AND

PHILADELPHIA'S SHARE
In Its Early Improvements

BY

JOSEPH HARRISON JR.
Mechanical Engineer

"A NEW DEPARTURE."

Design for a new Locomotive for freight. *By* JOSEPH HARRISON, *Jr.* *Philadelphia*, 1872.

THE

Locomotive Engine,

AND

PHILADELPHIA'S SHARE IN ITS EARLY IMPROVEMENTS.

BY

JOSEPH HARRISON, JR.

Mechanical Engineer.

REVISED EDITION WITH AN APPENDIX.

A Paper read before the members of the Franklin Institute. February 21st, 1872. First published in "The Journal of the Franklin Institute," in March and April, 1872.

PHILADELPLIA:

GEORGE GEBBIE, - - SANSOM STREET,

1872.

WILLIAM P. KILDARE, PRINTER.

PREFACE.

The author of this paper, wishing that Philadelphia and her engineers and mechanics, should have their deserved meed of credit in the development and in the improvement of what must be admitted to be the most important machine of modern times, has brought together in it, facts in relation to the early story of the locomotive engine in Philadelphia which, from 1829 to 1843, came under his own knowledge and supervision. He states nothing that he did not see between these years. From 1843 to the present the story is better known to all, and great as are the improvements that have since been made in the same field, they cannot be deemed so important or interesting as those of the earlier period. No controversy is invited as to when or where or by whom the first locomotive was built and started in the United States; but even in this, if Oliver Evans' claims are admitted, Philadelphia might fairly claim precedence over any other place at home or abroad. It is the permanent practical and useful results that the author insists upon, and when these are justly measured, Philadelphia may well be proud of her high position.

JOSEPH HARRISON, Jr.

Rittenhouse Square,
Philadelphia, February 22, 1872.

TABLE OF CONTENTS.

APPENDIX.

THE LOCOMOTIVE ENGINE

AND

Philadelphia's Share in its Early Improvement.

By Joseph Harrison, Jr.,
Mechanical Engineer.

Some persons care little or nothing for the past. Musty records and old things have no charm for them, and their lives seem centred in the one word, "Now." Perhaps they may be right in their abstract way of viewing the question, and they might well be pardoned for saying *cui bono*.

Others, again, omit nothing in their efforts to explore all that can be possibly reached for record or memorial, telling of the earlier days of the world on which we live, and of the doings of the inhabitants thereof. They never weary in lavishing time, trouble and expense, in following their favorite pursuit, and often are fully repaid, after long and laborious research, in the mere bringing to light of some trifling relic of may be doubtful value, or some record not worth perhaps, the time it has taken to secure it.

In the researches of the antiquary, how little however is brought out of the inner workings of the individual minds which have evolved the beautiful and the practical, in Art, in Science, and in Mechanism, even in comparatively recent days. It is the detail of their work that those interested in the subject so much desire and do not find. They would know the ways and the means, and the chain of reasoning or experiment, whereby these early workers produced the results that are left to us. And how interesting is the little that has come down to our time.

The engineer, noting the curious things in bronze and in copper, exhumed at Pompeii, and gathered together in the Museo Borbonico, at Naples, will linger near a small vessel for heating water, little more than a foot high, in which are combined nearly all the principles involved in the modern vertical steam boiler—fire-box, smoke-flue through the top, and fire-door at the side, all complete;—and strange to say, this little thing has a *water-grate*, made of small tubes crossing the fire-box at the bottom, an idea that has been patented twenty times over, in one shape or another, within the period of the history of the steam engine.

The architect, looking at the faded drawings made many centuries ago, and still serving as a guide in the completion of that ~~epic~~ wonder in stone, the wonderful Cathedral on the banks of the Rhine, at Cologne, is interested not only in the beautiful forms and proportions portrayed in these now dim lines, made by the architect whose name is still preserved to us, but in noting the changes and alterations that mark their gradual approach towards perfection; showing plainly that revision and variation from the original design, was as necessary then as now, if perfection is to be achieved.

There are even still extant in record, if not in drawings, examples of Roman architecture indicating the same slow approach towards a more perfect ending, in the erection of the monuments that now excite our wonder, built to adorn the Capitol of the world more than two thousand years ago.

Knowing what we know, and seeing what we see of improvement and advancement in mechanical and engineering science and art all around us, how interesting it is to look at the first condensing steam engine made by James Watt, and the little locomotive "Rocket," of George and Robert Stephenson, both so carefully preserved in the South Kensington Museum, in London.

The history of a most remarkable machine, now so necessary in our daily wants, had its really useful commencement but forty years ago, and yet much that is exceedingly interesting in the detail of its early introduction and improvement is unknown to this generation, or has already become tradition,—and before many years are passed all those who labored at its beginning, and who only can tell the story of its early progress towards its present perfection from their personal knowledge, will have passed away.

To prevent this loss in part, an effort will be made in the following pages, and without going too much into technical detail, to bring together some facts in connection with the early and very important work of Philadelphia Mechanics and Engineers in the the origination, and in the development of the improvements in the LOCOMOTIVE ENGINÉ. No controversy will be invited as to when or where or by whom the first locomotive was built and started in the United States; but even in this, if Oliver Evans' claims are admitted, Philadelphia might fairly claim precedence over any other place at home or abroad. It is the practical and the permanent useful results that will be insisted upon only, and when these are justly measured, Philadelphia may well be proud of her high position.

The following letter from Chancellor LIVINGSTONE to Col. STEVENS, of Hoboken, fairly represents the public opinion of that time, and is most interesting as a contribution to the history of railroads. It is dated March 2, 1811, and is written from Albany.

"I had before read of your very ingenious proposition as to railway communication. I fear, however, on mature reflection, that they will be liable to serious objections, and ultimately prove more expensive than a canal. They must be double, so as to prevent the danger of two such heavy bodies meeting. The wall on which they are to be placed must be at least four feet below the surface to avoid frost, and three feet above to avoid snow, and must be clasped with iron, and even then would hardly sustain so heavy a weight as you propose moving at the rate of four miles (!) an hour on wheels. As to wood, it would not last a week. They must be covered with iron, and that, too, very thick and strong. The means of stopping these heavy carriages without a great shock, and of preventing them from running on each other, for there would be many running on the road at once—would be very difficult. In case of accidental stops, or necessary stops to take wood and water, &c., many accidents would happen. The carriage of condensing water would be very troublesome. Upon the whole, I fear the expense would be much greater than that of canals, without being so convenient."

In the opening part of an article printed in a supplement to the Encyclopædia Brittanica, 1824, may be found the following: "RAILWAYS.—A species of road or carriage way, in which the track of the carriage wheels being laid with bars or rails of wood, stone or metal, the carriage is more easily drawn over this smooth surface than over an ordinary road." And further, in the same article, after alluding to the early history of railways in Great Britain, and touching on the chief lines then in use, the article continues: "From these accounts of the chief railways in England and Wales, it will appear that this species of inland carriage is principally applicable where trade is considerable, and the length of the conveyance short, and is chiefly useful in transporting the mineral products of the kingdom from the mines to the nearest land or water communication, whether sea, river or canal. Attempts have been made to bring it into more general use, but without success, and it is only in particular circumstances that navigation, with the aid of locks or inclined planes to surmount the elevations, will not present a more convenient medium for an extended trade.

"South Wales, however, presents an example where the trade being great, and also chiefly descending, the country rugged, and the supply of water scant, railways have been adopted with complete success, and have been found, in some cases at least, equal to canals in point of economy and dispatch." After further discussing the topic, the conclusion of the article is as follows: "On some of the railways near Newcastle, the wagons are drawn by a steam engine placed on a wagon by itself, the wheels of which are driven by the engine, and, acting on a rack laid along the railway, impel forward the engine and the attached wagons. In some cases, the wheels of the wagon operate without rack-work, by the mere friction between them and the rail. The steam engines employed for this purpose are of the high-pressure kind, these requiring no condensing apparatus."

"But this application of steam has not yet arrived at such perfection as to have brought it into general use."

When it is considered that but a generation and a half has passed since its publication, the above reads strangely in the light of our present knowledge and experience. It is noteworthy, too, that in the article from which the above extracts have been taken, there is not one word in relation to the transportation of passengers by railroad, nor is the name of "LOCOMOTIVE," since become so distinguished, once used.

During the five years following the year 1824, little was done towards the improvement of the motive power for working the railroads of Great Britain, the only country in which they were used. In 1829, when the Liverpool and Manchester Railroad (the pioneer of a new system which has since attained such tremendous proportions) was well advanced towards completion, the locomotive was so unimportant an agent, that it was not even then easy to decide the question of motive power for working that important line. The locomotive had its friends in the Stephensons, father and son, in Hackworth, Braithwaite and Erickson, Trevethick and others. A plan for placing fixed steam engines at intervals along the line to draw the trains by endless ropes running over pulleys, had its supporters. Horses were looked to as a safe means to fall back upon when all else should fail. A machine to use horse power was even thought of, and was afterwards built, in which the propelling horses were carried on the carriage that was to be used for drawing the train.

During the year 1828 it became imperative, on the part of the Directors of the Liverpool and Manchester Railway, to decide in some way the question of motive power, and in that year a deputation of this body "was appointed to visit the railways of Northumberland and Durham, where the different varieties of motive power were most extensively practiced." This deputation returned from this mission without coming to any conclusion as to which class of motive power would most conduce to their interests. They *did*, however, decide "that horse-power would be inapplicable for the great traffic that was anticipated upon the new line."

