vignoles then analysed the other heads of the working expenses—viz. carriages, which he seemed to consider an expensive item, varying from 4*d.* to 6*d.* per mile per train—say from ½*d.* to 1*d.* per carriage per mile, including the various descriptions of vehicles for passenger traffic. The maintenance of the railway varied most remarkably, from 2*d.* per mile per train (which had been the cost on the Dublin and Kingstown railway, and was now even lower, and Mr. Vignoles believed that on the Greenwich railway this was also a small item, since they had replaced their stone blocks by timber supports,) up to 1*s.* per mile per train, which was the cost on several lines; but, on a railway with the upper works properly constructed, he thought that 6*d.* to 8*d.* per mile per train ought to keep a double road in good order, including a reserve or depreciation fund for renewing the iron rails—a contingency that should by no means be lost sight of. The Professor her made a long digression on this item, as to how much of the cost should be assigned to atmospheric causes, and all collateral and contingent circumstances; how much to the mere dislocation of the upper works; and how much to the positive wear and tear of the iron; and pointed out some remarkable instances of saving in maintenance, where the longitudinal timber bearings had been adopted. The charge of police varied from 1*d.* to 6*d.* per mile per train, according to the vigilance exercised; in placing 2*d.* per mile as an average it was to be considered only as an approximation. Conducting the traffic and stations was an item that did not seem to differ much on the various lines; for the passenger department it appeared to be about 5*d.* Local rates and taxes would, of course, vary materially; the poor rate formed a serious charge on all railways; this item was indirectly contingent on the actual profits of the company; it appeared, however, to be seldom less than 8*d.* per mile per train. Government duty had heretofore been computed at ½*d.* per passenger per mile—henceforth it was to be calculated at 5 per cent. on the gross receipts for passengers only. This would, of course, make greater discrepancies; still, as the new duty on the gross was estimated to be eqivalent to the old duty, an account might be obtained if the number of passengers per train were known. Assuming this number to average forty, taking all the railways of the United Kingdom, the Government duty might be estimated at *5d.* per mile per train. Taking a mean of four or five railways, the miscellaneous expenses were found to be about *2d.* and the management about *3d.* per mile per train. Now, to make a summary of all these, which was, however, to be taken generally, and, of course liable to be affected in the details, but was still interesting to be submitted in a popular form, and might be useful as giving a comprehensive view of the system:

Abstract of the average working expenses of a railway per mile per train.

	s.	d.
Locomotive power—viz. wages. *2d.*; fuel, *4d.*; oil, hemp, etc. *1d.* ordinary repairs, *7d*; water and fuel stations, $\frac{1}{2}d.$; reserve fund, $1\frac{1}{2}d.$	1	4
Carriages,	0	4
Maintenance of line;	0	8
Police,	0	2
Conducting traffic and stations;	0	5
Local rates and taxes,	0	3
Government duty on passengers;	0	5
Miscellaneous expenses;	0	2
Management;	0	3
Total,	4	0

Mr. Vignoles did not, by any means, pretend that this was other than a probable approximation. Some lines had been worked at a lower rate per mile per train, including all the above expenses; for example, the latest accounts of the North Union railway show the cost to have been only *3s. 4d.*, not including any funds for reserve. The professor himself thought that *3s.* was a fair sum, exclusive of taxes and duty, which, however, together form a large proportion of the expense. On the other hand, there were instances in which the expenses had gone up to *5s.* per mile per train. He considered it would be a great public benefit if all railway companies, in their reports, would give fuller details of the working expenses, and state the number of miles run *by trains*. Some few boards set a very good example in this respect. This was sometimes done for locomotive power, but the miles should only be computed as actually run with the trains, and not to include the various extra distances passed over in manœuvres, piloting, signals, etc., which, though necessary, were not part of the actual mileage of trains.

The Professor then drew the attention of the class to the fact, that the locomotive power formed about one-third of the gross expense, and of that one-half only is likely to be affected by the gradient or load, being only one-sixth of the whole of the working expenses, which was but a small item upon which a saving was to be made, to justify a railway being constructed theoretically perfect, unless the traffic was likely to be continued, regular, and very heavy. He further observed, that though he had proposed, for the sake of an easier comparison, to reduce all the items of the working expenses of a railway to a mileage per train, it was manifest that a considerable addition to the number of trains daily, and, of course, to the number of miles run, would very materially affect the locomotive power only. The taxes would be contingent on the receipts; and all the other items would be increased but in a very small degree, on the annual totals, by an increase in the number of the trains with a carriage or two less at a time. It was important to remember this, as it affected greatly the question of laying out railways. Mr. Vignoles insisted that the extension of railways in England, especially in remote districts, would not be carried into effect until this subject had been more closely analysed, and had become better understood. Looking at the practical working of the Newcastle and Carlisle, the North Union, the Manchester and Leeds, the Sheffield and Manchester, as far as opened, and other lines, all having very heavy gradients, and contrasting their working expenses with those of lines whose inclinations were much more favorable, the average cost per train per mile did not vary greatly. Lines which had been formed at a cost of from £50,000 to £60,000 per mile, a large portion of which was to obtain perfect gradients, seemed to require little less to work them than lines costing only from one-third to one-half that sum. It is true they might be able to carry heavier trains, and did so carry them occaaionally, but the average was very nearly what had been stated, and, besides, the public were best accommodated by lighter trains going more frequently. The Professor said, he could only hope that his arguments would draw attention to the subject, and that when, after the analysis of the cost of all the railways had been brought out in the way shown in his last lecture, and that of the working expenses, as in the present one materials would be obtained for the solution of the problem, of what must be the rule for constructing lines of passenger railways hereafter.

ELECTRO-MAGNETIC RAILWAY LOCOMOTIVE.

A trial of this very ingenious machine, constructed by Mr. Davidson, was made last month on the Edinburgh and Glasgow railway, in presence of a number of gentlemen, many of whom were eminent for their scientific knowledge. The construction of the carriage is the first attempt which has been made in this country to apply the powers of electro-magnetism to railway traffic, and from the success which attended this trial, sanguine hopes may be entertained that the period is not distant when it will either supersede, in many cases, the employment of steam, or lend a powerful aid to this mighty instrument in all the operations in which it is at present employed. The carriage was impelled along the railway about a mile and a half, and travelled at the rate of upwards of four miles an hour, a rate which might be increased by giving greater power to the batteries, and enlarging the diameter of the wheels. We understand that the carriage was built at the expense of the railway Company, and we cannot but congratulate them in having the discernment to employ Mr. Davidson, a gentleman of much practical knowledge and talent, to whose genius great discoveries have been made in electro-magnetism, by whom the carriage was projected, and to whose unwearied exertions the practicability of the scheme is almost placed beyond a doubt.

The dimensions of the carriage are 16 feet long by 7 feet wide and is propelled by 8 powerful electro-magnets. The carriage is supported by four wheels of 3 feet diameter. On each of the two axles there is a wooden cylinder, on which are fastened three bars of iron at equal distances from each other, and extending from end to end of the cylinder. On each side of the cylinder, and resting on the carriage, there are two powerful electro-magnets. When the first bar on the cylinder has passed the faces of two of these magnets, the current of galvanism is then let on to the other two magnets. They immediately pull the second bar until it comes opposite them. The current is then cut off from these two magnets, and is let on to the other two. Again they pull the third bar until it comes opposite, and so on—the current of galvanism being always cut off from the one pair of magnets when it is let on to the other.

The manner in which the current is cut off and let on is simply thus:—At each end of the axles there is a small wooden cylinder, one-half of which is covered by a hoop of copper; the other is divided alternately with copper and wood (three parts of wood and three of copper.) One end of the coil of wire which surrounds the four electro-magnets, presses on one of these cylinders, on the part which is divided with copper and wood; the other end of the coil presses on the other cylinder in the same manner. One end of the wires or conductors which comes from the battery, presses constantly on the undivided part of the copper on each cylinder. When one of the iron bars on the wooden cylinder has passed the faces of two magnets, the current of galvanism is let on to the other two magnets, by one end of the coil which surrounds the magnets, passing from the wood to the copper, and thereby forming a connexion with the battery. This wire continues to press on the copper until the iron bar has come opposite the faces of the two magnets, which were thus charged with magnetism. On its coming into that position, the current is cut off from these two magnets, by the wire or rod of copper passing from the copper to the wood and thereby breaking the connexion with the battery. But when the wire or rod of copper leaves the copper on the one cylinder, it leaves the wood, and passes to the copper on the other cylinder at the other end of the axle, and in so doing connects the other two magnets with the battery, and they pull the next iron bar in the same manner. At the other end of the carriage there are other four magnets and wooden cylinder, with iron bars arranged in the same manner.

The battery which is used for propelling the machine is composed of iron and zinc plates immersed in dilute sulphuric acid, the iron plates being fluted so as to expose greater surface in the same space. The weight propelled was about six tons.—*Edinburg Eve. Journal.*

Naval Experiments on the Defences of Steam Boilers.—A highly interesting experiment was tried at Portsmouth last month, on board the Excellent gunnery-ship, Captain Sir Thomas Hastings, to test the efficacy of the defences of the boilers in steam-ships of war. One of the greatest difficulties to surmount, in order to render the steam navy of greater efficiency in action, is to afford adequate protection to the boilers against the shot of the enemy, as a ball perforating them would at once place a vessel *hors de combat.* With the view of affording this protection to the boilers, several war steamers have been fitted up with extra defences at the parts where the boilers are fixed. These defences consist of 15 plates or layers of metal, each $\frac{5}{8}$ inch thick. The object of the experiment on board the Excellent was to ascertain what resistance these defences of boilers would offer to a cannonade at point blank distance, which is 400 yards. An iron target was prepared, made exactly of the material which constitutes the protection of the boilers of a steamer, and placed at the distance of 400 yards from the ship, from which guns at different calibre were fired at it. Admirals Sir E. Codrington and Parker, and a great number of naval officers, including those from the Austrian frigate, were present to witness the experiment. The first shot that was fired was an eight-inch hollow shot, and was projected from a 68-pounder, medium gun. It struck the bull's-eye, or centre of the target, and, slightly indenting it to the depth of about 5 in., rebounded therefrom, and was split into several pieces by the concussion. The second shot was a solid 32-pounder, and was fired from a gun of 9 ft. 6 in.; it struck the edge of the target, glanced off, and was split into two pieces. The third shot hit the centre of the target, where it lodged, having penetrated several plates. The fourth shot struck the third, and sent it clean through all parts of the iron, splitting it into numberless pieces, which were found on the off-side of the wooden stage on which the target was fixed. The fifth and sixth shots went through the perforation made by the third and fourth. About 10 other shots were fired, all striking the target in various parts, and completely destroying it. The result of this experiment has shown how totally inadequate are the present defences of the boilers of war steamers to protect them from the assaults of the enemy where a precision of fire had been attained.—*Times.*

THE CROTON WATERWORKS.

In order to understand the real magnitude and value of the Croton Waterworks, our readers may refer to the following article from the New York Commercial Advertiser. The work, as the editor observes, is worthy in its conception and design to form an era in history, from the utility, vastness, and simplicity of the undertaking. For centuries to come, it will stand a noble monument of the enterprise, art, and science of the present generation. No population of three hundred thousand ever before executed such a plan—not undertaken to mark a field of battle—nor, like the vast walls of China, Rome, or of modern Paris, in preparation for defence in war. On the contrary, the Croton aqueduct regards the health, temperance, and happiness of myriads of the present generation, and of ages to come. Annexed is the brief historical and descriptive account, which is full of interest:

"The work was commenced in July, 1835, and the whole amount of expenditure since (Aug. 8), has been $7.606,213 84. Here are some of the principal items:

Aqueducts, reservoirs, bridges etc.	$6,370,587
Salaries of engineers, etc.	503,042
Law expenses	16,138
Real estate purchased	349,932

The whole line is divided into one hundred and one sections, generally half a mile long, and the first is the Croton dam, by which the Croton water is collected. This embankment is 250 feet long, 65 high, and 55 wide at the top, and is made of hydraulic stone masonry. The beautiful sheet of water thus formed has been named the Croton River Lake, to distinguish it from the artificial reservoirs; it covers four hundred acres of land, and will contain six hundred millions of gallons. This will allow a discharge of thirty-five millions of gallons every day, an ample supply for a long time to come. Other dams can increase the quantity if it shall be ever needed.

In the distance of 25 miles through Westchester county are passed an arch bridge of 88 feet, 12 tunnels or excavations under ground for the acqueduct, the aggregate length of which is 4,406 feet; 32 ventilators and four waste-weirs for the discharge of surplus water; and all are finished at an expense of about four millions of dollars. At section 86 the aqueduct crosses the Harlem river; here a bridge is now building for this purpose, which is indeed a Herculean task, requiring more skill and watchfulness than any part of the whole line. It will consist of seven arches over land, and 50 feet span, with eight arches over water of 80 feet span, and when finished will nearly equal in dimensions any bridge in the world. Its cost is estimated at one million of dollars, and its elevation is so great as not to impede the navigation of the stream; thus taking care of posterity and the wants our metropolis when she shall have extended to the Harlem river. Some idea of this vast undertaking may be formed from the fact that the excavation for one pier has been carried 34 feet below the surface of the water, and then, a rock foundation not having been reached, 240 piles, from 30 to 40 feet long, were driven in for the purpose. Several piers have been already carried, by the aid of coffer dams, from four to fifteen feet above high water mark.

"Nearer the city there are more than 1,200 feet of tunnels cut through rock for two lines of iron pipes, 36 inches in diameter. Section 96 embraces the receiving reservoir at Yorkville—an immense structure, covering a surface of 32 acres, resembling an inland lake, and containing 158 millions of gallons. The walls and embankments are of the most massive and durable construction, and the whole is enclosed by a beautiful iron railing. The next two miles form the connecting link with the distributing reservoir on Murray's hill. This is a beautiful spot, and an admirable piece of workmanship, of solid granite, in form square, but much smaller than the other reservoir. Around its elevated summit, 115 feet above mean tide, and 31 feet above the surface, is a noble and broad walk, affording a most extensive view of the city, the Hudson, and the the surrounding country.

The work south of the distributing reservoir consists in laying pipes to supply the lower part of the city with the water. More than 100 miles have been finished, and 30 more are yet to be added. Splendid public fountains will be built in our principal squares and public places, furnishing a supply of water to the poor, and highly ornamental to the city. Those at Union square and the Park are now in operation; the basin of the latter forms a circle 100 feet in diameter, with a turf bank, and the jets rise to a height of 55 feet. The former has a basin 60 feet in diameter, and three feet deep, with various jets 60 feet high, the most imposing of which presents the form of a wheat sheaf, resembling one in the court of the Palais Royal at Paris. Both fountains are strikingly beautiful, and few in the world are of equal dimensions.

The whole length of the aqueduct is 32 miles; its foundation is stone, and a bed of concrete made from broken granite and hydraulic stone; the sides are of hammered stone, and the floor an inverted arch of brick eight inches thick; the upper arch the same. On the 8th of June last the superintendents went through the aqueduct on foot, and the whole being found complete, on the 22d the water was admitted to the depth of 18 inches. 'The Croton Maid,' a small boat prepared for the purpose, and holding four persons, was then placed in the aqueduct, and navigated its entire length by some of the same party. This novel voyage was made sometimes at a depth of 75 feet below, and then again 80 feet above, the natural surface of the earth, at the rate of a mile in 40 minutes, the velocity of the current. When four feet deep this will probably reach two miles per hour.

On the 27th the water was admitted into the immense receiving reservoir in the presence of a large assemblage, including the Mayor, Governor, Military, Firemen, etc. etc. To this basin the stream was admitted on the 4th day of July, amidst general and imposing demonstrations of public joy.

Since then the water has continued to flow about two feet deep through the aqueduct, delivering into the receiving reservoir twelve millions of imperial gallons per day, and as yet only five or six millions in the pipes; nor has any defect been found in any section of the work. The Harlem bridge is alone unfinished, and it will require a vigorous prosecution of that work to finish it in two and a half years. In the mean time the temporary pipes used there answer every purpose for the passage of the water. Over twelve millions of dollars is the estimated cost of the entire work when done. From ten to twelve dollars is the rate charged per annum to families for the use of the water; its own force carries the stream into the highest stories of the most elevated buildings. The names of Major Douglass and his successor John B. Jervis, Esq., the engineers, will be connected with the Croton aqueduct as long as it endures. We have heard of the 'seven wonders of the world.' This may justly be considered the eight; and, although last in time, it is amongst the foremost for its magnitude, expense, and public utility."

Astronomical Clock at Strasburg.—An astronomical clock of remarkable ingenuity has lately been constructed at Strasburg by a M. Schwilgue. It is composed of three parts, respectively indicating the time of the day, the day of the month and year, and the movements of the constellations. The central moving power, which is another and very exact timepiece, shows on the face the hour and its subdivisions, strikes the hours and the quarters, and puts in motion several curious allegorical figures. The cock-crow, which had been mute since 1789, has been reproduced, and a procession of the apostles takes place daily at noon. The calendar shows the months, the days, and the dominical letter, as well as the Catholic calendar, showing every Saint's day in the year. The plate or face on which these figures and signs appear makes one revolution in 365 days for the common, and 366 for the bissextile year, always reproducing the irregularity which takes place three times in every four secular years. The moving fasts and feasts are shown by an extremely ingenious process. On the 31st of December, at midnight, Easter day and the other moving feasts for the year appear on the calendar. The third division is the triumph of the artist's skill. A complete orrery after the Copernican system is produced. The movements of all the planets visible to the naked eye are represented. The earth is shown accompanied by her satellite, the moon, which accomplishes her revolution in one month. The different phases of the moon are represented on a different and separate globe. Another globe represents the apparent movement of the heavens, making one revolution in the sideral day. This movement. is subjected to that almost imperceptible power, known by the name of the procession of the equinoxes. The mechanism, besides many other things, shows the apparent movements of the sun and moon with wonderful precision, and for an indefinite period so that the rising and setting of the sun, its passage to the meridian the eclipse of the sun and moon, etc., are all represented on the face of the apparent time in a most ingenious manner.

Electrical Experiment.—In the course of experiments instituted by Messrs. Wright and Bain for the improvement of their electrical telegraph, they discovered that the electric circuit of a galvanic battery is as effectually completed through a large body of water as through an insulated wire. They have applied this curious discovery so effectually as to be now able to dispense with two of the wires heretofore thought necessary for the action of their printing telegraph; and they are thus enabled to print all communications, either verbal or symbolical, at any distance, by the use of a single wire. We understand they are now in treaty with the government to construct a telegraph on this principle between the admiralty and Portsmouth. One insulated wire would be laid down between the two points, to connect the galvanic battery of the outport with the printing apparatus of the Admiralty, and the return current would be sent through the earth in lieu of using a second wire to complete the circuit. Should the moisture in the ground not prove sufficient to conduct the electricity, the inventors propose to transmit the return current by water; making it pass down the Thames to the German Ocean, and thence along the Channel to Portsmouth; this roundabout voyage to be performed instantaneously. By thus simplifying, and consequently greatly reducing the cost of the electrical printing telegraph, the inventors have gone far towards rendering it generally available; another step in advance will dispense with all metallic connection whatever.

The Manufacture of Watches by Machinery.—A gentleman, who has devoted twenty years of his life to the subject, has made a variety of machines by which an incredible number of watches, of every variety of size, may be made in a day. By one of the machines 300 perfect plates can be produced in a day, by another the same quantity of barrels; by five machines the requisite number of centre, third, and fourth wheels (crossed, polished and cut) with balances for 300 movements. By another 200 pinions can be cut and rounded; by another the holes are drilled, the tapping, the screw-holes, the various parts in the plate are sunk, planting the depths and escapement, etc., and all with such exactness as cannot be excelled, another for the making and polishing of pivots, etc. Four other machines will be sufficient for making pivots for 50 movements a day; and to add to these, there are 20 other machines for every description of work connected with the watch making, and which altogether constitute a set. The inventor has submitted these machines to the scrutinizing inspection of the most experienced makers of chronometers and watches in London, and not one has expressed a doubt of the work so produced being incomparably superior to that done in the usual way. Among other distinguished names in the trade we have observed those of Mr. Barwise, Mr. Earnshaw, Mr. Hewett, Mr. Vieyres, Messrs. Frodsham and Co., with about a hundred watchmakers in the country, who, with the Duke of Hamilton and Mr. Howell, (of the firm of Howell and James,) at their head, are engaged in carrying out the great and national object of restoring this lost and important manufacture to England by means that while they greatly lessen the price, will improve the quality, and entirely undersell our foreign rivals, and be very largely profitable to all parties concerned.

Dredge's Suspension Bridge.—A new iron suspension bridge on Mr. Dredge's principle has just been completed, at Wraybury, in Buckinghamshire, about 20 miles west of London. It is stated to be a very light and powerful structure, and is not half so expensive as is the timber centreing for a common stone bridge of the same magnitude. It is 17 ft. wide, 100 ft. span, and is intended for every description of traffic. It is perfectly level from end to end. It was completed in three weeks after the foundation stone was laid.

Caoutchouc Cement.—M. Valle, a color maker, observing the injury caused to the works of some of the greatest masters by the influence of the atmosphere upon the canvass, has invented a solution (said to be of caoutchouc) which, although applied to both sides of the canvass, leaves it sufficiently elastic to prevent cracking, and secures it against the action of the atmosphere. To this he adds a peculiar kind of varnish for the painting, which is said to defy the ravages of time.

Mr. Jeffrey's Cement.—Some further experiments have been made in the marshes at Woolwich. A block of wood submitted by Mr. Jeffrey was bored to the centre, exactly in the middle of the joining, and a 5½ inch shell inserted, for the purpose of tearing it to pieces. On a port-fire being ignited, the shell soon exploded, tearing the solid wood in all directions, and into numerous fragments, but in no part separating the pieces where the joining with the cement was made.

The Galvano-plastic Process.—A proposition has been made by M. Corney to employ this process after embalmment, for the preservation of the human body after death. The idea, however extravagant it may appear, is said not to be original, and that beautiful specimens are to be seen of small animals, birds, insects, etc., which have been thus preserved by M. S[illegible]z, of the Place Vendome.

A German paper states that a proposition has been made to the Porte for the construction of a railroad from Constantinople to Adrianople, and that it was well received. The ground, however, between the two places is so difficult, that the work, if undertaken at all, will be one of great time and expense.

AMERICAN

RAILROAD JOURNAL,

AND

MECHANICS' MAGAZINE.

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CANALS OF CANADA; THEIR PROSPECTS AND PROBABLE INFLUENCE ON THE COUNTRY. *By* W. R. CASEY, *Civil Engineer.*

An account of the great public works now in progress in Canada will probably have some interest for most of the readers of the Journal.

Many of the newspapers are bringing forward their "ship canals" as rivals likely to sweep away the western trade from the Erie canal, because they are 8 or 10 times larger, avoiding all allusion to their cost increasing in the same ratio, or very nearly so. They also do not inform us how the main consumers of the produce of the west—the people of New York, New England, New Jersey, the Army, Navy, commercial marine, etc.—are to receive their supplies via the St. Lawrence; and, although exaggerating the really great advantages of that route as far as tide-water, say not a word of the immense superiority of New York as a port of shipment, open throughout the year, and with rates of freight scarcely half those from Montreal to England. The average difference is from 2*s*. to 2*s*. 6*d*. stg. per barrel of flour, though the last Montreal quotations were 6*s*. sterling to "London, Liverpool and the Clyde," the New York rates being at the same time, 1*s*. 6*d*. sterling. Now the average rates from Lake Ontario to Montreal, are 1*s*. 6*d*. sterling, per barrel of flour, which is only two-thirds the difference in favor of New York; so, that were flour carried for nothing from Kingston or Ontario to Montreal, that city would still be unable to compete with New York on equal terms. Western flour is delivered at Montreal for about 10*d.* sterling per barrel less than at New York, but the natural advantages of New York, as a port of export, more than counterbalance the advantages which Montreal derives from the downward navigation of the St. Lawrence; and, but for the English corn laws, the western trade of Lower Canada would be limited to the quantity required for home consumption.*

That portion of the western trade which seeks a foreign market via the St. Lawrence, is attracted by political rather than national or engineering advantages, and, to this extent, does not come within the province of this Journal. The works now in progress, however, are to reduce the cost of transportation from Ontario to Montreal, and, as this is the highest engineering consideration involved in their projection, its discussion in these pages is anything but out of place.

It may be well to glance at the Welland Canal—the feeder of the St. Lawrence canals. The locks of this canal were originally of wood, but the Canadian government is now replacing them with locks of stone, 120 feet long 26 feet wide, and 8½ feet water on the sill, which will easily pass lake craft of 150 tons burden. The original cost was £491,777 currency ($4 to the pound) and the sum required for its completion, is estimated at £450,000—say 4 millions of dollars on about 36 miles of canal, requiring an income of $240,000 to clear expenses and 5 per cent. interest. It is said that the income this year will reach $100,000, and the writer believes it will eventually cease to be a burden on the Province, from the very peculiar advantages it possesses over every route which can be projected in the state of New York for the trade of Lake Erie; which advantages are given at length, in an article on the "spring trade," in this Journal of 15th April last.

Steamboats have for many years descended the St. Lawrence about 100 miles below Kingston, where the first canal begins. This branch is called the Cornwall canal, and is just opened. It is 11½ miles long, 140 feet wide by 10 feet deep, locks 200 feet long in the chamber, 55 feet wide and 9 feet water on the sill. Lockage 48 feet, cost $1,600,000 without any protection to inner slopes.

* Competition on equal terms with New York is generally considered impracticable in Canada, though it appears to the writer, that, by carrying western produce to Quebec in the St. Lawrence barges and transhipping there, some saving might be effected.

This work reaches from the head of the "Long Sault" to "Lake St. Francis," as the next 40 miles of the river are called. At the foot of this lake commence the "Coteau" rapids, then the "Cedars" and the "Cascades," in which distance—15 miles—the St. Lawrence falls 82 feet, expanding again into "Lake St. Louis." These rapids are to be surmounted by the "Beauharnois canal," commenced last summer; 120 feet wide, 10 feet deep, locks 200 by 45. *Estimated* cost £255,900 ($1,023,600.)

Lake St. Louis is about 24 miles long and is connected with the port of Montreal by the Lachine Canal, around the Lachine rapids, which has been in operation many years. It is 9 miles long, lock 100 by 30 with 5 feet water on the sill. Lockage about 40 feet. This canal varies much in width and depth like the Erie canal. Its enlargement has just been commenced.

The distance (by steamboats and stages,) is estimated at 180 miles, of which about 105 miles are still-water, 40 miles strong current though navigable, and about 35 miles are rapids, the river falling about 170 feet in that distance, though not uniformly, about 100 feet occurring in less than 10 miles.

Lake Ontario and Montreal are also connected by the "Rideau," a military work, which is used for the ascending trade. Distance by this route about 240 miles.

The down-trade is by the river, about 200 miles, barges and small steamers running direct from Kingston to Montreal. The draft of water is limited by the depth in the "Cedars," where, at lowest water, a vessel cannot pass, drawing more than 4 feet, to 4 feet two inches. It must be observed that nothing has ever been done to improve the down-trade of the St. Lawrence, and, the writer believes, that a sum not exceeding £20,000 cy. would give 5 feet water at lowest water in the Cedars, besides less important improvements, such as removing boulders, placing buoys, etc., at other places. In the spring of 1841, a large steamer from Ontario passed over all the rapids for the first time. Previous to this the trade had always used the Lachine canal both ways, but, during the past summer, the leading forwarders sent their barges and steamers over the Lachine rapids; their example was followed by others, and, finally, the Insurance Companies were forced to include *these* rapids in their policies.

These little steamers are only 20 feet beam—some with paddle-wheels, others with propellers—and take both passengers and freight. The barges carry from 1000 to 1400 barrels of flour, and, with the trifling improvement above spoken of, would average about 1500 barrels. The charges may be taken, throughout the season, at 35 cents, (1*s*. 9*d*. cy.) per barrel of flour—insurance about 2 cents per barrel. The up-freight is comparatively small in amount, as the merchandize, consumed by the farmers who produce the flour, etc., which descends the St. Lawrence, reaches them through the Erie canal. Notwithstanding this, the charges from Montreal to Kingston differ little from those up the Erie canal.

Now the grand question is, how much will the canal reduce the cost of transportation—more especially on the down-freight, which is indeed the only *great* consideration; for, if the western states are to receive their merchandize via the St. Lawrence, this up-freight will be regulated entirely by the down-trade, if, as at present, via the Erie Canal, the down-trade becomes the *only* consideration.

The proportions of the locks show that these canals are to be navigated by large steamers, the Welland canal is a schooner canal, hence the success of the work rests on the difference in cost of freight from Kingston to Montreal, in steamboats, as compared with the present mode by barges; transhipment being of course necessary in both cases at Kingston. The lake schooners may go to Montreal, but, as they only require locks 26 feet wide, it is clear that the projectors of these canals looked *principally* to steamboats to warrant the enormous difference in cost.

The government of Canada, like that of New York, proposes no reduction of tolls in consequence of enlargements. The tolls of the Lachine canal are 2*d*. cy.=3⅓ cents per barrel of flour for 9 miles, the boat pays $4, the hauling costs $2 50; in all $39.83 per 1000 barrels for 9 miles = very nearly 4 cents per barrel. Steamboats do not require towing, hence the cost by canal will be $2,-50 less = $37.33 per 1000 barrels, supposing the steamer to pay nothing additional on account of injury to banks, lock gates, etc. Assuming the tolls on the great canals to be no higher than on the old Lachine canal, we have for 36 miles of canal 15 cents, (14.932) or 9*d*. cy. per barrel for these charges alone, leaving the forwarder only 20 cents per barrel for 180 miles, on which sum the saving—if any—must be effected.

We may safely take the rate from Albany to New York by the Hudson, as the lowest possible, because—the navigation is scarcely equalled—a single steamer tows 3 or 4 barges of from 200 to 500 tons each, and frequently a dozen canal boats besides—the competition is great—they have the advantages of many years experience—the navigation is open during 8 1-2 to 9 months in the year—the up-freight is large and the number of emigrants also great. The charge is still 12 1-2 cents per barrel of flour carried 150 miles = 15 cents (9*d.* cy.) per barrel, for 180 miles, carried in barges towed* by steamers under the most favorable circumstances. But if the freight be carried *in* the steamers—if the up-freight be trifling—if the navigation be far inferior, 36 miles indeed of strong current bordering occasionally on rapids—if the season be shorter and the total amount of business not to be mentioned with that of the Hudson—it will at least not be allowing *too much* to add one third for the same duty on the St. Lawrence which gives 20 cents (1*s.* cy.) as the minimum probable, or rather possible cost per barrel of flour, carried from Kingston to Montreal, in large steamers, via the St. Lawrence canals, exclusive of tolls.* These are, even on the present Lachine canal, at the rate of 15 cents, (9*d.* cy.) and that the enormous sum to be laid out on its enlargement—estimated at $100,000 per mile—is to reduce these tolls, will be asserted by no man of ordinary intelligence or integrity.

All the pilotage and the greater part of the insurance will be saved, by using the canals; the former is $8 per barge and two thirds of the latter 1 1-3 cents = $21.33 per 1000 barrels against $149.-32 by the canals. The latter could be used when gales or head winds would render the rapids impracticable to barges without steam—on the other hand, the saving of time by the rapids would *generally* be about 12 hours, and they can be navigated earlier and later than the canals, as is only too well known in Montreal, so that the river has the advantage of the canals even in these minor considerations.

But if an additional foot of water can be had in the "Cedars," 1500 barrels will be the average load of the present barges with no other cost to the forwarder than insurance and handling, about 5 cents per barrel, and thus enable him to carry from 27 to 28 cents per barrel or even 25 cents in iron barges. The introduction of such vessels, with the improvements already mentioned, would, in the opinion of the writer, do all that is practicable or even desirable towards giving facilities to a downward trade per day equal to that of the Erie canal per year. Taking every thing in the most

* Flour was carried during the past season from Montreal to Quebec for 5d. cy. per barrel, equal 8 1-3 cents, also from Kingston to Montreal for 25 cents, but at a loss in both cases.

favorable light, it appears at least, barely possible, that the contemplated plan of carrying freight in steamboats, should be equal in economy to the present mode of transportation without any other than the natural advantages of the St. Lawrence.

It will be said that barges may be towed on the St. Lawrence as on the Hudson. But why then build steamboat canals at 7 times the cost and with 3 times the tolls of a canal for barges, when the tolls on the steamer alone must be more than the cost of towing the barges by horses. If barges are to be used, all acquainted with inland navigation know, that towing by steamers on natural waters, and by horse power on canals are the cheapest modes of effecting such transportation yet devised.

The good people of Canada have also been entertained with the idea of ships from the ocean taking in cargos at Cleveland and Chicago; but as this journal is not devoted to romance or politics, it is unnecessary to allude to it further than to say, that the same story is now used as a bugbear to frighten the people of New York into a continuance of their insane expenditure; as the enlargement of the Erie canal—now indefinitely postponed—has been used for a similar purpose in Canada. Lake schooners may be taken by the canals to Montreal and thus may transhipment at Kingston be avoided. These vessels *must* go through the canals and pay the tolls which the barges avoid, the capital invested in the same tonage is three times as great, they are much heavier and more difficult and expensive to handle, they will be towed with difficulty above the Long Sault, which objections united and properly estimated could not be less than six times the mere cost of transhipment.

Lastly, there is to be considered, what dimension of barges will carry at the minimum cost. Judging from the coasting trade of all countries, where almost any depth of water may be had as well as full loads, also from the great lakes, it will be found that the average will not exceed 150 tons burden. But, in the present case, there is another element—the cost of the canal—which again should be determined from the present and probable future business within a reasonable period. About 700,000 tons (exclusive of stone, lime, clay, etc. for the enlargement, but including 150,000 tons lumber) pass annually over the Erie canal, of which about 140,000 tons are up-freight. Now it will be looking as far ahead as any man, not ship canal mad, can desire, to assume the up-freight of the St. Lawrence at 70,000 tons per annum. The tolls on merchandize on the Erie canal are 9 mills per 1000 pounds per mile

=2 cents per ton of 2240 pounds, very nearly = for 36 miles $50,400 (£12,600 cy.) for up-freight. Repairs, superintendance and renewals cannot well be estimated at less than $30,000, leaving only $20,000 = at 4 per cent. the interest of a capital of $500,000, a sum just about sufficient to connect Lakes St. Louis and St. Francis by a canal similar to the Lachine. But it is not fair to consider these canals as useful to the *up*-freight only, although their revenue must be almost exclusively derived from it. Hence, increasing the rates 40 per cent. above those of the Erie canal, we shall have $70,-000 gross income or $40,000 nett revenue, the interest at 4 per cent. on $1,000,000 (£250,000), the greatest amount of capital which could be safely invested, as well as a sum, the writer thinks, quite sufficient to have placed the up-trade on the best possible footing. But as the almost incredible sum of $6,600,000 has been spent, or, to speak more correctly, squandered on 11 1-2 miles of the Cornwall canal, there remains only the Beauharnois and Lachine canals on which any saving can be effected by the application of common sense and a little knowledge of the western trade.

The construction of the Beauharnois canal is estimated at £255,-000, the enlargement of the Lachine canal at £225,000, together, £480,000, though, judging from experience in Canada, £750,000 will be nearer the mark. Experience in the same country also shows, that £100,000 to £120,000 will unite lakes St. Louis and St. Francis by a canal similar to the Lachine and adding £30,000 for forming a proper entrance to and clearing out that canal, we have £150,000 against £480,000 by the present plan; the former sum deduced from the actual costs of the Lachine and Chambly canals, the latter directly against the actual cost of the Cornwall canal.

Not only should the least possible amount be expended on the Lachine canal, but the tolls should be immediately reduced to, at most, the rates of the Erie canal, which has no St. Lawrence to contend with. These are about one fourth the rates of the former canal, and as the Lachine is the only one which can by any possibility be extensively used for down-freight, every inducement should be offered to that part of the trade by lowering the charges.*

* The tolls on the Erie canal are 35 cents per barrel of flour carried 363 miles, equal 3.5 cents per barrel for 36 miles canal, equal $35 per 1000 barrels, to which adding charge on boat, and towing, $26, we have $61 as the total canal charges against $28 pilotage and insurance by the river. It is possible that some portion of the down trade might be drawn to the Lachine canal by adopting the rates of the Erie canal after 1st October, and about half those rates during the summer. The saving of wear in the boat and also of time—though the distance is about twice as great—are however in favor of the rapids.

It is unnecessary to more than barely allude to the present policy as leading to a very different result by enlarging the Lachine canal for a very large class of vessels, which, without any reduction of toll, are, from their *size* alone, to reduce the total cost of transportation. It may be incidentally remarked here, that there is a vast difference in the effects on this trade by increasing the capacity of vessels by improvements in the St. Lawrence, and, on the other hand, by enlarging the canals. By means of the former, an additional load is taken in the *same* vessels with a trifling additional expenditure, by the latter, a *new* and *more* costly class of barges must be built, and the tolls—the principal item of charge—are increased in the very same ratio as the load, thus in a great degree, neutralizing the anticipated advantages, besides rendering competition more difficult, on account of the greater capital required. So wretched does the writer consider the present policy, that he does not believe there is an engineer of character, even tolerably well acquainted with the trade of the lakes, who would for a moment hesitate between reducing the Cornwall to or rebuilding it on the scale of the Lachine canal, and enlarging the Lachine to very nearly the scale of the Cornwall canal:—and, so far from attracting trade to the St. Lawrence, these mammoth canals can scarcely fail to have a directly contrary effect by increasing the tolls on up-freight, and leading to odious restrictions and regulations for the purpose of forcing the boats to use the canals downwards, thus—as in New York—mistaking the means for the end.