By this decision the question was narrowed down to the locomotive engine (then gradually becoming the favorite) and the fixed engine. This latter device was known to be clumsy in its management, and difficult to manage where a large traffic was to be carried on, or where it was of primary importance that greatly increased speed must be aimed at. Little scope, therefore, was left in the fixed engine system for improvement tending to meet these essentials, and little could be expected.

At this point in this most important controversy, it was suggested that the surest way to bring out the merits of the locomotive system, was to excite competition on the part of its advocates, by the offer of a premium or reward for the best locomotive engine. In the spring of 1829, and in accordance with this idea, first enunciated by Mr. Harrison, a member of the Board, it was decided by the Directors of the Liverpool and Manchester Railway, to make this premium £500, to be contended for under conditions to be fixed by the Company.

The very important conclusions which soon resulted from the competition induced by the above offer, in the rapid improvement of the locomotive engine, formed a new era, not only in *their* history, but in the importance of railways generally. The conditions upon which the premium was offered was in part, as follows:

"Railway Office, Liverpool,
25th of April, 1829.

"Stipulations and Conditions

On which the Directors of the Liverpool and Manchester Railway offer a premium of £500, for the most improved locomotive engine.

"1st. The said engine must 'effectually consume its own smoke,' according to Railway Act. 7th Geo. IV.

"2nd. The engine, if it weighs six tons, must be capable of drawing after it, day by day, on a well constructed railway, on a level plane, a train of carriages of a gross weight of *twenty tons*, including the tender and water tank, at the rate of *ten miles* per hour, with a pressure of steam on the boiler of *fifty pounds* to the square inch.

"8th. The price of the engine that may be accepted is not to exceed £550, delivered on the railway; and any engine not approved is to be taken back by the owner."

The following engines were entered for the prize:

The "Novelty," by Braithwaite and Erickson.
" "Rocket," by Robert Stephenson.
" "Sans Pareil." by Timothy Hackworth.
" "Perseverance," by Mr. Burstall.

All these engines had distinct principles in their construction, the most important of which being in the plan, and in the steam generating properties of the boilers.

After a fair test of all the locomotives competing in accordance with the regulations fixed, the prize was easily won by the "Rocket," built by George and Robert Stephenson; this engine having fulfilled, in some respects, more than all the requirements of the trial.

It is remarkable that the "Rocket," in all or nearly all of the general essentials that go toward making the locomotive what it is, was as complete as the engine of our day. Its weight was but 3 tons, 1 cwt. From the success achieved by the "Rocket" at Liverpool, the locomotive engine took the place it now fills so perfectly, as the great motor for land transportation.

The type of locomotive established by the success of the "Rocket" became in its immediate successor the "Planet," the then standard in England, and the Directors of the Liverpool and Manchester Railway lost no time in stocking their railway with engines mainly after this model, although some English engineers seemed still to have had doubts as to the great value of this new revelation in steam power that had been born into the world.

With this preliminary, it is now the purpose of this paper to tell the early history of the locomotive in Philadelphia, and to show how great a share the minds and hands of our engineers and mechanics have had in the improvement and development of (without doubt) the most important agent of this or any other age. In telling this completely, it will be necessary to take a retrospect and go back to the year 1786.

In that year, Oliver Evans, a man who deserves at this day all honor at our hands, as one of Philadelphia's noblest sons, "petitioned the Legislature of Pennsylvania for the exclusive right to use his improvements in flouring mills and steam carriages in his native State. In the following year he presented the same petition to the Legislature of Maryland. In the former case he was only successful so far as to obtain the privilege for the mill improvements, his representations respecting steam carriages savoring too much of insanity to deserve notice."

"He was more fortunate in Maryland, for although the steam project was laughed at, yet one of his friends a member, very judiciously observed that the grant could injure no one, for he did not think that any man in the world had ever thought of such a thing before. He therefore wished the encouragement might be afforded, as there was a prospect of its producing something useful." The exclusive privilege was granted, and after this Mr. Evans considered himself bound in honor to the State of Maryland, to produce a steam carriage as soon as his means would permit him.

To Oliver Evans must be awarded the credit of having built and put in operation the first practically useful high-pressure steam engine, using steam at 100 pounds pressure to the square inch, or more, and dispensing with the complicated condensing apparatus of Watt The high-pressure engine of Evans had advantages for us in its greater simplicity and cheapness, and ever since his day it has continued the standard steam engine for land purposes in this country.

English writers have tried to detract from the fame of Oliver Evans, but it is well known that early in his engineering life he sent drawings and specifications of his engines, &c., to England by the hands of Mr. Joseph Stacey Sampson, of Boston. It is well known also, that these drawings, &c., were shown to and copied by engineers in England, and from this period dates the introduction into Europe of the first really useful high-pressure steam engine, now so generally applied to locomotive and other purposes.

Basing his hopes of success on the use of the high-pressure engine in his steam carriage, Oliver Evans, notwithstanding the opposition and even the derision of his best friends, and of almost every one, made earnest efforts in the beginning of this century to carry out his design for building his favorite machine, but without success. He had a good friend in Mr. Robert Patterson, then Professor of Mathematics in the University of Pennsylvania, who recommended the plan as highly worthy of notice, and who wished to see it tried. Evans' plans were shown to Mr. B. H. Latrobe, a scientific gentleman of great eminence in his day, who publicly pronounced them chimerical, and who attempted to demonstrate their absurdity in his report to the American Philosophical Society on "*Steam Engines*," in which he also undertook to show the impossibility of making steamboats useful.

In Mr. Latrobe's report, Mr. Evans was said to be seized with the "*steam mania*," which was no doubt most true. To the credit of our then and now most learned Society, the portion of Mr. Latrobe's report which reflected so harshly upon Mr. Evans was rejected, the members conceiving that they had no right to set up their opinions as an obstacle in the way of an effort towards improvements that might prove valuable for transport on land. The Society did, however, admit in the report the strictures on steamboats.

Oliver Evans never succeeded in constructing a steam carriage such as he had contemplated. It was commenced, and unaided he spent much time and money in fruitless efforts to complete it. Finding himself likely to be impoverished if he persisted in the scheme, he finally abandoned it, and devoted his time thereafter to the manufacture of his high-pressure steam engine and his improved milling machinery. Previously however, to the final abandonment of his favorite project, Oliver Evans, on the 25th of September, 1804, submitted to the Lancaster Turnpike Company a statement of the cost of and probable profits of a steam-carriage to carry *one hundred* barrels of flour *fifty* miles in twenty-four hours, tending to show also that one such carriage would make more net profit on a good turnpike road than ten wagons drawn by five horses each.

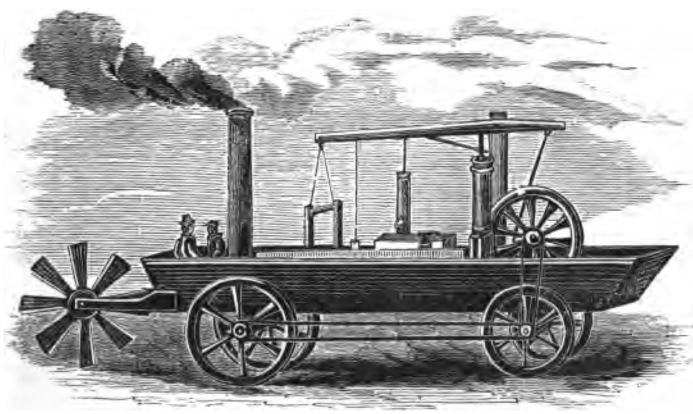
He offered to build a steam carriage at a very low price. Evans' statement to the turnpike Company closed as follows: "It is too much for an individual to put in operation every improvement which he may invent. I have no doubt but that my engines will propel boats against the currents of the Mississippi, and wagons on turnpike roads with great profit. I now call upon those whose interest it is, to carry this invention into effect."

Oliver Evans, in the early part of 1804, came nearest to realizing his favorite idea, in obtaining an order from the Board of Health of Philadelphia to construct at his foundry (a mile and a half from the water) a dredging machine for cleaning docks, the first one ever contrived for dredging by steam, now so common.

To this machine Evans gave the name of "Oructor Amphibolis," or Amphibious Digger, and he determined, when it was completed, to propel it from his work shop to the Schuylkill River, which was successfully done, to the astonishment of a crowd of people gathered together to see it fail. When launched, a paddle-wheel, previously arranged, was put in motion at the stern, and again it was propelled by steam to the Delaware, leaving all vessels half-way behind in the trip, the wind being ahead.

This result Evans hoped would have settled the minds of doubters as to the value of steam as a *motor* on land and water. But his attempt at moving so great a weight on land was ridiculed, no allowance being made by the *hinderers* of that day for the disproportion of power to load,—rudeness in applying the force of steam for its propulsion, or for the ill form of the boat. A rude cut of the "Oructor Amphibolis" is still extant, which shows a common scow, mounted on four wooden wheels, with power applied to the whole number of the wheels by the use of leathern belts.

Evans, after this experiment, willing to meet the question in any way, silenced the *carpers* around him by offering a wager, that for $3,000 he would make a steam carriage that would run on a level road as swift



OLIVER EVANS' "ORUCTOR AMPHIBOLIS," OR AMPHIBIOUS DIGGER.

THE FIRST AMERICAN LOCOMOTIVE.—1804.

as the fastest horse they could produce. His bet met with no takers.

This movement by steam power of Oliver Evans' dredging machine on land was, without any doubt, the first application of steam to a carriage in America, and in fact the first locomotive engine. It was a more important experiment than any that had preceded it, anywhere in the same direction.