Indeed the similarity is too striking throughout to be passed by without further notice. In both countries the great aim of government appears to be to effect a reduction of a few coppers on each barrel conveyed from the western states to the Atlantic—to accomplish this pitiful object—which they appear to regard as the great end of human existence—millions are thrown away with a prodigality contrasting strangely with the niggardly sums reluctantly yielded to establish good common roads for the farmers, the vast majority, or even to aid the great cause of education. Within a few years about 20 millions of dollars have been spent on canals in New York, from which no revenue will ever be derived—a direct tax has been lain on all the property in the state, and, for fear of diminishing the income of the Erie canal, and thus rendering further taxation necessary, the citizens of New York are prohibited from using railways for eastern freight, a restriction unknown even in the slave states. There is also another object which beautifully illustrates the results of uniting public works with politics.

If the people of New York were emancipated from their present "peculiar institution," and the trade thrown open to competition, there would be no possibility of plausibly advocating the enlargement of the Erie canal and numerous speculators and adventurers would thus lose all chance of speculation and patronage.

Canada is peculiarly an agricultural country, and nine-tenths of the population would not be in the slightest degree benefitted by any increase of western trade, though *all* must bear their share of taxation if these canals do not clear expenses. The public works required in Canada are better communications from the interior to navigable water, and, secondly, a better commmunication for travel between the eastern and western portions of the province. Without the former the settlement of the country will go on slowly—as in the counties 30 or 40 miles north and south of the Erie canal—and the latter is indispensable, if the trade by the St. Lawrence is to be anything more than a mere carrying trade *from* the western states to the Atlantic. The fare from Montreal to Kingston is (including meals) no less than $10, the time about 84 hours consuming 2 days, the distance 180 miles of which 143 are by steamboat! What would be the western trade of New York with such drawbacks? The—at least—4 millions of dollars required for the St. Lawrence canals would, as already explained, have given the greatest posible facilities to the up and down trade of the river at a cost of about one million, and the remaining three millions would have constructed railways around the rapids of the St. Lawrence, and from the western extremity of Ontario to the outlet of Lake Huron, which would bring Montreal and Sarnia almost as near, with regard to time and cost, as are now Montreal and Kingston. As these railways would undoubtedly clear expenses and interest†—there being a large business—the charge on the provincial treasury for the best desirable communications for both trade and travel would not have exceeded £8,000 per annum. The "prospects" at present are that, without either one or the other, the deficit will be from £50,000 to £70,000 per annum. The improvement of the Cedar rapids, frequently alluded to, forms no part of the policy of the Board of Works; the trifling amounts at which great benefits may often be conferred on the trade having no greater

† The advantages of the contemplated railway across the peninsula of Upper Canada are given by the writer in this Journal. The paper was written in 1837. The railway in the neighborhood of Montreal would command a large local travel, the travel by the St. Lawrenee and Ottewa, the raftsmen, emigrants, etc., and is the only great public work spoken of in Lower Canada in which the writer would feel himself warranted in recommending investments.

attractions for Canadian than for New York politicians;* this plan was brought forward some time since by Mr. Henry Roebuck, and, judging from the feeling evinced in the late short session appears likely to meet with almost unusual favor in the legislature. Should this be effected during the next session, and fulfil the expectations of the projector, experience and common sense may perhaps be permitted to save something "from the fire."

If these stupendous canals prove equally stupendous failures—which to the writer appears inevitable*—their "influence on the country" may be predicted with great certainty from the results of a similar course of folly and extravagance in some of the western states. Indeed the Lower Canadians consider that the union alone saved the Upper Province from bankruptcy, and, but for the fear of disturbing their countrymen in office, would at once introduce the admirable system of finance which characterized the Lower Province before the Union. This will however soon be impracticable, and, as in New York, the people must pay by taxation the interest on the engineering capers which are cut by their rulers.

It is impossible to overrate the injury to the profession and to the cause of public works arising from these unfortunate and unprincipled extravagancies. The engineer is viewed as a man whose trade it is to aid the private or political adventurer in fleecing the public;—what individual would invest his own money in works projected by and to be executed under the direction of men who refer to the ship-canals of Canada or to the "lateral canals" of New York as evidences of their skill? to men who carefully avoid, or are incapable of applying that great principle, without which engi-

* The Chairman of the Board of Works is a Member of Parliament and of the Executive Council or Cabinet! The money is voted in the lump to be laid out pretty much as the Board pleases, and the "division of the spoils" is laughable. Of about £320,000 appropriated to common roads, £75,000 are to be expended in the Lower Province, containing two-thirds of the inhabitants; so that, according to the Board of Works, one Upper Canadian is entitled to more than eight Lower Canadians. Of the £245,000 to be laid out in Upper Canada, about £170,000 are to be laid out in the extreme western part of the province, and the rule of apportionment appears to be, that the amount expended, shall be inversely as the magnitude of the interests to be accommodated by roads as well as canals. The intelligent reader will not fail to observe that the total amount spent or to be spent on canals for forwarding is many times greater than the £320,000 to be spent on the roads to accommodate the agricultural which is twenty times greater than the forwarding interest; though it should be observed that the forwarders are not to be held responsible, as they think very little of the "ship-canals." (Memoranda, 12 Aug. 1841.)

* The great majority of persons with whom the writer conversed on this subject in Montreal and Kingston, including French and English Members of Parliament, forwarders and other competent persons entertained a similar opinion—some loud in their denunciations, others afraid to investigate the subject.

neering cannot rise to the dignity of a liberal profession—*the adaptation of expenditure to income*—of the means to the end?

The writer will conclude with remarking that no system of public works in Canada can, in his opinion, be successful, which overlooks the interests of the *Province itself* in grasping at the phantom of a western trade, of "an almost inconceivable extent," "doubling almost annually," (to use the definite language of the Chairman of the Board of Works) and that he has never been able to see the justice of that enlarged philanthropy, which, in its eagerness to add to the happiness of others, overlooks *its own*.

New York, 1842.

We cheerfully insert the communication of Mr. Trautwine's, both because we desire to do every one justice, and because it gives us an opportunity to correct a misapprehension, that may have occurred to others, as well as to that gentleman.

From the tone of Mr. Trautwine's previous communication, we thought some improper expressions in our correspondent's criticism, might have given offence, and our reperusal referred to the criticism, and not to the original article. We did not state, and did not mean to state, that we endorsed any of the views of our correspondent—a thing we seldom do—whatever may be our own opinion. We merely intended to defend ourselves from having admitted any thing like personal reflection—and to assert in general terms, the privilege of criticising an article by means of quotations. All criticism in regular reviews, is so conducted—but of course the fairness of the quotations is a matter that may be questioned. It did not appear, to us at least, that there was any intention to misrepresent in the extracts made from the article of Mr. Trautwine, and we give place immediately to the original paper with a view as we then said, to the satisfaction of all parties and the right understanding of the matter.

Upon another examination after reading the foregoing letter we think we understand the reason of Mr. Trautwine's disapprobation of the criticism, but we presume that the very commencement of the criticism alluded to would, to most persons, explain what followed—at any rate the article itself as well as this note of Mr. T. will set all right.

We doubt not that the observation of the gentleman engaged in this controversy when turned to particular roads give more and more clear notions upon this subject and readily explain away the apparent difference of opinion.

For the American Railroad Journal and Mechanics' Magazine.]

Mr. Schaeffer—*Dear Sir*, I was somewhat surprised in reading the number of your Journal for September 1st, to find that you endorse the criticism of your correspondent on my paper on the injudicious policy pursued on many railroads in the United States; which criticism appeared in your number for July 1st. Had I been at liberty to suppose your remarks the result of a hasty glance over my paper, I should not perhaps have been so much astonished at your mistaking the scope of my arguments; but as you aver that a reperusal of it, has only tended to confirm your previous opinion, I feel myself called upon to show that in my opinion you, as well as your correspondent, are entirely incorrect in the deductions which you have drawn from it: and must ask you to allow me the use of one or two of your pages for that purpose.

I shall not examine all the minutiae of your correspondents criticism, as my object is merely to prove that you and he have misunderstood entirely the *general principle* which it was the intention of my paper to defend. One point alone will serve for this purpose.

Your correspondent remarks that "availing himself of all the lights furnished by the trials and failures so far, Mr. Trantwine, himself, has tried to supply us with a true model and estimate of a railway. In this however he carries us back to the point at which the improvement commenced, the flimsy flat bar of 24 tons per mile, or 15 lbs. per yard." Omitting all such of my remarks as would have a tendency to prevent such a conclusion, your correspondent here leaves his readers to infer that the model and estimate alluded to, are such as I would recommend for our railroads generally: Let all my assertions, made in the most express and emphatic terms, and frequently repeated for fear of misconstruction, so to show that I conceive it to be totally unfit for roads intended for accommodation of a very heavy traffic. Thus, I say on the contrary, that "a perfect railroad would be that on which the least imaginable force would draw the greatest imaginable load," and that it "is the duty of the Engineer to approximate to it in every instance, as closely as the trade of the road, and the interest of the Company admit."

In another place I say, "the grounds of every expenditure on a railroad should be, that the annual saving thereby induced should more than counterbalance the increased cost:" and again, "I sincerely trust that I shall not be accused of disaffection towards permanent railways, and heavy engines; on the contrary, I repeal emphatically, that they should be as permanent, and as heavy as the business they are to accommodate can possibly justify;" and again, "In conclusion let me earnestly request that no misconstruction be put upon the foregoing pages. There are many railroads in the United States to which my remarks are not at all applicable; but there are also many to which they are. Where there is a very heavy trade to be accommodated, I am in favor of easy grades, curves of large radii, heavy rails, and powerful engines," etc.

Now instead of giving these quotations, or any of a similar import, your correspondent has carefully refrained from even intimating the occurrence of any such in my paper. He assumes gratuitously, and unwarrantably, that I give a model, which he leaves his readers, by implication, to infer that I consider calculated for the use of all railways; and then strives to show that it is not so calculated, as if I myself had not most expressly stated that it is not.

Nothing in my paper offerded the slightest grounds for the caracature which he has drawn: and you must allow me to add that I consider you totally unjustifiable in affirming that his "quotations give a fair view of Mr. Trautwine's article." Your subsequent publication of my paper, render it unnecessary that I should reply to the remainder of your correspondent's strictures. It would be very easy to prove them all equally fallacious and distorted with the one I have selected. E uno discite omnes. Your readers have it now in their power to form their own opinions as to its merits and demerits, and I am perfectly willing to abide by their decision.

I am very respectfully
Yours, &c.,
JOHN C. TRAUTWINE.

P. S. Will you do me the favor to correct an error in my paper; viz, page 124, 16 lines from the top, between "one" and "Engine" insert *wheel of an.*

RAIL ROAD NOVELTIES.

The attention of Engineers has recently been called to two remarkable variations from the ordinary routine of invention—neither of which in fact are really new—but only novel in their application.

We refer to the Pneumatic Railway and to the employment of electro magnetic engines upon railroads.

The latter experiment recently made upon an English road, and the details of which are given in our Journal, seems to have inspired hopes of the ultimate success of this agent as a propelling power. It is true that the velocity attained was short of that which is required, but it seems that the model was a small one and susceptible of improvement. When sufficient attention shall have been paid to the laws of electricity in this form, by those who are experimenting upon this matter we may look for some still more remarkable results.

Of the other novelty as we have ventured to add it, although in a dormant condition long known—we must confer our doubts as to its success. But a new impetus has within the last year been given to it—and some confidence in its practicability has been inspired by the strenuous part taken by Mr. Vignoles in its behalf. The general reliance in this gentleman's professional knowledge and discernment has led many to believe that the invention is not chimerical as it has long been thought.

The description of the rude specimen now in operation will be found in the Report of Mr. Vignoles' lectures.

The difficulty of obtaining a sufficient vacuum has been overcome, as it has been determined that a partial exhaustion of the air is all that is necessary and at this low pressure it is evident that the danger of leakage will be much less. The means adopted for closing the valves as the train passes are explained in the notes of the lecture, but we must say that the explanation is not clear to us at least. Still the fact that an engineer of high standing has seriously taken up the matter should induce us to pay more attention to it than has hitherto been given.

MR. VIGNOLES' LECTURES ON CIVIL ENGINEERING.

Lecture 15.—*Working Expenses of Railways.*—Having, in the last lecture, analysed the working expenses of railways, in reference to the train—that is, reduced to a rate per train per mile, with an average load at the usual velocity, the Professor considered it might be well to consider the same subject in another light. In the preceding mode of calculation no regard was paid to the amount of what might be called the useful weight carried. It seemed to the Professor, that the proportion between the dead weight of the engine, tender, and carriages, and the weight of the passengers and their luggage—in short, between the unprofitable and the profitable load—formed an important element for consideration, even if it did not affect the principle on which railways ought to be worked. In the common omnibus, with a full complement of passengers, the proportion was one to one—taking the average load about five to three—or including the weight of the horses (the moving power which has also to carry itself) about three to one, or, with a full load of passengers, something less than two to one. But on the railway, owing to the far greater weight of the carriages, and general arrangement on most lines, the proportion of dead weight is much greater. In a first class carriage, as adapted for long lines, and fully loaded with passengers and their luggage, the proportion is two and a half to one, but, taking the average load, it is about four to one, and, when but little luggage is taken, four and a half and five to one. On short lines, where the trains run often, with many carriages, the proportion is sometimes as high as eight to one, or, including engine and tender as twelve to one. In an ordinary train of about seven carriages, their weight, and that of the engine and tender, may be taken at about fifty tons; the average number of passengers has, on a former occasion, been shown to be about sixty per train, or four tons without, and, perhaps, five tons with, their ordinary weight of luggage, and say one or two tons of packages and parcels paying freight, being a proportion of six or seven of unprofitable to one of profitable load; and if the carriages were all full, about four and a half or five to one, as above, and on the average, the proportion might very fairly be taken as at least five to one. It appeared to the professor that there was some radical error here, and that some arrangements were wanting to reduce this proportion, as far as the carriages were concerned, for of course, as long as the locomotive engine was used its weight would always form a large proportion of the load, particularly with light trains—though the carriages certainly required to be made strong and heavy on this system—and this seemed an inherent defect on this principle of locomotion, perhaps quite irremediable. Yet, at all events, on many lines the proportion of dead weight of carriages was much too great, and might be remedied. Of late this had been done on the Greenwich Railway, where, by combining two classes of seats in the same vehicle, much fewer carriages sufficed. There was a great contrast to this on the Blackwall Railway, where, from having a separate carriage for each station, according to the peculiar mode of working that line, the proportion of dead carriage weight was generally about three, and often four, times as much as on the Greenwich, though the carriages were of the same build. Owing to this and to other causes, extra guards, rope, etc., notwithstanding the generally admitted economy of stationary power, the expenses of working the Blackwall Railway, per train per mile, was double what the Professor found was the average for the working on several locomotive lines, and quite as high, if not higher, than the present rate of working on the Brighton Railway, which was the highest of any that had yet come under his cognisance. Although, abstractedly, this over proportion of dead weight carried was not always connected with the moving power, yet an engineer ought to point out, and, when within his control, to remedy such an evil, as the loss consequent on carrying useless weight is equivalent to that arising from increased resistance of gravity in surmounting an unnecessary ascent —a case which every engineer is naturally anxious to avoid.

In the mode of reducing railway expenses to a mileage, adopted in the last lecture, the number of passengers, and their proportion to dead weight of carriages, had not been considered, for it was clear that the arrangement of carriages in any train being supposed to be duly proportioned to the average traffic, any addition to the average assumed load would be pure profit, and would not cause any sensible addition to the cost of the transit of the regular load, for which all the necessary arrangements of engines, tenders, carriages, guards, stations, and the whole working and carrying establishment of the railway was already provided and paid for. But, suppose another mode of considering the working expenses be adopted, viz. from the number of passengers in a train, deduced from an average of many lines for several years, or from any assumed number per train, let the cost per passenger per mile be worked out, and this will lend to the consideration of the true policy for attracting the greatest number of persons, and trying to fill the trains up, as they must go, at any rate.

The Professor then went through the various items of railway expenses stated in the former lecture, and brought them out in decimals of a penny per passenger per mile—the result being, that, taking account of experience gained and applied, and economical arrangements duly introduced, the expense of locomotive power might be taken at ¼*d.* per passenger per mile, which was coming back to the original estimate made for the working of the London and Birmingham Railway. Other expenses, including Government duty, would bring the total up to two-thirds of a penny, and, under favorable circumstances, of well filled carriages, this might sometimes be brought down to ½*d.*, but taking the average of lines as now worked, the cost was about 1*d.* per passenger per mile. On many of the American railways the cost was as low as ½*d.*, and for long lines on the continent, in India, etc., where wages were low, and coal or wood might be got very cheap for locomotive fuel, and no rates or taxes on profits and passengers were laid, the charge of carrying passengers per mile might be fairly taken at ½*d.* only. Now, if the proportion between the unprofitable and the profitable parts of the load were reduced to three to one, as regarded carriages only, and six to one as regards the whole weight of the train the expense of carrying passengers, taken by weight, will be still at least three times as expensive as carrying goods only at the same velocity, the proportion being of wagons to goods as two to three, and of the whole train, including engine and tender, at less than two to one, and with heavy trains, of goods only, about one to one, and for coal and mineral traffic, at diminished rates of travelling, still less. The Professor observed, that the cost of conveying merchandise might be taken at about 1*d.* per ton per mile for railway expenses only, exclusive of collection and distribution at the termini of lines, and that of coal and minerals at about ½*d.* per ton per mile.

With these elements, therefore, of the expense of working railways either per train, or per passenger, or per ton, it is for the politic manager of a public concern to consider what should be the rate of charges above these cost prices to make to the public, so as to induce the greatest amount of traffic. Mr. Vignoles then observed, that there was a third way of considering the subject of the working expenses of railways, in reference to the number of engines employed, which was the mode adopted by the Irish Railway Commissioners, and which was, perhaps, the proper way of calculating the annual cost on lines of little intercourse, on which, however small the traffic might turn out to be, yet a certain number of engines must be kept to do any work at all. The commissioners, in following out this inquiry, endeavored to determine the proportion the cost of locomotive power bore to the total working cost of a railway. For the Liverpool and Manchester line it was found that this proportion was only one-fourth the gross annual charges on that line, including much town carriage of goods collected and delivered; but on the Dublin and Kingstown Railway the proportion was, at that time, nearly one-half. It was observed by the Professor, in a digression, that for the average of railways it was now determined to be about one-third. The commissioners finally assumed the cost of locomotive power to be one-third of the total expense of working a line of mixed traffic, and that to run a given number of trains per day, a certain number of engines must be provided; it was then calculated that £1750 a year would be the cost of each engine to work about from 25,000 to 30,000 miles annually, and then they computed the amount of gross receipts necessary to cover those expenses and interest of capital. This was working backwards, to ascertain whether it is justifiable to make a railway at all in certain districts. The result of the commissioners' calculations were, that, supposing there went only two trains daily throughout a given line, the average load of each train ought to consist of either fifty tons of goods or eighty passengers, or a mixed load of twenty-five tons of goods and forty passengers, or in that proportion, in order to justify a line being made—the average charge for passengers being assumed each 1½*d.* or for goods 2*d.* per ton per mile, which, it may be obsered, is scarcely the half of the average rates of charge on the principal English railways. Mr. Vignoles observed, in conclusion, that having shown that the cost of conveyance of passengers, merchandise, minerals, etc. could be nicely calculated from the experience gained, and could be brought to the definite mileage rates before mentioned, *he thought the proper railroad eharge should be, double the cost for working;* which when the railways had been judiciously constructed, and without extravagance, would sufficiently remunerate the undertakers, as such moderate principle of charging would bring the most traffic.

[From the Journal of the Franklin Institute.]

Remarks on the Injudicious Policy pursued in the Construction and Machinery of many Railroads in the United States. By *John C. Trautwine*, Civil Engineer.

[continued from page 125.]

The argument is not admissible, that perhaps in ten or fifteen years, the business of the road may increase to such an extent as to pay a profit on its cost. If the engineer wishes to ascertain if this be acceptable reasoning, let him suggest it to the stockholders before the road is commenced, and I suspect he will find but few to acquiesce with him.

But I see the sceptical reader elevate his eyes in astonishment. "What," says he, "the old flat bar! light engines! heavy grades! Is it possible the writer expects his readers to subscribe to so antiquated and exploded a creed as this? Even supposing his road to answer very well at first, with the limited business assigned to it, what will be done with it when the trade increases? *Ours* is a growing country, and the present business is no criterion to act on: in a few years it will have increased fifty, nay, a hundred per cent.; what is to be done then?"

The answer readily suggests itself: if the business increases 100 per cent., put on four engines instead of two. "But, ah!" says the objector, "there I have you. Don't you know that one heavy engine will draw a given amount of freight at less expense than a greater number of light ones can?" I most assuredly do know this to be true in the abstract; and I know, moreover, that a blind adherence to this "abstraction," has nearly ruined more railroad companies than one, in the United States. Let us illustrate this, also, by an example. Suppose our $10,000 a mile road to be finished, and in operation; its little models daily steaming it modestly over the line, with their thirty tons gross; and the stockholders annually pocketing their eight per cents. "nett." This all does very well for a time; but "ours is a growing country," and soon the business on our road increases one hundred per cent. What is now to be done, is the question. One heavy engine can take all our increased freight at one load, at an annual expense for the maintenance, of but $5000; while on the other hand, if we employ two small engines to carry it, we incur an expense for maintenance of motive power, of some $9000 per annum. "Here is a pretty piece of business," say the Directors; "why did not our engineer foresee all this: here he has entailed on us an annual loss of $4000, at the very least. Did not experience, all the world over, show that railroads attracted new business to themselves? Did he not know that heavy engines were more economical than light ones? Did he not see that they were introducing them on all the English railroads? However, what is done cannot be helped; we have been behind the age long enough: let us try to catch up with it at last; let us order a thirteen ton engine, or rather, as the business will certainly continue to increase, let us get a twenty ton one, at once." This is accordingly done; and the "fell destroyer," this "monstrum horrendum *ingens*," is trotted out. They build a fire in him;—he snorts;—he starts;—he is off. "Ah! this is something like; now we are up with the age." But, alas! in a few months things undergo a change. Rumors, faint at first, but gradually gaining strength, reach the Directors' ears, that something is going wrong on the road. An investigating committee is appointed; they visit the road, or rather the spot where once it stood; for the road itself has vanished: it is "*non est.*" After a long and laborious investigation, assisted by several scientific and practical gentlemen, the committee report that, first of all,—the bar was mashed into the timber;—and then—the timber was mashed into the ground. They moreover state their conviction that the flat bar has proved itself utterly unfit for railroad purposes; and suggest that as the Directors of the Liverpool and Manchester railroad have recently found it expedient to adopt an edge rail, weighing seventy-five pounds to the yard, *therefore* a similar rail should be substituted for the miserable flat bar on their road. The heavy rail is accordingly ordered, and laid down. "Now we are certainly up with the English; we have as heavy engines as they have, and as heavy rails; therefore, the road *must* pay well. We can carry sixty tons with our new engines, as easily as we could carry thirty with our old ones, and at very little more expense; that settles the matter. If the road yielded eight per cent. before, it must unquestionably yield sixteen per cent. now, with double the business; and the expenses of transportation only the same as originally."

This certainly looks somewhat plausible; but it is found, notwithstanding, that somehow or other the road now don't pay at all. "What! our miserable flat bar road, and tea-kettle engine, pay eight per cent., and our edge rail, and twenty ton engines, a losing concern? How does this happen?" It happens thus: *the road has now cost too much;* eight per cent., on a road costing $10,000 per mile, is but four per cent., on one costing $20,000 per mile; and in our order to England, we omitted one very essential item to the success of heavy rails and powerful engines, and that is, a heavy trade. Now, had we, when our business increased 100 per cent., merely put on two more small engines, every thing would have worked very well; and the road would in this case have yielded sixteen per cent., instead of eight. It is true, that two heavy engines could, at an expense of maintenance of but $10,000 annually, have done the work of the four light ones, which cost annually, perhaps, $18,000; but in order to save this difference of $8,000, we must have had a road proportioned to the heavy engines; and to secure this would probably require an expenditure, the interest on which would be many times greater than the $8,000 saved on the engines.

The foregoing is, of course, but an imaginary case. Still it serves to illustrate the principle, or rather, *want of principle*, on which far too many of our railroads are now being constructed, all over the Union. We see whole states falling into the error; indeed, we are falling into it, nationally.

I conceive that this mania for the *indiscriminate* use of heavy engines and rails, has done more injury to the railroad cause, than perhaps any other single consideration that has been brought to bear upon it; but "Dulce est desipere in *Loco*," appears to be the general motto, and it is probably useless to cry out against it. No position can be more tenable, more absolutely palpable, than that it is true economy to use the very heaviest engines, and best constructed road, *that the business requires.* But what constitutes a heavy business in one case, may be a very light one in another, and vice versa. The matter admits, in almost every instance, of calculations sufficiently approximate to determine the class of road, and machinery, that should be adopted; and had this expedient been resorted to on all our railroads, we should probably not have had a single one in the United States, yielding less than ten per cent. on its cost.

I sincerely trust that I shall not be accused of disaffection towards permanent railways, and heavy engines; on the contrary, I repeat emphatically, that they should be as permanent, and as heavy, as the business they are to accommodate can possible justify. What would we think of a company who should purchase the Great Western steam packet, to ply hourly across the river at Philadelphia, with some five or ten passengers at a trip? Would we not pronounce them demented? And should they tell us that Philadelphia had gone on increasing so rapidly, and so regularly, for many years past, that they felt confident their number of passengers would increase 100 per cent. in ten or fifteen years more, would that diminish our suspicions of their insanity? But yet does it follow, because the Great Western would not be a profitable investment in this case, that therefore she is not a fine sea vessel, and admirably adapted to carry on a lucrative business between England and America? Or does it follow, that because *she* was a losing concern when running between Philadelphia and the opposite shore of the river, that therefore a first rate, substantial little steam ferry *boat* should not do an excellent business on the same route? Or, lastly, suppose that the engines of the two boats, should be respectively converted into locomotives, for accommodating precisely the same limited amount of business *on land*, does that in any degree alter the case? Is it not equally apparent in either instance, that the magnitude of the *trade*, and not of the *boiler*, must be depended on as the great prime mover of the enterprise? I certainly should consider the engineer who would advise the same character of road, and machinery, in every case, fully as deficient in judgment as the company who should convert the Great Western into a ferry boat.

The remarks applicable to heavy engines, apply also to heavy cars. To diminish the weight of the engines, and still allow that weight to be exceeded by the cars, were evident impolicy. As before remarked, I should on our road, limit the weight on any one wheel, to one ton; and should, consequently, so proportion the cars, as that when loaded they should not exceed that limit.

We often hear the remark, nay, I presume that nine engineers in ten, throughout the profession, will yield it their unqualified assent, that the power of an engine is less on the flat bar, than on the edge rail, by some twenty or twenty-five per cent. In *strict justice*, I suspect there is no foundation for this assertion. I doubt not that an engine *adapted to the flat bar road*, will be found to exert quite as much power on it, as on the edge rail; but, unquestionably, if we place on it engines so heavy as to crush it, and deflect the timbers, a different result must follow. Indeed, it would not be difficult to conceive of an engine so heavy as to deflect the road to such an extent, as almost to deprive her of all locomotive power.

The examples assumed in the foregoing pages, have been taken at hazard, merely for the purpose of illustration; but so far as the character of road, and engines, which I have suggested, are concerned, I am of opinion that they will be found in very numerous instances, preferable to light grades, heavy edge rails, and powerful engines; particularly on the score of original expense. Roads built after this plan, will not partake so much of an experimental character, as those involving greater outlays; and, moreover, they would be adequate, under proper management, to accomodate, with perfect ease, far more trade than passes over half the roads in the Union. For example, there are few of our roads doing a business as great as could be taken at two trips daily, in each direction, by eight ton engines, over sixty feet grades. What folly is it then in such cases, to double the cost of the road for easy grades, heavy rails, and powerful engines? The arguments usually brought to bear against advocates for cheap roads is, that the business will soon increase to such an extent as to pay well on the cost of a first-rate road. This may be true in many iastances, but there are more cases to which it is not applicable; for even admitting that the business did, in ten or twenty years, increase 200 or 300 per cent., it by no means follows, that even *that* amount would justify a first class road.

The engineer is not left altogether to the exercise of his discretion, or judgment, in the matter, It admits, as before stated, of an arithmetical determination, having the data of the probable amount of trade that will be accommodated by the road. In collecting this data, he should shun alike, assumptions based upon the probable business of the road for the first day, or even week, or month, or year, of its going into operation; and thus having in view the prospective resources at the termination of the coming half century.

I will here take occasion to remark, that more, both of time and skill, will be required, to locate a railroad on the principles I have advocated, than on the ordinary plan. When, as is usually the case the route is located, in a great measure, with a view to long stretches of straight lines, easy curves, and light grades, the "modus operandi" is much less complicated, than when the engineer shall be obliged, at almost every step of his progress, to test his cuts, curves, etc., by the standard of justifiable expenditure. It is a very easy matter for the engineer to draw a long straight line on his map, and then tell his assistants to run it out; but it will be somewhat more difficult to decide on that line, between the same points, that shall best subserve the pecuniary interests of the company. In the one case; the route may be located *by miles;* in the other, it must be done *almost by inches.* Perhaps every engineer will bear me out in the assertion, that the difficulties of a proper location must be inversely as the finances of the company, should this system be adopted. As before remarked, the present plan has but little, if any, reference to that point.

I shall not attempt to follow Mr. Ellet into those cases which he supposes, in which it may become advisable to assume grades, more nearly coincident with the natural surface of the ground, and to dispense with the use of iron rails altogether; using cars no heavier than a light barouche. I may, however, be permitted, en passant, to express my entire assent to his views in that particular. Many short branches, from great thoroughfares to watering-places, or to small towns, might be constructed, and made to pay well, could we but divest ourselves of our "stereotyped" notions of what constitutes a good railroad. Witness the railways laid in coal mines: there are none more serviceable;—there are none that pay better; yet they do not cost $20,000, or $30,000, a mile; nor do they ever feel the weight of even a *model* locomotive. How powerful an appeal do they make to us, *to proportion the means to the end.*

I will now add some further remarks in support of my views respecting the location of a line of railroad; and again let me express the hope that I shall not be misunderstood as expressing my ideas of the best *abstract* line, but of the best *paying* line;—not that on which a load can be propelled by the least expenditure of *power,* but by the least expenditure of *money;*—not that whose merits are apparent on the ground itself, but which are evidenced forth resplendently, in the countenances of the stockholders, as they button up their pockets, on dividend day. I am fully aware of the obloquy to which an engineer exposes himself, in lifting up his feeble, and almost solitary voice, against any of the prominent evils of the day; and I am therefore the more desirous to be distinctly understood.

On nearly all our railroads, of any length, there occur at various points, maximum grades, of from thirty to fifty feet to a mile. These grades limit the capacity of the engines; and one such occurring on a road, (unless additional power be employed at that point,) does this quite as effectually as fifty would. Yet on the same road, we almost universally (perhaps *universally,*) see very great expense incurred all along the line, to secure much lighter grades, even where somewhat heavier ones would have coincided with the natural surface, and have involved little or no expense. This practice, *at least to the extent to which it is generally carried,* (for there are many exceptions,) I look upon as radically wrong.

Undulations in the acclivities of a railroad, it is admitted, must be allowed to a certain extent; but the precise limits of the expression, "certain extent," it is needless to say, have not been as yet defined. The application of the term must, of course vary in each separate road; and perhaps its most literal interpretation, as sanctioned by practice, would be, "Such as the engineer considers the nature of the ground to require." This construction I should be willing to modify, by adding, "and the best interests of the company demand."

Admitting then, *that acclivities must occur* on the line, affecting the load of the engine, I am under the impression that the *number* of them may be increased greatly over what is customary; or, in other words, that the graded surface may be made to conform much more closely to the natural one, than is generally done; and that it would be to the interest of companies, were that system adopted. Under such circumstances, a succession of undulations, within limits not too restrictive of the speed of the engine, it is well known would involve no loss of either time, or power, injurious in practice.

It is true, that Robert Stephenson, Esq., Civil Engineer, in his report to the directors of the London and Birmingham railroad company, on the subject of undulatory railroads, objects that the variations in speed attendant on alternate ascents and descents, would create an irregularity in the intensity of fire in the engine, which is calculated to injure their boilers by frequent expansion and contraction;—and he states, moreover, that the parts of an engine should be calculated for a certain degree of speed; and that rate maintained as regularly as practicable while on duty, in order to secure the attainment of the most effective performance. He speaks, however, with regard to the "*undulatory system*," so called, of Mr. Badnall; and from one of his observations, I suspect that his remarks are not intended to apply to such rates of acclivity as those I refer to; or to such as would permit the engine to start up them, with her load, from a state of rest. For he says, "*Inconvenience would, in my opinion, result from not having the power to halt at any given point on the line of railway. This may be done, without inconvenience, on a line of road not possessing inclinations beyond the power of the engine.*" Such inclinations, my suggestions, of course do not embrace.

This is, then, the only objection (if indeed it be one) that I have ever seen, that appears to militate against the adoption of a constant succession of short undulations. Should there be others, that have escaped my notice, I have little doubt but that they would be countervailed many fold, by the saving of expense accruing from their adoption, on almost every road in the Union. Indeed, many of our roads might, in my opinion, have been materially improved, by applying the saving that would have been thus effected, to the reduction of their maximum grades. The profile of the road would, it is true, in this last case, present a greater number of undulations; but both the time, and expense, of overcoming them, would be less than in their present condition. The increased facility of drainage, in a railroad of this undulating character, should be taken into consideration, in deciding on its adoption or rejection. The draining of long level reaches, is, in some cases, a matter of considerable difficulty. I doubt not, most of my professional readers can recal instances in which this inconvenience could have been obviated, and a far better road-bed made at much less expense, by the use of moderate undulations, in which the acclivities need not have been one quarter so steep as the maximum grade. None but a very inexperienced engineer would abuse this system, by so arranging his undulations as to create a continual variation in the speed of the engines, so considerable as to become a source of annoyance to either the passengers, or the engine-man.

But there is, unfortunately, a very powerful antagonistic principle, subject to no laws of either science, common sense, or economy, that is too frequently brought to bear upon the grades, curves, etc., of our railroads; and that is, a puerile pride: a determination to have a *handsome* road, at all events. We know that a succession of ascents and descents, mars the beauty of a straight line most deplorably; and as the expense of the cosmetic is paid by the stockholders, and they are not aware of its precise amount, it does not matter so much to the engineer, if the road, in consequence of these superfluous embellishments, should happen never to realize any dividend. In this case, nobody ever thinks of attaching censure to him: the road is very straight, and very level; and, in their opinion it follows that the engineer has done all that was in his power to make the project succeed. The amount of trade he, of course, cannot control; and the very fact of his having ruined one road, thus becomes his strongest plea for procuring the management of another. Had he made a road that would pay well, his professional character would probably have suffered an injury, from which it never would have recovered. Until the *public*, therefore, as well as engineers, begin to view this matter in its proper light, we cannot reasonably hope to see the proper remedy applied. A long straight line is considered quite a stepping stone, by our aspirants after professional fame. It shows for itself; and speaks for itself; silently, but convincingly. A straight line, five or ten miles in length, creates more *talk*, and begets more *honor*, than a judiciously curved route could possibly do; although the latter would have answered just as well, and have cost many thousands less. The public must learn, that in a railroad, as in women, beauty is not a safe criterion of merit.

Another frequent source of unnecessary expense in the location of railroads, is the attendance of a "Committee of Survey," appointed from among the Directors, *to assist the engineer in making his location!* The primary object of this committee, we are in charity bound to suppose, is to prevent, by their intuitive skill, too much use of the level and compass; at least, this is certainly all they ever *do* effect. These gentlemen are generally as innocent of all knowledge of the principles of a location, as "the child unborn;" and, by their twaddle, they soon torment the very life out of the engineer. Their questions, and remarks, must be listened to; and to do this is utterly incompatible with any attention to the location. This demands, at every step, the undivided observations of even the most skilful engineer; and admits of no diversion from the main object. Therefore, after a few miles are located, the engineer, completely exhausted by his double duty, invokes all sorts of maledictions upon the committee, and determines upon the long-straight-line system, as the only relief from his misery. He starts his corps off at a tangent, through thick and thin, for some object several miles distant; and *then he is at leisure to talk.* He is commended for his long straight lines; the committee for their vigilance; and the stockholders pay the costs.