Oliver Evans' conceptions respecting the power of steam, many of them practically exemplified by him, reflects great credit on his sagacity as an engineer, and many of his predictions in regard to its great value, particularly for land transport, may well be termed prophetic.

In the early part of this century he publicly stated that "The time will come when people will travel in stages moved by steam engines from city to city, almost as fast as birds fly,—fifteen or twenty miles an hour. Passing through the air with such velocity, changing the scene in such rapid succession, will be the most exhiliarating exercise." "*A steam carriage will set out from Washington in the morning,—the passengers will breakfast in Baltimore,—dine in Philadelphia, and sup in New York the same day.*" "To accomplish this, two sets of railways will be required, laid so nearly level as not to deviate more than two degrees from a horizontal line,—made of wood or iron, or smooth paths of broken stone or gravel, with a rail to guide the carriages, so that they may pass each other in different directions, and travel by night as well as day."

Much stress is laid upon these early efforts of Oliver Evans towards the introduction of steam for land and water transportation, and much space has been given here to set them forth. With no light to guide him (for it is fair to suppose that he knew nothing of the little that had been done up to his day in Europe), how his trumpet-tones ring out in the words above quoted, compared with the "uncertain sound" made by the English engineers in 1829. *They*, with a quarter of a century or more of later experience, during which period much had been done to improve and develope the locomotive engine, then no new thing, nor was it barren of useful practical results, hesitated and doubted in their course. *He*, with no misgivings as to the future, and with no dimmed vision, saw with prophetic eyes all that we now see. To *him* the present picture, in all its grandeur and importance, glowed in broad sunlight. In the history of these efforts of Oliver Evans it is noteworthy, and most creditable to our sister State of Maryland, that that Commonwealth extended to him the first public encouragement in his steam carriage project.

Again our enterprising neighbor was first in the field, since become so important, for we find that in March, 1827, the State of Maryland chartered the first railway company in America, and in 1828 her citizens commenced the construction of the Baltimore and Ohio Railway, aiming to cross the Alleghenies; certainly the greatest railway scheme that had been thought of up to that date, and now, in its completed state, a triumph of railway engineering. To this first effort to make a great railway in the United States, and its influence upon the history of the locomotive in Philadelphia, reference will be made hereafter.

Oliver Evans died in 1819, and his plans for a steam carriage died with him, and although he produced nothing practically useful in the great idea of his life, he has left behind him an enduring monument in his grain and flour machinery.

[NOTE. The improvements of Oliver Evans in grinding flour, as described in his "Young Millwrights' Guide," (a standard authority at this day on the subject of milling), changed the whole system of handling grain and its products. The principles and, in many respects, the arrangements in detail of the great grain elevators used so extensively at the present hour, came originally from the teeming brain of Evans. In the first edition of the Young Millwrights' Guide, published eighty years ago, an engraving may be seen of an elevator unloading a vessel at the river side, and conveying the grain to an upper granary on the wharf, just as it is done to-day. It is painful to read Evans' own story of his struggles against the prejudiced and doubting men of his time, in his efforts to introduce his improved milling machinery. Those who were ultimately most benefited by his inventions were his most persistent opponents. But he triumphed at last in this, although failing to get his steam carriage into use.]

The materials for the history of the next attempt at making a steam carriage in Philadelphia, eight or

2

nine years after the death of Oliver Evans, are not very full. At this period a steam carriage to run on a common road was projected by some parties in our city whose names cannot now be easily reached. This steam carriage was built at the small engineering establishment of Nicholas and James Johnson, then doing business in Penn Street, in the old district of Kensington, just above Cohocksink Creek.

An eye witness of its construction, and who saw it running under steam on several of its trials, describes it as an oddly arranged and rudely constructed machine. It is believed to have had but a single cylinder, set horizontally, with connecting-rod attachment to a single crank at the middle of the driving axle. Its two driving wheels were made of wood, the same as an ordinary road wagon, and were of large diameter, certainly not less than eight feet. It had two smaller wheels in front, arranged in the usual manner of a road wagon, for guiding the movement of the machine. It had an upright boiler hung on behind, shaped like a huge bottle, the smoke-pipe coming out through the centre at the top, formed the neck of the bottle. Its safety valve was held down by a weight and lever, and it was somewhat amusing to see the *puff*, *puff*, *puff*, of the safety valve as the machine jolted over the rough street. This was before the days of spring balances for holding down the safety valves of locomotives.

On its trials, made on the unpaved streets of the neighborhood in which it was built, this steam carriage showed an evident lack of boiler as well as cylinder power. It would, however, run continuously for some time and surmount considerable elevations in the roads. It was sometimes a little unmanageable in the steering apparatus, and on one of its trials, in running over the High bridge and turning up Brown Street, its course could not be changed quick enough, and before it could be stopped, it had mounted the curbstone, smashed the awning posts, and had made a demonstration against the bulk window of a house at the south-west corner of Brown and Oak Streets.

After this mishap it was not seen on the streets again, nor is it known what ultimately became of it. This last effort may be classed in some respects no doubt, with what Oliver Evans promised in his mind to carry out, and it is very evident that up to its time no great amount of knowledge, or of practical or theoretical skill, had been brought to bear upon the construction of locomotives in Philadelphia. No books were as yet published in America describing the locomotive, or telling what had been done in land transport by steam in Europe. The trials on the Liverpool and Manchester railway in 1829 had not been made, and a better result could have hardly been expected than this recorded above.

With the wonderful success of the "Rocket" in October, 1829, the attention of our engineers and capitalists was strongly turned towards this new revelation in land transport, that had so suddenly flashed upon the world. It was a matter of the greatest importance to us, with our rich lands everywhere teeming with produce, the producers meanwhile crying aloud for better means to get their harvests to market, and for getting our people too, more speedily from point to point, that we should know more of this new thing, and if it fulfilled its promise, to get the advantage of it as soon as possible.

It is true that the river, the canal, and the turnpike road had done good service in the past; but they did not keep pace with the growing wants of the country. The river, Nature's own free highway, is, when navigable, often hindered by flood and frost, by currents and by drought, nor does it run everywhere, or always where it would best conduce to man's use and benefit. The slow, plodding canal did its work cheaply, and with nothing better, it must have continued the favorite means for inland trade. But canals are only possible where water can be had in abundance to keep them full, and with winter's cold to interrupt their movement, they are practically useless for half the year. Their capacity at best, is limited too, in many ways. The turnpike road, most useful in its place, had a very narrow limit of usefulness, when the means to do the the carrying trade of a continent were to be attained. Man's restless nature longed for, and demanded something better than the river, the canal, or the turnpike road, and this had been found in the RAILROAD and the LOCOMOTIVE. It did not take long, therefore, to come to a decision that railways *must* be built, and the locomotive brought into use, and that speedily.

It has been seen that Maryland took the lead, and she had her great road well under way before other States looked the question fairly in the face. South Carolina followed the lead of Maryland, and granted a charter at an early period to the South Carolina Railway, intending to cross the whole breadth of the State, and ultimately aiming to reach the far west.

Signs of railway movement were seen in Pennsylvania, Delaware and New Jersey, and in New York and New England. The Columbia railroad (a State work) was projected in Pennsylvania at this time, and the Philadelphia, Germantown and Norristown Railroad was begun in Philadelphia. New Jersey had chartered and commenced her road from Camden to Amboy, and little Delaware, ahead of all the States north and east of her, had two miles of the Newcastle and Frenchtown Railroad ready for use on the 4th of July, 1831.

The South Carolina Railroad was amongst the first to encourage the manufacture of American locomotives, and Mr. Horatio Allen, a gentleman honored still as a good citizen, and as one of the first engineers in the country, designed and had built, in 1830 and '31, at the West Point foundry in New York, the first locomotives, it is believed that were ever ordered and made in the United States for regular railroad traffic.

Other engines, subsequently built in New York after designs by Mr. Allen, did good service on the South Carolina Railroad, and it is curious to note that, in these later engines, was embodied every valuable point of the "Fairlie" engine, now making so much noise in England. These points being the use of a vibrating truck at both ends with cylinders thereon, fire-box in the middle, with flues from fire-box to each end of the boiler, double smoke-box and double chimney, with fire-door at the side of fire-box, flexible steam and exhaust pipe, &c.

[NOTE. The first locomotive ever run on a railroad in America was undoubtedly the "Lion," one of two engines built at Stourbridge, in England, under the direction of Mr. Horatio Allen, and imported into this country in the autumn of 1829, for the Delaware and Hudson Railroad in the State of New York. Mr. Allen, in describing its first movement, says that he was the only person upon the engine at the time, and he (living still) made the first trip by steam on an American railroad. The "Lion," built before the "Rocket," had vertical cylinders, arranged somewhat after the manner of the old style of Killingworth or Stockton and Darlington engines, with four driving wheels all connected. The boiler of this engine approached closely to the locomotive boiler of the present day, in having a fire-box with five flues leading to the smoke-box, this latter feature being, in fact, the first step towards the present multi-tubular boiler.]

The Directors of the Baltimore and Ohio Railroad in January, 1831, by advice of Mr. Jonathan Knight, of Pennsylvania, still taking the lead in the railroad movement, and with the desire to encourage

American skill, adopted the same plan that had been so successfully carried out at Liverpool in 1829, and offered a premium of $4,000 for the best American locomotive.

At this period in this history, more mind and more practical knowledge had been brought out in Philadelphia, aiming towards the improvement of the locomotive engine. In March, 1830, Col. Stephen H. Long, of the United States Topographical Engineers, a gentleman of high scientific culture, and noted for his originality, obtained a charter from the State of Pennsylvania, incorporating the "American Steam Carriage Company," and soon thereafter commenced the construction of a locomotive in Philadelphia. This engine was designed somewhat after the then recently improved locomotives made in England, but had several original points.

This first engine of Col. Long was placed, when finished, upon the Newcastle and Frenchtown Railroad, and the Hon. Wm. D. Lewis has furnished the following account of its trial at various times on that road, with which he at that period was connected in an official capacity.

Col. Long's Locomotive.

"On the 4th of July, 1831, two miles of the rails being laid on the Newcastle and Frenchtown Railroad, Col. Long made trial on it of his locomotive, which weighed about 3½ tons. The first effort was not a success, the failure being attributed to lack of capacity to furnish a sufficient supply of steam. It would go well enough for a while, but the steam could not be kept up. The next day the Colonel had better luck; his engine then going to the end of our rails and back, drawing two passenger cars packed with people, (say 70 or 80,) with apparent ease, and it had fifty pounds of steam at the end of the experiment.

"The Colonel, however, was not satisfied with it, and the machine was brought to Philadelphia again, and a new boiler was constructed for it at Rush & Muhlenburgh's works at Bush Hill. This engine was again taken to Newcastle and tried upon the road but it again failed. It would go very well for a time, but on the 31st of October, 1831, a pipe was burst and it became disabled. This being repaired, two days thereafter another trial was made, but with equal want of success, which was ascribed to lack of power as well as of specific gravity. Alone, this engine went very well, and rapidly, say at the rate of 25 miles an hour, but it would not draw a satisfactory burden.

"Soon after the above date, Col. Long removed his engine from the road, and I do not know what became of it afterwards." Mr. Lewis adds, "The above memoranda I now enclose of the trials of Col. Long's locomotive in 1831, are made from a book in which all the facts I give you were set down contemporaneously with their occurrence." This unsuccessful attempt of Col. Long was, up to its date, much the most important movement that had yet been made in Philadelphia towards the improvement of the locomotive, and as such it deserves special notice. It was furthermore not without its value in inducing him thereafter to pursue the subject to much better results. Had Col. Long more faithfully copied the English engine of his day, he would have had better success in his first effort; but he, as with all our Philadelphia engineers and mechanics at that time, and in the succeeding years, aimed at making an American locomotive.

Whilst Col. Long was engaged in the construction of his engine, the late Matthias W. Baldwin, a name that has since become so famous in the history of the improvements, and in the manufacture of the locomotive in Philadelphia, was engaged in making a model locomotive for the Philadelphia Museum. In this work Mr. Baldwin was assisted by that highly eminent practical mechanic and engineer, the late Franklin Peale, then Manager of the Museum

To gratify the curiosity of the public to know more of this new thing, this little engine was placed upon a track laid around the rooms of the Museum, in what was then the Arcade, in Chestnut Street, above Sixth, and where it was first put in operation on April 25th, 1831, It made the circuit of the Museum rooms many times during the day and evening, for several months, drawing behind it two miniature passenger cars, with seats in each for four persons but often carrying twice that number, in a manner highly gratifying to the public, who attended in crowds to witness for the first time in this city and state, the effect of steam in railroad transportation. This little engine was perhaps the first made expressly to draw passengers, that had ever been placed on a railroad in America.

[Note. In rendering a just meed of credit to all who aided in the early development of the Locomotive in Philadelphia, it is not out of place here to introduce the following extract from an obituary notice of Franklin Peale, read before the American Philosophical Society at a meeting on December 16th, 1870, by his friend Robert Patterson, a grandson of Robert Patterson, who had been Oliver Evans' firm friend in the latter's efforts in the last century to introduce a steam carriage. "It was while engaged at the Museum that Mr. Peale placed there a miniature locomotive, the first seen in this country, and manufactured by his friend, M. W. Baldwin, on a plan agreed upon between Mr. Peale and his friend. It was put in operation on a track, making the circuit of the Arcade, in which the Museum then was, drawing two miniature cars with seats for four passengers. The valuable aid of Mr. Peale was afterwards given to Mr. Baldwin in the construction of the locomotive for the Philadelphia and Germantown Railroad, built in 1832, the success of which led to the establishment of Mr. Baldwin in the great business of his life."]

With the knowledge of the success that had been achieved in England, the desire to *know* more of, and the necessity to *have* as speedily as possible, this new power, soon became a paramount question in the Middle, Northern, Southern and Eastern States of the Union.

The reward of $4000 offered for the best American Locomotive by the Directors of the Baltimore and Ohio Railroad, brought out many competitors, and in after years several very curious specimens of locomotive engineering might be seen in one of the shops of this road. An eye-witness of these efforts in 1834, describes one which sported two walking beams, precisely like the river steamers of the present day. Mr. Phineas Davis, of York, Pennsylvania, bore off the prize offered by the Baltimore and Ohio Railroad, and his engine was the only one that survived the trial. With the Peter Cooper upright tubular boiler adapted thereto, this locomotive of Mr. Davis became for several years the type of engine for the road upon which it won its fame, and to this day some of these Grasshopper or Crab engines, as they are sometimes called, may be seen doing good service at the Camden Street Station, in Baltimore.*

Philadelphia mechanics, following the lead of their predecessors in the same field, entered with zeal into the Baltimore contest. An engine was built by a Mr. Childs, who had invented a rotary

*Previous to the competition on the Baltimore Railroad, Mr. Peter Cooper, the well known New York Philanthropist of the present day, sent to Baltimore, a small engine, not larger than an ordinary hand-car. This little locomotive had an upright tubular boiler, (no doubt the first of its kind,) which developed such good steam making qualities, as to induce Mr. Phineas Davis to purchase the Cooper patent right, and boilers of this kind were used by Mr. Davis in the locomotives built by him, subsequent to the competitive trial on the Baltimore and Ohio Railroad.

engine which in a small model promised good results, and an engine of about fifty horse-power on this rotary plan was built and sent to Baltimore for trial. A record of its performance cannot now be easily reached, but it is known that it was never heard of as a practically useful engine after this time.

The second locomotive built in Philadelphia, to compete at Baltimore, was designed by Mr. Stacey Costell, a man of great originality as a mechanic, and the inventor of a novelty in the shape of a vibrating cylinder steam engine, that had some reputation in its day, and has come down to our time exactly, in the little engine now sold in the toy shops for a dollar.

The Costell locomotive had four connected driving wheels, of about thirty-six inches in diameter, with two six-inch cylinders of twelve-inch stroke. The cylinders were attached to right-angled cranks on the ends of a counter shaft, from which shaft spur gearing connected with one of the axles. The boiler was of the Cornish type, with fire inside of an internal straight flue. Behind the bridge wall of this boiler, and inside the flue, water tubes, were placed at intervals, crossing each other after the manner of the English Galloway boiler of the present day. The peculiar arrangement of this engine made it possible to use a very simple and efficient mode of reversement by the use of a disc between the steam pipe and the cylinders, arranged with certain openings, which changed the direction of the steam and exhaust by the movement of this disc against a face on the steam pipe near the cylinder, something after the manner of a two-way cock.

It is not known whether this locomotive of Costell's went to Baltimore or not. It is known, however, to have been tried on the Columbia road in 1833 or 1834, but its success was not very striking, and it was subsequently broken up. The boiler of the Costell locomotive had very good steam-making qualities. It was used for a long time as a stationary engine boiler.

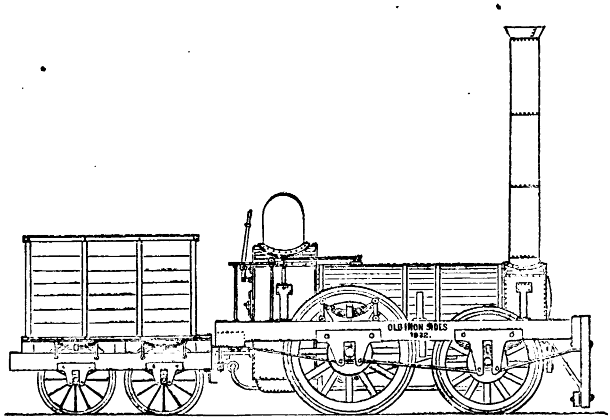
The third engine begun in Philadelphia for the Baltimore trial in 1831, was after a design of Mr. Thos. Holloway, an engineer of some reputation forty years ago as a builder of river steamboat engines. This engine was put in hand, but was never completed.

Something was gained even by the failures that are here related, and these early self-reliant efforts show with what tenacity Philadelphia engineers clung to the idea of building an original locomotive, and it will be seen hereafter that a type of locomotive essentially American was ultimately the result.

Whilst these movements towards the improvement of the locomotive were going on amongst us, the desire to have the railroad in every section of the country became more and more fully confirmed. The railway from Newcastle to Frenchtown, sixteen miles in length, was finished in the winter of 1831 and 1832, and two locomotives built by Robert Stephenson at Newcastle-upon-Tyne, were imported to be run upon this line, which made then an important link in the chain of passenger travel between New York and Washington. In this case, as in several others in the early history of the railroad in the United States, this new element came in as an adjunct mainly of the river steamboats, and was considered most useful in superseding the old stage coach in connecting river to river, and bay to bay.

That the railway would supersede the steamboat for passenger travel, and the canal for heavy transport, was not dreamed of in the early day of the new power.