Let Directors, if they *must* appoint "Committees of Survey," give them instructions to *remain at home, and let the engineer alone;* and further, if he reports that he has finished his examinations, and surveys, in an unprecedently short time, discharge him, and procure another to make a thorough and correct survey. They will generally save at least one-third of the costs of their grading by this process. *It must be a long purse that pays for a short survey.* Although I have treated this subject in a somewhat sportive manner, it is nevertheless one worthy of the most serious consideration. Let Directors employ an engineer, in whom they can place *unlimited* confidence for professional skill and integrity; then give him his general instructions, if they have any to give; and afterwards leave him entirely to himself in his operations. And especially let them in their mercy, refrain from urging upon him their sons, nephews, and other "very talented young gentlemen," as assistants. Let him choose his own assistants; and let the Board abstain, most religiously, from any interference with them. They are the engineer's tools, by which he carries his plans into execution. No one else should meddle with them; to do so, will inevitably blunt their edge, and give to both the workman, and his employers, trouble and expense. Harmony among the officers is all essential to the proper prosecution of any project; and the remark applies with peculiar force to works of internal improvement. The engineer, if he be the kind of man above supposed, will feel himself identified with the work under his charge. His interest, his pride, his professional character, are all concerned in its success. No stockholder, no director, can possibly feel that intensity of interest in it, that he does. Every effort he can make, will be brought to bear upon its successful accomplishment: but let once the Directors begin to meddle with his operations; let them pass along the line, and give directions to his assistants, or contractors; let them evince any want of confidence in his integrity, and the charm is dissolved. His interest is changed to disgust. His profesional pride no longer sustains him, and inattention must inevitably follow; and just so certainly as that happens, the work must suffer.

If Directors could consent to leave the principal management of the matter to the engineer, there can be no doubt, that in almost every instance, he could either prevent claims for land damages entirely, or else reduce them to a very unimportant item. But to effect this, it is essential that he should act either alone, or through a discreet agent, who must be entirely in his confidence, and *under his control.* A sum sufficient to defray the engineering expenses of the entire work, could thus be saved, in nearly every case; but it can be done only through the engineer; and not even through him, unless he be permitted to keep his own secrets, until the whole matter is arranged. It is not my intention to treat on the management or conducting of a railroad, after its completion. I will merely observe, that it is a great error to entrust it, as is almost universally done, to men of very limited information. The general agent of transportation, under whose direction the operations of the road are conducted, should be an engineer, of considerable attainments; although it is not necessary that he should be one of the first grade. The professional ignorance of most of the conducting agents of our roads, is a lamentable source of waste. Many of our unproductive works could be made profitable, by a change in that department alone.

In conclusion, let me again earnestly request that no mis-construction be put upon the foregoing pages. There are many railroads in the United States, to which my remarks are not at all applicable; but there are also many to which they are. Where there is a very heavy trade to be accommodated, I am in favor of easy grades, curves of large radii, heavy rails, and powerful engines. But in all cases, these traits should be combined only so far as *the interests of the companies will justify.* I maintain that our engineers should construct their roads, with a view to *paying* well, instead of *looking* well; and that in looking to England for precedents, they should rather apply the *principles* there developed, to our own case, than attempt to indulge in an imitation of their splendid *practice,* when so doing must necessarily bring ruin upon those who embark their all in the enterprise. Nothing can be more evident, than that we have, in numerous instances, transcended the limits between *abstract* and *practical* perfection in our railroads. The former, as before remarked, is that in which the greatest load can be propelled by the least *power;* the latter, in which it can be done at the least *expense.* The expression, "a good railroad," is a *comparative* one; we have erred all along, in supposing it to be *positive.* It is to correct this evil, at least partially, that I have been induced, on the perusal of Mr. Ellet's pamphlet, to add my exertions to his, by the publication of these pages. Being written on the spur of the moment, and in the order they presented themselves, on reading his pamphlet, my remarks are, of course, crude and incomplete. The subject admits of much enlargement, and I hope to see it followed up in future numbers of the Journal, by more vigorous pens than mine. In the meantime, I cannot do better than to recommend to those who wish to see it more ably handled than they have found it in this paper, to study carefully Mr. Ellet's judicious remarks, in the pamphlet alluded to.

Tennessee, February, 1842.

"*The History of the Canal of Katwyk, (Holland) with a Description of the principal Works.* By the Chevalier F. W. Conrad, translated by Charles Manby, Secretary, Inst. C. E.

This communication is divided into three parts:—1. The introduction; 2. The history of the Canal of Katwyk; and 3. A description of the principal works.

1. The introduction gives the general outline of the locality of this canal, which is probably one of the most useful and extensive works undertaken in Holland, for the purpose of draining the low lands and rendering them capable of cultivation; it is carried in a north-east direction from the village of Katwyk-binnen through the sand-banks to the North Sea, where it is terminated by five sea locks: it was undertaken for the purpose of draining the district called "Rhynland," a succinct account of which is given, with details of the early attempts at draining, such as the embankments of Marendyk, those of Spaarndam, etc., tracing them up to the time of Count William the Second, king of the Romans, in the year 1253; at which period the level of the district was identical with that of medium tide, and each "Polder" (or spot of cultivated land) was separately protected from the spring tides by an embankment; a change has occurred in the relative levels, whether by the sinking of the land or the elevation of the sea is, it appears, a subject of dispute, but it is certain that the level of the river Y and of the Zuyder Zee is now much above that of the Rhynland district. The natural consequence of this change, has been to increase the demand for artificial drainage by canals, and of windmills for pumping, and also the establishment of local boards of direction, whose duty is the superintendence of the works for the protection of the lowlands.

The district of Rhynland contains 127,000 bonniers or 317,500 English acres, which is thus divided:—

	Bonniers.		English Acres.
1. Polders, or Districts embanked and drained by windmills.	54,831	=	137,077·5
2. Lakes and Peat-bog already laid dry.	15,262	=	38,155·0
3. Land without mills and sandbanks on the borders of the North Sea.	32,630	=	81,575·0
4. Lakes, Canals, Ditches, Peat-bogs abandoned, etc.	24,277	=	60,692·5
	127,000	=	317,500·0

The drainage is effected by 268 windmills, working scope wheels or Archimedean screws.

Within this district, is included the Lake of Haarlem, which alone extends over 18,000 bonniers or 45,000 English acres; the drainage of it is now commenced and will restore a tract of very valuable land.

The enumeration of the original locks at Spaarndam and other places, is given, showing their incapacity for carrying off the waters, particularly when unfavorable winds prevented their free current into the Y, and hence the necessity for the canal of Katwyk and the choice of that particular spot, which is not affected by the prevailing winds.

2. The historical portion of the memoir, treats of the naturally unfavorable position of the district for drainage; it mentions a project for a canal at Katwyk in the year 1404, as related by Professor Lulofs,* on the authority of the historian Van Mieris; and enumerates all the various examinations of the levels, the projects of tunnels, canals, etc., the appointment of numerous committees, the local opposition to the several plans, the repairs of the embankments, which had become so expensive that the landholders abandoned their estates, rather than pay the cost of preserving them; the attempt to form a small canal through the sandbanks, which was either closed by a heavy storm or was suffered to fall to decay; the effect of the siege of Leyden by the Spaniards in 1573–4, when instead of draining the country, every attempt was made to cause an influx of the waters to annoy the invading army. It appears that subsequently the expense of renewing the hydraulic works would have been so considerable, that they were in a great measure abandoned for a time. In 1627, attention was again given to the subject, and Katwyk was pointed out as the only spot for an effectual system of drainage. The map by Bolstra, which the author promises to send, shows all the plans with great precision.

The reports are then given of all the various engineers and scientific men on the drainage of the Lake of Haarlem, in all of which the Canal of Katwyk is a principal feature. The very able tract by Mr. Twent on the state of the drainage of Rhynland, and the necessity for a canal at Katwyk, is mentioned as one of the principal causes for its final construction. After the publication of this tract, Mr. Brunings, in the year 1802, caused the nomination of Mr. Conrad (the father of the author) and Messrs. Blanken, jun. and Kros, to report upon the project; which they did with such effect, that in May 1804, it was ordered to be executed by the reporters, under the superintendence of Mr. Brunings, the director-general of the "Waterstaat;" the plan selected being that which was laid down by Mr. Conrad. In August of the same year, the works were commenced, and in 1805 were so far advanced, that in June the first stone of the inner lock was laid; Mr, Conrad, who in consequence of the decease of Mr. Brunings had assumed the chief direction, carried on the works with such activity, that they were entirely finished by the month of October 1807, without the occurrence of any accident, although they had to support several very severe storms during their progress. On one occasion just as

* Lulofs' Treatise on the Elevation of the Sea and the Depression of the Land on the coasts of Holland. Transactions of the Society of Haarlem p. 1, f. 86.

the masonry of the locks was finished the level of the tide was raised by a storm 2·36 metres (2·54 yards) higher than usual, carrying away the external cofferdam, but such was the solidity of the masonry that it resisted perfectly.

A steam-engine was fixed for pumping up a head of water for scouring the sand from the exterior canal; and the final opening of the canal took place with great ceremony on the 21st October, 1807, when a medal was struck to commemorate the event, a copy of which is given by the author to the Institution.

Mr. Conrad made a series of experiments which completely proved the efficacy of the works, and then was carried off within the short space of three months from the termination of his successful labors, which will hand down his name to posterity, as the projector and executor of one of the most useful engineering works on record.

A slight sketch is then given of the origin of the Lake of Haarlem, the cause of its extension, and the works already executed in anticipation of its eventual drainage.

The third part consists of a detailed description of the principal works at Katwyk, with their dimensions, and the necessary references to the drawings which accompany the paper.

The length of the canal from the Rhine to the sand-banks near the lock, is 2260 metres (2471·53 yards) of an average depth of 2·20 metres (2·40 yards) beneath the conventional height of tide for the kingdom of Holland, from which all tidal measures are taken; it corresponds with the average tides of the river Y; the common tide at Katwyk falls 0·60 metres (0·65 yards) below and rises 1·02 metres (1·115 yards) above that standard.

From that lock to the next is 490 metres (535·86 yards) of the same depth; the additional canal is 1108 metres (1211·70 yards) long, the widths at the standard level vary between 13 and 40 metres, (14·21 and 43·74 yards) and the side slopes, which are all puddled and covered with turf, vary between 1 to 1 and 3 to 1.

The outer canal which has been made chiefly by scouring, is 151 metres (165·13 yards) long, to low-water mark, at a depth of 0·47 metres (0·5139 yards;) below that point, it is 37.67 metres (41.19 yards) wide and the sides are constructed of fascines covered with stone.

The principal works enumerated are—

1st. The sea locks (buiten sluis.)

2nd. The interior lock (binnen sluis.)

3rd. A bridge of three arches at the sea locks, with balance gates and rising sluices.

4th. A bridge of two arches over the canal in the Noordwykerweg.

The five sea locks are each 19.78 metres (21·63 yards) long and 3·77 metres (4·12 yards) wide; with the mouths of the out-fall culverts 1·83 metres (2·05 yards) below the standard tide level. They are founded upon piles of red and white deal, with sleepers, and the whole faced and covered with deal plank sheathing.

The masonry of the foundations and of the principal part of the construction, is of blue limestone from Escosine, squared and well bedded. A hard stone called "klinkers" is also much used for ashlar work, and an inferior quality of stone for rubble-work, with bricks.

The mortar used up to a short distance above the standard tide level, was made from stone lime, and above that, of lime made from sea-shells; cement was also used in several parts.

The modes of constructing these various works are given in minute detail; many of them, differing materially from the English method of construction, possess great interest; particularly those which relate to the embankments and the fascine work.

A description is then given of the Canal of Oegstgeest, which is a prolongation of the Canal of Katwyk for the purpose of bringing into the latter, the waters from the Lake of Haarlem; as well as a means of carrying off the waters of a portion of Rhynland, during and after the drainage of the Lake.

In consequence of the establishment of this canal, the Canal of Katwyk required to be enlarged, which was done to the extent of rendering it 52 metres (56·86 yards) wide, with an average depth of 2·20 metres (2·40 yards) below the standard level. The bridges were also enlarged, and it is now contemplated to add two openings to the inner lock, those of the sea locks being already of sufficient capacity.

Having described the works in detail, the author enters into some general remarks upon the effect produced by the canal, one of the principal being its beneficial use in determining the possibility of draining the Lake of Haarlem. Thirty-five years of experience, have demonstrated that this canal is the surest remedy for the peculiar position of the district of Rhynland with regard to drainage; the constant action of the North Sea has made no impression upon the simple but solid masonry of the sea locks, in fact, the Canal of Katwyk appears to be one of the most remarkable hydraulic works ever constructed for the protection of Holland.

The author concludes the paper by stating, that although he could with difficulty spare the time from his professional labors on the Amsterdam railway, of which he is the engineer, he was induced to undertake the labors of drawing up this memoir, by the subject being one of those proposed by the Institution of Civil Engineers, in the list for Telford and Walker Premiums for 1842, and by the desire of doing justice to the memory of his father, whose early decease alone prevented his name from becoming as extensively known as his talents deserved.

The paper is illustrated by nine comprehensive drawings and charts, with some lithographic views, a portrait of Mr. Conrad, sen., and the medal which was struck on the occasion of the first opening of the sluices.

Iron as a Material for Ship-building. By John Grantham.

"The first iron steam-vessel, and the first that ever put to sea, was built at the Horseley iron works, for the river Seine, and called the 'Aaron Manby,' after the name of the projector and builder. I have lately been favored by Mr. Manby with the particulars relating to this vessel, which are very interesting as recording the origin of iron steam-vessels. He states in his communication, dated 10th February, 1842, that under a patent which he took out in France for iron steam-boats, in 1820, he, with his friend Captain (now Admiral Sir Charles) Napier, formed a society, and immediately began to construct the first boat at Horseley, but owing to some circumstances connected with the parties at Paris, she was not completed till the end of 1821. She was then sent to London in parts, and put together in the Surrey Canal Dock. She took in a cargo of linseed and iron castings and Captain Napier took charge of her, and navigated her from London direct to Havre, and thence to Paris, without unloading any part of the cargo, she being the first and only vessel of any description that ever went direct from London to Paris. Mr. Manby continues, 'Some time after, I built another iron steam-vessel of the same description, with a few alterations, at Horseley: but, owing to the navigation laws in France, she could not be admitted, and was obliged to be shipped in parts, and I put her together at Charenton, near Paris, where I had then established iron-works, and where I subsequently constructed two other iron steamboats, the whole for the navigation of the Seine. They continued prosperously at work till 1830, when, owing to the Revolution, and some disputes among the shareholders, they were sold to a new society. In this new society I had no further interest, but they continued navigating up to the period of my quitting France, and I believe are all at work at the present time. From 1822 to 1830 the hull of the 'Aaron Manby' never required any repairs although she had been repeatedly aground, with her cargo on board.'

"The next iron steam-vessel with which I am acquainted was one built by the Horseley Company, under my father's (Mr. Grantham, sen.) superintendence. This vessel was commenced about the year 1824; was put together in this port (Liverpool,) and after a series of delays, crossed the Channel in 1825, and proceeded to her destination, Lough Derg, on the river Shannon. Since then she has been constantly at work, and is now in good condition.

"Shortly after this time, Mr. John Laird of North Birkenhead, commenced building them on a large scale, and has since been extensively and successively engaged in this pursuit. Mr. Fairbairn, of Manchester, also very early took an interest in iron-vessels, and was a party to a series of experiments made at Glasgow, in which iron vessels were employed.

"The 'Ironsides' was the first iron sailing vessel of any magnitude that was employed for sea voyages, and she has been highly successful. She has made three trips to and from South America, and fully realizes all the advantages proposed in her construction."

In a letter from Charles Wye Williams, Esq., dated Dublin, Aug. 21, 1842, he says, "The old iron steamer called the 'Marquess Wellesley,' built for Mr. Grantham at the Horseley Works, is still working and in good order. I went in her recently through Lough Ree and some of the tributary streams that run into the Shannon." —Sec. Inst. C. E.

"*On the construction of Model Maps, as a better mode than Sectioplanography for delineating the Drainage and Agricultural Improvements of a Country, or projected lines of Railways, Canals, etc.*" By John Bailey Denton, Assoc. Inst. C. E.

This communication was accompanied by a map in relief of an estate, as a specimen of the method which the author recommends. The subject of mapping in relief is not new, and the author had previously published a treatise on the subject, but having made extensive experiments, he was enabled to bring the subject before the Institution in a more defined form, showing that the construction of the models had been reduced to a simple and cheap method. These models are peculiarly recommended for pointing out the capabilities of a district for drainage either for agricultural purposes, or for collecting waters together for manufacturing power. They are superior to maps, as they show at a glance the relative heights of the various points, display the geological phenomena, and may be made to delineate the state of cultivation of the districts. The lines of railways, of roads, or of canals, can be more clearly defined upon them, and they are stated to be peculiarly adapted for parish surveys. The expense of making a model of an estate of compact form is stated to be from 2*s.* 6*d.* to 3*s.* 6*d.* per acre.

The following table will show the low rate of charge on minerals as compared with merchandize and passengers *per ton per mile*, the former nevertheless, from the regularity and magnitude of the business being the most profitable species of freight.

Liverpool and Manchester Railway, Passengers carried 31 miles, 50 ft. grade, 41 cents 4 mills, per ton per mile nett load, 6½ tons. Merchandize carried 31 miles, 50 ft. grade, 5 cents 7 mills, per ton per mile nett load 32 tons. Coals carried 15 miles level, 1 cent. 9 mills per ton per mile nett load 94 tons.—dividend 9 per cent.

Stockton and Darlington Railway, Coals carried 20 miles 50 ft. grade 2 cents per ton per mile nett load 63 tons.—dividend 15 per cent.

Philadelphia and Pottsville Railway, Coals 94 miles level 1 cent. 5 mills per ton per mile nett load 200 tons.—Just opened.

Durability of Wood Pavement.—The first wood pavement that was put down in London, at the east end of Oxford Street, four years since, is now being reversed and relaid, and causes much surprise by its great durability, many of the blocks not being reduced half an inch of their original length, which was one foot, though exposed to all the traffic of Oxford Street.

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DESCRIPTION OF THE LONG ISLAND RAILROAD, WITH SOME REMARKS ON THE PRESENT CONDITION OF THE WORK.

The importance of the Long Island Railroad, as affording the means of communication with distant points of the island, and as one of the links in the chain of connection with Boston, has hitherto received a share of public attention, and efforts tending towards the completion of the road have been vigorously made, which so far as persevered in, have been successful.

Passing over the early history of this enterprise, and its completion as far as Hicksville, 26¼ miles, it will only be the object of this communication to detail the progress, and present condition of the work east of the latter place. The whole line of which has been permanently located as far as Jamesport, a distance of 54 miles from Hicksville, 80 from Brooklyn, and within 15 miles of the intended termination at Greenport.

The second division of the road commences at Hicksville, and the construction of the same was began in the spring of 1840, and completed for the most part in the winter following, and is now in operation. The line leaves the latter place by curving to the right and pursuing a south-easterly course passes over the plains of Oyster Bay, four miles, when it again deflects to the left in turning the south flank of the hills found stretching northward along the line dividing Oyster Bay and Huntington, and from thence on a course of about ten degrees north of east to the vicinity of Ronkonkoma pond, eighteen and a half miles additionally, passing a small but well cultivated section of country, near Farmingdale, soon after leaving which the line traverses the famous pine plains of the island, which afford but little evidence of cultivation within the vicinity of the road for upwards of forty miles. Although the division extends but twenty miles east of Hicksville to the head of Connectiquot river about three miles southwest of Ronkonkoma pond, a point equi-distant between Islip and Smithtown. The grades on this portion of the line do not exceed 26.40 per mile, and are for the most part under 10 feet per mile, and the minimum radius of curvature, 1146 feet. The soil which is uniformly sand, or gravel, or both combined, is favorable to the cost of the road, and affords an excellent road bed for the superstructure. The estimate of the entire cost of this division, inclusive of contingencies was $9,000 per mile, but will not probably exceed $8,400 per mile. The graduation is received as finished, and the superstructure as completed 17¼ miles to Suffolk station, being on a continuous line of 44¼ miles from Brooklyn. The width of the road east of Hicksville, which is graded for a single track, is 13 feet in excavations, and embankments, and the plan of laying the superstructure nearly the same as that ordinarily adopted where the heavy rail is used. The iron is of the same weight and dimension as that laid on the first division of the road, viz. an ⌶ rail of 55 pounds per yard. The mud sills were laid, measuring 3 by 9 inches, and varying in lengths of 12, 15, and 20 feet, breaking joints horizontally, on which cross ties placed 3 feet apart support the rail. The ties measuring not less than six inches over the smallest end were only used, and consisted of white oak and chestnut, which were procured on the island. The junction ties were cut to receive the plate into which the rail was received, and securely spiked as also the intermediate ties. The culverts used have been built of wood of a cheap and temporary construction, it being intended to replace them hereafter with rubble masonry.

The third division of the road commences at the termination of the latter, and after passing the range of hills south of Smithtown, at a favorable point, curves to the south about twelve degrees, and pursuing an easterly course for 12 miles after leaving the vicinity of Ronkonkoma pond, passes south of the Bold Hills (to Carman's river, about one mile below Hawkins' Mills, when the line deflects about twenty-five degrees to the north on the west side of the river, curves and crosses the same, and thence pursues a general course to the Manor, 17¾ miles. The topography of this division of the road is much broken by the approach to Carman's river, the descent to which is rapid. The estimate of the cost of this portion of the line for graduation, including wooden culverts, is $64,000 or about $3,600 per mile, but the work having been placed under contracts, on 14 miles of this division at a considerable reduction of the estimate, the terms may be considered very advantageous. The grades on this division are as high as 40 feet per mile. The minimum radius of curvature, 2865 feet. The location of this part of line is equi-distant between Coram and Patchogge, being about three miles from either place. The fourth division commencing at the termination of the latter, on the Manor, continues to pursue the same direction until the line approaches Peconic river within 5 miles, when it deflects to the left a few degrees, and crosses the last named stream about half a mile west of Tuttle's Mills, where it has only a width of 90 feet, after which the line curves to the right, and passing along the margin of the river on the north, enters the village of Riverhead, passing a few rods north of the court-house, continuing on the east of the town, where the line again deflects to the left, crossing the head of Saw Mill Pond, and other tributaries of the bay, curves to the south at Meeting House Creek, and on an east course proceeds direct to Jamesport, the termini of this division of 15 miles. About 6 miles of this portion of the road has been graded in detached sections, but at present is temporally abandoned. The estimate of the graduation including culverts, was about $37,500 or $2,500 per mile. The maximum grade 40 feet. Minimum radius of curvature, 1910 feet.

The 5th and last division of the road has not yet been definitely located; but from the surveys that have been had, sufficient is known to determine the route which will be quite direct from Jamesport, having only one curve after leaving the latter point, and the expense of graduation will not vary from $2500 per mile, as on the 4th division. The grades will not exceed 30 feet per mile, and any radius of curvature can be had. From the above it will be seen that about 44 miles of the road is completed and in daily use, leaving 50 miles of graduation and superstructure yet to be finished, 29 miles of which is contracted for, though only 14 miles is being now worked upon, with an average force of 120 men. Of the whole amount contracted for about 9 miles may be considered as finished, and about 19 miles not under contract.

From Hicksville to Greenport, 68 miles, the line is broken by 10 curves, having a radius in every instance, except one, of 2000 feet and upwards, and composing an aggregate length of 2 1-2 miles, all of which occur on easy grades, and by equating the latter on the entire line, there exists only a difference of 2 per cent. in the motive effect of trains passing either way. The greatest elevation of the road above tide water is 146 feet, which occurs at Hicksville.

The estimates to complete the graduation, ready to receive the superstructure, amount to the sum of $139,000, to which we will add $11,000 additional for contingencies, and call the aggregate amount $150,000, three-fourths of which amount the contractors are willing to receive in bonds of the company at 4 years; hence there is only required $37,500 in cash to complete the grade of the road. And it is believed the iron can be purchased entirely on the credit of the company. If so, the entire road could be constructed by the expenditure of $100,000 cash, using the bonds of the company only for graduation, iron, and laying of the superstructure in part.

The receipts of this road, which is now only half finished, will not fall short of $70,000 the past year, which is something more than the expenses properly chargeable to the working of the road, renewals, and repairs. On the completion of the road to Greenport, the additional income will no doubt be sufficient to pay all necessary expenses and yield 1 or 2 per cent. upon the cost, and this from the local travel and freight of the island, depending as it does mostly upon the through travel, to afford a fair interest. That the eastern travel will be sufficient for that purpose, very few, if any doubt. On the completion of the road, and judicious management of the same, we may look upon it as likely to become one of the most popular as well as profitable roads in the Union. The economy with which the management of the road is now conducted under its able President, is deserving of all commendation.

E. S.

EXAMINATION OF THE RAILROAD SYSTEM.

No. II.

Having in our last number considered the errors of location on railroads we next proceed to the

Errors in Construction.—But here we must again be allowed to remark that while we are endeavoring to enumerate all the errors which have occurred during the advancement of the railroad system, we do not wish to be understood as attributing all or any one of these errors to every railroad. Such a hasty generalization would be equally presumptuous and unjust.

The first error in construction which we notice, is improper extravagance. By this we mean an outlay of money by a company not warranted either by the resources, or by their objects--the legitimate business of the road. Under this head, we do not intend to touch upon those points which may be considered as professional questions, and in regard to which engineers themselves are in doubt. The spirit of extravagance so generally prevailed during those years in which the railroad system was developed, that it would be manifestly absurd to attribute to the system itself those errors which may never again coincide with the advancement of railroads. Still as we have in regard to other institutions the means of comparing their condition before, as well as during this period, while the existence of railroads before this time can hardly be asserted—it will not be useless to separate those faults which were peculiar rather to the times than to the system.

We include the charge of extravagance under the head of errors in construction, because it has chiefly affected this department, although the improvident spirit which was peculiar to the times, was rather an error of financial mismanagement. In fact, we might assert that the wasteful expenditure of money upon railroads, was in all cases rather a disregard of details of outlay and a want of attention to those various and often minute items of expense which are so apt to absorb not only the profits, but even the capital of companies as well as of individuals. Probably the most extraordinary cases when properly examined, would show not any *one* item of useless expenditure, but a host of small matters, amounting however to a very serious misappropriation of funds.

The most striking instances of extravagance in construction which can be produced, are those of roads not included in any main line of communication with no prospect of forming part of any such line, and intended to meet the purposes of a purely local and very limited traffic; but constructed upon the model of some of the most important roads in the country, with grades, superstructure, buildings and accessories, equal to the greatest demand upon the greatest thoroughfare. These instances, as far as we have been able to ascertain, are exceedingly few in number, and undertaken either as sheer speculations, or else to carry out and assist extensive and reckless land operations. It is hardly necessary to state that these railroads have proved utter failures, and have contributed not a little to throw discredit upon the whole system.

We notice too another error in construction, the injudicious use of inclined planes, and stationary power. It is true that the highest professional authorities at one time sanctioned their adoption, but that they were admitted for some time after their inexpediency had been demonstrated, cannot be denied. It is certain that wherever this mode of surmounting heavy grades has been employed, great expense and little profit have been the result.

The use of horse power instead of stationary engines, is open to the same objections, and re-locations to avoid it, show that this is the fact.

Under the same head we might notice the adoption of light grades, which in the infancy of railroads were considered absolutely necessary, to the use of locomotive power. These and similar *experimental errors*, as we might call them, belong to the early stage of railroad history, and although, at the time, they were not in fact errors, yet so rapid has been the progress of improvement, that we are too apt to regard as faulty, what was in accordance with the most correct practice of the day. Several important works were constructed at great expense, upon the supposition of the necessity of exceedingly light grades wherever locomotive power was to be employed.

A third error of construction, and one rather more common than any one yet named, has been the grading of roads for two tracks where one was needed. On all great thoroughfares, and on short roads, two tracks are proper, provided the passage of trains is to be very frequent. But upon lines of great length, one track may always be made to answer, and with proper precautions, it is not unlikely that in all cases two tracks may be avoided by a suitable system of turnouts, and a vigorous discipline. It is a fair question and deserving careful examination, whether the punctuality and systematic management of locomotive power thus introduced would not more than counterbalance the inconvenience which might sometimes occur.

Although but few companies have laid a complete double track, yet very few have been so economical as to grade for but one, and the amount of money thus spent upon extra land and labor, is enormous. Allowing $1000 per mile, for this extra expense, which every one will admit to be a low estimate, and supposing 1000 miles of railroad to have been thus unwisely constructed, the waste will have been one million of dollars. It is gratifying to observe that this practice of dispensing with the second track is finding favor and will soon generally prevail.

As it is the fault of human nature to pass from one extreme to another, we need not be surprised at finding in our list of *errors* that of *parsimony*. Yet this fault will in some instances be found to have accompanied the opposite one of extravagance. While money has been lavished upon a heavy rail, for example, it is not uncommon to find insufficient fastenings, etc. But pure and unmitigated parsimony in the construction of roads can easily be found—not that we mean by the use of this word, to stigmatise the motive, but simply to describe the fact. A "cheap" railroad is a poor affair. Iron straps a little above hoop iron in size, imperfectly fastened to timbers laid *upon* the ground--embankments with their sides deeply furrowed with gullies which in some cases nearly cross the track—excavations with the sides standing ready for the first heavy rain to wash them into the middle of the road—crazy bridges, stilted over a rapid stream at a fearful height—these are the characteristics of a "cheap" railroad—and we have drawn no fancy picture, but have faithfully adhered to the painful reality, strongly impressed upon us by unpleasant experience.

Much more mischief than is generally imagined, has resulted from false economy in providing insufficient superintendence. On a long line, with but few engines, and few or no responsible superintendents, to assist them, much bad work may be covered up and never come to light until all chance for redress has passed by—and what is worse, at a time when no one else is remembered to be blamed, but the engineer. In masonry such things have frequently happened. It is by no means necessary that fraud should have been intended to produce such results, for carelessness or ignorance may do equal damage and should be equally provided for.

An error in the construction of railroads of no small amount but not generally recognized—is a disregard to the geological character of the site of the road and its general result an improper or insufficient system of drainage. When this fault has been committed, it never fails to show itself in the annual expense of repairs on the road. The effects of frost are greatly increased by an imperfect drainage, while the decay of timber is equally accelerated and the amount per mile per annum consumed in this way alone is a most serious item in the "Maintenance of Way."

A neglect of the peculiar geological formation is in some cases productive of lasting mischief, and cannot be remedied, or only at great expense. A very instructive illustration of this in the experience of English Engineers, may be found in Mr. Vignoles' lectures.

The following account of the Atmospheric Railway we find in the National Intelligencer.—The extract will be read with great interest by professional men in this country.

ATMOSPHERIC RAILWAY.

Several years ago the public attention was attracted to a proposal for establishing a railway on which carriages were to be propelled by atmospheric pressure. If we remember correctly, some experiments of that nature were tried which completely failed, and it was supposed that the design was abandoned as impracticable. It appears, however, that since that time an atmospheric railway on a small scale has been formed at Wormwood Scrubs, on which experiments have been tried that have satisfied scientific men that the application of the atmosphere as a locomotive power on railways is not only practicable, but would be attended with many advantages over the locomotive engines at present in use. Mr. Pim, the treasurer of the Dublin and Kingston railway, addressed a communication to the Earl of Ripon, the president of the Board of Trade, requesting him to cause an inquiry to be instituted by competent persons to ascertain whether this invention was entitled to a further and more extended trial under suitable superintendence. As any thing connected with the subject of railway travelling must interest the community generally, we doubt not our readers will be gratified by having laid before them some extracts from Mr. Pim's communication, which fully explain the mode of working and the alleged advantages of atmospheric railways:

"It is very generally known," says Mr. Pim, "that several ingenious persons have, from time to time, proposed to employ the pressure of the atmosphere as an element of locomotive power; but their speculations and suggestions were so far removed from practical efficiency that proposals to adopt an atmospheric or pneumatic railway have hitherto been received with contempt or ridicule; indeed, so great has been the prejudice against the principle that very few, even among those most interested in railways, have taken the trouble of investigating what has been accomplished by the very simple and complete apparatus constructed by Messrs. Clegg and Samuda, whose invention has been publicly exhibited on the West London Railway at Wormwood Scrubs for nearly eighteen months past.

"Although the scale upon which these experiments have been tried may be thought scarcely sufficient to arrive at an absolute demonstration by those who only view it superficially, every successive visit has tended to confirm the conviction in the minds of those best qualified to decide, that the invention combines the great essentials of economy, expedition, and, above all, of safety.

"On this system of working railways, the moving power is communicated to the trains by means of a continuous pipe or main, of suitable diameter, laid in the middle of the track, and supported by the same cross sleepers to which the chairs and rails are attached; the internal surface of the pipe being properly prepared by a coating of tallow, a travelling piston made air-tight by leather packing is introduced therein, and is connected to the leading carriage of each train by an iron plate or coulter. In this position, if part of the air be withdrawn from the length of pipe in front of the piston by an air-pump, worked from a stationary engine or by other mechanical means, placed at a suitable distance, a certain amount of pressure on the back of the piston (being the locomotive force) will take place, proportioned to the power employed; in practice, and to work economically, it will be sufficient to produce an exhaustion of air in the pipe equal to causing a pressure from the atmosphere upon or behind the travelling piston of eight pounds per square inch, which is only about one half the pressure due to a vacuum. Supposing the main pipe of 18 inches internal diameter, it will receive a piston of 254 superficial inches area, on which, with the above pressure, a tractive force of 2,032 pounds is consequently obtained; and this is capable of propelling, a train weighing 45 tons (or eight to nine loaded carriages) at the rate of 30 miles an hour, up an acclivity of 1 in 100, or 53 feet per mile.

"The iron coulter being fixed to the travelling piston within the pipe, and also to the leading carriage of the train, connects them together, moving through an aperture formed in the top and along the whole length of the pipe; while one set of vertical rollers attached to the piston rod, at some little distance behind the piston, progressively lift up for the space of a few feet, and another set of rollers attached to the carriage close down again, a portion of a continuous flexible valve or flap, of a peculiar construction, covering the aperture; and it is the very simple, ingenious, and efficient mode of successively opening and closing down and hermetically sealing this valve, as each train advances and moves on, that constitutes the merit of the invention, and the foundation of the patent. The operation consisting, first, in opening the valve to admit the free admission of the external air, to press on the back of the piston and produce motion, and then in effectually closing down and sealing the valve again, so as to leave the pipe in a fit state to receive the travelling piston of the next train, and ready to be again exhausted of its air.

"Stationary engines, of sufficient power, proportioned to the amount of traffic and speed required, would, in practice, be placed at intervals of about three miles apart, and be arranged to work the railway to that length, alternately on either side of their position, as might be required.

"It may be sufficient here to observe that the composition for sealing the valve has stood the effect of exposure to the seasons, and of continued use for nearly eighteen months; that the tallow lining of the pipe produces a smoothness over its interior infinitely cheaper and probably more effectual, than the most finished boring; and that the connexion of the piston in the pipe with the train will be readily comprehended by any one who will examine a pencil moving in an ordinary pencil case.

"When it becomes necessary to stop or retard the carriages, in addition to the use of a common break, a valve in the travelling piston may be opened by the guard or conductor of the train, whereby the external air being admitted in advance of the piston into the exhausted portion of the pipe, the propelling power is at once destroyed.

"The separating valves in the main or pipe between each section or division of the line being made self-acting, there will be no occasion for stopping or even retarding the movement of the train, in passing from one division of the pipe to another, as the air is successively exhausted by the stationary power placed at the proper intervals. The carriages may, therefore, pass continuously, at any required velocity, as if drawn by a locomotive engine; and it is necessary to keep this circumstance in mind, as, by any other system of traction by stationary engines than the atmospheric, a stoppage and a charge at each engine is unavoidable.

"The great feature of the modern system of railway traction is this locomotive steam engine; and nothing is, perhaps, better calculated to demonstrate the mechanical genius of the country than the successive improvements which have been applied in the details of its construction. While our engineers have gradually ventured to lay out railways deviating greatly from the truly horizontal lines, originally considered nearly indispensable, and have increased the velocity of the trains to an extent almost alarming, the skill of the mechanist has kept pace with the necessity of finding powers to do the duty required; and, by dint of strict regulation of expenditure and various minor improvements, the cost of locomotive power has certainly decreased, when calculated upon a mere mileage of the trains. But, as the gradients of railways have been made steep, and as the rate of travelling has been augmented, the engines have of necessity, been made of greater power and weight, and additional sources of danger created by the introduction of assistant locomotives to surmount inclines or to keep up high speeds, and by the necessary increased momentum of the trains.

"With all the recent improvements and saving in the cost of locomotive power, the wear and tear, as compared with stationary power, is, however, fully 20 to 1, as may be exemplified in many instances of stationary engines working 10 or 12 years without any material repairs, and scarcely without stopping, and contrasting this with the costly establishments and constant expenditure incurred, even on short lines of railway, in keeping up locomotive engines to their effective performances.

"In addition to the causes of damage and expense from the use of this travelling power, there are the delays incident to the slipping of the engine-wheels from the want of adhesion when the trains are heavy, or the gradient steep, or the rails 'greasy' from slight rain, or glazed by fog or hoar frost, and again by the freezing of the pumps in severe wintry weather; each of which causes of delay becomes an additional source of danger, from which repeated and serious accidents, attended with fatal results, have happened. Although the occurrence of the pumps freezing is not frequent in this country, yet in many parts of northern Europe and America it must almost act as a total stoppage to railway traffic with locomotive engines in the depth of winter. The variation in the rate of travelling, from the varying velocities of trains drawn by locomotive engines, is likewise a cause from which accidents occur; and yet these different rates of speed can scarcely be avoided, as third class passengers and luggage, to be economically transported, must necessarily go by slower trains.