When the English locomotives were landed at Newcastle, Delaware, it became necessary to select a skilled mechanic to put them together as speedily as possible. Through the agency of Mr. Wm. D. Lewis, a most active Director of the Newcastle and Frenchtown Railroad Company, this task was assigned to Matthias W. Baldwin. These engines were of the most improved English type, and were greatly superior in design and workmanship, to any that had then been seen in this country. In putting these engines together, Mr. Baldwin had all the advantage of handling their parts and studying their proportions, and in making drawings therefrom. This proved of great service to him when he received an order, in the spring of 1832, to build a locomotive for the Philadelphia, Germantown and Norristown Railroad. This engine, called, when finished, the "Old Ironsides," was placed upon the above road in November, 1832, and proved a decided success. Mr. Franklin Peale, in an obituary notice of M. W. Baldwin, writes; "that the experiments made with the 'Ironsides' were eminently successful, realizing the sensation of a flight through the air of fifty or sixty miles an hour." The "Old Ironsides," in its general arrangement, was a pretty close copy of the English engines on the Newcastle and Frenchtown Railroad, but with changes that were real improvements. The reversing gear was a novelty in the locomotive, although the same mode had been long used for steam ferry boats on the Delaware. This arrangement consisted of a single excentric with a double latch excentric rod, gearing alternately on pins on the upper and lower ends of the arms of a rock shaft. This mode of reversing was used in the Baldwin locomotives for many years after the "Old Ironsides" was built.



"OLD IRONSIDES," 1832.

It is creditable to Mr. Baldwin as an engineer that the "Old Ironsides" was the first and last of his imitations of the English locomotives. He, following the bent of all the Philadelphia engineers and mechanics that had entered the field, aimed too, at making an American locomotive, and his second engine, and those succeeding it, were entirely different in design from the "Old Ironsides."

Following the success of this first locomotive, other orders soon flowed in upon Mr. Baldwin, and on these later engines many valuable improvements were introduced, of which mention will be made hereafter. Col. Stephen H. Long, nothing daunted or discouraged by the unsuccessful results of his first engine in 1831, renewed his efforts, and under the firm of Long & Norris, the successors of the American Steam Carriage Company, commenced building a locomotive in 1832, subsequently called the "Black Hawk." This engine when finished, was run for some time on the Philadelphia and Germantown Railroad, and did good service in the summer of 1833, in competition with Baldwin's "Ironsides." The "Black Hawk" burnt anthracite coal with some success, using the natural draft only, which was increased, for the first time, in a locomotive by the use of a very high chimney, arranged to lower from an altitude of at least twenty feet from the rails, to a height which enabled it to go under the bridges crossing the railroad. In all of Col. Long's experiments he seems to have discarded the steam jet, or exhaust, for exciting the fire. The "Black Hawk" had several striking peculiarities beside the one just mentioned. The boiler, a very good and a very safe one, was unlike any that had preceded it, in having the fire-box arranged without a roof, being merely formed of water sides, and in being made in a detached piece from the waist or cylindrical part. The cylinder portion of the boiler consisted of two cylinders, about twenty inches in diameter, and these lying close together, were bolted to the rear water side, and thus covered the open top, and their lower half-diameters thereby became the roof of the fire-box. A notch was cut half way through these two cylinders on their lower half-diameters about midway of the length of the fire-box, directly over the fire, and from these notches flues of about two inches diameter passed through the water space of each cylinder portion of the boiler to the smoke-box. These flues were about seven feet in length. Besides passing through the flues, the fire passed also under the lower halves of the cylinder portions of the boiler, a double sheet iron casing, filled between with clay, forming the lower portion of the flue and connecting it with the smoke-box.

The "Black Hawk" rested on four wheels, the driving wheels about four and a half feet diameter, being in front of the fire-box. The guide wheels were about three feet diameter. Inside cylinders were used, and these required a double crank axle, and the latter, forged solid, could not easily be had. Col. Long overcame this difficulty by making his driving axle in three pieces, with two bearings on each, and with separate cranks keyed on to the ends of each portion of the axle, with shackle or crank pins arranged after the manner of the modern side-wheel steamer shafts.

Flanged tires of wrought iron could not then be had easily, and this was overcome in the "Black Hawk," by making the tread for the wheels of two narrow bands, shrunk side by side on the wooden rim, with a flat ring, forming the flange, bolted on the side of the wheel. Springs were only admissable over the front axle, and to save shocks in the rear, the after or fire-box portion of the boiler was suspended upon springs. The camb cut-off, then much in vogue on the engines of the Mississippi steamers, was used in the "Black Hawk." Other locomotives, mainly after the design of the "Black Hawk," were built by Long & Norris, and by William Norris & Co., in 1834, but they were not greatly successful.

With the firm of William Norris & Co. Col. Long retired from the manufacture of locomotives in Philadelphia, and his name was not thereafter heard of in connection with its improvement. On the retirement of Col. Long, William Norris, a gentleman then with no acknowledged pretensions as a mechanic or engineer, brought other skill to his assistance, and after several not very successful efforts with engines of a design more like those that had succeeded of other makers, brought out an engine, in 1836, called the "George Washington," the success of which laid the foundation of the large business done for thirty years thereafter at Bush Hill, Philadelphia, by William Norris, and subsequently by his brother Richard Norris.

The "George Washington" was a six-wheel engine with outside cylinders, having one pair of driving wheels, 4 feet in diameter, forward of the fire-box, with vibrating truck, for turning curves, in front. This engine weighed somewhat over fourteen thousand pounds, and a large proportion of the whole weight rested on the single pair of driving wheels.

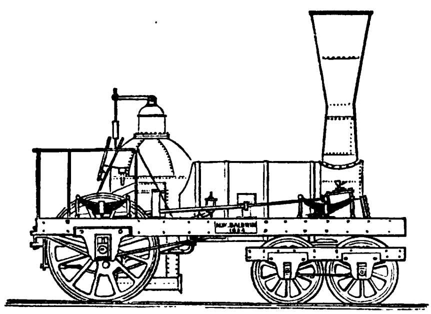
This locomotive, when put upon the Columbia road (now Pennsylvania Central), did apparently, the impossible feat of running up the old inclined plane at Peter's Island, 2,800 feet long, with a rise of one foot in fourteen, drawing a load of more than nineteen thousand pounds above the weight of the engine, and this, too, at a speed of fifteen miles per hour. This was no doubt impossible, if the simple elements of the calculation are only considered. But there was a point in this experiment, well known to experts at the time, which *did* make it possible, even by calculation; and this point consisted in the amount of extra weight that was thrown upon the drivers by the action of the draft link connecting the tender with the engine,—the result being that about *all* the weight of the locomotive rested upon the drivers, less the weight of the truck frame and wheels in front. This most extraordinary feat, a writer on the subject says, "took the engineering world by storm, and was hardly credited."

The "George Washington," an heir of the earlier efforts of Col. Long, was unquestionably a good and well made engine, and greatly superior to any that had preceded it from the Norris Works. The fame this engine earned, led to large orders in the United States, and several locomotives of like character were ordered for England and for Germany.

Improvements were made from time to time in the Norris locomotives—the establishment fairly holding its own, with its rivals until the Norris Works ceased to exist about 1866 or '67. Mr. William Norris, who in connection with Col. Long, had founded the works at Philadelphia, at one time commenced the building of locomotives at Vienna, Austria, but with no very great success; and after his return ceased his connection with the Norris Works. At the epoch from 1833 to 1837, the Norris and Baldwin engines had each their advantages and defects.

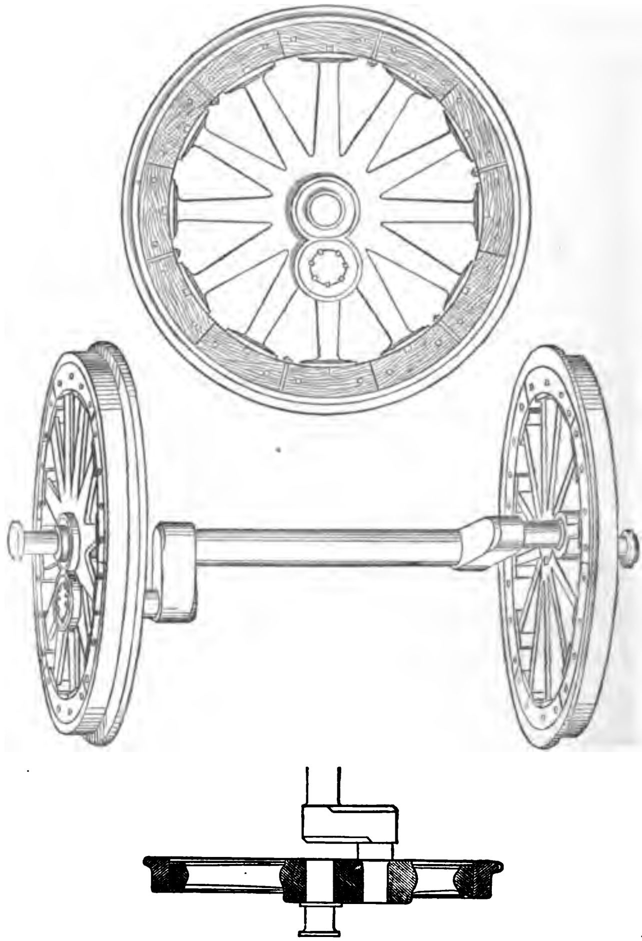
The Norris engine, as it was at the commencement of 1837, may be described as follows: The boiler was of the dome pattern, known in England as Bury's, and used by that maker in 1830; the framing was of wrought iron. The cylinders were placed outside of, and were fastened to the smoke-box as well as to the frame. The engine was supported on one pair of driving wheels, placed forward of the fire-box, and on a swivelling four-wheeled truck placed under the smoke-box. The centre of the truck being so much in advance of the point of bearing of the leading wheels in the English engines of that day, there was considerably greater weight placed upon the driving wheels in proportion to the whole weight, while it was not unusual to adjust the draw bar so as to throw a portion of the weight of the tender upon the hinder end of the engine when drawing its load. These engines used four excentrics with latches. Hand levers were used for putting the valve rods into gear when standing. The valve motion was efficient, as the performances of these engines fully attested.