"To these various disadvantages in working with locomotive power may be added the necessity of using coke almost exclusively, which, in remote districts particularly, adds enormously to the expense. Fixed engines, consuming coal or turf (and, on the continent of Europe and in America, wood) as the case may be, will give out steam-power at a greatly less cost than locomotives can do under the most favorable circumstances. But, besides the wear and tear of the locomotive engine, and its injurious effects on the railway, there are some other striking disadvantages connected with it: a very considerable proportion of its power is manifestly absorbed in moving its own weight and that of its tender; while it is equally obvious that the faster it travels and the further the gradient deviates from a horizontal line, the more power is thus absorbed; but few persons are aware that this loss takes place in a rapidly increasing proportion, not only arising from the causes I have stated, but from others which are inherent in the construction of the machine; so much so, that it is stated by Mr. Wood, in the last edition of his work on railways, that, under ordinary circumstances, increasing the velocity of a train from 25 to 30 miles per hour is attended with a loss of more than half the effective power of the engine. A similar loss is sustained if the locomotive has to draw its load up an incline scarcely perceptible to the unpractised eye; and should this inclination be increased to 1 in 100, the effect is reduced to about one-fourth of that produced on a horizontal plane at the previous velocity, the power being lost or absorbed in the inverse ratio in which it requires to be augmented, precisely at the moment when it is most important to obtain an increase. This subject has been ably treated in the Second Report of the Irish Railway Commissioners (see notes D and E, pp. 104 to 110, which are understood to be from the pen of Professor Barlow.) It is there shown that 'the power thus absorbed, in what may be termed the preparation for motion, with first-class locomotives, is 1,075 lbs. which is sufficient to draw more than 14 tons on a good road by horse power,' 'and on a canal, with the usual barges,' 'more than 190 tons,' and that 'this absorbed power is nearly one-third of the whole power of the engine.' Now, the great advantage of the atmospheric system will be to obviate the waste of power, and consequent absorption of profits, arising from transporting useless weight and overcoming unnecessary friction, which it is hopeless to succeed in effecting by any other known mechanical means; for as it is proposed to work on this system, there will be nearly obtained a corresponding dynamic effect for the amount of power generated, whatever it may be; whilst, by the present system, as I have already shown, there is an enormous obsorption of power by the locomotive, whether moving at high rates of velocity, or up any material acclivities.

"It is manifest that on railways intended to be worked by atmospheric power, there is not at all the same necessity for having 'good gradients' as on those now at work; and wherever it may be necessary to adopt rather steep inclines for some short distance, it can easily be accomplished by increasing, at the place of difficulty, the dimensions of the apparatus and the amount of mechanical power.

"The economical advantages of the atmospheric system will be further exemplified in the diminution of the expense of maintenance. The destructive action of the locomotive engine (seldom, with its compliment of water and fuel, of less weight than fifteen, and often nearer to twenty tons) no longer impinging on the rails, a comparatively small sum will keep the line in repair; and though it may be difficult beforehand to assign the exact proportion of saving, it is evident the amount must be very considerable.

"In the carrying department the whole of the water stations, repairing shops, and fittings up necessary for the locomotive engines, are at once dispensed with, and the coverings and general arrangements of all stations much diminished in cost; heavy turnplates may be wholly done away with, and even the smaller ones, except at the termini of great lines, as the carriages can move in either direction; every description of carriage, having no longer to sustain the shock and tug of the locomotive, may be made very much lighter and cheaper, and built to carry a greater useful load both of goods and passengers in proportion to the weight than is the case at present, and will last considerably longer.

"The rate of travelling by the atmospheric railway will depend on the rate at which the air in front of the piston may continue to be pumped out by the engine, a sufficient degree of exhaustion having been previously obtained to move the load at the required velocity; and I see no reason to doubt that a speed of sixty miles per hour may be easily, economically, and safely obtained by this means; and in addition the passengers will be relieved from the noise, smell, dust, sparks, and hot cinders from the locomotive engine.

"A moment's inspection of the apparatus, or a little consideration of the description, will be sufficient to produce the conviction that the pressure of the atmosphere cannot move two trains at the same time in opposite directions between any two stationary engines, and thus collision becomes impossible on the atmospheric railway. It is equally obvious that one train cannot overtake another, and the leading carriage of each train being firmly attached to the piston-rod, it is scarcely possible that a carriage can be driven off the rails. Thus the ordinary sources of railway accidents appear to me to be removed, and the apprehension of danger, now unfortunately so general, would soon naturally subside on the introduction of this principle into practice.

"It becomes manifest, from the preceding statements, that, by the proposed means single lines of railway may be worked with perfect safety. There are but few districts of country through which, by starting trains with sufficient frequency, a single line of railway would not be adequate for all their present or prospective traffic, even with the use of locomotive engines; but single lines cannot be worked by these machines without incurring that risk of collision which will render the practice highly objectionable, and will always prevent the use of such lines to their full extent or capabilities.

"The atmospheric principle is free from this objection, and single lines can be worked thereby fully and effectively. Trains may be despatched from each end of any line in opposite directions, as frequently as the traffic may demand, without the possibility of coming into collision; as it has been already shown that no trains in motion can possibly approach nearer to each other than one section of the main pipe, being at the least three miles. Sidings would of course be provided at every station.

"With stationary engines placed at intervals of say three miles, there may be at those distances, under judicious management, a large amount of spare power to be employed for many useful purposes. At times between the passing of the trains, when the engine would not be required to work the air-pump in exhausting the pipe, it might grind oats or wheat, saw wood or stone, pump water drain lands in one part or irrigate them in another, thus performing various mechanical or agricultural operations. In suitable situations a smaller engine might be continually employed, in lieu of the larger one, in raising water to a proper reservoir, where it would be always ready and available as the trains might arrive, being equally applicable as steam to work the air-pump. All the contrivances for the economic generation and use of steam, such as clothing the boiler and working by expansion, are available to the fullest extent with the stationary engine, which is not the case with the locomotive. In some places the natural supplies of water might even be accumulated in sufficient quantity to dispense with the steam-engine altogether.

"What the ultimate result would be of having a large amount of steam power, which may be hired out on most reasonable terms for various useful purposes, spread over the face of the country at intervals of three miles, and having a railway communication with each of them, I shall not now stop to inquire; but I submit it as an interesting and peculiar feature of the proposed plan, and one eminently deserving your lordship's attention.

"As it is practicable by the introduction of the atmospheric system to reduce the cost of constructing, maintaining, and working railways so materially, a corresponding reduction in the charges for transmission of goods and passengers will follow; if, in addition, we are enabled to carry passengers at considerably greater speed and with much greater comfort, and, above all, if we are able to remove the apprehension of personal danger, who is there bold enough to assign the limit to the advantages of railway intercourse by this means?"

On the receipt of Mr. PIM's communication, the Earl of Ripon considered the subject of sufficient importance to induce him to refer it to Lieutenant Colonel FREDERIC SMITH, of the Royal Engineers, and Professor BARLOW, with directions that they should inquire into the application of the atmospheric principle in producing locomotion on railways. Sir F. SMITH and Professor BARLOW prosecuted the inquiry thus delegated to them, and the results of their investigation are summarily stated in the following declarations, with which they conclude their report on the subject:

"Firstly. That we consider the principle of atmospheric propulsion to be established, and that the economy of working increases with the length and diameter of the tube.

"Secondly. That the expense of the formation of the line in cuttings, embankments, bridges, tunnels, and rails will be very little less than for equal lengths of a railway to be worked by locomotive engines, but that the total cost of the works will be much greater, owing to the expense of providing and laying the atmospheric tube, and erecting the stationary engines.

"Thirdly. That the expense of working a line on this principle, on which trains are frequently passing, will be less than working by locomotive engines, and that the saving thus effected will in some cases more than compensate for the additional outlay; but it will be the reverse on the lines of unfrequent trains. However, there are many items of expense of which we have no knowledge and can form no opinion, such as the wear and tear of pistons, valves, etc. On these further experience is needed.

"Fourthly. That with proper means of disengaging the train from the piston, in cases of emergency, we consider this principle, as regards safety, equal to that appertaining to rope machinery. There appear, however, some practical difficulties in regard to junctions, crossings, sidings, and stoppages at road stations, which may make this system of less general application.

"We may add that the atmospheric principle seems to us well suited for such a line as the projected extension for Kingstown to Dalkey is represented to be, but we should have been glad if this line had been three miles instead of only one mile and three quarters in length, as it would have then brought this principle to a more complete and decided test."

"*On the Construction of the Bridges on the Bolton and Preston Railway.*" By A. J. Adie.

This paper which was written at the request of General Pasley, and by him communicated to the Institution, contains a description of the bridges over the Cowlin Brook, the Lancaster Canal, and the Chorley Road, which alone possess any peculiarities of construction, and they formed the types upon which the other bridges were built.

In Colonel Sir F. Smith's report upon the Cowlin Brook bridge, he advised great attention being paid to the bridge on account of its "unusual slightness, and the badness of the ground upon which it was founded." The author states, that the latter circumstance induced him to design the present proportions of the work as he wished to reduce the weight of the piers as much as possible; he therefore ventured to deviate from the original design given by Mr. Rastrick. The result has justified his anticipations, as "after the most careful inspection not a single crack nor a splintered stone can be detected."

The ground where this bridge was to be placed, was found to be a rotten and compressible mixture of moss, decayed wood, and sand, with a few large stones; a foundation was made for each pier by driving in piles 20 feet long by 12 inches square; upon these were placed the footing courses of Limerick stone 8 inches thick; the piers were built hollow, so that the utmost weight placed upon each superficial foot should not exceed 5½ tons, which the author states to be a light load for ashlar work:—"In Edinburgh there are old rubble walls 34 inches thick and above 100 feet high, which in addition to all their proportion of eight floors, and a roof, have 6¼ tons on each superficial foot of the bottom courses, and there is a brick chimney in Bolton, the bottom courses of which support 8⅔ tons on the superficial foot."

The bridge consists of eight arches, each of 30 feet span; the arch stones are 18 inches thick, of hard sandstone from the Whittle hills, except seven courses at the crown, which are from a better quarry at Ackrington, near Blackburn.

The author then mentions, as a precedent for such dimensions, some arches constructed under Mr. Jardine's direction on the Edinburgh and Dalkeith Railway; they were of Craigleith stone, semi-elliptical in form, of 24 feet span, with a rise of 4 feet., or ⅙th of the span; the stones for these arches were 12 inches deep at the springing, and 9 inches deep at the crown; the abutments of one of them are founded on platforms of timber, without piles, resting upon soft plastic blue clay; they have been standing for upwards of ten years, and exhibit no signs of failure. Another arch is also mentioned, constructed by the same engineer, over the South Esk, near Dalkeith, the span of which is 55 feet, and the versed sine 12 feet; the keystone is 18 inches deep, and the springers 21 inches in depth.

The author objects to placing a mass of earth upon the haunches of the arch, as, from the tremour caused by the passing of the railway trains, the earth has always a tendency to be wedged in between the side walls and to force them out; he therefore left voids above the arch stones, allowing only sufficient weight of masonry upon the haunches, and thus securing the rapid hardening of the mortar; for this latter reason also the walls of rubble-work never much exceed 3 feet in thickness, and they have been found much stronger in consequence.

The railway is carried over this viaduct on longitudinal bearers, 13 inches deep by 6 inches thick, laid on planks 3 inches thick; the bearers and planks are not fixed together with a view to diminish the vibration of the passing trains; this method of laying is stated to be very effective in this respect.

The Lancaster Canal Bridge was originally intended to have been a direct span of 60 feet, constructed of iron, but the directors subsequently decided on building a skewed stone arch of 25 feet span on the right angle. The arch is semi-elliptical on the square, with a transverse axis of 41 feet 2 inches and a semi-conjugate axis of 8 feet 9 inches; the arch stones are 2 feet 3 inches on the square at the springing, and 1 foot 6 inches at the key-stone; the bed joints intersect at right angles all the lines of sections of the intrados, made by vertical planes, parallel to the elevation; and it is that property that causes the chamfer lines of the beds of the stones to diverge from the springing to the crown. These lines of the curved joints are easily laid down on the sheeting of the centres from a full-sized development, and by lines drawn at different heights, parallel to the springing of the arch. The lines of the radiating bed joints are always perpendicular to the tangent of an ellipse of the same form as the elevation of the bridge, the moulds used to form this being applied in the plane of the elevation. The twist on the length of the beds of the courses was taken from full-sized skeleton moulds of the form of the oblique ellipse or elevation. The five courses running parallel to the abutments are all of the same form and have the same amount of twist on the beds of each stone, except the end stones of the courses, which are varied in length to suit the general breaking of the joints of the courses resting together. The centre part of the arch is plain square work.

This mechanical method of finding the lines, and the twist of the radiating beds for an elliptical skewed arch, is destitute of the scientific accuracy of the mode by which Mr. Buck calculates his spiral lines for oblique bridges, of which the section at right angels to the abutment is an arc of a circle; but the workmen had no difficulty in putting it in practice, and the author states that he would have had more trouble in constructing trussed centres for a flatter curve of a circular arc, and at the same time keeping the towing path of the canal open. He states that he has not met with any description of an arch executed in this manner, but he considers it the only true principle. Every very thin section parallel to the elevation is a proper elliptical arch, and there is a very great saving of stone from the smallness of the twist on the curved beds as compared to the common method of working them.

The Chorley Road Bridge is a compound of the common and skewed arches, which the author finds convenient and economical. He has executed several upon this plan; they are as perfect as the best common arches, and free from skirting of the soffits of the stones. The section of this bridge at right angles shows a rise of 5 feet, with a span of 25 feet. The springers at this part are 15 inches deep, and the key-stone is 13 inches deep; on the oblique section, or the elevation, the span is 37 feet 9 inches, and the rise 5 feet; the springers are 24 inches deep, and the key-stone is 17 inches deep.

The straight part of the arch is formed with courses about 10 inches on the soffit, and these are turned round in curved lines which are portions of circles, the straight parts of the courses being then tangents, and they cut the lines of the elevations at right angles, so that there is no more tendency of the arch to sink at the elevation than would be the case with any elliptical segment of similar dimensions worked in the ordinary way. The part of the acute angle of the arch is formed with courses which converge from the elevation to the abutments, on account of being arcs cutting the elevations at right angels, and then becoming nearly tangential at the springing. The curves for these courses were transferred from the development to the sheeting, in the same way as those for the Lancaster Canal Bridge, and the twist of the beds was taken off full-sized sections of the arch, made in the directions of the converging lines of the extremities, so that at each of these places the beds were worked as if for part of a true elliptical arch, and the beds between the points thus formed were worked off with curved rules found from the development. After the masons got into the way of working this kind of arch, they of their own accord preferred it to the complete skewed arch. In brick work built in this way, it would be very easy to skew the ends of a long archway by having the bricks moulded to the curvature of the key-course, as with a very little alteration they would fit any part of the concentric courses and a few tapered bricks would facilitate the filling up of the fan-shaped part of the haunch of the acute angle.

The communication was illustrated by several detailed drawings and a model of the bridge, with schedules of the prices and cost of the works.

EXTRACT FROM THE REPORT OF THE SECRETARY OF WAR.

The report of the Colonel of Topographical Engineers affords new and continued evidence of the great usefulness of that corps, and of the zeal and ability of its officers. An accurate knowledge of the topography of our very extended territory, particularly of its maritime and internal frontiers, of its lakes and rivers, of the obstructions to intercommunication, and of the positions most required and most capable of densive works, is indispensable alike to intelligent legislation and to efficient executive administration. As a mere question of economy, such information can scarcely be acquired at too high a price. The advantage of an organized scientific corps, qualified by study and practice for this peculiar duty, over the irregular services of persons transiently employed, without organization, and without the opportunities of mature and systematic deliberation, doubtless dictated the formation of this corps; and all our experience has shown the wisdom of the measure. The reports in detail of the several officers of the corps, appended to that of the Colonel, present a mass of the most valuable information respecting the topography of various parts of the Union, from the remote North to the extreme South. They exhibit the progress made in the surveys, in the improvement of harbors and rivers, in the construction of light-houses and breakwaters, and in various other works in charge of the corps. A brief notice of a few of those which seem to require attention is all that will be attempted on the present occasion.

It will be perceived that considerable progress has been made in the survey of the North-western lakes, and that preparations for its continuance the next season have been made, which will enable those in charge of the work to accomplish more than was practicable during the last year. The expense of these surveys is comparatively so trifling that they can scarcely be liable to objection in almost any state of the Treasury. I cannot omit to call attention to the report of Captain Williams, respecting the urgent necessity of a harbor on the west side of Lake Michigan, and the improvement of the navigation at the mouth of St. Clair river. These are exceedingly important to the United States, to enable us to furnish supplies to the Indian tribes, and military stores and subsistence for the troops which, even in time of peace, must be maintained in that quarter, and which, in the event of hostilities, will afford the only barrier between savage ferocity and our frontier settlements. But to our fellow-citizens of that region, who have purchased the public lands, a safe access to the markets of the East is so essential as to justify their calls upon the Government for a common share of its protection. The commerce of the lakes, comprising the production of seven States and one Territory, which must annually exceed twenty-five millions of dollars, would seem entitled to consideration and assistance, not only on account of the great interests involved in its success, but on the ground also of a fair apportionment of the fostering and protecting aid of the Government. This commerce affords the only effective means of supplying the nation with the mariners who will be found indispensable in that quarter in the event of hostilities.

It will be seen that the surveys for the defences of Sollers's flats and of Delaware breakwater harbor are completed: those for the defences of Sandy Hook, and the harbor and town of Portsmouth, New Hampshire, are in execution; as well as the military reconnoissance of the peninsula of Maryland, south of this city. It is gratifying to learn that an extensive and very thorough reconnoissance of the defences of New Orleans, embracing a large extent of territory, has been completed.

The raft which formed the obstruction to the navigation at Red river has been removed—an event of no small importance to our fellow-citizens in that quarter.

The Potomac aqueduct is so far completed as to warrant the confident expectation that it will be in a condition to receive water in the course of the next season. The repairs of the Potomac bridge are drawing to a close, and it is belived that it will be passable in January next.

The measures taken to execute the law of the last session, appropriating one hundred thousand dollars for the improvement of the Ohio, Mississippi, Missouri and Arkansas rivers, are also stated. So soon as the application for an injunction by Henry M. Shreve, Esq. which has arrested the progress of those measures, shall be disposed of, they will be resumed. But it is manifest that the present appropriation is wholly inadequate; that it can only provide the necessary snag boats; and that, unless followed by others, the expenditure of the money will be but to waste it.

The proceedings of the corps under the laws respecting the construction of the light-houses, are also detailed in the report. It would seem that the expense of these invaluable auxiliaries to commerce may be much diminished by the adoption of Mitchell's patent screw moorings, a recent English invention; and that by means of such moorings, they can be placed in positions far more advantageous to the mariner than any that can be occupied in the present mode of building them. The sanction of Congress is invited to the the steps recommended by the Colonel of Topographical Engineers to procure the necessary apparatus, and acquire a knowledge of its application.

It will be seen that a party of engineers is in the field for the survey of the Arkansas and Platte rivers and the adjacent country. A survey of the country north of the Missouri having been completed, the map of which, constructed by Mr. Nicollet, unequalled in the accuracy and fulness of its details, is now nearly finished, and will be published in January next. It is intended to cause a similar survey of the country south of that river, embracing the approaches to Rockey Mountains, their several passes, and gradually the region between them and our possessions on the Pacific. These explorations and surveys are indispensable to such a knowledge of the country, its resources and its streams, as we must possess before we can establish any communication with a region that is every day becoming more important to us; and it is hoped that there will be no reluctance to granting the very moderate appropriations asked for the continuance of the "military and geographical surveys west of the Mississippi river."

Practical detals of Management are always useful. The following notes from "The Civil Engineer and Architects Journal," seem to contain some good hints.

NOTES ON STEAM NAVIGATION.

The management of the furnaces.—It is a common practice in steam vessels to pile the coal much too abundantly on the fire grate, the stratum of incandescent fuel is too thick, and the generation of carbonic oxide is the consequence, to the manifest diminution of calorific effect. The coals should be strewn upon the grate bars evenly and equally; the depth of the stratum should be about three inches, but this is a point dependent in a great measure upon the intensity of the draught; the stronger the draught the thicker should be the stratum of incandescent fuel. The bars should never exceed 7 feet in length, and should be as much less as possible; 5 feet is a good length, and not an uncommon length in the best boilers. It is impossible to fire long furnaces properly, especially in a sea way. We have known the length of the fire bars to be reduced from 8 ft. 6 in. to 5 ft. 6 in, with a great accession to the steam-producing powers of the boiler. The bars should always have a considerable inclination, both to facilitate the transmission of the fuel from their foremost to the aftermost extremity, and to diffuse the air more equably over their lower surface. The skill of firemen varies greatly, and due attention should be paid to their selection. A dead plate at the mouth of the furnace is a good thing, and combined with a slow combustion will obviate smoke and save fuel. These are the true secrets of combustion on chemical principles.

Boilers, wear and tear.—The wear of boilers is not unfrequently chiefly from the outside round the steam chest, from the dripping of water from the decks, in the ash pits from the wetting of the ashes, and on the bottom of the boiler from the action of the bilge water. This last source of wear is now almost altogether obviated in some of the best steam vessels, by placing the boiler upon an efficient *caulked* platform, bedding it in putty—not an incorporated mass of lime and oil, but really sound substantial putty, such exactly as glaziers use. A cooming of timber is attached to this platform, encircling each boiler, and the interstices between the timber of the cooming and the iron of the boiler are filled in with roman cement, and sloped off on the upper side, so that no water can lie on the cement or cooming. It might be expected that these coomings would be disturbed by the expansion of the boiler when heated, but we find that the expansion is so inappreciable in practice as not to be productive of any visible derangement. The upper parts of boilers should be covered with felt and sheet lead, soldered wherever there is a joining; the practice of covering boilers with felt and sheet lead is now almost universal among the best engineers.

Blow-off cocks are a perpetual source of annoyance if they be not well made at first. The metal of which they are composed should be hard and tough, without any lead in it. The plugs of the cocks, if made with too little taper, will be very apt to jam, and after having been ground a few times, will sink so far into the socket as to come in contact with the bottom, if there be one, and diminish materially the effective area of the water way. If the taper be too little on the other hand, a great strain will be thrown on the gland, which keeps the plug in its place, and if they give way it will be driven out with great force. This did occur in the Great Western, and the engineer was scalded to death.

The durability of brasses is dependent upon a variety of circumstances, but chiefly upon the quantity of rubbing surface and the quality of the metal. We have seen a brass of Boulton & Watt's which had worked for thirty years, and was at the end of that time in good preservation, whilst we have seen other brasses which, in the course of a couple of years, were quite worn out.

De omnibus rebus et quibusdam aliis.—Should the engineers be subject to the captains? In generals, YES—in particulars, NO. The Admiralty regulations in reference to engineers are just as preposterous as might be expected, inasmuch as the Admiralty is invariably a century behind the merchant service, but in their regulations respecting engineers, they have out-Admiraltied themselves and earned a title to a squabash with our tomahawk, with which we may probably honor them on an early occasion. The Admiralty desires to have young men of education as engineers, and yet with Admiralty consistency rates the engineer *beneath* the ship's carpenter—and what engineer of talent and education would place himself in so abject a situation, or submit to be snubbed and browbeaten by every whiffling lieutenant or embryo midshipman who does not know the garboard streak from the log line? As to your amateur mechanics, we always shun them as carefully as we would do a rabid dog; their bite is dangerous, and their bark—why that of Cerberus was heavenly music to it. We have never recovered from the alarm we once experienced from the spectacle of one of these *cognescenti* with blackened fustians and white kid gloves, crawling daily for the space of a whole week, through the labarynths of an oily steam engine, to vindicate his title to engineering proficiency. We bethought ourselves of Nebuchadnezzar, and betook ourselves out of reach of the saliva. When we take upon ourselves the administration of the Admiralty, which, between this and 1942, we may perhaps be prevailed upon to do, our first operation will be to get a leviathan besom constructed to sweep away all such incurables, preparatory to placing engineers in their proper position.

Ventilation is a thing greatly neglected in steam vessels, although so many facilities exist for establishing an effectual system. Every vessel should be fitted with one or more fans, or Day's patent Archimedean Screw ventilator, worked by the engine for exhausting the air from the different cabins, gratings being left above the doors and other suitable places for the admission of fresh air from without. The same mechanism might be made to draw air from the holds and other parts of the ship, so that any bad smell from bilge water, etc. would be entirely obviated. In tropical climates, in particular, no steam vessel of any considerable size ought to be unprovided with a ventilating apparatus.

The rolling of steam vessels in a sea way gives a lateral impulse to several parts of the machinery, which it is often not well calculated to resist, without a considerable jolting. Thus the side levers will, when the vessel rolls heavily, slip in and out upon the main centres, and the shafts will move endways. It is true there are collars to prevent this, and in new engines no great movement of this kind can take place; but the collars are in most cases much too small—they are deficient in rubbing surface, and they consequently wear, in a short time, considerably into the brass, leaving a lateral play upon the journal, which admits of no adjustment. To obviate this evil, Messrs. Maudslays & Co. are in the habit of making their journals with very large fillets in the corners, so as, in fact, to make each end of the journal a short frustrum of a cone. This has the desired effect, but occasions a wasteful expenditure of the oil. Mr. Robert Napier makes his cranks to bear against the flanges of his brasses. This plan obviates the rapid wear, but still leaves any wear that has taken place unsusceptible of re-adjustment. The best plan, it appears to us, would be to make each journal bulge out in the middle, so as to constitute, in fact, a portion of a spheroid, and recess each brass correspondingly. The act of tightening the top screws of the journal would then have the effect of preventing the shafts from moving on end, as well as of preventing them from moving up and down. The outer bearing of the paddle shaft should be always so made as to admit of easy adjustment. A common plummer block with the top constructed for holding tallow, placed upon a good stout carriage bolted to the fore and aft bearers, is, in our judgment, the best arrangement. The plummer block bolts should be so made that they may be dropped down to admit a piece of plate iron between the sole and the carriage at any time the shafts may require re-adjustment. A brass in the upper part of the plummer block at the outer end of the shaft is unnecessary, as there is no upward strain, and the cover bolts should be merely sufficient for holding it on in a sea way. This journal always wears forwards as well as downwards, and the brass should be so made as to admit of the aftermost side being turned before. The sides of the brass should also be thicker than in journals where this action does not exist.

Piston Rods.—The best mode of attaching the piston rod to the cross head is by means of a cone and cutter and gib, and a screw above the cone; this cone should have considerable taper both to obviate any injurious expanding action which a cone of little taper would occasion, and to facilitate the disengagement of the rod when it requires to be taken out. Some of Boulton and Watt's cross heads are made close over the piston rod, except that a little hole is left in the top to admit the introduction of a drift to start the piston rod when it requires to be disengaged. This we think is a very objectionable plan, and we have known it in practice to be productive of the most serious inconvenience; for a small drift will not start a rod on which the taper is not considerable, and which is rusted into its place. The drift may indeed be assisted by a cutter driven into the cutter hole, and so contrived as to force the rod down instead of keeping it up; but even with this aid we have known the largest drift that could be introduced through the top hole to be quite ineffectual in starting the rod. It is a bad practice too to make the upper part of the rod that fits in the cross head eye parallel; a blow or two upon this parallel part will stand and swell it so as to rivet the rod into the socket.

Iron Ships have been much cried up of late by iron ship builders. We admit their claims to favorable consideration, but at the same time maintain that they are attended by many serious disadvantages. In the first place the accumulation of seaweeds and barnacles is a formidable objection. We have seen indeed a scheme of a scraper for removing these accumulations whilst the vessel was under weigh, but it is in our mind puerile and impracticable. Again, the iron of which vessels is composed has been found to become brittle in the course of years, so that although tough at first, it will in the course of time, star like glass when struck by a hard and sharp body. The action appears analagous to that which takes place in railway axles. Mr. Nasmyth, indeed, has shown that railway axles are rendered brittle by cold hammering, and may be toughened again by annealing; but he has not shown that axles are not rendered brittle also by continued wear, or that this species of brittleness admits of the same remedy.

Bilge pipes are best of lead, both because lead resists the action of the bilge water better than any other metal and because it is much cheaper than copper. But the blow off pipes should never be of lead; lead blow off pipes bulge and burst from the continued heat and fragrance to which they are subjected. We find that Mr. P. Taylor at the Institution of Civil Engineers, a short time ago recommended all the pipes exposed to the action of the bilge water in any measure to be of lead, and his recommendation was allowed to pass without comment. We therefore think it expedient to say that we altogether differ from Mr. Taylor in this particular. Neither the blow off or deck pump pipes should ever be of lead though they are always more or less exposed to the action of the bilge water. No engineer in this country ever thinks of making blow off, deck pump, or injection pipes, of any thing but copper.

Waste Steam Pipe should be as high as the funnel, especially if situated before the funnel. When the waste steam pipe is shorter than the funnel, the action of the steam on the iron of the funnel rapidly oxidizes it and speedily makes the funnel very thin in that part of the ascent to the mouth of the waste steam pipe. When the pipe is made as taunt as the funnel, the steam is carried clear of the funnel altogether.

Stop valves between the boilers should be permitted always to act of their own accord, and should never be opened and kept open by drawing up the spindle and keeping it up. Unless the stop valves be allowed to act spontaneously, like the safety valves, they will soon become so fixed by corrosion that they cannot be shut at all, and are consequently of no avail. If the increased pressure incident to the weight of the valve be objected to, that weight may easily be balanced by a weight and lever attached to the spindle, where it emerges from the stuffing box of the valve box cover.

Rudder.—It is a judicious practice to make the rudder rather shorter than is requisite to reach the keel—the rudder will thus be unaffected if the vessel takes the ground. The keel should always project a little beyond the rudder joint so as to prevent warps or ropes of any kind from catching in the joint as the vessel passes over them. The rule joint is the best species of joint for a steam packet rudder, and by far the neatest: the rudder head should be round and should fit accurately in the rudder trunk, which of course should be a cylinder.

Paddle box boats of Capt. Smith are we think inconvenient—unsightly and ineligible. It would be greatly preferable to have a dozen boats stowed inside one another like the nests of pill boxes of the apothecary. In a heavy sea the paddle box boats could not be raised without great difficulty, and when raised could scarcely be approached. Their proximity to the paddle when launched is dangerous, and the waves would fly up through the paddle box in a sea way with great force, and cut off all communication between the boat and the ship. We regret that Capt. Smith has not found a better vehicle for his ingenuity than this cumbrous, ineffectual and unsailorlike contrivance.

GEOLOGY OF SOILS.

1. Agricultural chemistry aims to explain all the actions of earth, air, and water, upon plants. It refers to all their chemical relations, to the geology, minerology and chemistry of soil.

2. Agricultural geology explains the relations which soil bears to plants, and the manner in which that affects vegetation.

3. Agricultural geology confines itself to facts. It digs into the earth, observes what composes that; how its components act upon plants. Conversant only with facts, or logical deductions from these, it leaves to geology proper, the vast mass of observations, supported by the highest modern science, which teaches the origin, mode of formation, original condition, and successive changes which our globe has undergone.

4. The terms, primitive and secondary, used by geologists, are almost parts of common language; yet, need to be explained to the farmer.

5. A large tract of any extensive country is composed of rocks of a granite texture. This needs no definition. Such rocks having been observed to underlay all others, in the scale of rocks composing the earth's crust, were called primary. It was supposed that these were first formed. Out of the ruins of these, no matter when or how ruined, other rocks have been made, called secondary. The ruins of the primitive rocks have been transported by

water, and then gradually deposited layer upon layer. Under immense pressure, these layers of mud, sand, fine gravel, rolled stones, etc., have been, hardened into solid rock; forming sandstones, slates, or even rocks presenting the crystalline structure, or texture of granite, by the action of heat, which the facts of modern geology teach, exists in the interior of our globe.

6. This central heat is supposed to be the case of volcanoes, and the primitive rocks themselves, to have been the ejection, under circumstances unknown, of the melted mass of the globe; ejections, similar in kind, to those of modern lava, but greater in degree.

7. Intermediate between modern lava, and primitive rocks, and actually passing into either, is a large class of ancient volcanic rocks, called, trappean; such are basalt, trap, and highly crystalline porphyry.

8. However named and classed are the rocks of the earth's surface, they have one common origin, the molton matter of the globe. Hence, having a common origin, their ultimate chemical constituents are similar. If granitic rocks have a certain chemical constitution, then sandstone, slate, etc., having been formed from worn out and worn down granitic rocks, have a constitution chemically like them.

9. To the agriculturist, the terms *primary* and *secondary*, are useless. Equally so are all distinctions of soil based on these terms.

10. Soil is the loose material covering rocks, and often is included in that term. Both are to be classed by their origin. The origin of rocks refers not only to the mode of their first formation, but to their subsequent arrangement. The origin of all rocks, geology teaches, is from the molton matter of the globe. These have been, afterwards, in some cases, removed by water, and in part remodified by heat [5]. Referring rocks to their origin, they are divisible into two great classes.

1st. Those formed by fire.

2d. Those formed by water.

11. This division relates both to the origin and distribution. In their origin all rocks are truly *igneous* or by fire. In their distribution they are *aqueous* or by water. This is the only division necessary to the farmer. It is the division taught and demanded by Agricultural Geology.

12. The first class includes all the highly crystalline rocks, granite, gneiss, sienite, greenstone, porphyry; basalt, lava, volcanic sand. The products of volcanoes, whether ancient or modern, agricultural geology places in the same class, including thus all that portion which forms the largest part of the earth's surface.

13. The second class includes sand, clay, gravel, rounded and rolled stones of all sizes, puddingstone, conglomerates, sandstones, slates. When these various substances are examined, a large part of sand is found to be composed essentially of the ingredients of the igneous rocks. This is true also, of sandstone, slate, of conglomerates, of bowlders.

14. There is a large deposit, or formation in some districts, composed almost wholly of one of the chemical constituents of the igneous rocks, united to air. The constituent is lime, the air is carbonic acid, forming by their union carbonate of lime. Marble, limestone, chalk, belong to this formation. These are not to be ranked as original igneous products, subsequently distributed by water. The lime, originally a part of igneous rocks—has been separated and combined with air, by animals or plants, by a living process, called secretion. The modern production of carbonate of lime, is still going on under the forms of shells and corals. Though belonging to neither division, the subject will be simplified by referring limestone to the second class of rocks—but it is truly a salt, and belongs to neither division and it will be discussed hereafter.

15. The chemical constitution of all rocks is similar. If rocks are divided into two classes, the first composed of the highly crystalline, usually called primary, such as granite, gneiss, mica slate, porphyry; and the second class composed of rocks, usually called trappean, as bassalt, greenstone, trap, then the great difference in their chemical constitution is this:

The first class, or granitic rocks, contain about 20 per cent. more of silex, and from 3 to 7 per cent. less of lime and magnesia and iron, than the second or trappean class.

16. If the language of geology is borrowed, and rocks which present the appearance of layers, or a "stratified structure," are divided into two classes, fossiliferous and non-fossiliferous, or those which do, or do not contain remains of animals or plants, it will be found that the fossiliferous are neither granitic nor trappean, yet they are to be classed with the last, agreeing with them in containing less silica, and more lime, magnesia, and alumnia.

17. The stratified non-fossiliferous rocks agree in chemical composition with the granitic, and the fossiliferous with the trappean and volcanic.

18. The trappean and fossiliferous contain the most lime and magnesia; the granitic and non-fossilferous, the most silex. The great difference in chemical composition, between the two classes, is produced by lime and magnesia,—two substances, which, more than all others, have been thought to influence the character of soil.

19. The amount of this difference is about from 4 to 7 per cent.; yet notwithstanding this, the general chemical constitution of all rocks approaches so nearly to identity, that this may be laid down, as the first principle in agricultural chemistry, that there is one rock, consequently one soil.

20. To the farmer, all soil is primary. The question then arises, how do rocks and soil affect vegetation? As a consequence of the first proposition, it may be laid down as the second principle of agricultural chemistry—that rocks do not affect the vegetation which covers them.

21. This is opposed to the geological doctrine of the times, and may seem to be opposed to the statement, section 18. The differ-

ence there stated, may be thought to produce corresponding effects in vegetation. This would be true if rocks exerted any influence on soils, due to their chemical constitution. A survey of the geographical distribution of plants, used for food, will show that the common doctrine of the chemical influence of rocks on vegetation, is not so well supported, as to be considered an established principle.

22. The plants used for food are cultivated on every variety of rock foundation which the earth presents. Then cultivation is limited neither by granitic nor trappean, by fossiliferous nor non-fossiliferous rocks. Then product varies not more on different, than on the geological formation. Every where, over every variety of rock, the cultivation of the food-bearing plants, repays the labor of the farmer.

23. Surveying Massachusetts, it is evident the grain crops are not influenced by the peculiar rock formations over which they are grown; for in this state, with the exception of modern volcanic rocks, all the various formations, which the earth presents, are found. Yet no difference in the quality and quantity of crops of rye, oats, barley, wheat, Indian corn, is found which can be attributed to different geological tracts.

24. All plants have a natural limit, a peculiar region, in which, unaided by the human race, they flourish and spread spontaneously. The smaller the limit of this natural boundary—the more difficult is the cultivation of the plant. Yet we find that the natural boundary is passed, and so plants come to live in an artificial region. There is a natural, and there is an artificial "habitat," or region; and this last is either horticultural or agricultural. The first is unlimited, the second is limited by the great external circumstances of temperature and moisture.

25. The extreme north and south limits, which bound the cultivation of the food-bearing plants, are determined wholly by physical, physiological and social causes. Temperature is the great agent, which limits the agriculture "habitat" of the grain-bearing plants.

26. The distribution of plants is governed by the two following laws:

1st. The polar agricultural limits are bounded by lines passing through places of equal summer heat.

2d. The equatorial limits, by lines of equal winter heat.

These lines are called respectively, isotheral, and isochimenal. They by no means coincide. They often cut each other at right angles, and generally, from about 45° north latitude, they are parallel neither to one another, nor to the latitude. They are often highly curved.

And now for the proof of these general laws—beginning with barley, the grass or grain which has been cultivated the farthest north. Its fields are found in the extremity of Scotland, in the Orkneys and Shetland Isles, 61° N.; in the Feroe Islands, 61°—62° 1-2 N.; in Western Lapland, near North Cape, in latitude 70°;

on the borders of the White Sea, in Western Russia, between 67° and 68°, and near to Archangel, in Eastern Russia, about 66°, in Central Siberia, the limit of barley is between 58° and 59° N. There are no extended observations of the temperature of the northern portions of our own continent, and therefore the limit of barley in Northern America is left undefined. But its European line will probably define that which will limit grain cultivation in America.

Tracing a line through the points above named, it is the northern boundary of all the cereals, or grains. A little beyond this line is the boundary of the potato, and the belt between the two, is remarkable. It is the zone between agriculture, and fishing and hunting, between races of men, subsisting on animal, and on vegetable diet, and those whose chief food is animal. The northern cultivation of barley is bounded, if its course is traced, by a very curved line. Is this determined by geological causes, or do causes purely physical erect a barrier to its farther northward advance? The answer will be found, in tracing the temperature of the seasons of the different places, through which the limit of the northern cultivation of barley passes. It will be evident that the line of this limit is isotheral, for the mean temperature, Fahrenheit, is as follows:

	Latitude.	*Year.*	*Winter.*	*Summer.*
Feroe Isles,	61—62°	+45°	+39°	+51°
W. Lapland,	70	+33·8	+21·2	+46·2
Russia, at the mouth of the White Sea,	66—68°	+32	+10·2—8·8	+46·3

Casting the eye on this table, it is evident that the annual or the winter temperature has little influence on the barley limit, and that a mean summer temperature from 46 to 43° is the only indispensable physical condition, to the cultivation of barley. On the Atlantic islands, a mean temperature from 3 to 4° higher is necessary, which compensates for excessive humidity. It is remarkable, that all the cereals have failed in Iceland, though its mean temperature is above that necessary for barley. Nor is this owing to its geological structure. In that, it agrees with the fertile shores of the Mediterranean. It is volcanic. So far as nitrogen, and carbonic acid, and ammonia, may be supposed, to be evolved from the earth, and to contribute to the growth of grain, Iceland should equal fertile Italy. But such is not the fact, and it goes to prove that rocks affect very little the crops grown over them, even when the great physical element, temperature, is as high as necessary. That grains fail in Iceland, is due to the excessively tempestuous rains with which that country is visited. If then, the limits of barley are defined by an isotheral line of 46 1-2° in Europe, that will also limit its cultivation in America. So far as observation has extended, this is true, and the line of boundary is equally curved, and winding. If a similar table for the limits of wheat is constructed, by drawing a line through the most northern places, where this grain has been cultivated, the physical conditions, essential to its cultivation, will be found as follows:

	Latitude.	Mean temperature, Fahr. of the Year.	Summer.	Winter.
Scotland, (Inverness)	58°	+46.3	+57·3	+36·5
Norway, (Drontheim)	64°	+39·5	+59	+23·5
Sweden,	62°	+39·5	+59	+23·5
St. Petersburgh,	60·25	+38	+60·8	+15·6

North latitude 64° appears then to be the utmost limit of wheat. It is evident by inspection, that this is not determined by the cold of winter; for spring wheat would not be affected by it; and even if sown in autumn, in these far northern regions, the seed would be effectually preserved from the rigors of winter, by that thick mantle of snow, which becomes thicker and more lasting towards the north. The temperature of the air exerts no influence on seeds of plants buried under snow. Nor does the mean temperature of the year exert any effect; it is seen ranging 9°, while the summer temperature varies only 3 1-2°. The summer temperature alone defines the limit of northern wheat cultivation, and this is an isotheral line of 57·4°. Yet it is found, that there are places, where, as in Russia, the means of spring and autumn, both depending on that of winter in part, are too low to allow wheat to be raised under this line of 57·4 degrees. In truth, the relation of climate to cultivation cannot be accurately determined without observations on the mean temperature of the days which elapse between sowing and harvest, and to this point the philosophic farmer should direct his attention. In our country, the isotheral line of 57·4 degrees, starting from Labradore, 51 degrees, and passing between Hudson's Bay and Lakes Superior and Huron, 50 degrees, then turning north it approaches 58 degrees. At Cumberland House, 54 degrees north, Capt. Franklin found fields of barley, wheat, Indian corn. The line approaching the Pacific ocean turns more southerly to compensate the increasing humidity. As the limits of barley mark the boundary between the races of shepherds and hunters and fishers, and thus presents itself in a moral view, so the limit of wheat becomes interesting from coinciding in some parts with that of fruit trees, as apples and pears, and also with that of the oak. The whole aspect not only of agriculture, but also of the orchard and forest changes at once on approaching the isotheral line of 57·4 degrees, the northern limit of wheat. It would be easy to extend these remarks to rye, still the staple food of a large part of the population of Europe, and to oats, little used for food for man out of the "land o' cakes," yet growing in Norway, as high as latitude 65 degrees. Each of these grains has a distinct isotheral line parallel to that of wheat and barley. Indian corn and the potato have each its isotheral line. Turning to the equatorial limits of the grains it will be found, that extreme heat arrests their cultivation. Observations in these regions, and experiments performed by profound vegetable physiologists, confirm this statement. They have proved that the seeds of the food-bearing plants, even after germination has began, can support greater degrees of drought and heat, than ever occur in the hottest climates.

The grains all germinate in a soil of a temperature from 104 to 105 degrees, and require at least from 116 to 120 degrees to arrest this process. Barley ceases to germinate at the lowest temperature. After barley follows wheat, then rye. Indian corn endures the highest heat, viz.: 120 degrees before its germination is arrested. The grains flourish under a mean annual temperature of from 77 to 80 1-2 degrees. Defining their equatorial limits, they are bounded not by lines of equal summer, but equal winter temperature; the reverse of their polar limits. Hence, climate, always determines the sowing season. In Bengal, wheat, barley, oats, are sown in October and harvested in March and April, while rice and maize are sown in May, to be harvested as with us in October. It is this line of equal winter temperature, or rather that of the coolest months, which allows the grains to be cultivated in many places within the torrid zone, and the line of 68 to 70 degrees, which constitutes the tropical limits of wheat culture, varies between 20 and 23 degrees latitude. The other grains enduring from 5 to 7 degrees lower temperature, are found in higher latitudes.

27. The wide belt of our globe, comprised within these limits, extending from 20 to 70 degrees north latitude, presents every variety of geological structure; yet, nowhere, in all this space is the quantity or quality of crops affected, by the chemical nature of the underlaying rocks.

28. A similar principle governs the growth and cultivation of the grain-bearing plants on mountains. Their limits are found at heights, which correspond to the latitude, which marks the isotheral line. In the Swiss Alps, the grains cease growing at the following heights.

Wheat	at	3400	feet	corresponding	to latitude	64 degrees.
Oats	"	3500	"	"	"	65 "
Rye	"	4600	"	"	"	67 "
Barley	"	4800	"	"	"	70 "

This shows a beautiful correspondence between latitude and altitude, and leads a step farther in the proof of this principle, that rocks do not affect the vegetation which covers them.

29. The space which has thus been surveyed, presents amid great diversity of rocks, a singular identity in chemical composition of the soil. These facts lead to the third principle of agricultural chemistry, rocks have not formed the soil which covers them

30. Everywhere, with the exception of the tops of some mountains, the rocks of the globe are covered from a few inches, to some hundred feet in depth, with gravel, sand, clay, rolled stones, sometimes alternately with each other, sometimes in confused heaps. The best attested, and most universally admitted fact of geology, is, that the loose materials of our globe have been transported, from a few, to many hundred miles from their original situation. With a few exceptions, the soil which now covers rocks, has been derived from places distant, and from rocks distinct, from those on which it now reposes. This is peculiarly true of soil on limestone districts, which does not contain more lime than the soil reposing on granite.

31. Transportation of soil, is a fact so well established, that it needs only to be mentioned. There has been a universal mingling of the loose material, soil, derived from worn down and mingled rocks.

32. The same uniformity of chemical composition characterizes soil, which characterized rocks; that is, great similarity, but not identity, and it is on limited patches only, that soil partakes decidedly of the character of the underlaying rocks.

33. The extensive analyses of soil, excuted by the geological surveyor of Massachusetts, taken from every variety of rock formation, present a remarkable uniformity, both of chemical constitution, and mineralogical composition of the earthy ingredients. The same truth is presented by the analysis of soil from various parts of the globe. It is a conclusion, warranted by the widest examination, that the mineral constituents of 100 parts of the soil of our globe, is composed of sand or silicates 89·28; salts of lime 00·85.—*Dana's Muck Manual.*

Engineering Science.—The tunnel on the line of the Sheffield and Manchester Railway will be 3 miles in length, upwards of 600 feet below the surface or summit of the hill at its greatest height, and in rock formation throughout its entire length. The works were projected and commenced upwards of two years ago, under the direction of Charles Vignoles, Esq. Five shafts were opened, at about half a mile distant from each other, for the purpose of proving the formation, of facilitating the driving of the drift-ways and ultimately, of ventilating the tunnel. Whilst these were in progress, the drift-ways were carried on from each side, or face, of the mountain: the distance, or length, driven, on the eastern side, extending to nearly 1000 yards, and from the next shaft 180 yards. The junction between these two portions of the drift-way was effected on the 17th Sept., and the levels, when checked, on a tie-bench, at the point of meeting, had varied but 9 decimals, or 1 in. nearly, and the range was within less than 2 in. of being geometrically true.—*Weekly papers.*

The Naval Observatory.—We learn from the Boston Courier that Lieutenant J. M. Gillis of the United States Navy, took passage in the Acadia for Europe, and that he goes out vested with full powers by the Secretary of the Navy to purchase a complete set of instruments for the observatory soon to be erected in this city. He has been charged by the secretary to visit the principal observatories in Europe, and to procure from the most eminent makers the following capital instruments:

One sixteen feet Parallactic Instrument, to be mounted in a similar manner to the Pulkowa Refractor; one Transit Telescope for the meridian, of seven feet focal length; one Transit Telescope for the prime vertical, of seven feet in length; one Mural Circle, of five feet diameter; one Transit Circle; together with complete sets of magnetic and meteorological apparatus, with the most modern improvements. Also a library, embracing all the standard mathematical works; annals of all the observatories; catalogues of stars, nebulæ, etc. etc.—*National Intelligencer.*

The Boundary.—Captain Talcott of the corps of Topographical Engineers, states, in a recent letter to the Secretary of State, that the extent of the boundary line separating the United States and Territories from the British possessions, and lying between the monument of the St. Croix and the Stony mountains, is estimated as follows for each adjacent state:

Maine, (line as awarded by the King of Holland)	460	miles.
New Hampshire, - - - - -	40	"
Vermont, - - - - - -	90	"
New York, - - - - -	420	"
Pennsylvania, - - - - -	30	"
Ohio, - - - - - -	200	"
Michigan, - - - - - -	740	"
Territory west of Lake Superior, -	1150	"
Total length of boundary line, - -	3130	miles.

The Courier Français, alluding to the contract for the first section of the railroad from Paris to Belgium, says: "This is the second example of English contractors, after having finished railroads in their own country, coming to take part in ours. It is well known that the Rouen railroad, in which English capitalists have an interest, is exclusively directed by English engineers. This is an advantage for France, because several methods in use on English lines, particularly in forming the embankments, are superior to ours, and will in this way gradually become known among us, and be adopted at last generally."

The Commerce says: "Engineers under the direction of the Minister of Public Works, have formed a plan for laying a continuous railroad completely encircling Paris. It is to run at a certain distance from the continuous wall, and form in the whole an extent of 40,000,000 metres. The cost is estimated at 12,000,000 francs at the least. Its object is to establish a direct and rapid communication between all the railroads which sooner or later will diverge from the capital.

ERRATA IN ARTICLE "CANALS OF CANADA."

Page 257, 4th line from top, for "their" read "these;" page 259, 12th line from top, for "lock 100 by 30" read "locks 100 by 20"; page 262, 1st line from top, for "least," read "best;" page 262, 6th line from top, for "7 times," read "3 times;" page 263, 14th line from top, for "$6,600,000," read "$1,600,0000;" page 265, 7th line from bottom, for "desirable," read "possible;" page 264, 3d line from botton, for "eastern," read "western;" page 266, 4th line from top, for "unusual," read "universal."

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EXAMINATION OF THE RAILROAD SYSTEM.

No. III.

As railroad companies are liable to all those difficulties and errors which are peculiar to corporate bodies, we must expect to find causes of error peculiar not to the railroad system, but which have nevertheless exercised a powerful control over the system itself. The effects of these we may consider under the general head of

Financial Errors.—Although many of these are only to be unravelled by an inquiry into the mysteries of stock-jobbing, we do not propose to weary our readers with any such investigations but simply to give a general view of those errors which are open and well known to the public.

The first and most striking of these unfortunate agencies which we propose considering is the diversion of a railroad incorporation from its legitimate purposes, and its consequent conversion into what is commonly called "a fancy stock." This has frequently occurred when in times of extraordinary fluctuations in the money market, the stock of a company has suddenly changed hands, and become the property of those who, having no real interest in the prosecution of the work, have used it for any other purpose than that for which it was originally designed. Such we are informed is the condition of several works which are now cited as instances of failures. The generally low and fluctuating state of the stock of such railroads, keeps them constantly in public notice, and affords a ready instance for those who declaim upon the unsafe and speculative character of railroad investments. A single glance at any newspaper for several years past, will verify the truth of our assertion.

Another unfortunate influence and one equally foreign to the system itself, has been the connection of banking privileges with the proper business of a railroad. There are not many instances of this, but as far as we know, the result has been uniformly unfavorable. Besides the difficulties which have attended banking operations, it will generally be admitted that the very connection has had an unfavorable influence upon the railroad itself. No wonder then that these should be classed among the "failures."

A third and very important financial error we have recently seen noticed in report of Mr. Garnett's, if we are not mistaken. The writer states that the value of several railroads in the Southern country has been permanently injured by the injudicious policy of making large loans instead of raising the amount required at once by asking for a larger capital. Cases are cited in which although the capital might have been obtained without difficulty, the preference was given to loans, on account, it appears, of the larger dividends to be obtained. The soundness of this argument is certainly not apparent to us, but as we disclaim all pretension to knowledge of finance, we are willing to admit that it may be apparent to others. Whatever may have been the reasons for pursuing this line of policy, the result has been uniformly unfortunate—the raising of money which has been actually refused, when it was offered, has been postponed by the temporary expedient of a loan until a time arrived when the utmost difficulty was experienced in paying the mere interest—and the receipts of the company, were diverted from the proper maintenance of the work, with the design of preserving the credit of the company.

This error seems to have operated with the same results in very many cases, but in some instances at least the cause has been diametrically opposite to the one above named. Companies have been organised and have commenced their operation with an adequate capital, but before the whole has been paid in, the great crisis in the commercial world took place, and the difficulty of calling in the remainder of the capital in a measure compelled the adoption of a policy not originally intended. We have consequently the remarkable case, of companies with but a small portion of their capital actually paid, building their roads entirely upon credit.

Our enumeration of errors would be manifestly incomplete without a notice of a mistake, having the same consequences with those just mentioned, but still another and more culpable origin. We refer to miscalculation of the cost of the work, sometimes the fault of the directors, sometimes of the engineer, and occasionally of both. When this miscalculation is ignorantly made, the parties are certainly blameable, for either gross incompetence, or neglect of duty—but when designedly made it is a criminal act, deserving the punishment it probably does not receive by mere technical evasion. We know of no instance of this fraud, although we are assured that such do exist. In either case, the misfortune of the stocholders is the same, amounting to a partial or even total loss of their investment—and the addition to the list of "failures" thus made, is we fear not a small one.

The financial character of railroads, has also been injured by their connection with other works or operations which not being profitable have diminished the value of the stock and thrown discredit upon railways really profitable. Several important lines of road from being thus situated have appeared to those not aware of the circumstances as weighty objections to the profitableness of railroads generally. Thus one railroad has a canal attached to it, another, an extensive steamboat establishment, a third is obliged to consolidate the various interests and diverse management of the two or three original companies, of which it is constituted. All these things are unknown to the public, yet produce an effect upon the value of the stock which has a serious influence upon capitalists.

The usual quotations of stock are attended with another disadvantage to railroads, although arising from a cause which is really creditable, and shows their value. It is this; while "fancy stocks," are continually noticed at every sale—the best railroad stocks are seldom heard of, and in proportion to their value as investments, are they kept from public notice. A newspaper taken at random, containing a weekly price current, gives no quotation for the stock of three of the best railroads in this portion of the Union. In the same paper are to be found all our City Incorporation and City and State Stocks.

The operations of banks, insurance companies, etc., are upon money almost entirely—those of railroads are far different and hence the ignorance of capitalists upon this point, even when authentic information is accessible to them. Thus we find that the very advantages of railroads have in some measure kept them from public notice and favor, and that in general notoriety is attached only to those works which either from being remarkable failures, or from some other cause have become a sort of foot ball among brokers.

[The following communication contains a suggestion which is new to us, but seems to be well worth consideration. The introduction of Croton Water into the city of New York seems destined to produce a great change in many ways. We notice that our ferry boats now use this water exclusively. The saving of the boilers and the less need for blowing out, have rendered it an object to pay the small sum demanded for the use of the water. After the pipes have been thoroughly cleansed we have no doubt that the water will be found so pure that very little if any sediment will be found after the longest use.]

[To the Editor of the Railroad Journal.]

Some time ago, while at St. John's, N. Brunswick, I strolled, out of curiosity, into the India House there (a large grocery establishment so called) where a small steam engine stands in the window of the shop, and is employed in grinding coffee, sugar, etc. for the retail trade of the shop. In the course of conversation with Mr. McConkey, the proprietor, I found that he saved the power commonly expended in working the force pump for feeding the boiler, by conveying the water to the boiler directly from the Water Company's Street Mains—the pressure of the head between the Company's reservoir and the boiler being more than sufficient for forcing the water into the boiler, and thus the expense of the pumping power is saved.

As this hint may be usefully employed in other places besides St. Johns, you will please to give this an insertion in your widely circulated journal, if you think the hint may be useful. In many places where the pressure of the head of water may be found rather deficient for forcing the water into the boiler, the place for the boiler may be excavated—the boiler placed as low as necessary, and then built in with solid masonry as I understand some of the Cornish engine boilers are, which confines the caloric much better by such jacketing, and consequently must be a great saving of fuel. By taking the boiler water from the street mains wherever it is available, and paying a small tribute over and above the value of the water to the Water Company, the advantage gained will yield a very large proportionate return to the proprietor of the engine, by saving that power which would otherwise be absolutely necessary for working the force pump, unless indeed the charge for the privilege was too exorbitant. R. R.

Nov. 1, 1842.

EASTERN DIVISION,
N. Y. & E. RAILROAD.

To the Assignees of the N. Y. Railroad Company:

GENTLEMEN,—In compliance with your request I submit a general Report of the business of the Eastern Division of the road.

I assume the duties of Superintendent under your direction at the date of assignment on the 18th April last, and the time covered by this exhibit is five and one half months.

The duties I was instructed to perform were

1st. To take charge of and protect the property of the Assignees upon this Division.

2d. To employ the same as far as was necessary in the transportation of passengers and freight so long as it should appear evident that a revenue could be derived from running the road, thereby consulting the interest of the creditors of the Company.

I have in accordance with your instructions made weekly and monthly reports of the business of the road, containing statements of the sums daily received and expended with vouchers therefor, to which I beg leave to refer you for a more minute account of the expenses incurred than can well be contained in a general report.

The road when opened for use in Sept., 1841, was in an unfinished state, through the earth cuts the banks in many places were nearly perpendicular, the ditches were not sufficiently deep or wide to carry off the water, and the embankments in frequent instances had been so much washed by the rains as to require additional earth. These defects had in a great degree been remedied by the Company prior to the assignment, yet much remained to be done to secure the regular and uninterrupted running of the trains through the winter months from the effects of alternate frosts and thaws. A due regard to economy required that this labor should be performed during the summer months. It is now nearly completed, and but little further expenditure for this purpose will be necessary.

It was found that the number of cars was quite inadequate to the economical transmission of the increasing freight, and as the business of the road can be sustained only by regularity and promptitude, it was deemed of the first importance to have the number increased so that in the event of accident by which a train might be disabled, there would be no interruption or delay in the transmission of freight. The failure to carry the *market* freight for a few days would seriously affect the revenue of the road for a long time.

Notwithstanding a considerable portion of the earnings of the road has been expended for the objects above mentioned, it is believed that the interests of the creditors of the Company have been consulted more than if they had been appropriated to the payment of the claims against the Company. The increasing revenues of the road tend to confirm this belief. Indeed had the Assignees not directed the improvement of the road by the removal of slopes, deepening the ditches, and repairing the track, it would have been impossible to run it, and the only alternative would have been to sell the property of the Division. The personal property consisting of cars, engines, etc., being adapted to a six foot track, are worthless for any other road in the United States, and would of course be sold only for the value of the materials. It was evident from the past revenues of the road that the Assignees would be enabled by the *use* of this property to pay all the indebtedness of the Eastern Division without depreciating the value of the machinery and fixtures belonging to it.

In conducting the business of the road the general rules adopted by the Company have been adhered to. The tolls on freight have been changed but on one article. The salaries of the Agents have been reduced, and the numbers employed is barely sufficient to perform the necessary duties.

Had the Assignees found the road properly prepared for economical management, the shops in order and well supplied with Machinery, together with Engines and Cars sufficient to accommodate the business to be done, they could have introduced still greater economy in the Departments of Repairs and operations, and many of the expenditures which have been incurred might have been postponed until the first class creditors were paid. Having but a sufficient number of cars for two freight trains, none can be left, or only occasionally, at either terminus, or at intermediate stations for loading, but each car is required to pass up or down the line daily, receiving and discharging freight.

The whole machinery of the road at the time of the assignment, consisted of

5 Locomotives,
4 Passenger Cars, 8 wheels,
13 eight wheel body Freight Cars,
3 do Cattle Cars,
5 do Platform Cars, 2 unfit for use.

This outfit has been increased by the Assignees as follows:

2 eight wheel Passenger Cars,
2 do Cattle Cars, and
2 four wheel Body Cars, for Freight.

The freight cars first mentioned were, when furnished by the builders, unfit for use. The weight of the cars was about 7 tons, and the wheels and axles were of sufficient strength to carry 2 tons per journal, but the draws and bearing springs and truck frames, would carry from 7 to 8 tons only. These parts had to be replaced and the roofs re-covered. This work was in progress prior to the assignment, but much of it has been done since, and the capacity of the cars has been increased about one-third.

Since the assignment there have been transported in these cars an amount equal to 424,320¼ tons one mile. The whole distance travelled by the cars has been 96.733 miles. The number of tons carried by each journal one mile has been at the rate of 5260 tons per year.

Full statistics of the work performed by the Engines and cost of transportation, are annexed.

It should be borne in mind that the curves and grades of the Eastern Division of the road, are unfavorable to cheap transportation, but the statistics will show that the *tonnage* per mile (with one Engine) compares favorable with more level roads and consequently the cost per ton.

The curvature of the 46 miles is equal to 2767 degrees, and the rise and fall to 1706 feet, rise going West being 1064 65, fall, 641 5 feet, and grades of 60 feet in the same direction are equal to $9\frac{1}{2}$ miles, and East 7 and 42 one hundredth miles.

It has not been our object to show that the road has been worked cheaper per mile *run* than others, for we might have run a greater number of miles with the same Engines, and performed the same business and not have increased our expenses in proportion. Our object *has* been to show that under the circumstances of the road outfit and business, the work has been done as cheaply per *ton* per mile as elsewhere.

Our *charges* are *per ton, per mile*, and not per *mile run*. Our rule is to run as few miles as possible with a given quantity of freight or to tax the Engine to her maximum power whenever a sufficient amount of freight is on hand. The freight trains have sufficient time given them to avoid fast running, and should a storm occur so as to slip the wheels on any of the 60 feet grades, (for which the limit of load is fixed) a portion of the load is left, and the remainder is placed on a side track at the top of the grade, and the Engine returns for the cars which were left. This seldom happens, and the distance thus travelled is not taken notice of. The greatest tonnage taken by one Engine over the road is 90 9-10th tons or nett freight useful load.

We also allow a higher pressure of steam than is usual on most roads, and keep in view the repairs and construction of our cars, a load equal to $1\frac{3}{4}$ tons per journal, that we may reduce the weight of cars per ton of useful load.

We thus undoubtedly increase the cost per mile run for our freight trains, but should such increase amount to 20 cents per mile, and the average load be increased 10 tons, then

46 miles at 20 cents,	$9,20
and 10 tons at $2,30,	23,00
will show a saving of	$13,80 per trip.

By separating the expenses of the Ferry from the Railroad it will be seen that the cost of the freight train has been $106\frac{1}{2}$ cents per mile run, and of the passenger train 45 cents, and the average of freight and passenger $72\frac{88}{100}$ cents per mile run. The cost per ton per mile has been $2\frac{27}{100}$ cents, and per passenger per mile 1[illegible] cents. The average *charge* per ton per mile, including loading and unloading is $5\frac{11}{100}$ cents, and per passenger per mile is 2,64 cents.

It cannot be supposed that upon a road where the charges are so low, the nett revenue will bear the same porportion to the earnings as upon roads where the charges are much higher. The usual charge upon most roads is for passengers 4 cents per mile, and for freight 5½ to 8 cents per ton, per mile.

The Assignees are aware that the Ferry is a charge upon the revenues of the road, but it is believed that this service is performed at as cheap a rate as can be obtained under an arrangement which would secure its performance during the whole year.

The following exhibit of the revenues and expenditures will show how much has been appropriated to the different objects here explained. A much larger portion of the nett revenue it is believed can soon be appropriated to the payment of the creditors of the Company.

Very Respectfully.
H. C. Seymour.

Piermont, 20th October, 1842.

The earnings of the Division from the 16th of April to the 30th of September, have been as follows:

FROM FREIGHT.

Eastward tonnage		11,905,103 lbs.	and revenue		$13,463 73
Westward	do	12,972,443 do	do		12,724 29
Total	do	24,877,546	total do		$26,188,02

FROM PASSENGERS.

From passengers Eastward	24,741¼	$10,158 94		
From passengers Westward		11,400 22		
Total,			21,539 16	
Total earnings R. R. & Ferry,				$47,747 18
Of which the R.R. portion is		$37,138 24		
And Steamboat's portion		10,608 94		

The expenditures during the same period on account of transportation have been:

FOR REPAIRS.

Of Locomotives,	$757 28	
Of Freight Cars,	1,105 61	
Of Passenger do,	228 40	
Of Buildings,	30 05	
Of Superstructure,	1,015 78	
Of Grading,	32 07	
Of Work Shops,	7 48	
Total		4,076 67

COST OF RUNNING.

Engine and Firemen,	$1,285 72
Conductors and Brakemen,	1,527 83

Fuel,	$2,745 44			
Oil and Waste,	481 47			
Running Contingencies,	60 62			
Total,		6,101 08		

GENERAL EXPENSES.

Superintendence,	$1,375 00			
Agents and Clerks,	2,512 04			
Stationary, etc.	381 17			
Car House Attendants,	419 58			
Loading and unloading,	2,391 96			
Contingencies,	640 00			
Total,		7,719 75		
Total expenditures of the Railroad,		$17,897 50		

FERRY EXPENSES.

Steamboat Charter,	12,630 00			
do Labor,	450 00			
		$13,080 00		
Barge Charter,	825 00			
do Labor,	990 00			
		1,815 00		
Incidentals,		339 89		
Total Ferry Expenses,			15,223 89	
Total Expenses of R. R. and Ferry,				33,132 39
Nett Revenue,				$14,614 79

Expenses during the same period otherwise than for transportation incurred by Assignees.

For materials and fuel purchased for use since Sept. 30th.,	$1,237 92
For removing 5,249 cub. yards of earth from slopes and ditches,	1,431 05
For laying track and spiking and construction of switches,	197 58
For land expenses and fencing,	13 00
For roofing and enclosing machine and work shops, offices, wood houses and water stations,	1,590 46
For purchase and construction of cars and machinery,	3,509 49
For Agents, office expenses, and general expenses of assignment, including legal expenses,	2,680 29
For cash paid to Creditors,	3,509 82
For unappropriated,	345 78
	$14,614 79

ABSTRACT OF EXPENDITURES.

On account of Passenger Transportation from April 16th to September 30th, 1842; together with the service performed, the cost per mile, and per Passenger per mile.

DISTANCE *Run by Engines in miles.*	TOTAL PASSENGERS *Conveyed equal to one mile.*
Total, 13,392	Total, 594,500
AVERAGE NUMBER OF PASSENGERS *For every mile run.* Total, $44\frac{3}{10}$	

Items of Expenditures.	Amount.	Cost per mile.	Cost per Pas. per mile.
	$ cts.	$ cts fr	cts. m. fr.
MACHINERY.			
Repairs of Locomotives,	428 92	3 20	72
" Passenger Cars,	228 40	1 71	39
" Machinery in Shops,	3 74	03	00
Total,	661 06	4 94	1 11
WAY AND BUILDINGS.			
Repairs of Buildings,	15 05	11	02
" Superstructure,	1,015 78	7 59	1 71
" Grading,	16 57	12	03
Total,	1,047 40	7 82	1 76
OPERATING.			
Engineers and Firemen,	428 64	3 20	72
Conductors and Brakemen,	509 28	3 80	86
Fuel,	1,276 95	9 54	2 16
Oil and Waste,	206 34	1 54	35
Running Contingencies,	30 31	23	05
Agents and Clerks,	550 00	4 11	93
Stationary, etc.,	95 30	71	16
Car-House Attendants,	219 00	1 63	36
Total,	3,315 82	24 76	5 59
GENERAL EXPENSES.			
Superintendence,	687 50	5 13	1 16
Contingencies,	315 00	2 35	53
Total,	1,002 50	7 48	1 69
Grand Total for Passengers,	6,026 78	45 00	1 0 15

Total cost upon railroad for freight and passenger transportation from April 16th to September 30th, 1842, is $17,897 50, and the average cost per mile run is $72\frac{866}{1000}$ cents.

ABSTRACT OF EXPENDITURES.

On account of Freight Transportation from April 16th to September 30th, 1842; together with the service performed, the cost per mile, and per ton per mile.

DISTANCE	TOTAL TONNAGE
Run by Engines, in miles. Total, 11,172	Conveyed distances equal to carrying the whole one mile. Total 424,329 $\frac{242}{1000}$
AVERAGE TONNAGE For every mile run each month. Total, 37 $\frac{981}{1000}$	

Items of Expenditure.	Amount	Cost per mile run	Cost per ton per mile
	$ cts.	$ cts. fr.	cts. m. fr.
MACHINERY.			
Repairs of Locomotives,	328 36	2 93	77
" Freight Cars,	1,105 61	9 90	2 60
" Machine Shops,	3 74	03	01
Total,	1,437 71	12 86	3 38
WAY AND BUILDINGS.			
Repairs of Buildings,	15 00	13	03
" Superstructure,	900 00	8 06	2 12
" Grading,	15 50	14	04
Total,	930 50	8 33	2 19
OPERATING.			
Engine and Firemen,	857 08	7 67	2 02
Conductors and Brakemen,	1,018 55	9 12	2 40
Fuel,	1,468 49	13 15	3 46
Oil and Waste,	275 13	2 46	65
Running Contingencies,	30 31	27	07
Agents and Clerks,	1,962 04	17 56	4 62
Stationary, etc.	285 87	2 56	67
Car-House Attendants,	200 58	1 80	47
Loading and Unloading,	2,391 96	21 41	5 64
Total,	8,490 01	76 00	2 0 00
GENERAL EXPENSES.			
Superintendence pro rata,	687 50	6 15	1 62
Contingencies,	325 00	2 91	77
	1,012 50	9 06	2 39
Grand Total for Freight,	11,870 72	1 06 25	2 7 96

NOTES.—Going west, the total ascent is 1064 $\frac{05}{100}$ feet, and descent 641½ feet. Grades of 60 feet ascending 9½ miles, descending 7 $\frac{92}{100}$ miles. Total curvature is 2767 degrees.

12,345 $\frac{9}{100}$ tons of freight were loaded into and unloaded from the cars from April 16th to September 30th.

The maximum load in September westward was from Piermont to Laurel Hill, 11 miles, 90 $\frac{9}{10}$ tons.—maximum load eastward in September was, from Blauveltville to Piermont, 5 miles, 83 $\frac{4}{10}$ tons. The average load westward in September from Blauveltville to Clarkstown, was 63 $\frac{733}{1000}$ tons; and eastward from Tallman's to Monsey was 53 $\frac{745}{1000}$; ascending the highest grades, and passing the shortest curves.

HYDRAULIC PROPULSION ON RAILWAYS.

Of the many plans to which the fertile ingenuity of the present day has given birth, for the purpose of diminishing the cost and danger of railway locomotion, the most novel in design, and amongst the most recently invented, is the Hydraulic Railway, for which Mr. Shuttleworth, of Manchester, has taken out a patent. The principle of the invention was announced 12 months ago, but the patentee has since made considerable alterations in his original plans for carrying his design into execution. For the purpose of making it more generally known, he has just published a pamphlet setting forth the claims of his invention, describing at great length its proposed mode of operation, and calculating minutely the advantages to be derived from the adoption of this system of propulsion on railways. Independently of the ingenuity of the invention which claims notice on that account alone, the consideration of the subject gives rise to some interesting questions relative to the motions of fluids, that well deserve attention. We propose, therefore, shortly to describe Mr. Shuttleworth's invention; to state the principal grounds and calculations on which he rests its claims for adoption; and by an examination of the phenomena and laws of hydrodynamics bearing on the subject, to ascertain whether this mode of propulsion can be rendered practically available.

The arrangements proposed by Mr. Shuttleworth for carrying his plan into operation, are in their general features similar to those of the atmospheric railway. A pipe a foot in diameter, with a longitudinal slit on the top, is to be fixed between the rails. Within this pipe a piston is to work, which is to receive the propelling impulse, and communicate it to the carriages by means of a connecting rod passing through the opening at the top of the pipe; which slit is to be kept closed by a continuous valve. So far the two plans exactly agree, and in Mr. Shuttleworth's first proposed mode of working the hydraulic railway, its resemblance to the atmospheric was still further continued. His intention was then to employ an exhausting pump, worked by a stationary engine, the pipes being filled with water. The advantage proposed to be gained by employing water instead of air in the pipes was the greater facility by which a vacuum could be obtained by exhausting an inelastic fluid. At that period Mr. Shuttleworth did not seem to have made sufficient allowance for the friction of the water in the pipes, nor for the weight of water the stationary engine would have had to drag along with great velocity. The resistance presented by these causes of retardation would, however, have required far more power to overcome than the weight and friction of a rope, the disadvantage of which it was a principal object of the invention to obviate. It is true, that Mr. Shuttleworth from the first development of his plan contemplated the occasional application of the direct pressure of a column of water, as an additional means of propulsion; but he seemed to rely principally on the power to be gained by the pressure of the atmosphere on the water forced through the horizontal pipes, to supply the place of the water pumped from that portion of the pipe in advance of the piston.

The plan of working by hydraulic propulsion now proposed, which is detailed at great length in the pamphlet before us, has effected a complete change in the mode first intended. Mr. Shuttleworth now relies entirely for the propulsive power on the pressure of a column of water, acting against the pressure of the atmosphere, without any exhaustion. He proposes to have reservoirs of water, of sufficient height to produce a pressure of six atmospheres, placed at short distances along the line of railway. From these reservoirs vertical pipes, of the same diameter as the horizontal, are to convey the water to the commencement of each section of propulsive piping. The length of each of these sections is to be about 70 or 80 yards, and the termination of each section of propulsive piping Mr. Shuttleworth proposes to connect with double its length of what he terms "skeleton piping," along which the railway carriages are to be propelled by the momentum previously acquired. In the intervals between the running of the trains, it is proposed to employ stationary engines of great power to pump the water back again to the elevated reservoirs.

The foregoing is an outline of the principal features of the hydraulic railway. The advantages which are expected to result from its adoption are, diminished cost in the mode of working, increased safety, by the avoidance of collisions, and greater facility in the construction of railways in hilly countries. Mr. Shuttleworth makes various calculations for the purpose of showing the economy of his system of propulsion compared with that by locomotive engines; but into these details we do not propose now to enter. Our present purpose is to examine the principles on which he founds the hydraulic mode of propulsion; for if these prove to be defective, as we believe them to be, it will be useless to inquire further.