The "Baldwin" engine of the same period had a similar boiler, and somewhat similar position of, and fastening of the cylinders. The driving wheels were placed behind the fire-box, the usual truck being placed under the smoke-box. These engines ran steadily, owing to their extended wheel base, although they did not have the weight on the drivers, and the consequent adhesive power of the Norris engine. The framing was of wood covered with iron plates, and was placed outside the wheels.



M. W. Baldwin, 1837.

The driving wheels had two outside bearings. The cylinders, although outside of the smoke-box, were placed so as to give a connection to the crank inside of the driving wheels. The crank was formed in the driving axle, but instead of being made as a complete double or full crank, the neck, to which the connecting rod was attached, was extended through and fastened into a hole in the driving wheel, the



M. W. Baldwin's Improved Crank Axle, 1834–37.

distance from the centre being equal to the throw of the crank. A simple straight pin, fitted to the centre of the wheel, and extending outwards, formed an outside bearing for the axles. This device of Mr. Baldwin's was most ingenious and efficient. It simplified by more than one-half the making of a crank shaft, and increased its strength, and at the same time caused the thrust of the cylinder to act close to the driving wheel inside, in the same manner as the outside crank pin.

With the introduction of the outside cylinder, this mode of making a crank axle has gone into disuse The guide bar for the cross-head, which had a double V top and bottom, was clasped by the cross-head, and being hollow and with valve-chamber attached, was made to serve the purpose of a force pump. The valve-gear, already described, was placcd under the foot-board, and although efficient, was cramped for room, the excentric rods consequently being rather too short.

In workmanship and proportion of parts, the Baldwin engine was the superior of the two class of locomotives that had then become in their manufacture, an important feature in the trade of Philadelphia.

M. W. Baldwin, in 1834 and 1837, had greatly the advantage of the Norris establishment, as he had had from the first, in being a good practical machinist himself, and in having had some experience in steam engine building previous to the making of the "Ironsides," in 1832; whereas, William Norris, after Col. Long retired, in 1833–34, having personally little engineering knowledge and no practical skill in engine building, was left entirely dependent upon hired assistance, which at that time, in the construction of the locomotive, was most difficult if not almost impossible to obtain.

Mr. Baldwin had also the great advantage of better workshops and better tools than his early competitor at the commencement of this new business; hence his success was at once more decided, and the improvements in his locomotives, both in design and in workmanship, were more important from the beginning. It is needless to speak of the "Baldwin Locomotive Works" of to-day.

With a record of forty years, during the early period of which it passed successfully through many vicissitudes, it maintains its well-earned character of the first locomotive manufactory both in quantity and quality, in this country; and it is doubtful whether it is not now the equal to, if not the superior, in these particulars, of any establishment doing similar work in the world.

The Baldwin engine of 1837, with its driving axle behind the fire-box, was steady at high speeds, but with insufficient adhesion to the rails.

The Norris engine, of the same date, having a great proportion of the weight overhanging the driving axle, and having adhesion equal to its cylinder power, was unsteady on the rails. Improvement rested between the two systems of Baldwin and of Norris.

In the spring of 1835, the firm of Garrett & Eastwick, then making steam engines and light machinery in Philadelphia, desiring to engage in this new business, obtained an order for building a locomotive engine for the Beaver Meadow Railroad. This firm, having no practical knowledge of locomotive engine building, had called to their assistance as foreman, Mr. Joseph Harrison, Jr., a young man of twenty-five, with ten years experience in the workshop, and a good practical workman, who had been employed for nearly two years as a journeyman in the Norris works, and who when there had been schooled amidst the indifferent successes or real failures of Long & Norris, and Wm. Norris & Co. The first locomotive designed under the above auspices was called, when finished, the Samuel D. Ingham, after the President of the road. It had outside cylinder connections, then not much in vogue,—running gear after the Baldwin type, with one pair of driving wheels behind the fire box, and with four wheel truck in front. It had the dome or "Bury" boiler.

This engine had some points about it which differed from any locomotive that had preceded it. Its most distinguishing feature was an ingenious and entirely original mode of reversement, invented and patented by Mr. Andrew M. Eastwick, the junior member of the firm. It is scarcely possible to give a correct idea of this device without a model or drawings, but its principle consisted in the introduction of a movable block or slide, called a reversing valve, between the usual slide valve and the opening through the cylinder face. This reversing valve had an opening through it vertically for the exhaust, and two sets of steam openings, corresponding, when placed opposite thereto, to the openings on the cylinder face. One set, called direct openings, passed directly through the valve, and when fixed for going forward, made the usual channels to the cylinder. The second set of openings through the reversing valve, called indirect openings, coming into play when the engine moved backwards, passed from the upper surface of this valve but half way through it, and thence were diverted laterally to the side of the valve, and thence along the side and again laterally, came out of the under side where the reversing valve rested against the valve face of the cylinder, directly opposite a second indirect opening on the upper surface of this valve.

When the reversing valves were fixed for going forward, the direct openings were then exactly over the steam openings on the cylinder, whilst the indirect openings came over the solid surface of the cylinder face, and were entirely out of use. The exhaust opening through the reversing valve in this case, came directly opposite the exhaust opening on the cylinder. The slide valve, never detached from the excentric, moved always over both sets of openings in the usual way. Moving the reversing valve to the opposite end of the steam chest from where it had been placed in going forward, and the case was different, Then, steam, entering the reversing valve at the upper side, instead of going directly into the cylinder as before, was diverted in the manner just described, and came out at the cylinder face at the opposite end from which it had entered on the slide valve face on the upper side of the reversing valve, and thus the direction of the engine was changed from forwards to backwards, or *vice versa*, without detaching or re-attaching any of the moving parts of the valve gear.

The principle and action of Mr. Eastwick's invention may be guessed at from what has been described, although its detail may not be so easily made out.

This new arrangement, neat and efficient as it was, had its defects, which no doubt interfered with its general use. It increased by the thickness of the reversing block, the length of the steam openings, in going forward, and further increased their length in going backwards. It also prevented the use of a long lap on the slide valve, for, any lead of the excentric in going forward, causing a corresponding delay in receiving steam in moving backward. In reviewing these defects, the beauty and originality of Mr. Eastwick's device must not be overlooked.

Nothing for the same purpose, so novel in its mode of action had preceded, or has succeeded this invention of a Philadelphia mechanic, and it is doubtful whether any locomotive has since been made with so few moving parts as this first engine of Garrett & Eastwick. This engine had for the first time, the rear platform covered with a roof to protect the engineman and fireman from the weather.

The success of the "Samuel D. Ingham" was quite equal to any locomotive of its class that had been built up to that period in Philadelphia, and orders came to the makers from several sources for others of the same kind.

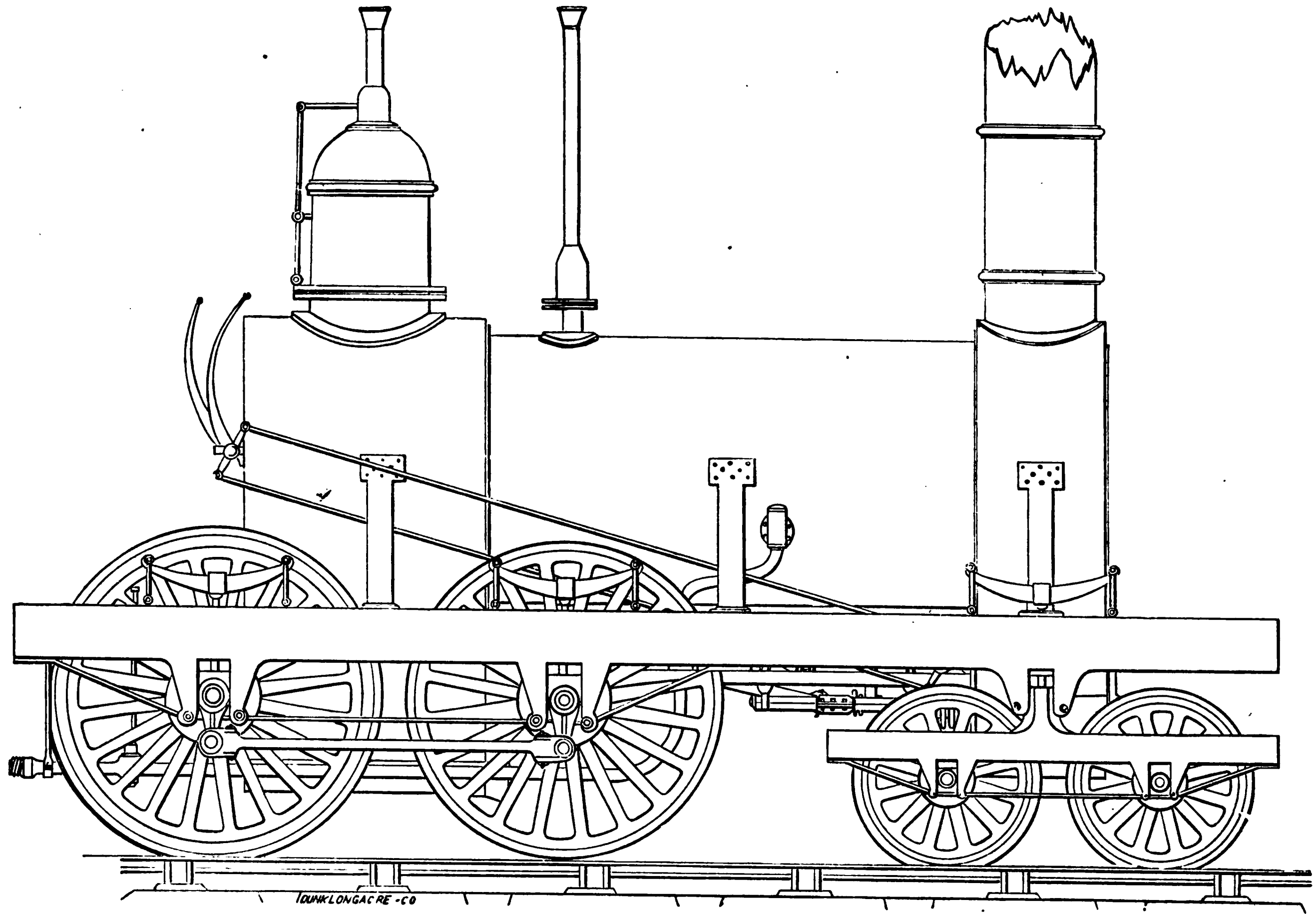
In 1836, Henry R. Campbell, of Philadelphia, "in order to distribute the weight of the engine upon the rails more completely," patented the duplication of the driving wheels, placing one pair behind and one pair in front of the fire-box, using the swivelling truck in front, of Baldwin's and others.