The first great error into which we conceive Mr. Shuttleworth has fallen, is in the calculation of the initial velocity that could be communicated to the carriages by a vertical column of water of the same diameter as the horizontal pipe. He professes to take all his data from the best authorities in hydrodynamics, among whom Mr. Tredgold ranks foremost, and it is only due to Mr. S. to say that he claims no more in favor of his plan than the calculations of the authorities he relies on seem to warrant. His fault, like that of many other ingenious inventors, lies in the attempt to apply general principles to particular circumstances wherein those principles are inapplicable. Founding on Mr. Tredgold's formulæ, Mr. Shuttleworth estimates the velocity of water rushing from the bottom of a column 198 feet high to be equal to 67$\frac{4}{6}$ miles an hour; this, therefore, he assumes to be the initial velocity which might be communicated to the train of carriages on the hydraulic railway. Now, granting that water would rush from a small aperture at the bottom of such a vertical column with a velocity of 67$\frac{4}{6}$ miles an hour; we cannot concede that the *whole column* would rush out with that velocity. According to theoretical estimates, water rushes from an orifice with the velocity which a body falling freely would acquire in moving through a space equal to the height of the water above the orifice; but many circumstances may cause the velocity of the issuing fluid to deviate from this general law. If the size of the aperture approximate to that of the tube, the velocity will be diminished; and if the aperture be of the same size as the tube, so that the whole column of water must fall as rapidly as the issuing fluid, the velocity will be diminished one half, without making any allowance for friction. That this must be the case will appear from the circumstances attending the fall of a column of any other body the particles of which cohere. The accelerated motion acquired by all bodies in their descent, would naturally give to the water towards the bottom of the vertical pipe a much greater velocity than to the water at the top; and were the particles of the fluid without cohesion, they would separate into drops in their fall, instead of acting in one connected column. The cohesion of the particles is, however, sufficient to prevent this separation, and the fluid column must, therefore, move with an uniform velocity, in the same manner as a chain or a rope thrown over a pulley must fall throughout its whole length with uniform velocity. The lower portions of the water or chain which, if detached, would move with greatly accelerated velocity, are retarded in their descent by adhering to the more slowly moving portions above, to which they in turn impart some of their superior momentum gained in the descent. The communication of velocity from the lower portions of the falling column to the upper is evidenced in the flow of water down pipes, by the force with which the water in the reservoir is drawn into the pipe; which force increases with the height. It thus appears, that the resulting velocity of a vertical column of water must be the average motion given by gravitation to the whole; or less than half that which Mr. Shuttleworth calculates would be the initial velocity in his system of propulsion. He might, it is true, obviate this difficulty by greatly enlarging the size of the conduit pipe, but this would materially add to the cost of construction.

Another important error appears in Mr. Shuttleworth's calculations in consequence of the velocity of water flowing freely being considered the measure of its propulsive effort. Now, it is very obvious, that any effort required to propel the train of carriages on the railway must diminish the velocity of the acting fluid; and that in proportion to the velocity communicated to the train, the propulsive effect of the fluid pressure must diminish; for it is only when the pressure is resisted that its effect operates. For example; if the carriages were propelled by some other power at a velocity equal to that with which the water rushed along the horizontal pipe the fluid would evidently exert no impulsive effort on the piston. If the carriages were propelled with half the velocity of the fluid, then only half the impulsive effort would be exerted; and not until the train was stationary, would the full pressure of the fluid be brought to bear on the piston. The whole of Mr. Shuttleworth's calculations of the power to be derived from hydraulic propulsion would, consequently, only apply to pressure against a stationary resistance; so soon as the train was put in motion the power exerted on the piston would diminish and would continue to decrease in proportion to the increase of speed attained.

One of the objections urged against the system of propulsion by locomotive engines is the great waste of power occasioned by the weight of the engine and tender, yet Mr. Shuttleworth seems to have entirely everlooked the fact, that the same objection applies, in a tenfold degree, to his plan of hydraulic propulsion. He has, indeed, no heavy engine to propel, but the weight and friction of the water, which constitutes his moving power, offer a far greater resistance to motion than an engine and tender. The length of each section of propulsion piping is proposed to be only 70 yards, yet towards the end of that short length the weight of water to be propelled would amount to nearly 5 tons. This weight of water would have to be put in motion with great velocity, with the additional objection of being exposed *throughout its whole course* to retardation by friction in the pipe; whereas the friction of a locomotive engine acts only on those points of the rails whereon the wheels rest. The loss of power by retardation in the tube is, indeed, taken into account by Mr. Shuttleworth, but he appears to overlook the fact that this loss is occasioned by communicating motion to his moving power. The amount of power lost by propelling the water through the pipe is much greater than would at first be supposed. Mr. Shuttleworth himself estimates that his calculated initial velocity of 67½ miles an hour would be reduced in a length of pipe of only 70 yards, to 29½ miles an hour; and in another part of his pamphlet it appears that the estimated initial propulsive power of 693 horses (!) would be reduced, after passing through 70 yards of piping of one foot diameter, to 71 H. P. We have thus, by Mr. Shuttleworth's own showing, a power of 622 horses absolutely lost in propelling the moving power; and that too for the short distance of only 70 yards! Surely no system of railway propulsion was ever before proposed, which by the statement of its inventor exhibited such a waste as this; and yet it is proposed as a means of economizing power!

Nor is this all. An enormous waste would arise also from the attempt to regulate the speed communicated by a power varying, by the estimate, from 693 horses to 71, in the space of 70 yards. To obviate the objection which would be urged against the plan, were the rates of speed to be so unequal, Mr. Shuttleworth proposes to fix a self-acting throttle-valve at the commencement of each section of propulsion piping, so as to reduce his estimated initial velocity of 67½ to 27 miles an hour. Thus nearly two-thirds of the power would be absolutely thrown away for the purpose of regulating the speed to agree with that of the terminal velocity of the water. Mr. S. appears to imagine, however, that this check on the flow of the water, would not diminish the pressure, because, according to the laws of hydrostatics, the pressure is as the base of the resistance, and that the area of the piston would therefore sustain the same pressure however small the opening of communication from the vertical column of water. He forgets that this law obtains only in fluids at rest; and that as soon as the piston moved under the impulse of the whole vertical column of water, the impulsive force would be diminished. If the throttle-valve were so regulated as to reduce the velocity to 27 miles an hour, the pressure on the piston would correspond with that velocity, and not with the pressure of the whole vertical column. All the force lost by checking the water at the throttle-valve would consequently be so much power wasted.

It might be supposed from the lavish waste of power which is exhibited throughout the whole plan of the hydraulic railway, that the inventor had at command the falls of Niagara every 200 yards of his proposed line; the waters of which he could send rushing through the pipes without any limitation. Not so, however, for every drop of water thus uselessly squandered is to be forced back again into artificial reservoirs. Of these reservoirs, indeed, though they form an essential part of his system, he makes but littlemention. In the construction of a railway on the hydraulic propulsion plan, they would, we conceive, figure rather prominently among the items of expenditure, and add very materially to the engineering "difficulties" of any line of railway. The erection of immense towers 200 feet high every 200 yards, would present formidable obstacles to the trial of such a mode of railway propulsion, even did it present theoretically much greater advantages than those claimed for the hydraulic; and unless our views are exceedingly erroneous, the plan could never be practically carried into execution, in consequence of the immense waste of power which every part of it presents. We have, we think, pointed out sufficient instances of this waste to justify our opinion, but on reading over Mr. Shuttleworth's "plain statement" others will be found which we have not thought it necessary to enumerate. Objectionable as Mr. Shuttleworth's first plan of the hydraulic railway appeared, we consider it far preferable to his "improved" mode of employing the water propulsively. The principle of exhaustion, on which it depended, is more simple, and its effects would be more certain, and produced with vastly less expenditure of power.

We regret to be obliged to decide so unfavorable on the claims of an invention which bears evident marks of great ingenuity and labor; but we consider it much more to the interest of an inventor who has been misled by the application of erroneous data, to endeavor at once to convince him of his error, than to indulge fallacious hopes, which can only end in more bitter disappointment.

INSTITUTION OF CIVIL ENGINEERS.

"*On some peculiar Changes in the Internal Structure of Iron, independent of, and subsequent to, the several processes of its manufacture.*" By Charles Hood, F. R. A. S., etc.

The singular and important changes in the structure of iron, which it is the object of this paper to explain, are those which arise in the conversion of the quality of iron, known by the name of "red short iron," which is tough and fibrous, into the brittle and highly crystallized quality known by the name of "cold short iron." This change the author considers has never been attributed (as it ought to be) to the operation of any definite and ascertained law, but has generally, when observed, been supposed to arise from some accidental cause, and been considered as an insolated fact.

The fracture of railway axles, by which some of the most lamentable accidents have occurred, arises from this molecular change in the structure of iron, by which the axles lose a vast proportion of their strength.

The principal causes which produce this change are percussion, heat, and magnetism, and the author traces through a great number of practical cases of ordinary occurrence the joint, as well as the separate effect of these three causes; showing that the rapidity of the change is proportional to the combined action of these several causes, and that in some cases where all the three causes are in operation at the same time, the change of structure is almost instantaneous; while in other cases, where this united operation does not occur, the change is extremely slow, extending over several years before it becomes sensible. Among the examples given, and of which the causes are explained, are the conversion by means of heat, as in the case of wrought iron furnace-bars, and other analogous cases, particularly when any vapor is present: the operation of the tilt hammer in the planishing of iron, by which both vibration and magnetism of the bar is produced, when the temperature is within a certain limit, beyond which limit the bar loses its magnetic power, and no crystallization occurs; and the instance of piston-rods and other cases, where from any accidental circumstance a peculiar jar or vibration has been given to particular parts. The effect of the continual jar or vibration upon the axles of common road carriages is a case of the opposite kind, where, notwithstanding the continual vibration, this molecular change does not take place *when the axle is insulated from the effects of magnetism.* In railway axles, however, the case is very different. The rapid rotation of the axle produces powerful magnetic action, while the friction causes much heat; and these effects, added to the constant percussion which is produced by the peculiar motion of railway wheels, causes the crystallization to be produced with extreme rapidity; the effect being probably further increased in the axles of locomotive engines by the magnetising power of the electricity generated by the effluent steam. The crystallized structure being the natural condition of iron, as well as of several other metals, the author considers that in these changes we observe a constant effort to return from the artificial to the natural and primal condition of the metal, and the conclusion arrived at is, that this crystallization is not necessarily dependent upon time for its development, but is determined by other circumstances of which the principal is undoubtedly vibration: that heat, although it assists, is not essential to it, but that magnetism, whether induced by percussion or otherwise, is an essential accompaniment of the phenomena. The paper concludes by pointing out the increased effects likely to result from the rigidity of the springs, the looseness of the brasses, and other causes which increase the vibration on the axles of railway carriages.

Several samples of broken railway axles were exhibited; some of them being cut from different parts of the same axles, showed that at the journals, where the vibration was the most intense, the crystallization was increased to a great extent beyond what occurred in other parts of the same axle.

Remarks.—Mr. Moreland had frequently noticed that pins for chains, and pump-rods, although made of the best iron, would, if subjected to concussion, after a certain time break suddenly, and that the fracture would exhibit a large crystallized texture. This was also frequently observed in the broken axles of road-carriages, although they were generally made of iron of the finest quality.

Mr. E. Woods had observed the crystallized fracture in all the broken axles on railways which he had seen.

Mr. Hood exhibited some specimens of broken axles, all of which showed a large crystallized fracture: he believed that the iron from which the majority of them had been made was of the best quality, and in the parts not immediately subjected to concussion the fracture was quite different. One of them had been in use only three months, and had become so brittle that, on attempting to break it, it jarred off at the shoulder of the journal, although an incision was made all round at the spot where it was intended to be broken.

Mr. York would account for the tendency of the axles to break at the journal, by that part being subjected during the process of forging to more hammering than the body.

Mr. Hood agreed that such might be the case, but he conceived that it was more probably produced by cold hammering. He had taken a sample from the body of a broken cranked axle, from the Grand Junction Railway, the iron of which was evidently of the best quality, but at the point of fracture which was certainly at that part where it had been most hammered, the fracture presented a large crystallized texture.

A large anchor, which had been in store for more than a century at Woolwich Dock-yard, and was supposed to be made of extremely good iron, had been recently tested as an experiment, and had broken instantly with a comparatively small strain; the fracture presented very large crystals; in this case he believed the length of time which the anchor had remained in the same position had produced the snme effects as magnetism and vibration.

Mr. Lowe stated that at the gas-works under his direction wrought-iron fire-bars, although more expensive, were generally preferred; a pan of water was kept beneath them, the steam from which would speedily cause them to become magnetic: he had frequently seen these bars, when thrown down, break into three pieces with a large crystallized fracture.

Mr. Miller had frequently seen in manufactories, that when the smiths had forged parts of engine-work which from their intricate forms had required to be much hammered, the ends were jarred off while they were being worked upon. He instanced particularly the side rods of the engine for the 'Lord Melville' steamer, of which, while shutting up the middle, one of the ends of each rod was jarred off and presented large crystals in the fracture; being well assured of the good quality of the iron in the rods, he had the same ends welded on again, and although the circumstance had occurred 20 years since, they were still at work, and had not shown any symptom of weakness. It must be evident that in this case, the fracture and the crystallized appearance of the metal must have been produced by the cold hammering to which it had been subjected.

Mr. York agreed with Mr. Hood in the fact of a change taking place in the texture of the iron, but he was of opinion that it more frequently occurred during than after manipulation; he alluded more particularly to railway axles, in which he believed the injury to be done by the cold hammering or planishing after they were faggoted; he had frequently seen one end of an axle fall off while the other was being hammered; in all such cases, and those of accidental breakage, such as recently occurred on the Versailles Railway, and in other places, the fracture always presented a crystallized appearance.

He then exhibited and described a railway axle, which he stated to possess the combined advantages of rigidity and toughness, and avoiding entirely the crystallization of the iron during the process of manufacture; this he described to be effected by maintaining the axle in a hollow state during the whole operation of hammering, thereby avoiding the vibration and concussion, to which cause he attributed the crystallization of the iron in solid axles, being of opinion that the repeated blows of the hammer on a solid mass, particularly during the process of "planishing," were the chief, if not the only cause of the ductile quality of the iron being destroyed. He stated, that he had made numerous experiments for the purpose of ascertaining this fact, and in every instance when the axle was sound, the iron presented the same crystallized fracture. although the bars, previous to their being welded together were of the most fibrous quality, but if the axle was not quite sound, and the bars not perfectly welded to the centre, then the fracture was somewhat fibrous, the axle being partially hollow and thereby avoiding the vibration to a considerable extent. This fact suggested to him the propriety of keeping the axle hollow; and the mode of manufacture he described to be by taking two dished half-cylindrical bars of iron, of the entire length of the axle, putting them together and welding them under a hammer in swages, by which means the particles are not driven asunder by the heavy blows and the axle of faggot lengthened, but are driven together and towards the centre. The axles produced by this means, he stated to be as perfectly ductile as the bars in the first instance. A further advantage, he stated to consist, in being able to make half the whole length of the axle at one heat; thereby avoiding to a considerable extent the danger of burning the iron by repeatedly heating it; the iron in the axle he described, as being a uniform cylinder in thickness, and consequently requiring a uniform heat, whereas the external bars of a faggot for a common axle were liable to be burnt, before the centre was heated to a welding state. The diameter of the hollow axle was increased from 3½ inches (the general size of a solid axle) to 4 inches, in order to give a proper degree of rigidity, but without increasing the weight.

The usual proof to which solid railway axles were subjected, was by allowing a weight of 6 cwt. to fall upon them from a height of 9 feet; with that force they were frequently broken at the second blow, and sometimes by the first—he had tried some of the hollow axles, by letting fall upon them a weight of 10 cwt. from a height of 15 feet, without breaking one of them.

Mr. Simpson expressed the obligation of the Institution to Mr. Hood, for bringing before the meeting such an interesting communication, upon a subject which it is of the utmost importance to railways, should be carefully examined. It was to be regretted, that the late period of the Session had prevented the attendance of those members whose attention had been more particularly directed to railways; but on the renewal of the subject next Session, upon the production of the report upon the projected experiments, promised by Mr. Hood, a very useful discussion might be anticipated.

"*Description of the Calder Viaduct, on the Wishaw and Coltness Railway, with the Specifications, Estimates, and a series of Experiments to ascertain the Deflection of two of the Strutted Beams.*" By John Macneill, M. Inst. C. E.

When first the author was called upon to carry out the extension of the Wishaw and Coltness Railway, he found that the funds for that purpose were very limited, and that it was necessary to construct the works in the cheapest manner possible. To accomplish this it was necessary to design and lay out a single line of railway, which would be sufficient to carry on the trade by H. P., but if possible, and consistently with limited funds, to construct the viaduct over the valley of the Calder (the principal work on the railway) in such a manner as to be able to widen it hereafter, and to make it suitable for locomotive power, in the event of the trade being increased, or of the railway forming a part of the great line of communication between England and the West of Scotland. Having these objects in view, and being so restricted in funds, he was obliged to lay out the works in the first instance, very differently from what he otherwise would have done, if there had been ample funds.

The valley of the Calder, which the railway had to cross, was nearly half a mile in length, and the elevation of the line over the surface of the ground, varied from 50 to 130 feet. The first intention was to construct a viaduct, 480 feet in length, of stone arches, 60 feet span and 12 feet wide between the parapets; but as this mode of construction would have been the cause of much expense when it became necessary to widen the viaduct for a double line of railway, and would also have involved an embankment of nearly 60 feet in height, composed of clay and marl, which was considered unsafe and likely to slip, an effect which subsequent experience on other portions of the line, has since fully proved would have been the case; it was determined to extend the viaduct to about 1200 feet in length, and to construct it of timber resting on stone piers, which allowed the means of widening and strengthening it hereafter, without stopping the trade or incurring more expense than would have been necessary in the first instance, if built to the full dimensions.

The piers and abutments are built hollow, of grey freestone from the adjoining quarry of Dalziel; the trussed wooden beams rest in metal sockets, and the springing plates are laid, for supporting the under arches of bent timbers, which are now in progress of construction, to render the viaduct capable of supporting safely the weight of locomotives and heavier trains than now pass along it by H. P. The usual load for horses is 4 wagons, each weighing 1¼ ton, and carrying 3½ tons of coal; there are frequently 3 of these trains in a single arch of the viaduct at the same time, and 30 loaded wagons weighing 120 tons exclusive of the engine and tender, have frequently been taken over; on one occasion a train consisting of 65 loaded wagons of 4 tons each, making a gross load (including the engine and tender) of 279 tons was taken over the viaduct, but the usual load is restricted to 30 tons, until the under arches are fixed.

The details of the construction of the general work are then given, and the total cost of the single width is stated to be about £15,000; this sum includes the metal castings for the future widening and when the strengthening and widening of the whole will be completed the total cost will not exceed £25,000, which is stated to be a low price for a viaduct of 1200 feet long, and varying from 50 to 130 feet in height.

A description is then given of the experiments upon the deflection of a trussed beam. Two stone piers were erected 100 feet apart, with metal caps and sockets built into them; two beams were laid and strapped together and the struts fixed, precisely as they would have been in the bridge; along each side of these beams, but quite unconnected with them, posts are driven in the ground, to which a horizontal beam was attached; six rods of deal carefully divided into inches and tenths, were then screwed to the outside faces of the beams. The beams were, in the first instance, brought as near as possible to a horizontal line, by means of a spirit level, and the zero points on the rods made to correspond with a fixed line on the horizontal bar. When the beams were loaded, and the deflection from the original level took place, it was marked by the divisions on the index rods, which being firmly screwed to the beams rose or fell with them, and showed the quantity of deflection as marked by the line on the horizontal bar; after each load was put on the beams, it was allowed to remain an hour or two before the deflection was measured, and after the load was taken off, the deflection was again measured at an interval of some hours to ascertain the permanent set, before another load was put on. The load made use of was railway bars; they were distributed over the beams in various situations, and in various quantities, varying from 1 to 60 tons: the results of which are stated in a series of elaborate tables: and a large collection of diagrams show the situation and form of the load and the space covered at each experiment. By examining these diagrams, the situation of the load, its weight, and the deflection caused by it, will be at once seen; the results of these weights are given in the tables in feet and decimals, which will be more satisfactory than the diagrams alone would be, to those who may wish to make any calculation, or to form a practical rule upon them for their own guidance.

The appendix contains the specifications for all the artificers' work, with the dimensions of the several parts and the priced estimates;—the drawings accompanying the paper were executed by Mr. Macneill's assistant, George Ellis, Assoc. Inst. C. E.

NOTES ON STEAM NAVIGATION.

Paddle Floats are usually of fir 3 in. thick or elm, 2 1-2 in thick. Each float should consist of only one piece, either from being cut off a plank as wide as the float, or from the pieces being bolted together edgeways if consisting of more than one. These bolts should go right through the float edgeways with a head on the one end and clinched on a ring at the other. There should be three in each float, and in distributing them care should be taken that they do not come in the way of the bolts which attach the floats to the arms.

Paddle bolts and plates constitute an item of considerable expenditure, especially if the ship's carpenter is negligent in screwing up the bolts firmly. New floats are particularly liable to become loose from the compression of the timber, and the bolts should therefore be tightened on every convenient opportunity. It is not uncommon to nick the thread of each paddle bolt with a chisel to prevent the nut from unscrewing, but this will seldom be necessary if the bolts be properly screwed up. When a float is broken, which will sometimes occur in a heavy sea, some of the paddle bolts will generally be lost, but none ought to be lost from any other cause. The carpenter in getting new bolts should always fetch back the old ones, if only to show that there has been no considerable loss from negligence. On one of the outward voyages of the British Queen she lost every float on the weather wheel, and was placed in considerable peril in consequence. This we are inclined to attribiute to the circumstance of the bolts not having been tightened after they had been shifted. The vessel on the occasion to which we refer had been in dock, and all the floats had been removed to enable her to go in. When she came out the floats were replaced, and we doubt not the bolts were screwed as tight as possible, This was in London: the vessel then started for Southampton, where the bolts should all have been tightened before she put to sea; but this we believe was not done, and the exposed wheel lost all its floats in consequence. Some of the floats indeed were probably broken by the violence of the waves, but the greater number we suspect were lost from the slackness of the bolts.

Against the rapid erosion of the paddle bolts by the sea water we know of no defence except frequent painting. The wheels should be well painted with red lead about four times a year. Red lead is, we think, a better protection to the iron than coal tar, and is much more manageable in its application. It will penetrate into all the joints and minute interstices which coal tar will not do, and will also adhere to the iron more firmly. Coal tar will sometimes peel off, especially if the wheel has been at all wet at the time of its application; and the iron will not unfrequently rust beneath the coal tar.

As paddle bolts are an article of large consumption, it is of course desirable to produce them with as little labor as possible. The practice of the London engineers is to wind a bar of square iron round an upright mandril fixed in the ground in the same manner as the links of cables are made, and then to cut every round of the spiral in two places; so that every round of the spiral will make two bolts. The mandril must of course be of the figure formed by placing two bolts with the point of the one touching the hook of the other. The nuts of the paddle bolts should not be hexagonal but square, and the carpenter should be provided with two or three good stout spanners that will fit on the nuts easily. These spanners should be single ended; the handles should be straight, and furnished with a hole at the end, through which a rope yarn should be rove. Whenever the spanner is used, the rope yarn should be tied to the rim of the wheel, so as to prevent the spanner from being lost should it happen to slip or fall from the man's hands into the water. Sufficient length of rope yarn should of course be left to permit the spanner to be wrought without impediment. The nuts of the paddle bolts may be quite well stamped in a die; a good stout punching press will answer very well for the compressing power.

Horses power.—There is a blessed uncertainty among engineers as to what area of piston and length of stroke constitutes a H. P.; in fact every engineer appears to have a measure of his own, whereby about as much confusion is introduced into engine making as would arise among the haberdashers if every shopkeeper had a yard measure of greater or less length than his neighbor. A horse power is as much a conventional unit as a pound avoirdupois, and we think it a disgrace to the Institution of Civil Engineers that it has not accurately defined what a horse power is. Mr. Watt, it is true, determined a horse power to be 33,000lb. raised one foot high in a minute; but, however useful such a standard may be for the power exerted by an engine with the power exerted by horses or any other species of prime mover, it is wholly useless for commercial purposes. In short it may inform you of the power actually exerted by any engine, but not of the number of horses power which a given diameter of cylinder and length of stroke are equivalent to. If a man purchases an engine he is charged at the rate of so many pounds sterling per horse power, and how is he to ascertain whether he has that number of horses power or not? He has no means of finding out, because it has not been defined what a nominal horse power is, and every engineer makes it a different quantity. Thus the West India mail packets are all said to be of the same power, but he will be very far out who shall conclude from thence that all the cylinders are of the same diameter.

Messrs. Maudsley & Co.'s 400 H. P. is about 72 in. diameter of cylinder.

Messrs. Miller & Co.'s 400 H. P is about 74 in., which is just about as reasonable as that one man's foot should be twelve inches and another only ten. Again a given sized cylinder, if devoted to the propulsion of a vessel through the water, is rated differently from what it would be if used for any purpose on land. And in Messrs. Maudslay's marine engines, while a cylinder of $47\frac{1}{2}$ inches diameter and 5 ft. stroke is rated at 80 H. P., if on the side lever plan, a 48 inch cylinder and 5 feet 6 inches stroke is only rated at 75 H. P., if on their double cylinder construction. Such capricious variations appear to us extremely reprehensible, and are calculated, we think, to give a false impression of the force of a new kind of engine or defraud purchasers of a part of their measure in the old kind. The power of an engine ought manifestly to be some function of the cubical capacity of the cylinder, and that function should not be determined by abstract or scientific views, but by the intent to equalize the cost of production for the same power, whatever be the stroke and diameter. In other words an engine of the same power should cost the same money whether its stroke be longer or shorter than that of other engines, any increment in the stroke being so compensated for by a decrement in the diameter, so as to keep the expense of production unaltered. This standard, it is true, would no longer be a measure of the power exerted, but of the expense incurred, and therefore "horses power" might be an inappropriate name for it. But the term horses power is not even now expressive of the real power an engine exerts, at least in common language. The *actual* power is sometimes determined for scientific purposes by means of the indicator, but it is by the *nominal* power that engines are bought and sold and always spoken of, unless when the contrary is expressly stated. The term horse power is therefore as applicable to the proposed new measure as to the existing one, yet we think a better term might be invented.

The following is Boulton and Watt's rule for determining the nominal horses power.

Let $D =$ the diameter of the cylinder in inches.

$V =$ half the velocity of the piston in feet per minute.

Then $\frac{(D^2 - 4D)V}{2650} =$ the number of nominal horses power.

But how is V to be determined before perhaps the engine has been made? Boulton and Watt fixed upon an empirical velocity for each different length of stroke. The several velocities are as follows.

stroke.		velocity.
ft.	in.	ft.
2	0	160
5	6	170
3	0	180
3	6	190
4	0	200
4	6	210
5	0	220

And so on with 10 feet of additional velocity for every 6 inches of additional stroke. Yet this rule docs not give results answerable to the dimensions observed by Boulton and Watt in their marine engines. Thus the original engines of the Thames and Shannon constructed by Boulton and Watt, were rated at 80 H. P., the cylinders being $47\frac{1}{2}$ in. in diameter, and the length of the stroke 4 feet 6 in. $(47{\cdot}5)^2 - 4\ (47{\cdot}5) = 2066{\cdot}25 \times 105 = 217930 \div 2650 =$ 83 H. P. nearly, instead of 80. Land engines of $43\frac{1}{2}$ in. diameter of cylinder and 8 feet stroke, making 16 double strokes in a minute, were rated by Boulton and Watt at 80 H. P. The average effective pressure on the piston is rated at barely 7lb. per square inch, and the power may be thus computed, $(43\frac{1}{2})^2 \times {\cdot}7854 = 1486{\cdot}2 \times$ by 7 and 256, and $\div$ by 33,000 = about 80 H. P. In marine engines a greater area of piston is allowed to represent a horse power than in land engines, because the motion of the piston is supposed to be slower, but the effective force is calculated a little higher, or at 7·3 per square inch.

To heighten all this perplexity, M. Pambour proclaims to all nations that the boiler is the true measure of an engine's power, and with the forwardness proper to a little knowledge, maintains this to be a discovery of his own. All engineers and most amateurs have long known that the power produced by an engine is proportional simply to the steam expended, provided there be no accidental circumstances to influence the result, and that the piston be not made to travel at an extreme velocity. M. Pambour's discovery, therefore, contributes nothing to our knowledge of the subject, unless it be his intention to allege that the power of an engine is to be determined by guaging the boiler instead of the cylinder. If this be his aim we willingly surrender to him the full credit of the ingenious suggestion.

We trust the Institution of Civil Engineers will give their early attention to this subject, and define what function of the length and diameter of a cylinder a horse power should be, so that a uniformity of measurement may be established among engineers, and purchasers may know what they are buying. Should this not be done by the Institution, we shall attempt the task ourselves—giving the proportion of our principal engineers, the rules for finding those proportions, and a new unit of our own.

Surcharged steam.—The question has been frequently raised whether steam to which a high temperature has been imparted without increasing its elasticity is more economical than common steam. The specific heat of steam has been found by experiment to be 847, that of water being 1, and if this result is to be relied on, there appears to be a saving worth attending to in the use of surcharged steam. Yet it appears questionable to us whether the specific heat of steam is not the same as water, the apparent diversity arising from some error in the experiment, which indeed in researches of such delicacy it is almost impossible to exclude. There are many analogies in favor of the conclusion that the specific heats of bodies are inversely as the atomic weights, and if that doctrine be true, the specific heats of steam and water must be the same. Yet great economy is said to have been realized by the use of surcharged steam, and upon the whole it seems worth while to inquire what amount of benefit may be expected from surcharged steam at a given temperature supposing the specific heat of steam be such as has been determined by experiment.

If δ denote the density of the steam, then $45\left(\frac{1}{\delta}-\delta\right)$ will denote the diminution of temperature when the steam is rarified to unity, or the number of degrees requisite to be added to maintain the temperature unchanged. The latent heat of steam being 1000° the heat necessary to raise water from 60° into steam is 1000 + 152 = 1152°, and if the steam after leaving the water at the temperature of 212° be heated to 600°, and at the same time be prevented from expanding, 600°—212° = 388° = equal the heat requisite to be added if the specific heat of steam were the same as that of water. But the specific heat of steam is ·847.

$$\therefore\ 1 : \cdot847 :: 388 : 328$$

Supposing now the steam be allowed to expand,

$$\left.\begin{array}{l}448+212 = 660\\ 448+600=1048\end{array}\right\}\ 660 : 1048 :: 100 : 158\cdot8 \text{ or say } 159.$$

or the steam when permitted to expand, will occupy 159 volumes at the original atmospheric pressure. The density of the steam when so expanded will be $\frac{100}{159} = \cdot629 \therefore 45\left(\frac{1}{\cdot629}-\cdot629\right)$ = the heat absorbed by steam during its expansion from 100 to 159 volumes, $45\left(\frac{1}{\cdot629}-\cdot229\right) = 45\left(\frac{1}{\cdot629}-\frac{\cdot629^2}{\cdot629}\right) = 45\left(\frac{1}{\cdot629}-\frac{\cdot401641}{\cdot629}\right) = 45\,(\cdot598359) = 26\cdot025015$ degrees. This is the result for air, the specific heat of which is ·2669.

$$\therefore\ \cdot2669 : \cdot847 :: 26 : 82°.$$

The total quantity of heat therefore requisite to produce 159 volumes of surcharged steam of the atmospheric pressure and temperature, 600° is 1152+328+82=1562°. To raise an equal quantity in the common way would require 1831·68°, for

100 : 1152 : : 159 : 1831·68° say 1832.

∴ 1832—1562=270° and 270÷1862= $\frac{1}{6.7}$ of the whole heat; in other words, by surcharging the steam to the temperature of 600° the saving is a little more than a seventh of the whole fuel consumed.

Deck Plates.—Every steam vessel should have an iron deck plate above the steam chest: the fore and aft bearers of the boiler hatch should also be of wrought iron. Boiler plate on edge with angle irons at top and bottom answers well. Dog bolts may still be used in the beams extending from the fore and after to the ship's side, and the knees can be placed as usual.

Safety valve Chest.—The weights should all lie within the chest or within the boiler. The practice of raising the valves by palms acting on the lower extremities of the valve spindles, and attaching the weights *beneath* the valve with a cutter, which admits those weights to be raised without lifting the valve, is, we think, a good practice, The valve can thus be *eased* without opening it, which is done by relieving the valve of its lower weights, the weights *above* the valve still keeping it down, though with a diminished force. By raising the palms still more, the cutter arrives at the end of the slit in the socket; and then the valve is lifted. The safety valve seat should never be driven tight in and rivetted, but attached by means of a weak flange and a few weak bolts so that the valve seat would be raised out of its place by the pressure of the steam before the boiler would be burst. The waste steam pipe should always be attached to the safety valve chest by a socket joint. If fixed by a flange it will speedily be cracked at the neck from the rolling of the chimney, when the vessel is in a sea way, the funnel shrouds never being so tight as to prevent *all* motion of the chimney.

Slide valves.—Messrs. Maudslays make all their slide valves up to 50 H. P., of the long D description, above that power, short D. Their long D's are just the same as those in commun use, but the attachment to the valve rod is at the top instead of at the bottom as is usual. The covers of the valve casings are made so that they may be moved in as the valve faces wear, the bolt holes being oblong, and the part where the joint is faced in the lathe. The joint is made with a piece of sheet lead *not* wrapped with canvass. The valve rods are steel; the long D's are of iron, the short D's of brass. Messrs. Miller & Co. also make their short D's of brass. The practice is an excellent one.

THE ARTESIAN WELL AT GRENELLE, PARIS.

We have at various times given an account of this well, the first description of the labors of M. Mulot, up to the time of his accomplishing the objects in obtaining water, appeared in the *Journal* for April, 1841, p. 131. vol. 4; and in the *Journal* for the following July we gave a further account, explaining the size of the tubes and the geological character of the strata through which the boring passed. All the reports that have recently appeared in different publications nearly correspond with our reports, and the engraving lately published in Paris, showing the strata does not differ much from our description, but it gives the strata more minutely, which we now give in a tabular form. It will be perceived that the formation is identical with that of the London Basin below the London Clay.

Depth in ft.	STRATA.	Formation.
	Gravel and sand	
13.		
	Cockle Shells	
	Quartoze Sand with fine particles of sulphuret of iron	
	Fine Sand	Plastic Clay.
	Argillaceous Sand	
	Mottled Clay	
	Sand and Clay with nodules of Limestone	
182.		
	White Chalk with layers of flints	
328.		
	White Chalk alternating with stata of dolomite and small pieces of silex	White Chalk.
886.		
	Gray chalk with small particles of silex	
1049.		Gray Chalk.
	Gray Chalk, compact without silex	
1453.		
	Green Chalk and green particles of the silicate of iron	
	Blue argillaceous Chalk	Chalk Marl.
	Blue argillaceous and sandy chalk, with particles of mica, and veins of green chalk	
1634.		
	Clay with iron pyrites, nodules of the phosphate of lime and fossil debris	
	Green Sand	
	Clay and Greenish Sand with grains of quartz	Gault.
	Argillaceous Sand	
	Green and White Sand	
1794.		
	Water	

PORTION OF THE MESSAGE OF THE GOVERNOR OF PENNSYLVANIA, RELATIVE TO INTERNAL IMPROVEMENTS.

No bids were received for the purchase of the public improvements of the State.

"The revenues upon our public works have not diminished in any proportion to the extent of the embarrassments which have been thrown in the way of trade. It will be seen by referring to the report of the Canal Commissioners, which will shortly be laid before you, that notwithstanding the scarcity and depreciation of money, the impaired condition of credit, and the enormous rates of exchanges, the receipts from tolls for the fiscal year, ending the 30th of November, 1842,

amount to	$920,499 42
The expenditures, for all purposes for the nine months commencing on the 1st March and ending 30th November, 1842, amount to	390,046 70
Leaving an excess of receipts for the year, over the expenses of nine months of	530,452 72

notwithstanding the decrease in tolls has been $169,396 61

The receipts and expenditures on the main lines have been as follows:

	Tolls received in 1842.	All expenses and liabilities for 9 months.
Columbia Railroad,	$357,461 50	$132,499 45
Eastern & Juniata, Divisions,	195,780 16	45,072 12
Alleghany Portage Railroad,	124,258 40	96,528 63
Western Division,	85,449 42	26,080 00
	$762,949 42	$300,080 20

Leaving an excess of tolls over expenditures of $462,769 28, on the above usually denominated THE MAIN LINE from Philadelphia to Pittsburg.

On the Delaware Division and other branches of the Canals, the excess of tolls over expenditures, during the same period, has been $67,683 44.—It is worthy too of remark that the expenses for repairs alone for the nine months have been only $164,526 30.

This exhibit cannot fail to inspire us with increased confidence in the ultimate value and usefulness of our public works, strengthened as it is by the fact, that there has been a falling-off in the canal tolls of New York, for the fiscal year ending 30th November, of $284,361 89.

The Governor then speaks of the delapidated condition of the works and the heavy amount required to put them in navigable condition when he came into power—the amount of the debt due for ordinary repairs, unprovided for, etc., which amounted in the aggregate to $2,367,566, which has been hanging like an incubus on the whole system, and which has contributed much to embarrass its operation for the last few years. These renewals have been made, and the expenses for repairs will be light for several years to come.