Mr. Campbell subsequently made an engine after his patent, which was tried on the Philadelphia and Germantown Railroad, and although not a decided success, it was a great step in the direction in which improvement was most needed. Its principal defect consisted in its having no good means of equalizing the weight on the driving wheels, so as to meet the various undulations in the track.

To remedy the defects in the Baldwin, Campbell and Norris engines, Garrett & Eastwick, (soon thereafter changing their firm to Garrett, Eastwick & Co., Joseph Harrison, Jr., becoming the junior partner), commenced in the winter of 1836-7, a new style of locomotive, for the Beaver Meadow Railroad Company.

Adopting the Campbell plan of running gear, they aimed at making a much heavier engine, for freight purposes, than had yet been used. This could be only rendered possible on the slight roads of the country at that time, by a better distribution of the weight upon the rails.

In the first of the improved engines made by Garrett & Eastwick for the Beaver Meadow Rail-

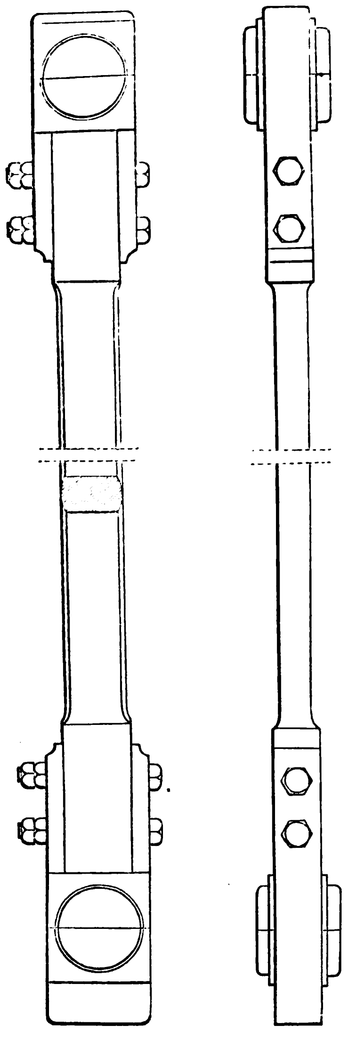


HENRY R. CAMPBELL'S FIRST DESIGN FOR AN EIGHT-WHEELED LOCOMOTIVE.—1836.

COPIED FROM THE ORIGINAL DRAWING.

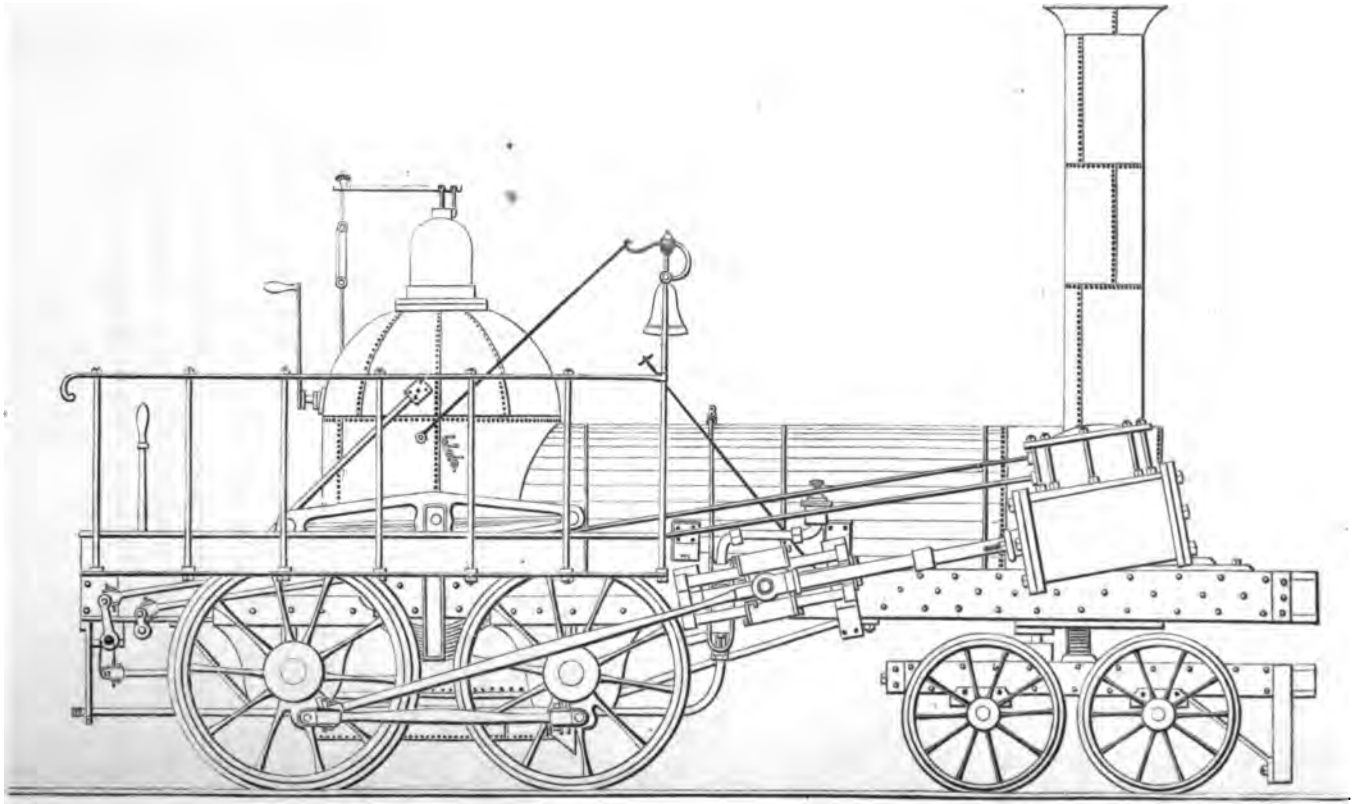
road, Mr. Andrew M. Eastwick introduced an important improvement in the Campbell eight wheel engine, for which he obtained a patent in 1836. This improvement consisted in the introduction under the rear end of the main frame, of a separate frame in which the two axles were placed, one pair before and one pair behind the fire box. This separate frame was made rigid in the "Hercules," the first engine in which it was used, and vibrated upon its centre vertically, and being held together firmly at the ends, both sides at all times moved in the same plane, thus only accommodating the undulations in the track in a perfect manner, when the irregularities were on both rails alike. The weight of the engine rested upon the centre of the sides of this separate frame through the intervention of a strong spring above the main frame, the separate frame being held in place by a pedestal bolted to the main frame, the centres of the separate frame vibrating upon a journal sliding vertically in this pedestal.

Mr. Eastwick's design was, however, somewhat imperfect, in not accommodating the weight of the four driving-wheels to the irregular undulations on both tracks. There were other minor improvements in the "Hercules," one of which was the introduction, for the first time into steam machinery, of the bolted stub-end instead of the old fashioned and unsafe mode of gib and key for holding the strap on the connecting rods. This device, an idea of Mr. Harrison's, is now universally used in the connecting rods of the locomotive engine.



HARRISON'S STUB-END, 1837, MADE WITHOUT KEYS.