The bridges which cross the state Canals, and which have been heretofore kept in repair at the expense of the state, the Governor suggests, ought hereafter to be kept in repair at the expense of individuals and counties, for whose use they were constructed.

The Governor also alludes to combinations among a few private companies to monopolize all the advantages from the carrying trade on the public works at their own prices, and hopes that the recent conviction at Pittsburg will remedy the evils complained of.

He refers the Legislature to the Canal Commissioners Report for other grievances complained of, which the Legislature ought to remedy.

Nothing has been done with regard to the incorporation of private Companies, to take and finish those portions of the public works that remain in an unfinished state.

Claims by Domestic Creditors to the amount of $1,191,710 23 have been entered on the books of the Auditor General, and only an instalment of 20 per cent., and the interest amounting to $209,-589 43 have been paid. The Governor also calls the attention of the Legislature to the amount due the laborers who keep the improvements in repair, and who, the message states, have been heretofore overlooked.

ON THE ACTION OF LIGHTNING CONDUCTORS.

At the meeting of the Electrical Society on Tuesday evening, 19th July, a paper on this subject by Mr. Charles Walker, the Secretary, was read. The author entered into a very close investigation of the most important experiments that have been adduced in illustration of the nature of these instruments and stated that discharges of Leyden batteries have been very generally selected as representatives of lightning flashes. He then showed the great difference between the visible character of the two flashes, and analyzed the cause on which each depends; demonstrating that the only case in which the resemblance is in any degree to be traced, is when a Leyden discharge fractures the glass, and passes directly between the coatings; and that in all other cases the said discharge is the result of two forces acting counter to each other. Thus he reaches his first conclusion, that the discharge of a Leyden jar does not resemble a flash of lightning; and therefore that Leyden jars should not be employed in these experiments. He then said that many points on which philosophers of the present day differ, are in connexion with the results of the Leyden experiments; and hence if it can be shown that these experiments ought to be excluded, the at present complicated inquiry will be much simplified. He proceeded to trace the close resemblance between the discharge of a prime conductor and a cloud, illustrating his opinion by the aid of the magnificent machine belonging to the Polytechnic Institution; and showed that experiments with this conductor are in all essential points legitimate. He then described an extensive series of experiments to prove that a wire on which sparks are thrown from the prime conductor represents a lightning-rod; and then that sparks will pass from such a wire, and therefore from a lightning-rod, to vicinal conducting bodies. This last position was illustrated in a general manner by an assistant holding in his hand a glass rod surmounted by a brass ball; the ball was connected by stout wire with the gas-burners of the room, and thus when sparks were thrown on it from the conductor the electricity passed into a good discharging train to the earth. Now, while this took place, the application of a piece of metal to any part of the wire produced a spark; and not only so, but the same could be obtained from any of the gas-burners in any part of the room; and even when the writer descended into the workshops, two stories below the machine sparks could be obtained from the burners there, which were indeed very much out of the direct line of circuit, so great is the desire of the electric current to use a wide path. This is the source of danger alluded to in the paper on Brixton church, reported in the last *Journal*. However, as the wires in this, as in several other similar experiments, were not directly between the conductor and the earth, the following arrangement was made, which answers every condition, and the general result of which proves that the wires above described do act as lightning-rods. Attached to the prime conductor of the machine was a thick brass rod, terminating in a five-inch ball; immediately beneath this was erected a similar rod surmounted by a ball. This rod was screwed into a small brass disc on the floor, and was considered a perfect representation of a lightning-rod, when sparks or flashes were passed into it. Near this a shorter and smaller rod (also terminating in a ball) was held; when the end of this rod touched the brass disc, no sparks passed between the two, when it did not touch, sparks passed in abundance. Much of the value of the inquiry was shown to depend on this experiment. If the former state of things represents what occurs in nature, there is no danger of a lateral spark; but if the latter, the danger is great. That metallic contact in this experiment prevented the appearance of sparks is an experimental proof of the safety resulting from the metallic connexions formerly recommended. These latter results are given in explanation of the well-known experiment of the two metallic discs; and Mr. Walker shows that no lateral discharge takes place between these discs, because the vicinal metal is in contact with the lower disc. While, therefore, the author agrees in recognising the value of lightning-rods, he has strong reason to believe that this lateral spark will occur unless proper precautions are taken; and though he differs in some degree from others, he does so in a feeling of perfect good-fellowship, and expresses a willingness to forsake his opinions whenever they are shown to be untenable. He states, in conclusion, that even if he is in error, still science will have gained something; for the received opinions will then have been able to withstand another assault, and will only stand the firmer.

PATENT STUCCO PAINT CEMENT.

In a former number we slightly alluded to this new cement, deferring until we had an opportunity of examining into its qualities, to recommend it to the notice of the profession, which we are now enabled to do, after having carefully investigated its properties, and examined several samples of the cement, at Messrs. Mann's, Maiden-lane, in the City. It appears to be a cement possessing superior qualities, and to be well adapted for external works, particularly in exposed and damp situations, such as on the sea coast, and south-western aspects. At Plymouth, where the cement is manufactured by Messrs. Johns, the patentees, and where the principal ingredient is obtained, it has been tried for the last three years, and subjected to the most rigid tests with perfect success. Its strong adhesive properties cause it to adhere to almost any substance; specimens may be seen on glass, wood, slate, tile, and brick. The nature of the materials of which the cement is composed, renders it highly repellant of water, and impervious to wet or damp. It is sold in a semi-liquid state, which has the appearance of white lead; and when used it is mixed with three times its weight of sharp sand to the consistency of mortar, and laid on the wall with a trowel in the same manner as cement, and with about the same labor. It is finished off at once, with either a fine or a coarse coat, as may be desired; it dries gradually, and in two or three days time the surface becomes as hard as stone, to which it has all the appearance, without coloring. It may likewise be used for interiors, and painted over within a few days, a couple of coats being sufficient to cover it, as the cement is not of that absorbent character as stucco or roman cement.

The cost of the fluid cement is 14s. per cwt., and for covering a yard superficial of brick-work, it requires 7 lbs. of cement, and 21 lbs. of sand, or 4 lbs. of cement, and 12 lbs. of sand, if laid on a coat of plastering. or 1 cwt. of cement will take one bushel of sand, and cover 14 yards. The prime cost, including labor, is about 1s. 6d. per square yard, which is a low price, considering the excellent qualities of the material, and that it does not require coloring. We strongly recommend the architect to give the cement a fair trial. Some specimens may be seen at the office of the Journal.

Alabama Gold.—The East Alabamian says: The broken lands in some parts of Randolph and Tallapoosa counties are said to teem with the precious mineral. In the latter county, a considerable number of persons have recently made entries of land with a view to commence mining operations immediately. The gold is found, we are informed, in what miners term "rock veins;" and a yield is obtained by crushing the rock in some rude wooden contrivance, of two or three dwts. per day to the hand. In a short time we have confident expectations the pure bullion will be very plentiful in this vicinity.

A wire rope 5,300 yards in length and weighing twelve tons has been manufactured at Newcastle-upon-Tyne, for the inclined plane on the Liege and Antwerp railway.

AMERICAN

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AND

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NEW YORK STATE WORKS.

In the last number of this journal for 1839, we gave a not very flattering view of the prospects of State works in general, and we leave it to our readers to say, whether the reality has not more than borne out our predictions. We said (Vol. IX, 1839, p. 363,)

"In some states, the grand argument will be, that if they can *complete* the works commenced, a revenue is immediately certain, which will render taxation to pay the interest unnecessary. That the completion of these projects will make the fortunes of many individuals, is well known, but, for the *permanent interests* of the State, the only plan is, to sell out at once with the present comparatively trifling loss. It is impossible to pay too much attention to the fact, that the greater part of the works projected by the governments of the different States are not such as will ever be of any essential benefit, and, when we add to this, that they are constructed at twice the cost of similar works in the hands of companies, are generally much inferior in execution and always managed and repaired in the most inefficient manner—we shall be at no loss to account for the present condition of State works in general."

Time has however shown, that, in our remarks on repudiation (in the following page) we egregiously overrated the "good faith" of only too many States, whose delinquency has caused an amount of suffering, here and in Europe, which is now past the possibility of cure; the original holders having in many cases disposed of their stock at a nominal sum, at least, a ruinous depreciation.

An insignificant amount of work has been done in the States of Ohio and Indiana since that time—during '40 and '41 large sums were expended in New York; and, during '42, in Canada alone have new works been undertaken. Considering the system of State works—as far as any new works are concerned—as defunct throughout the Union, New York *perhaps* excepted, we propose to offer our views on the prospects in that State.

The system, uniformly pursued during the last 20 years, of doing everything for the Erie canal counties—the lateral canals being mere feeders to supply the requisite votes to carry appropriations for the enlargement—as well as the present plan of taxing *all* the state to keep up these accommodations for a *part* of the state, can scarcely be tolerated any longer. To expend 30 to 40 millions for the purpose of effecting a reduction of 15 cents on the transportation of a barrel of flour from the western states to the Atlantic—and *that* reduction more than doubtful—will not hereafter be considered as more important, than, by an expenditure of less than one fourth of that sum, to insure the rapid construction of the main communications required in the State.

The canal system must be abandoned on account of the enormous capital invested in these works, as compared with railways—on account of their being closed, during at least one third of the year, and not accommodating when open, the travel which the railway has in addition to the freight of the canal. This travel again increases the freight, and thus with a much smaller capital we have a vastly greater income. It is impossible to conceive a stronger proof of the general belief in the superiority of railways, even as a means of carrying coarse freight, than the dread with which the legislature regards any measure tending in any way to, even at a distant day, permit them to enter the lists with the canal.

When the products of the people of *this* state are unable to find their way to market by the Erie canal and the adjacent railways, then may the enlargement be considered. Until that time and until the other parts of the state are as well accommodated as the central counties, the enlargement cannot be advocated without virtually disfranchising the rest of the state.

If the system of constructing works by the state be abandoned then the question as to the policy to be pursued becomes purely financial; but, if the system of Government works is to be continued, what kind of works shall be undertaken, and how shall they be carried on?

To the first question *we* at least answer, by railways, and not the less readily, because we believe that opinion very general at present and rapidly extending,—more especially among the farmers.

The second is more difficult. The Erie, Cattskill and Ithaca railways show, that loans to private companies have, in their cases, turned out failures, and though the entire loss will fall short of that on the Genessee valley canal alone—the works themselves being of *some* use to the public which can scarcely be said of that canal—the plan cannot be recommended without very important modifications. The necessity which exists, that the whole business of a railway must be under *one* head,—in other words, that the proprietors of the railway must be common carriers, precludes the idea of the state conducting these works by its own agents.

She may become a stockholder as in Massachusetts—the extent to be determined by the circumstances of the case. The able and elaborate article on this subject by "Fulton," (Vol. XI, 1840, pp. 358, etc.) renders any remarks of ours unnecessary, but we cannot help quoting his views (p. 361,) on the first question.

"The conviction is indeed very general that the canal system, pushed as it has been to an extreme, must, so far as it regards the construction of any new works, be abandoned, and the grave question arises, whether in the prosecution of the better improvement of railways, the arm of the State is necessary to its success.

The view we have taken of the subject has brought us to the conclusion that, whether right or wrong in the abstract, the aid of the State *will be invoked* and *successfully* in support of railways, and it becomes therefore an object of importance to ascertain the best and safest and most effective mode by which that can be rendered. It is for the purpose of contributing our mite to the enlightenment of the public mind, that the foregoing plan is presented, and unless such a plan, or one similar to it, is adopted, the state must continue the practice already partially introduced of aiding railway companies by a loan of its credit, or otherwise railroads, like canals, must be made State works."

The state may also furnish a certain sum per mile to build superstructure and to supply equipments per mile of *graded road* free from all encumbrance whatever. Or may loan money under certain restrictions, so that the interests of the company and the state may be the same—not antagonist. The discussion of details is however not required until the general policy has been determined on.

The farmers suffer much from the "State monopoly," even more than either the manufacturers or merchants, and are rapidly making the discovery. They are already calculating the immense benefit they would *now* derive from its repeal, and find, that their pork, at Boston prices, would nett them 50 per cent. more than in the Rochester market.

Is the farmer to be forever excluded from the advantages of railways, because the state owns the Erie canal? Does not the falling off in the receipts of the Albany and Boston railway show the sacrifice of the interests of the farmer to bolster up the Erie canal.

For, freight is, by the peremptory mandate of the State, to remain on the banks of the canal from November till nearly May, thus depriving the farmer of the use of his money during the entire winter, and, in the spring—after paying (directly or indirectly,) storage, insurance, etc.—his produce sells at a lower price. The course of legislation has been for years, to give the farmer a route open during the months when he is busy producing, and closed during the months when his productions are ready for market—to shut him out when the demand is greatest and prices uniformly highest—to, in a great measure, allow him to be forestalled by Baltimore and New Orleans in supplying the great and rapidly increasing demand for pork, beef, butter, cheese and lard, *during the winter*, for shipment to Europe. Lastly, to pay a tax on every thing he has in the world for these inestimable blessings!

The merchant is idle during the winter and loses a large amount of trade altogether. It is quite immaterial to him whether produce reach him by the channel of the Erie canal or by railway—so also with the manufacturer. Cheapness and regularity are all they require. Their interests therefore, as well as those of the farmer, are diametrically opposed to the enlargement of the Erie canal, the object of which is not to furnish the grand desideratum of a less tardy communication open throughout the year, but, to perpetually restrict the so called *free* and enlightened citizens to a channel open only eight months in the year, and even then offering inferior advantages to those which private enterprise will furnish without any taxation.* It does appear to us that, to go on with the enlargement, under existing circumstances, is literally "adding insult to injury."

The only public work of importance which can now be said to

* Not only so, but these private railways actually pay a large amount to the towns through which they pass---the Utica and Schenectady railway alone paying to the towns 14,000 dollars per annum!

be fairly before the public on its own merits, is the New York and Albany Railway, and it is likely to have much influence on the future policy of the state.

The wealth, business and population of the counties, *through* which this work is to run, will eventually accomplish all by their own unaided efforts. These counties will pay *more than half the state tax* imposed to pay the interest on works in which they have not and never can have the least imaginable interest, (the N. Y. and Erie railway excepted,) as the enlargement, Chenango, Black river and Genessee valley canals, on which about 18 *millions have been expended!*—twice the amount lost in the great fire of 1835!

The river counties have—exclusive of New York—much weight in the legislature. They cannot be expected to agree, on *any* terms to *any* expenditure of money, on *any* public work whatever, if they are obliged to construct the New York and Albany Railway at *their own* cost exclusively. Look at the counties of Rockland and Orange, in which two millions have been spent on the New York and Erie Railway, at the counties traversed by the Chenango, Genessee valley and Black river canals, and compare their wealth, population and the amount of tax they will pay as compared with the sum drawn from the river counties—even omitting the city of New York. Hence we conclude that the New York and Albany Railway will have great weight in the approaching death struggle between the railway and canal systems.

The following are the total appropriations we should recommend, say one million per year for 5 years.

N. Y. & E. R. R.	$2,000,000.	(in addition to the 3,000,000.)
N. Y. & A. R. R.	1,500,000.	
Northern N. Y.	1,500,000.	(including completion of Saratoga and Whitehall Railway.
	$5,000,000	

Again, we cannot see the propriety of taxing *all*, including those who derive no benefit from the Erie canal, instead of raising the required amount by a slight increase of toll, and thus tax those, *and those only*, who receive an *equivalent* in return. A considerable sum would thus be derived from other states, which derive immense advantages from the Erie canal. We quote again from (Vol. 10, 1840, p. 4,) our remarks on this subject three years since.

"Now, the Erie canal is a work as general in its character as any undertaking of the kind can well be, yet, beyond a distance of 25 or 30 miles, its *beneficial* influence ceases, and it is notorious, that it has been the means of retarding the advancement of the southern and northern counties by offering every inducement to the husbandman to leave his native state, because it costs less to send his produce to market from Ohio and Michigan than from nearly one half the state of New York. The western states offer great natural inducements to settlers, and it would be as unfair to *them* to attempt to check the tide of emigration as it is unjust to our own citizens to use indirect but most powerful means to retard the settling of *our* northern and southern counties. The views of our legislators appear to be too enlarged to be confined to their own state; and we would respectfully, but earnestly ask, Has the government of New York the *right* to tax her citizens in order that the property of the inhabitants of *other* states or provinces may be carried to and from the seaboard more cheaply than at present rates? Not only is the New York farmer to be taxed, but the amount so levied is to be expended in reducing the value of his property by adding, at his cost, great artificial to the already superior natural advantages of the west, and thus enabling the inhabitants of that region to undersell him in his own market. The entire course of New York legislation for many years appears to have had in view nothing higher, than to direct the energies and resources of government towards aiding the interests of forwarders and brokers at the expense of the farmer, the regular merchant and the mechanic, who require no exclusive privileges to enable *them* to carry on their business. Thus, the idea that the enlargement would bring to the Erie canal a few thousand more tons of freight, and lead to the sale of a few additional bales of goods, has been considered of more importance than to double the population and wealth of the state in ten years, by developing the resources of the northern and southern counties."

We repeat, that the enlargement of the Erie canal will not only not afford the additional accommodations required by the advanced state of the country through which it passes, but it will effectually prevent any facilities whatever being afforded to other parts of the state— in other words, it stops the onward march of improvement in the the canal counties, and extinguishes all hope of *any* facilities being extended to the northern, southern or river counties. It also swallows up in a single year, $4,000,000, very nearly as much as we have above considered sufficient to *complete all* the required communications in the state and to be expended in 5 years.

When we consider the enormous cost of the enlargement with its inseparable concomitant, the state monopoly, it is not easy to exaggerate their withering influence on the agricultural and commercial interests of the state or on the progress of the public works really demanded by the wants of the country.

ON THE RELATIVE PROPERTIES OF IRON.

Made by the use of Cold and Hot Air Blast, in the Smelting Furnace; lately read before the West-Riding Geological and Polytechnic Society. By Henry Hartop, Civil Engineer and Mineral Surveyor.

In the early part of the year 1829, the use of hot air in the smelting furnace, for the manufacture of cast iron, was introduced at the Clyde Iron Works, near Glasgow, and at the fourth meeting of the British Association, held at Edinburgh in 1834, Dr. Clark gave an account of its success as follows:—

That in their previous operations with cold air, 8 tons, 1 cwt., 1 qr. of splint coal (made into coke, at a loss in weight of 55 per cent,) were required to make 1 ton of iron.

With the use of air heated to about 300° Fahrenheit, 5 tons, 3 cwt., 1 qr. of coal (in coke) produced a ton of iron, in addition to which, 8 cwt. of coals were used for heating the air.

In 1833, the temperature of the air used being 600° Fahrenheit, it was found that raw coal (not coked) might be used, which circumstance further reduced the quantity of coal required in the furnace to 2 tons, 5 cwt., 1 qr per ton of iron made.

Not having been present at Edinburgh, on the Association's meeting, the following year, in Dublin, I stated that the case had not been correctly represented to Dr. Clark,[1] inasmuch, as for some time previous to 1825, a saving in the coking operation had been

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[1] A similar misrepresentation has also been made to Mr. Mushet, by reason of which he has been led into an error so far as to state in his most valuable work on iron and steel, pages 922, 923, that the materials used at the Milton Works in December 1834, with cold blast, were for each ton of iron made—

	tons.	cwt.	lb.
Coals - - - - -	6	3	2
Ironstone - - - -	4	1	0
Limestone - - - - -	0	13	0

At the same works in December 1836, with hot blast—

	tons.	cwt.	qrs.	lb.
Coals per ton of iron in the furnace -	2	4	3	14
Ironstone - - - - - -	3	11	2	21
Iron Ore - - - - - -	0	0	1	0
Limestone - - - - - - -	0	16	0	14

It is, however, well known, that on an average of the year through, previous to April, 1829, when cold blast was used at the Milton Works, the materials consumed were—

made at every well-conducted iron work, by which a ton of iron could be made with 5 tons of splint coal in the furnace, when cold blast used; so that in reality a saving only took place by increasing the temperature of the air, so far as to enable them to use coal uncoked in the smelting furnace, from 5 tons to 2 tons 15 cwt., or 2 tons 5 cwt.

The account, therefore, as regards economy, by the use of hot air, will stand thus:—

	tons.	cwt.	s.	d.	£	s.	d.
Saving in coal used in the furnace	2	5	5	0	0	11	3
In Coker's Wages					0	2	3
					£0	13	6
Against this may be set down—							
A greater quantity of ironstone used per ton of iron made	0	3	8	6	0	1	3
Extra wear on ditto					0	3	6
Coal to heat the air used	0	8	2	0	0	0	10
					£0	5	7
Saving in materials by the use of hot air, per ton of iron					0	7	11

To which saving may be added a further sum of 4*s.* 7*d.* per ton, for the greater quantity of iron produced from each furnace, when hot air and coals are used, making the total saving of 12*s.* 6*d.* per ton of pig iron.

But in 1835, the deterioration in the value of iron so made was about 17*s.* 6*d.* per ton, as I stated at Dublin, and at the present time (March 1842,) I have no recantation to read so far as the above observations go.

In Dublin my observations on the deteriorated value of hot blast iron in the market of 17*s.* 6*d.* per ton were contradicted, but after seven more years of unceasing application, practised in the manufacture on a very large scale, of numerous experiments by indefatigable practical men of great ability, of the attention of learned professors of chemistry, mineralogy, and geology, together with the aid of that no inconsiderable engine the public press, the price of pig iron so made is 32*s.* 6*d.* per ton below that made by cold blast in the smelting furnaces.[a]

	tons.	cwt.	qrs.	lb.	
Coals in the furnace	4	18	0	0	per ton
Ironstone do	3	14	3	9	of Iron
Limestone do	0	14	3	23	made.

And in comparing this with the make by hot air, in December 1836, (one of the best months in the year for iron making) an addition of 8 cwt. of coal being made for heating the air, the difference is truly so small as to be altogether unworthy of consideration, on taking into account the deteriorated value of the produce.

[a] March 1842. per ton
Price of Scotch hot blast iron at Hull, (No. 1.) £3 7 6

If you ask why iron so made is sold for 32*s*. 6*d*. less in the market, the answer is 1st, "its great weakness under *impact*, and therefore its total unfitness for most purposes in which the greatest weight of iron is used.[1] 2d. Its greater loss in remelting in the cupola of 2 cwt. per ton. 3rdly, The great irregularity in the contraction of castings when cooling, if made from hot blast iron, on which account many castings of different sizes are produced from the same pattern, causing great expense in their after fitting, or if this expense is not incurred, great defect in all machinery, etc., so made. 4th. Its unsoundness, that when made into castings require to be turned, bored, or planed, etc., on which occasions, if the surface operated upon is not defective on its entire area, a defect so considerable will show itself, probably when nearly finished, that both the casting and the great expense bestowed upon it will be thrown away, and in many such cases the expense of making the casting itself will be at least three times greater than even the present great difference in the value of the two kinds of iron.

I need not unnecessarily occupy your time further than by going more fully into the first of these points, the great weakness, under impact, of hot blast iron.

My attention was first called to the subject by observing great quantities of pig iron on the wharfs at the iron foundries and other places in this neighborhood, very recently broken into pieces so short as to prevent the laborer piling them in cubical tiers in the

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Amount brought forward.	£2 7 6
To which add for its general inferiority to Yorkshire iron	0 5 0
	3 12 6
Price of Yorkshire cold blast iron at Hull, (No. 1.)	5 5 0
Difference in favor of cold blast iron generally	1 12 6

[1] In Mr. Fairbairn's recent experiments, published in the Manchester Memoirs, the difference in this respect is very striking:—Each bar being 1 in. square and 4 ft. 6 in. long between supports.

	Breaking weight.	Power to resist impact.
Oldberry cold blast iron	453 lbs.	822 lbs.
Oldberry hot do.	543	549
Using the same coal and ironstone.		
Elsecar cold do.	446	992
Milton hot do.	353	538
Working in the same mineral field in N. Wales.		
Ponkey cold do.	567	992
Plaskynaston hot do.	378	175

usual manner, and on inquiry, I found that they were so broken by loading and reloading, and that they were made by the new process of using hot air in the furnace, greatly miscalled an improvement in the manufacture of cast iron. From these and other circumstances I thought it a duty due to the iron trade to call the attention of the public to it, and having mentioned the subject at the meeting of the British Association in Dublin, its importance was at once recognised, and a sum of money appropriated for making the needful experiments, which were carried into execution by Mr. Fairbairn, the highly intelligent and indefatigable engineer of Manchester; and I was very sorry to see in his report read at the Liverpool meeting, as well as in several conversations with me on the subject, to find that he had experienced great difficulty in ascertaining the composition of the irons experimented upon, in consequence of many of the manufacturers being unwilling to give information; added to this, it is well known that in more recent experiments, one of the strongest irons in Yorkshire has been placed in the scale of strength so much below other iron, long since known to be no stronger, both irons being made from the same coal and ironstone, a fence only parting the mineral fields of each work, that I am driven to the conclusion that the object of the experiments in question has in a great measure been defeated. There are, however, some experiments in them, which may not have been affected in their results by these circumstances, two of which I shall point out for your consideration.

The first will be that of iron from two works using the same materials.

Elsecar iron (cold blast) mean ratio of its strength	1000
Milton iron (hot blast) mean ratio of its strength	809
Elsecar iron mean ratio of power to resist impact	1000
Milton do do do do	858

In this case, however, the difference is much greater than appears on the face of these experiments, inasmuch as the specimens of pig iron from the Milton Works were made with the addition of a portion of the red hematite iron ore from Ulverstone, for the express purpose of giving greater strength to that iron, as was invariably done many years for the purpose of making tin plate, and during the war for the casting of cannon.

The second circumstance is that where Mr. Fairbairn states that in a trial of 50 sorts of iron, of which each bar[4] of hot and cold blast iron were made of the same materials, and under the same circumstances.

Cold blast iron, with a load of 892 lb. increased the deflection in 108 days from 1·786 to 1·848 inches.

Hot blast iron do. do 1·891 to 1·966 inches.

Cold blast iron with a load for 448 lb. continued to increase in deflection, and ultimately broke, after sustaining the weight 35 days.

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[4] I take this to mean each pair of bars.

All the hot blast iron bars broke in the act of loading them with the above weight 448 lb.

Notwithstanding these and many similar facts brought out by the experiments in question, certain portions of them are constantly being quoted through the press for the purpose of proving that iron made by hot air is stronger than that produced by the use of cold air.

Contemporary with these experiments on a small scale, others of far greater importance have been going on; and we hear of hundreds of railway chairs, cast from iron made by the improved process, constantly breaking where tens only broke before,[4] of steam engines and other valuable machinery breaking in rapid succession, and in parts where, by regular work, they were never known to give way before the introduction of the improved iron—of the more respectable portion of mill-wrights being obliged to make new calculations, and a new stock of patterns, in order to lessen, as far as is in their power, the enormous losses and the great disappointment of their friends by such breakages. We hear of districts of coal masters and other prudent and humane proprietors of large establishments indroducing clauses in their contracts for castings, stipulating that no hot blast iron shall be used therein; and at length the same has become common in contracts for gas and other pipes, which it has hitherto been usual to make of the most inferior quality of irons, it having been found that the sockets of some miles of piping have been broken off in one or two years after being laid down, in consequence of their having been made of hot blast iron.

There has, however, still more recently been a series of experiments made, upon which a far greater dependence may be placed, inasmuch as the irons were all supplied in the regular way of business, without the makers knowing any such experiments were intended; and they were undertaken for the purpose of information only, to guide the founder and engineer who conducted the operations at his own establishment. The detail of these valuable trials by Mr. Todd, of Leeds, formed a paper read before this Society when last it met at Leeds; I need not therefore occupy your time with repeating them, and here, will only call your attention to a few of the results, for the purpose of more clearly explaining what I wish particularly to impress on your notice.[5]

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[4] In a paper recently read before the Institution of Civil Engineers, Mr. Macneill states that on the Dublin and Drogheda Railway, where chairs were used made of hot blast iron from Scotland, the breakage was very great as compared with those on the South Eastern Railway, which were made of cold blast iron, and that in his opinion the latter would be cheaper than the former at an increased price of 4*l.* per ton.

[5] They took place from August, 1840, to February, 1841.

		Breaking weight cwt.	qr.
Bierley pig iron, No. 3, made with cold blast	average	25	2

With respect to the strength of bar iron made from hot blast pig iron, very few experiments have been made public that I am aware of; they are, however, of very great importance, because they were made with the greatest possible care, and regardless of expense, by manufacturers of the first eminence and ability for their private information. The irons were eight in number; the first set of bars were 2¼ inches in diameter, made with cold blast scraps and hot blast respectively, all by Yorshire manufacturers. The weight required to draw them asunder by a steady direct tension was not very variable, but when all were cut round to the same depth, for the purpose of being broken with the hammer, they required about the following blows to do so:—

	Blows
Cold blast iron - - - - - - -	6
Scrap - - - - - - -	3
Hot blast - - - - - - -	1

The second and third set of bars you have now before you, the result of experiments on which stand thus:

	Diam. of bar. in.	Area of sec. where cut.	Blows required to break them with a 17lb. hammer.
Low Moor cold blast	2·66	3·976	18
Bierley cold blast	2·75	4·430	18
Milton hot blast	2·75	4·430	3
			Blows required to break them with a 20 lb. hammer.
Elsecar cold blast	2·58	3·976	21
Milton hot blast	2·58	4·203	1½

Made from the same materials.

So that the proportionate resistance of hot blast wrought iron to *impact* is still less than that of cast iron. I need scarcely say, cold blast iron was ordered at probably 6*l.* per ton more than the hot blast iron might have been bought for.

I may here take leave to mention the circumstance of scrap iron being any thing now but what it was formerly, when its name and

		Brought forward,		25 2
Elsecar do.	3,	do	do	24 0
Low Moor do.	3,	do	do	23 2
Summerlee (Scotch)	3,	hot blast	do	17 2
Level Staffordshire	3,	do	do	16 0
Mixed pig iron	3,	5 parts Low Moor, 1 part Elsecar	do	30 0
Mixed pig iron	3,	5 parts Bierley, 1 part Elsecar	do	33 0
Mixed pig iron	3,	equal parts Bierley, Elsecar, Low Moor, Staffordshire, (Cylinder iron in the market,) and also, Summerlee	do	20 2

excellent quality were synonymous. In former times the importation of scraps from the continent of Europe took place to a very considerable extent, all of which were manufactured in this country into bars, sheets, etc.; and from the circumstance of these scraps, being all of charcoal iron, the bars, etc., so made, could not but deserve the good name they acquired and long maintained. The flow of scraps into England has, however, long since ceased, and the exportation from this country having become a considerable trade, it follows, of course, that scrap iron now must be made from our own scraps; and when it is remembered how small a proportion of good iron to bad has for many years been made here, bars, etc., manufactured from them cannot but be of very irregular and dubious quality, hence it is that the best scrap iron cuts so poor a figure when compared with a well made iron from known good minerals.

The remarks I have made are in reference to irons of known good quality, but I am ready, and have pleasure in admitting that the use of hot air has been of very great advantage at those iron works whose produce had not a first-rate name, by enabling their proprietors to make it at a less cost, without a proportionate deterioration in quality; and there are some few works whose iron, made with cold blast, was so bad, that any change could not be but for the better. There is also at present a strong impression that iron cannot be made with anthracite coal only, but with hot air, and that iron so made is better than any other. The goodness of its quality is, however, due to the great purity of that coal. But even here we are told, in a paper read before the Polytechnic Society of Cornwall, by a gentleman of great practical skill, that iron made with such proportions of anthracite coal and coke as enabled him to use cold blast, became much weaker on his using hot air, all other circumstances being the same.

My apology in troubling you so far must be in the importance of the subject, and the daily increasing importance to society of the strength of that material by which the locomotive power is applied that so rapidly conveys a very large portion of the human race both by land and sea. When we are about to purchase a horse which is to convey ourselves and families at the moderate rate of 8 or 10 miles an hour, with what inherent caution our first object is to examine his knees, to ascertain his safety! In the steam-engine we are prevented taking this precaution, and yet in travelling three times as fast, our risk is in very much greater proportion. Now in this fast travelling it must not be forgot that in the engines which convey us there are two cylinders, and at least 280 returns of the piston, and therefore there are 280 precussions each minute of 9,240lb. pressure in the power itself, and also the tires of about 42 wheels and axles in each train, passing over a joint of the rails every 5 yards of our journey, the percussions of which are very sensibly felt, with numberless others of minor effect, by which it will be at once seen of what inestimable importance it is that all iron used for such purposes should not only be strong, but be so under percussion; for I need only remind you that it is more than probable, should any one of the numerous parts give way, by any one of the many percussions they have to sustain, that an accident of the most calamitous nature would be the result.

With this view of the subject I may probably be excused, if I so far further trespass on your patience as at least to endeavor to point out a duty which the public only can perform for itself, namely, to take especial care that the needful protection is given to that class of iron makers whose first care it is to maintain its utmost strength regardless of the expense of doing so. And in order that it may be understood how far such protection is required, the following statement should be made known. In the year 1830 the total quantity of pig iron made in Great Britain was about 653,500 tons. In 1840 the make had increased to 1,396,400 tons; and although the stock of pig iron at the latter date was very small, the price of No. 1 had declined since the use of hot air from 8*l.* 5*s.* in 1836, to 5*l.* 5*s.* per ton in 1842 for cold blast iron; and from 7*l.* 5*s.* to 3*l.* 12*s.* 6*d.* per ton for hot blast iron,[7] although the workmen's wages throughout that period were rather higher, which item forms nearly 75 per cent., of the cost, from which circumstance it has been very fairly concluded, that the price of the best pig iron made has been brought down at least 30*s.* per ton lower than it would otherwise have been by the badness of trade generally, had not the use of hot air been introduced in its manufacture.

In addition to the observations I have already made on this subject, I may refer to the price current of the present day, and those who do so will see the price of cold blast pig iron in South Wales stand at 3*l.* 10*s.* per ton for No. 1; hot blast pig iron in the Clyde, 2*l.* 10*s*, per ton for No. 1; and, upon the whole, it seems this case may now be thus summed up, that—

	per ton
The saving in the make of pig iron by the use of hot blast may (generally speaking) be	£0 12 6
Deteriorated value of such iron in the general market	1 0 0
Deteriorated value in the Yorkshire district	1 12 6
Deteriorated value of castings made of such iron, in the simple article of railway chairs, as reported to the Institution of Civil Engineers, on the 1st day of March last, by one of their own body, of the first eminence, and of very great experience in such matters	4 0 0
Deteriorated value of wrought iron when manufactured from pig iron so made, in the market	6 0 0

Indeed, of the last-named iron, engineers and intelligent manufacturers are agreed, and the experiments I have before referred to, show that 6*l.* per ton is far too little a deterioration for bar-iron of such a quality, and particularly when we reflect how very much bar (and other) iron has now to do with the personal safety of millions of our fellow-creatures.—*Barnborough Hall, near Rotherham.*

[7] I have been informed that No. 1 hot blast iron has been delivered in Leeds for 3*l.* 2*s.* 6*d.* per ton, the average of former years being 9*l*, 10*s.* per ton for No. 1 cold blast pig iron.

We need offer no apology to our readers for the length of the following article. The great interest attached to the Telegraph of Professor Morse and the vast utility which will result from its introduction renders the subject particularly interesting to the Profession as in course of time we hope to find it among the necessary equipage of a Railroad.

The History of his invention by Professor Morse is particularly worthy of perusal.

ELECTRO-MAGNETIC TELEGRAPHS.

December 30, 1842.

Mr. Ferris, from the Committee on Commerce, made the following

REPORT.

That they regard the question, as to the general utility of the telegraphic system, settled by its adoption by the most civilized nations; and experience has fully demonstrated the great advantages which may be derived from its use. Its capability of speedily transmitting intelligence to great distances, for national defence, and for other purposes, where celerity is desirable, is decidedly superior to any of the ordinary modes of communication in use. By it, the first warning of approaching danger, and the appearance of hostile fleets and armies on our coasts and borders, may be announced simultaneously at the most distant points of our widely-extended empire, thus affording time and opportunity for concentrating the military force of tho country, for facilitating military and naval movements, and for transmitting orders suitable to the emergency.

In the commercial and social affairs of the community, occasions frequently arise, in which the speedy transmission of intelligence may be of the highest importance for the regulation of business transactions, and in relieving the anxious solicitude of friends, as to the health and condition of those in whose fortunes they feel an interest.

The practicability of establishing telegraphs on the electric principle is no longer a question. Wheatstone, of London, and his associates, have been more fortunate than our American inventor, in procuring the means to put his ingenious system into practical use for two or three hundred miles, in Great Britain; and the movements of the cars on the Blackwall railroad are at this time directed with great economy, and perfect safety to life and property, by means of his magnetic needle telegraph. If a system more complicated and less efficient than the American telegraph is operated for great distances in England, with such eminent success and advantage, there can be no reasonable doubt that, if the means be furnished for putting in operation the system of Professor Samuel F. B. Morse, of New York, the original inventor of the electro-magnetic telegraph, the same, if not greater success, will be the result. Your committee are of opinion that it is but justice to Professor Morse, who is alike distinguished for his attainments in science and excellence in the arts of design, and who has patiently devoted many years of unremitting study, and freely spent his private fortune, in inventing and bringing to perfection a system of telegraphs which is calculated to advance the scientific reputation of the country and to be eminently useful, both to the Government and the people, that he should be furnished with the means of competing with his European rivals.

Professor Morse bases his system upon the two following facts in science:

First. That a current of electricity will pass to any distance along a conductor connecting the two poles of a voltaic battery or generator of electricity, and produce visible effects at any desired points on that conductor.

Second. That magnatism is produced in a piece of soft iron (around which the conductor, in its progress, is made to pass) when the electric current is permitted to flow, and that the magnetism ceases when the current of electricity is prevented from flowing. This current of electricity is produced and destroyed by breaking and closing the galvanic circuit at the pleasure of the operator of the telegraph, who in this manner directs and controls the operation of a simple and compact piece of mechanism, styled the register, which, at the will of the operator at the point of communication, is made to record, at the point of reception, legible characters, on a roll of paper put in motion at the same time with the writing instrument. These characters the inventor has arranged into a conventional *alphabet*, which is contained in the letter appended to this report, and which is capable of being learned and used with very little practice.

Professor Morse has submitted his telegraphic plan to the severe scrutiny of European criticism; and the Academy of Sciences, of Paris, the highest scientific tribunal in the world, hailed it with enthusiasm and approbation, when its operation was exhibited, and its principles explained by their distinguished perpetual secretary, M. Arago.

It appears, from documents produced by Professor Morse, that the thanks of several learned bodies in France were voted to him for his invention, and the large medal of honor was awared to him by the Academy of Industry. It further appears, that several other systems of telegraphs on the electric plan (among which were Wheatstone's, of London, Steinheil's, of Munich, and Masson's, of Caen) had been submitted at various times for the consideration of the French Government, who appointed a commission to examine and report on them all, at the head of which commission was placed the administrator-in-chief of the telegraphs of France, (M. Foy,) who, in a note to Professor Morse, thus writes:

"I take a true pleasure in confirming to you in writing that which I have already had the honor to say to you vivé voce—that I have prominently presented to Monsieur the Minister of the Interior your electro-magnetic telegraph, as being the system which presents the best chance of a practical application; and I have declared to him that, if some trials are to be made with electric telegraphs I do not hesitate to recommend that they should be made with your apparatus."

Your committee, in producing further evidence of the approbation by the scientific world of the system of Professor Morse, would cite the letter of Professor Henry, of Princeton College, well known for his eminent attainments in electrical science, (marked A,) in the appendix of this report.

More recently, a committee, consisting of some of our most distinguished scientific citizens, was appointed by the American Institute of New York to examine and report upon this telegraph, who made the report (B) in the appendix. In compliance with the recommendation of this report, the Institute awarded to Professor Morse the gold medal.

Besides the evidence these testimonials furnish of the excellence of Professor Morse's system, your committee, as well as the greater part of the members of both Houses of Congress, have had a practical demonstration of the operation of the electro-magnetic telegraph, and have witnessed the perfect facility and extraordinary rapidity with which a message can be sent by means of it from one extremity of the Capitol to the other. This rapidity is not confined in its effects to a few hundred feet, but science makes it certain that the same effects can be produced, at any distance on the globe, between any two given points connected by the conductors.

Your committee have alluded to other electric telegraphs; for, as is not uncommon in the birth of great inventions, scientific minds have, at nearly the same period of time, in various parts of Europe conceived and planed electric telegraphs; but it is a matter of national pride, that the invention of the *first electro-magnetic telegraph*, by Professor Morse, as well as the *first conception* of using electricity as the means of transmitting intelligence, by Doctor Franklin, is the offspring of American genius.

Your committee beg leave to refer to the letter of Prof. Morse, (marked C,) in the appendix, to C. G. Ferris, one of the committee giving, at his request, a brief history of the telegragh since it was before Congress, in 1838, for some interesting information concerning it, and for Professor Morse's estimate of the probable expense of establishing his system of telegraphs for thirty or forty miles.

They would also refer to the House document No. 15, (December 6, 1837,) and to House report No. 753, (April 6, 1838,) for valuable information on the subject of telegraphs.

Your committee invite special attention to that part of Professor Morse's letter which details the plan of a *revenue* which may be derived from his telegraphic system, when established to an extent sufficient for the purposes of commercial and general intelligence. From these calculations, made upon safe data, it is probable that an income would by derived from its use by merchants and citizens more than sufficient to defray the interest of the capital expended in its establishment. So inviting, indeed, are the prospects of profit to individual enterprise, that it is a matter of serious consideration, whether the Government should not, on this account alone, seized the present opportunity of securing to itself the regulation of a system which, if monopolized by a private company, might be used to the serious injury of the Post Office Department, and which could not be prevented without such an interference with the rights of the inventor and of the stockholders as could not be sustained by justice or public opinion.

After the ordeal to which the electro-magnetic telegraph system has been subjected, both in Europe and in America, and the voice of the scientific world in its favor, it is scarcely necessary for your committee to say that they have the fullest confidence in Professor Morse's plan; and they earnestly recommend the adoption of it by the Government of the United States. They deem it most fortunate that no definite system of telegraphs should hitherto have been adopted by the Government, since it enables them to establish this improved system, which, in the opinion of your committee, is decidedly superior to any other now in use, possessing an advantage over telegraphs depending on vision, inasmuch as it may be used both by night and day, in all weathers, and in all seasons of the year, with equal convenience; and also, possessing an advantage over electric telegraphs heretofore in use, inasmuch as it records, in permanent legible characters on paper, any communication which may be made by it, without the aid of any agent at the place of recording, except the apparatus which is put in motion at the point of communication. Thus, the recording apparatus, called the register, may be left in a closed chamber, where it will give notice of its commencing to write by a bell, and the communication may be found on opening the apartment. Possessing these great advantages, and the means of communication not being liable to interruption by the ordinary contingencies which may impede or prevent the successful action of other telegraphs, the advantages to be derived from it will soon be apparent to the community, and it will become the successful rival of the Post Office, when celerity of communication is desired, and create a revenue from which this system of telegraphs may be extended and ramified through all parts of the country, without imposing any burden upon the people or draughts on the Treasury, beyond the outlay for its first establishment.

As a first step towards the adoption of this system of telegraphy by the Government, your committee recommend the appropriation of thirty thousand dollars, to be expended under the direction of the Postmaster General, in constructing a line of electro-magnetic telegraphs, under the superintendance of Professor Samuel F. B. Morse, of such length and between such points as shall fully test its practicability and utility; and for this purpose they respectfully submit the following bill:

A BILL to test the practicability of establishing a system of electro-magnetic telegraphs by the United States.

Be it enacted by the Senate and House of Representatives of the United States in Congress assembled, That the sum of thirty thousand dollars be, and is hereby, appropriated, out of any moneys in the Treasury not otherwise appropriated, for testing the capacity and usefulness of the system of electro-magnetic telegraphs invented by Samuel F. B. Morse, of New York, for the use of the Government of the United States, by constructing a line of said electro-magnetic telegraphs, under the superintendence of Professor Samuel F. B. Morse, of such length and between such points as shall fully test its practicability and utility; and that the same shall be expended under the direction of the Postmaster General, upon the application of said Morse.

Sec. 2. *And be it further enacted,* That the Postmaster General be, and he is hereby, authorized to pay, out of the aforesaid thirty thousand dollars, to the said Samuel F. B. Morse, and the persons employed under him, such sums of money as he may deem to be a fair compensation for the services of the said Samuel F. B. Morse, and the persons employed under him, in constructing and in superintending the construction of the said line of telegraphs authorized by this bill.

A.

Princeton College, February 24, 1842.

My Dear Sir:—I am pleased to learn that you have again petitioned Congress in reference to your telegraph, and I most sincerely hope that you will succeed in convincing our Representatives of the importance of the invention. In this you may, perhaps, find some difficulty, since, in the minds of many, the electro-magnetic telegraph is associated with the various chimerical projects constantly presented to the public, and particularly with the schemes, so popular a year or two ago, for the application of electricity as a moving power in the arts. I have asserted, from the first, that all attempts of this kind are premature, and made without a proper knowledge of scientific principles. The case is, however, entirely different in regard to the electro-magnetic telegraph. *Science is now fully ripe for this application,* and I have not the least doubt, if proper means be afforded, of the perfect success of the invention.

The idea of transmitting intelligence to a distance by means of electrical action has been suggested by various persons, from the time of Franklin to the present; but until within the last few years, or since the principal discoveries in electro-magnetism, all attempts to reduce it to practice were necessarily unsuccessful. The mere suggestion, however, of a scheme of this kind is a matter for which little credit can be claimed, since it is one which would naturally arise in the mind of almost any person familiar with the phenomena of electricity; but the bringing it forward at the proper moment, when the developments of science are able to furnish the means of certain success, and the devising a plan for carrying it into practical operation, are the grounds of a just claim to scientific reputation as well as to public patronage.

About the same time with yourself, Professor Wheatstone, of London, and Dr. Steinheil, of Germany, proposed plans of the electro-magnetic telegraph, but these differ as much from yours as the nature of the common principle would well permit; and unless some essential improvements have lately been made in these European plans, I should prefer the one invented by yourself.

With my best wishes for your success, I remain, with much esteem, yours, truly, JOSEPH HENRY.

Professor MORSE.

B.

ELECTRO-MAGNETIC TELEGRAPH.

NEW YORK, September 12, 1842.

The undersigned, the committee of arts and sciences of the American Institute, respectfully report:

That, by virtue of the power of adding to their numbers, they called to their aid the gentlemen whose names are hereunto annexed, with those of the original members of the committee, and proceeded to examine Professor Morse's electro-magnetic telegraph.

Having investigated the scientific principles on which it is founded, inspected the mechanism by which these principles are brought into practical operation, and seen the instruments in use in the transmission and return of various messages, they have come to the conclusion that it is admirably adapted to the purposes for which it is intended, being capable of forming words, numbers, and sentences, nearly as fast as they can be written in ordinary characters, and of transmitting them to great distances with a velocity equal to that of light. They therefore beg leave to recommend the telegraph of Professor Morse for such testimonials of the approbation of the American Institute as may in its judgment be due to a most important practical application of high science, brought into successful operation by the exercise of much mechanical skill and ingenuity.

All which is respectfully submitted,

JAMES RENWICK, L. L. D.,
Prof. Chem. and Nat. Phil., Columbia Coll. N. Y.
JOHN W. DRAPER, M. D.,
Prof. Chem. and Min., University, city of New York,
WILLIAM H. ELLET, M. D.,
Prof. Chem. etc., Coll. of Columbia, S. C.,
JAMES R. CHILTON, M. D.,
G. C. SCHAEFFER,
EDWARD CLARK,
CHARLES A. LEE, M. D.

Extract from the minutes of the Institute;

Resolved, That the report be accepted, adopted, and referred to the premium committee, and that the recording secretary be directed to publish the same, at the expense of the Institute.

C.

New York, December 6, 1842.

Dear Sir:—In compliance with your request, I give you a slight history of my electro-magnetic telegraph, since it was presented for the consideration of Congress, in the year 1838.

During the session of the 25th Congress, a report was made by the Committee on Commerce of the House, which concluded by unanimously submitting a bill appropriating $30,000 for the purpose of testing my system of electro-magnetic telegraphs. The pressure of business at the close of that session prevented any action being taken upon it.

Before the session closed, I visited England and France, for the double purpose of submitting my invention to the test of European criticism, and to secure to myself some remuneration for my large expenditures of time and money in elaborating my invention. In France, after a patent had been secured in that country, my telegraph first attracted the attention of the Academy of Sciences, and its operation was shown, and its principles were explained, by the celebrated philosopher, Arago, in the session of that distinguished body of learned men on September 10, 1838. Its reception was of the most enthusiastic character. Several other Societies, among which were the Academy of Industry and the Philotechnic Society, appointed committees to examine and report upon the invention, from all which I received votes of thanks, and from the former the large medal of honor. The French Government at this time had its attention drawn to the subject of electric telegraphs, several systems having been presented for its consideration, from England, Germany, and France. Through the kind officers of our minister at the French Court, General Cass, my telegraph was also submitted; and the Minister of the Interior (M. Montalivet) appointed a commission, at the head of which was placed M. Alphonse Foy, the administrator-in-chief of the telegraphs of France, with directions to examine and report upon all the various systems which had been presented. The result of this examination (in which the ingenious systems of Professor Wheatstone, of London, of Professor Steinheil, of Munich, and Professor Masson, of Caen, passed in review) was a report to the Minister in favor of mine. In a note addressed to me by M. Foy, who had expressed his warmest admiration of my telegraph in my presence, he thus writes:

"I take a true pleasure in confirming to you in writing that which I have already had the honor to say to you viva voce, that I have prominently presented (signale) to Monsieur the Minister of the Interior your electro-magnetic telegraph, as being the system which presents the best chance of a practical application; and I have stated to him that if some trials are to be made with electric telegraphs, I hesitate not to recommend that they should be made with your apparatus."

In England, my application for a patent for my invention was opposed before the Attorney General, by Professor Wheatstone and Mr. Davy, each of whom had systems already patented, essentially like each other, but very different from mine. A patent was denied me by the Attorney General, Sir John Campbell, on a plea which I am confident will not bear a legal examination. But there being no appeal from the Attorney General's decision, nor remedy, except at enormous expense, I am deprived of all benefit from my invention in England. Other causes than impartial justice evidently operated against me. An interest for my invention, however, sprung up voluntarily, and quite unexpectedly, among the English nobility and gentry in Paris, and, had I possessed the requisite funds to prosecute my rights before the British Parliament, I could scarcely have failed to secure them, so powerfully was I supported by this interest in my favor; and I should be ungrateful did I not take every opportunity to acknowledge the kindness of the several noblemen and gentlemen who volunteered to aid me in obtaining my rights in England, among the foremost of whom were the Earl of Lincoln, the late celebrated Earl of Elgin, and the Hon. Henry Drummond.

I returned to the United States in the spring of 1839, under an engagement entered into in Paris with the Russian Counsellor of State, the Baron Alexandre de Meyendorff, to visit St. Petersburg with a distinguished French savan, M. Amyot, for the purpose of establishing my telegraphic system in that country. The contract formally entered into, was transmitted to St. Petersburg, for the signature of the Emperor, which I was led to believe would be given without a doubt; and, that no time should be lost in my preparations, the contract, duly signed, was to be transmitted to me in New York, through the Russian ambassador in the United States, in four or five weeks, at farthest, after my arrival home.

After waiting, in anxious suspense, for as many months, without any intelligence, I learned *indirectly* that the Emperor, from causes not satisfactorily explained, refused to sign the contract.

These disappointments, (not at all affecting the scientific or practical character of my invention,) combined with the financial depression of the country, compelled me to rest a while from further prosecuting my enterprise. For the last two years, however, under many discouraging circumstances, from want of the requisite funds for more thoroughly investigating some of the principles involved in the invention, I have, nevertheless, been able to resolve all the doubts that lingered in my own mind, in regard to the perfect practicability of establishing my telegraphic system to any extent on the globe. I say, "doubts that lingered in my own mind;" the principal, and, indeed, only one of a scientific character, which at all troubled me, I will state, and the manner in which it has been resolved:

At an early stage of my experiments, I found that the magnetic power produced in an electro-magnet, by a single galvanic pair, diminished rapidly as the length of the conductors increased. Ordinary reasoning on this fact would lead to a conclusion fatal to the whole invention, since at a great distance I could not operate at all, or, in order to operate, I should be compelled to make use of a battery of such a size as would render the whole plan in effect impracticable. I was, indeed, aware that by multiplying the pairs in the battery—that is, increasing the intensity or its propulsive power—certain effects could be produced at great distances, such as the decomposition of water, a visible spark, and the deflection of the magnetic needle. But as magnetic effects, except in the latter case, had not to my knowledge been made the subject of careful experiment, and as these various effects of electrical action seemed in some respects, to be obedient to different laws, I did not feel entirely assured that magnetism could be produced by a multiplication of pairs sufficiently powerful at a great distance to effect my purpose. From a series of experiments which I made, in conjunction with Professor Fisher, during the last summer, upon 33 miles of wire, the interesting fact, so favorable to my telegraphic system, was fully verified, that *while the distance increased in an arithmetical ratio, an addition to the series of galvanic pairs of plates increased the magnetic power in a geometric ratio.* Fifty pairs of plates were used as a constant power. Two miles of conductors at a time, from two to thirty-three, were successively added to the distance. The weight upheld by the magnet from the magnetism produced by 50 pairs gradually diminished up to the distance of 10 miles; after which, *the addition of miles of wire up to 33 miles* (the extent to which we were able to try it) *caused no further visible diminution of power.* The weight then sustained was a constant quantity. The practical deduction from these experiments is the fact that with a very small battery all the effects I desire, and at any distance, can be produced. In the experiments alluded to, the fifty pairs did not occupy a space of more than 8 cubic inches, and they comprised but 50 square inches of active surface.

The practicability of establishing my telegraphic system is thus relieved from all scientific objections.

Let me now turn your attention, sir, one moment to a consideration of the telegraph as a source of revenue. The imperfections of the common systems, particularly their uselessness, on account of the weather, three-quarters of the time, have concealed from view so natural a fruit of a perfected telegraphic system. So uncertain are the common telegraphs as to time, and so meager in the quantity of intelligence they can transmit under the most favorable circumstances, that the idea of making them a source of revenue would not be likely to occur. So far, indeed, from being a source of revenue, the systems in common use in Europe are sustained at great expense; an expense which, imperfect as they are, is justified in the view of the Government, by the great political advantages which they produce. Telegraphs with them are a Government monopoly, and used only for Government purposes. They are in harmoney with the genius of those Governments. The people have no advantage from them, except indirectly as the Government is benefited. Were our mails used solely for the purposes of the Government, and private individuals forbidden to correspond by them, they would furnish a good illustration of the operation of the common European telegraphic system.

The electro-magnetic telegraph, I would fain think, is more in consonance with the political institutions under wich we live, and is fitted, like the mail system, to diffuse its benefits alike to the Government and to the people at large.

As a source of *revenue*, then, to the Government, few, I believe, have seriously computed the great profits to be derived from such a system of telegraphs as I propose; and yet there are sure data already obtained by which they can be demonstrated.

The first fact is, that every minute of the 24 hours is available to send intelligence.

The second fact is, that 12 signs, at least, can be sent in a minute, instantaneously, as any one may have proof by actual demonstration of the fact on the instrument now operating in the Capitol.

There can be no doubt that the cases, were such speedy transmission of intelligence from one distant city to another is desirable are so numerous, that, when once the line is made for such transmission, it will be in constant use, and a demand made for a greater number of lines.

The paramount convenience, to commercial agents and others, of thus corresponding at a distance, will authorise *a rate of postage proportionate to the distance*, on the principle of rating postage by the mails.

To illustrate the operation of the telegraph in increasing the revenue, let us suppose that but 18 hours of the 24 are efficiently used for the actual purposes of revenue; that 6 hours are allowed for repetitions and other purposes, which is a large allowance. This would give, upon a single circuit, 12,960 signs per day, upon which a rate of postage is to be charged. Intelligence of great extent may be comprised in a few signs. Suppose the following commercial cummunication is to be transmitted from New York to New Orleans.

Yrs., Dec, 21, rec. Buy 25 bales c., at 9, and 300 pork, at 8.

Here are 36 signs, which take three minutes in the transmission from New York to New Orleans, and which informs the New York merchant's correspondent at New Orleans of the receipt of a certain document, and gives him orders to purchase 25 bales of cotton at 9 cents per pound, and 300 barrels of pork as 8 cents per pound. Thus may be completed, in three minutes, a transaction in business which now would take at least four or five weeks to accomplish.

Suppose that one cent per sign be charged for the first 100 miles, increasing the charge at the rate of half a cent each additional 100 miles, the postage of the above communication would be $2,88 for a distance of 1,500 miles. It would be sent 100 miles for 36 cents. Would any merchant grudge so small a sum for sending such an amount of information in so short a time to such a distance? If time is money, and to save time is to save money, surely such an immense saving of time is the saving of an immense sum of money. A telegraphic line of a single circuit only, from New York to New Orleans, would realize, then, to the Government, *daily*, in the correspondence between those two cities alone, over *one thousand dollars* gross receipts, or over $300,000 per annum.

But it is a well-established fact, that, as facilities of intercourse increase between different parts of the country, the greater is that intercourse. Thousands travel, in this day of railroads, and steamboats, who never thought of leaving their homes before. Estabilsh, then, the means of instantaneous communication between the most distant places, and the telegraphic line of a single circuit will very soon be insufficient to supply the demands of the public—they will require more.

Two circuits will of course *double the facilities, and double the revenue*; but it is an important fact, that the expense of afterwards establishing a second, or any number of circuits, does not proceed on the *doubling* principle. If a channel for conveying a single circuite be made in the first instance of sufficient capacity to contain many more circuits, which can easily be done, additional circuits can be laid as fast as they are called for, at but little more than the cost of the prepared wire. The recent discovery of Professor Fisher and myself shows that a single wire may be made the common conductor for at least six circuits. How many more we have not yet ascertained. So that, to add another circuit is but to add another wire. Fifty dollars per mile, under these circumstances, would therefore add the means of doubling the facilities and the revenue.

Between New York and Philadelphia, for example, the whole cost of laying such an additional circuit would be but $5,000, which would be more than defrayed by *two months'* receipts only from the telegraphs between those two cities.

There are two modes of establishing the line of conductors.

The first and cheapest is doubless that of erecting spars about 30 feet in height and 350 feet apart, extending the conductors along the tops of the spars. This method has some obvious disadvantages. The expense would be from $350 to $400 per mile.

The second method is that of enclosing the conductors in leaden tubes, and laying them in the earth. I have made the following estimate of the cost of this method:

Wire, prepared, per mile	$150 00
Lead pipe, with soldesings	250 00
Delivery of the pipe and wire	25 00
Passing wire into the pipes	5 00
Excavations and filling in about 1,000 yards per mile, or 3 feet deep, at 15 cents per square yard	150 00
Laying down the pipe	3 00
	583 00

One register, with its machinery, comprising a galvanic battery of four pairs of my double-cup battery	$100 00
One battery of 200 pairs	100 00
Expense for thirty-nine miles	$22,737 00
Two registers	200 00
Two batteries	200 00
Services of chief superintendent of construction per annum	2,000 00
Services of three assistants, at $1,500 each per annum	4,500 00
	29,637 00

As experience alone can determine the best mode of securing the conductors, I should wish the means and opportunity of trying various modes, to such an extent as will demonstrate the best.

Before closing my letter, sir, I ought to give you the proofs I possess that the American telegraph has the *priority in the time of its invention.*

The two European telegraphs in practical operation are Professor Steinheil's, of Munich, and Professor Wheatstone's, of London. The former is adopted by the Bavarian Government; the latter is established about 200 miles in England, under the direction of a company in London. In a highly interesting paper on the subject of telegraphs, translated and inserted in the London Annals of Electricity, March and April, 1839, Professor Steinheil gives a brief sketch of all the various projects of electric telegraphs, from the time of Franklin's electrical experiments to the present day. Until the birth of the science of electro-magnetism, generated by the important discovery of Oersted, in 1820, of the action of electric currents upon the magnetic needle the electric telegraph was but a philosophic toy, complicated and practically useless. Let it be here noticed, that, after this discovery of Oersted, the *deflection of the needle* became the principle upon which the savans of Europe based all their attempts to construct an electric telegraph. The celebrated Ampere, in the same year of Oersted's discovery, suggested a plan of telegraphs, to consist of a magnetic needle, and a circuit for each letter of the alphabet and the numerals—making it necessary to have some 60 or 70 wires between the two termini of the telegraphic line.

This suggestion of Ampere is doubtless the parent of all the attempts in Europe, both abortive and successful, for constructing an electric telegraph.

Under this head may be arranged the Baron Schilling's, at St. Petersburg, consisting of 36 magnetic needles, and upwards of 60 metallic conductors, and invented, it seems, at the same date with my electro-magnetic telegraph, in the autumn of 1832. Under the same head comes that of Professor Gauss and Weber, of Gottingen, in 1833, who simplified the plan by using but a single needle and a single circuit. Professor Wheatstone's, of London invented in 1837 comes under the same category; he employs five needles and six conductors. Professor Steinheil's, also invented in 1837, employs two needles and two conductors.

But there was another discovery, in the infancy of the science of electro-magnetism, by Ampere and Arago, immediately consequent on that of Oersted, namely: the electro-magnet, which none of the savans of Europe who have planed electric telegraphs ever thought of applying, until within two years past, for the purpose of signals. My telegraph is essentially based on this latter discovery.

Supposing my telegraph to be based on the same principle with the Europeane lectric telegraphs, which it is not, mine, having been invented in 1832, would still have the precedence, by some months at least, of Gauss and Weber's to whom Steinheil gives the credit of being the first to simplify and make practicable the electric telegraph. But when it is considered that all the European telegraphs make use of the deflection of the needle to accomplish their results and that none use *the attractive power of the electro-magnet to write in legible characters*, I think I can claim, without injustice to others, to be the first inventor of the *electro-magnet telegraph.*

In 1839, I visited London, on my return from France, and through the polite solicitations of the Earl of Lincoln, showed and explained its operation at his house, on the 19th of March, 1839, to a large company, which he had expressly invited for the purpose, composed of Lords of the Admiralty, members of the Royal Society, and members of both Houses of Parliament.

Professor Wheatstone has announced that he has recently (in 1840) also invented and patented an *electro-magnetic telegraph*, differing altogether from his invention of 1837, which he calls his *magnetic-needle telegraph.* His is, therefore, the first European electro-magnetic telegraph, and was invented, as is perceived, eight years subsequent to mine, and one year after my telegraph was exhibited in the public manner described at the Earl of Lincoln's residence in London.

I am the more minute in adducing this evidence of priority of invention to you, sir, since I have frequently been charged by Europeans in my own country with merely imitating long-known European inventions. It is therefore due to my own country, as well as to myself, that in this matter the facts should be known.

Professor Steinheil's telegraph is the only European telegraph that professes to *write* the intelligence. He records, however, by the delicate touch of the needle in its deflections, with what practical effect I am unable to say; but I should think that it was too delicate and uncertain, especially as compared with the strong and efficient power which may be produced in any degree by the electro-magnet.

I have devoted many years of my life to this invention, sustained in many disappointments by the belief that it is destined eventually to confer immense benefits upon my country and the world.

I am persuaded that whatever facilitates intercourse between the different portions of the human family will have the effect, under the guidance of sound moral principles, to promote the best interests of man. I ask of Congress the means of demonstrating its efficiency.

I remain, sir, with great respect, your most obedient servant,

SAMUEL F. B. MORSE.

HON. CHARLES G. FERRIS,

Member of the House of Representatives from the city of New York, and one of the Committee on Commerce, to whom was referred the subject of the expediency of adopting a system of electro-magnetic telegraphs for the United States.

The following is the alphabet for Morse's electro-magnetic telegraph:

ALPHABET		NUMERALS	
A	· —	1	· — — ·
B	— · ·	2	· · — · ·
C	· · ·	3	· · · — ·
D	— · ·	4	· · · · —
E	·	5	— — —
F	· — ·	6	· · · · · ·
GJ	— — ·	7	— — · ·
H	· · · ·	8	— · · · ·
IY	· ·	9	— · · —
K	— · —	0	———
L	———		
M	— —		
N	— ·		
O	· ·		
P	· · · · ·		
Q	· · — ·		
R	· · ·		
SZ	· · ·		
T	—		
U	· · —		
V	· · · —		
W	· — —		
X	· — ·		

FOOD OF GARDEN PLANTS.

It is obvious that a cabbage, a pine apple, or a primrose, can no more live without a due supply of food, than a rabbit or a canary bird; but animals must moreover have a peculiar kind of food; the rabbit, greens and oats; and the canary, rape, millet, or other small seeds; while in the case of plants, which are fixed to a spot and cannot travel about to select their food, such differences, when they do exist, are not often of practical importance, the food of all plants being nearly, for far as it is known, very similar in kind.

The principal difference in most garden plants compared with others is their greater delicacy; and hence, so far as practice is concerned, their food must require if I may use the term, more delicate and refined *cooking*, and management. This will appear as we proceed, in the several branches into which it will he advantageous to divide our subject, beginning with what may be termed Garden Chemistry, meaning thereby a detail of the chemical elements which enter into the food of garden plants.

Garden Chemistry.—Passing over, for the present, the food on which young plants are nourished at their first germinating from seed, which is as different, as we shall afterwards see, as the milk diet of our own infancy is from beef and bread,—let us consider the food requisite for plants after they have exhaustod the milky pulp contained in the seed lobes and seed leaves.

After young animals are weaned, they are nourished upon either vegetable or animal substances, or a mixture of both, together with water for drink, that is, a solvent to dissolve the more solid matters. These have to undergo the process of digestion in the stomach, where the heat is uniformly ninety-eight degrees, and the mixture of the various substances effected by the motion of the stomach, which is similar to that of an earth-worm. On the pulpy mass thus produced in the stomach passing onwards into the chyle-gut, it is mixed with a portion of bile which separates it into two portions, —one useless, that passes off through the bowels, and another useful which is taken up by the mouths of innumerable small tubes that open on the inner surface of the intestines, and after all these small tubes unite into a single large one, they discharge this useful portion into the blood. Such, in brief, are the first processes by which animals are nourished with food.

Plants, on the other hand, having no stomach, like animals, for the digestion of food, and not being capable of travelling from the spot where they are planted, (except very partially by extending their roots,) must depend altogether on what they can meet with there.

We find, accordingly, in the surface earth, or soil where the roots of plants are, that processes are always going on very similar to digestion in the animal stomach; I mean, that portions of animal and vegetable substances in the soil are dissolved (I might in one sense say digested) and mixed with the water and air diffused through the soil.

In this point of view, the whole of the soil where a plant is rooted, may be considered as similar to the mass produced in the animal stomach by the first process of digestion, and consisting of two portions, one useful and the other useless. The soil would thence appear to perform an office, similar to that of the animal stomach, in preparing the food of plants,—the process, independent of other circumstances, going on more slowly from deficiency of heat in the soil, which in this climate at least, is, on an average, far below ninety-eight degrees, which is the heat of the animal stomach.

The only thing in the soil that appears similar to the motions of the bowels of animals, by which the digested food is brought to the mouths of the little tubes, to be forwarded to the blood, is the motion of the water, or moisture in which the useful portion of the vegetable and animal substances are dissolved, a motion quite indispensable, as we shall afterwards see. This water being then diffused through the soil, a portion of it must offer itself to the tips of the root fibres, or rootlets, where are suckers somewhat similar to those on the inner surface of the animal intestines.

It being of the first importance to ascertain of what materials the useful portion of the substances thus dissolved in water consist, many experiments have been made for that purpose: but the great difficulty of the subject has caused much diversity of opinion among those who have engaged in the inquiry. As it would, I think, be unprofitable, if not injurious, to distract the beginner with conflicting views here, which he can examine at leisure in larger works, I shall confine myself to what is least disputed and most generally adopted.

Upon trying, by means of chemical tests, the materials taken up by plants from the soil, they are found to consist of water, with which are mixed carbonic acid gas, and nitrogen or azote, along with a few other principles, usually in small proportions, which it may be well to examine separately.

Water.—From experiments made by Van Helmont and Boyle, who reared plants in earth previously dried in an oven, and by Du Hamel and Bonnet, who reared others upon sponges and moss supplied only with water, it was concluded that water alone is the food of plants; though the inference is faclty, in consequence of overlooking what might be contained in the water before it was used, and also what it might afterwards derive from the atmosphere as well as from the earth or the sponge. That water, indeed is not all the food necessary, was proved by the plants so treated not remaining healthy; and it is well known, that though hyacinths and other bulbs will flower in glasses containing nothing but water yet they never in such cases form seed: and if thus kept for a few months, they will infallibly die, as other plants do when placed in calcined or roasted sand, and watered with distilled water. The hyacinths in glasses, moreover, are not found to thrive unless the water is frequently changed, indicating, that it is not the water alone, but something in the water which has become exhausted, or at least deteriorated, by the slimy matter thrown out by the roots.

The materials, which water holds or may hold disolved, are therefore important to be ascertained, and this may be partially known by color, taste, or smell, but more correctly by chemical tests. It is only, however, requisite for gardening purposes to discover the materials which may prove useful or hurtful, and these, for the most part, are but few in number.

Among the substances useful to vegetation dissolved in the water of soils, may be reckoned atmospheric air, carbonic acid gas, hydrogen gas, humic acid, and a small portion of the salts of lime and potass.

Among the things hurtful are most of the acids, the salts of magnesia and iron, metallic substances in general, and stagnant water.

It is also important to bear in mind, that the purest water is not a simple substance, but composed, as discovered by Cavendish, of eight parts oxygen gas, and one part hydrogen gas, or two volumes of hydrogen and one of oxygen, the correctness of which composition is proved by exploding, or burning these proportions of the two gases together, when the result is pure water. Plants seem to have the power of decomposing the water which enters into their system from the earth or the air; that is, of separating it into its component parts, oxygen and hydrogen.

Atmospheric Air.—All water openly exposed contains more or less of the air of the atmosphere, which consists of two gases, namely, twenty-one parts, by measure, of oxygen, and seventy-nine parts of nitrogen or azote with, in general, about one thousandth part of carbonic acid gas. It is chiefly owing to the atmospheric air, and a little carbonic acid gas, that common water, though said to be tasteless, is agreeable to drink; for when these are expelled by boiling, it taste vapid and unpleasant.

That the air contained in the water which enters into plants is important to vegetation, appears from water being found beneficial in proportion as it has had opportunities of becoming mixed with air. When meadows accordingly are laid under water artificial in the process of irrigation, it is found rather hurtful than beneficial if the water is not kept in motion, but allowed to stagnate.

It is on this account, that the water of rivers which run a long course, is much better for watering than that of springs or lakes, whose waters contain but a small portion of air, though this does not apply so well to the stagnant water of ponds or ditches whose deficiency as to atmospheric air is compensated by the greater portion of carbonic acid and other substances derived from the decaying animal and vegetable substances usually abundant in such places.

The best water however, with respect to the quantity of atmospheric air, is rain, which falling in small drops, often tossed about by the wind, has an opportunity of collecting a large proportion of air during its descent to the earth; and hence, the smaller the bore of the holes in the rose of a garden watering-pot the better.

As water becomes mixed with air by exposure and agitation, so does the air become mixed with water by its rising in vapor, and the driest air accordingly always contains more or less water in the state of invisible vapor. The quantity of this vapor is in proportion to the temperature; and hence, the warmer the air the greater proportion of vapor it contains. A beautiful provision for affording some little refreshment to plants at the very time they exposed to exhaustion in hot weather, the operation of which we shall afterwards see when we come to consider the use of leaves.

Carbon and Carbonic Acid Gas.—Carbon is pure charcoal, which is well known and easily proved to form a large proportion of most vegetable substances,—the oak, for example contains sixty ounces in a cubic foot; consequently the living plant must have the power of deriving it from carbonic acid gas, for it has been proved by the experiments of Sir H. Davy, that the most finely powdered carbon is not taken up by plants in the solid form. Nothing, indeed is more hurtful to plants than smoke, which is carbon mixed with watery vapor: though soot, which is condensed and collected smoke, is useful when spread upon the soil, so that water may derive from it a portion of its gases.

All animal and vegetable substances in a state of fermentation or putrefaction, give out a considerable portion of carbonic acid gas, and if it is not dissipated by heat, but confined on or beneath the surface of the soil, it will become mixed with the moisture there, and be taken up by the spongelets or the roots of plants. A great quantity of carbonic acid is also produced by the breathing of animals and by burning wood, peat, or coal; and being heavier than the air of the atmosphere, it must all descend, in the first instance, to near the surface of the soil, into which much of it must be carried by rains and dews. When it becomes diffused in the air however, its weight has little influence in causing it to descend.

The carbonic acid gas thus mixed with water, and taken up along with it into the system of plants, is there decomposed, as we shall afterwards see, into its constituent parts of oxygen and carbon, part of the oxygen being given off into the air, and the rest with the carbon remaining in the plant, where it goes to form most of the solid parts as well as the nutrient pulp.

The carbonic acid also exists in soils combined with lime, magnesia, iron, and some other substances in the form of carbonates. which are soluble with great difficulty in very small quantities in water, but readily in humic acid, as we shall immediately see.

Nitrogen or Azote.—This gas, as we have already seen, constitutes by much the largest portion of the atmospheric air, and consequently must enter largely into the system of a plant, though it is not found in general to contribute so much to vegetable as it does to animal substances, in all which azote is in considerable proportion.

Azote is found in larger quantity in cabbages, savoys. cauliflower brocoli, sea-kale, turnips, radishes, mustard, and cresses, than in any other garden plants, and it is this which in part produces in these the peculiar acrid taste which most of them possess. It is also a chief ingredient in starch and in the gluten of wheat. It is the nitrogen also, which, escaping from these when boiled, or when in a state of fermentation or decay, is diffused around and produces an odor in general very strong aud disagreeable.

It will follow, that as these plants when healthy, contain much nitrogen it ought in rearing them to be abundantly supplied from its two chief sources—the air and decaying animal substances,—in other words, by free air and animal manure. Though when it is an object, as in the rearing of sea-kale, to render the flavor mild, the supply of nitrogen must for the reason be diminished.