Doubts were expressed by some, and amongst them not a few engine builders, that the "Hercules," weighing about *fifteen tons*, would prove too heavy,—that this engine would not turn curves or go into switches without trouble &c., &c.,—but Eastwick & Harrison had good friends in Captain Mathew C. Jenkins, a director, and Mr. A. Pardee, the chief-engineer of the Beaver Meadow Railroad. They had committed themselves to this new style of locomotive and were not disposed to see it fail for lack of a fair trial. They had no cause to regret their confidence in after years. At the time the "Hercules" was placed upon the Beaver Meadow Railroad, this road had a flat rail, but five-eighths of an inch thick and two and a half inches wide, laid upon continuous string-pieces of wood, with mud-sills underneath.



"HERCULES."

Garrett & Eastwick's first eight-wheeled Locomotive.—1837. As arranged with "Harrison" equalizing levers.

The "Hercules," when put in operation on the Beaver Meadow Railroad, proved a great success, and led to other orders for the same class of engine. This division of the weight on more points of the road, and its more perfect equalization thereon, seemed at the time, as it has proved since, to have been the commencement of a new era in the history of the locomotive. To remedy the defect, incident to Mr. Eastwick's plan, as before mentioned, in these early eight wheel engines, an improvement was patented, in 1838, by Joseph Harrison, Jr., the junior partner of the firm of Eastwick & Harrison.

Mr. Harrison's patent showed many ways of carrying out the principle of his improvement, but the one preferred consisted in placing the driving axle bearings in pedestals, in the usual manner, bolted to the main frame, and by the use of a compensating lever above the main frame, vibrating on its centre, at the point of attachment to the main frame, the ends of this lever resting on the axle-boxes by means of pins passing through the frame. These levers vibrated on each side of the engine separately, and thus met all the unevenness in both rails within a certain prescribed limit, which was governed by the play of the axle-boxes in the pedestals.

This arrangement of Mr. Harrison's was simpler, lighter and cheaper than the one that had preceded it, and was used in all the eight wheel engines built by Eastwick & Harrison after the second one.

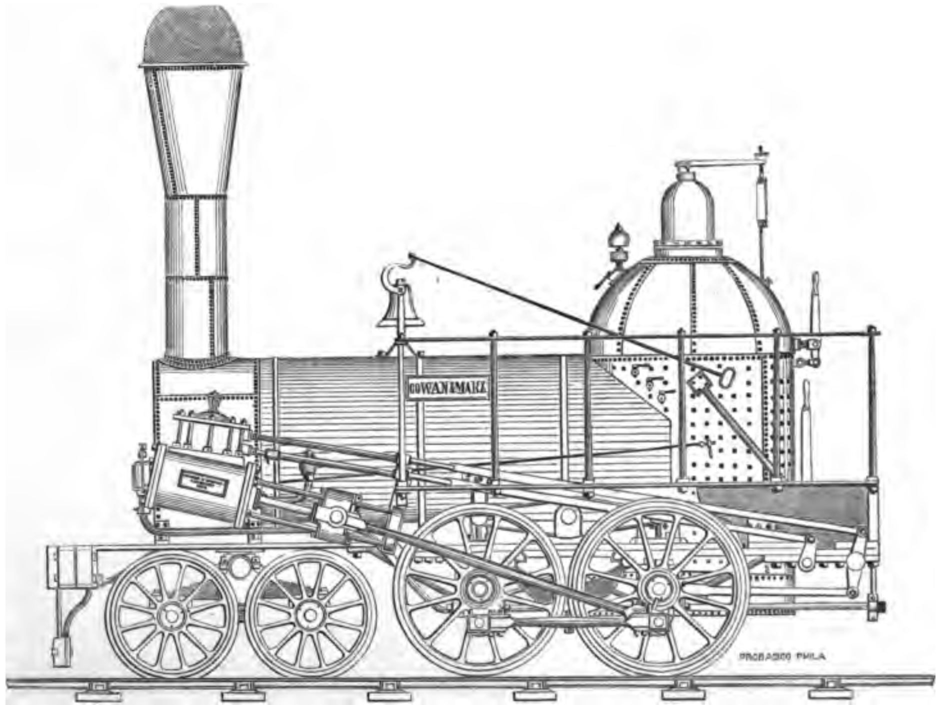
In all engines now built in this country or in Europe, with more than six wheels, this device of Mr.

Harrison is used in one or other of the different ways indicated in his patent. Mr. Harrison's patent included an improvement in the forward truck, making it flexible so that it would accommodate itself to irregular undulations on both rails.

The engineers and manufacturers of this period, did not at once fully understand the significance of the innovation so successfully carried out by Eastwick & Harrison. They clung to the older idea that one pair of driving wheels was quite sufficient whether placed before the fire-box or behind, nor did they fairly adopt the new system until after its value had been fully demonstrated by several years of trial.

In the summer of 1839, Eastwick & Harrison received an order from the Philadelphia and Reading Railroad Co., through the chief-engineer, Mr. Moncure Robinson, for a freight engine that had peculiar points. This engine was designed generally upon the "Hercules" plan, but it was stipulated in the contract that the whole weight should be *eleven tons* gross, with *nine tons* on the four driving wheels. It was also stipulated that it should burn anthracite coal in a horizontal tubular boiler.

To distribute the nine tons on the driving wheels, the rear axle was placed *under* the fire-box, and somewhat in advance of its central line, instead of being behind the fire-box, as in the "Hercules." This arrangement of the rear axle permitted nine tons of the whole weight of the engine to rest on the four driving wheels. The boiler was of the Bury type, and the fire-box had the then unprecedented length, outside,



FREIGHT ENGINE "GOWAN & MARX."

Designed and built by Eastwick & Harrison, Philadelphia, for the Philadelphia and Reading Railroad.—1839.
Slightly varied from the original.

of five feet. The tubes, two inches in diameter, and only five feet long, were more numerous than usual, and filled the cylinder part of the boiler almost to the top. Cylinders, 12½ inches in diameter, 18-inch stroke, using no cut-off; driving wheels 42 inches. The Gurney draft-box was used with many exhaust jets, instead of one or two large ones.

It is believed, that in this engine was used for the first time, the steam jet for exciting the fire when standing. The engine here described, called, when finished, the Gowan & Marx, after a London banking firm, excited much attention in the railroad world by its great tractive power, compared with its whole weight.

On one of its trips (February 20th, 1840,) it drew a train of *one hundred and one* four-wheel loaded cars from Reading to Philadelphia, at an average speed of 9.82+ miles per hour, nine miles of the road being a continuous level. The gross load on this occasion was 423 tons, not including the engine and tender, which, if the weight of the tender is counted, equalled *forty times* the weight of the engine.

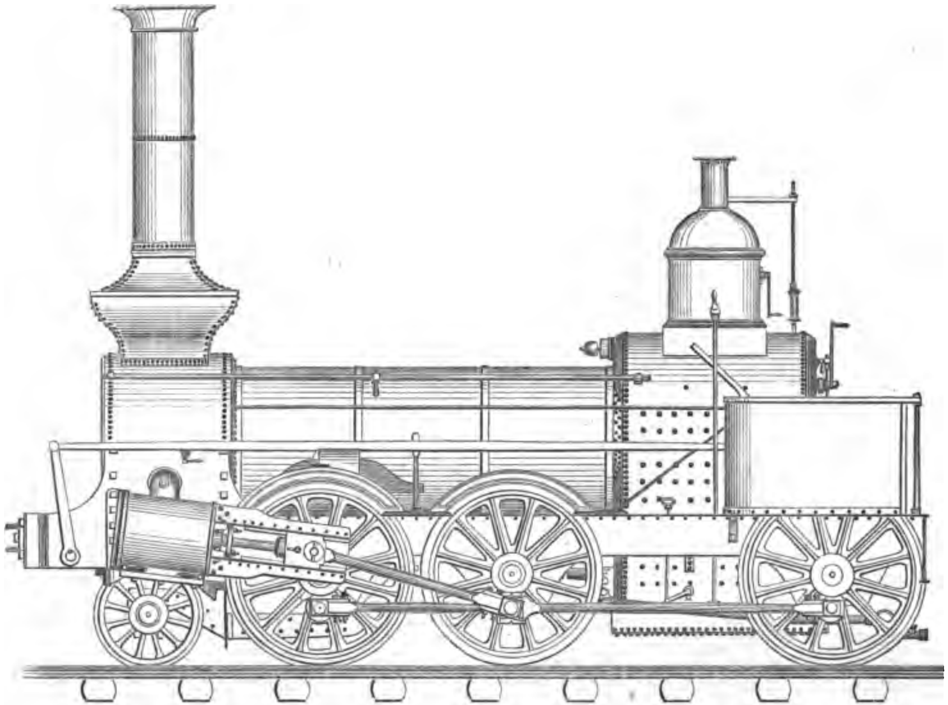
See "Journal of Franklin Institute," 1840, vol. 25, page 99, Report of G. N. Nicols, Supt. Philadelphia and Reading Railroad, which closes as follows: "The above performance of an eleven ton engine is believed to excel any on record in this or any other country." It may be doubted whether it has been excelled since.

How strangely this feat of the Gowan and Marx compares with the trials on the Liverpool and Manchester Railroad in October, 1829, but ten years before, when all that was required of the competing locomotives was, that they should draw about *three times* their own weight, tender included, on a level track, five miles long, especially prepared for the trial. The great success of the Gowan and Marx, induced the Philadelphia and Reading Railroad Company to duplicate the plan of this engine in ten engines subsequently built at Lowell, Mass.

In 1840, the Gowan and Marx attracted the particular attention of the Russian engineers, Colonels Melnikoff and Krafft, who had been commissioned by the Emperor Nicholas to examine into and report upon the various systems of railroads and railroad machinery, then in operation in this country and in Europe.

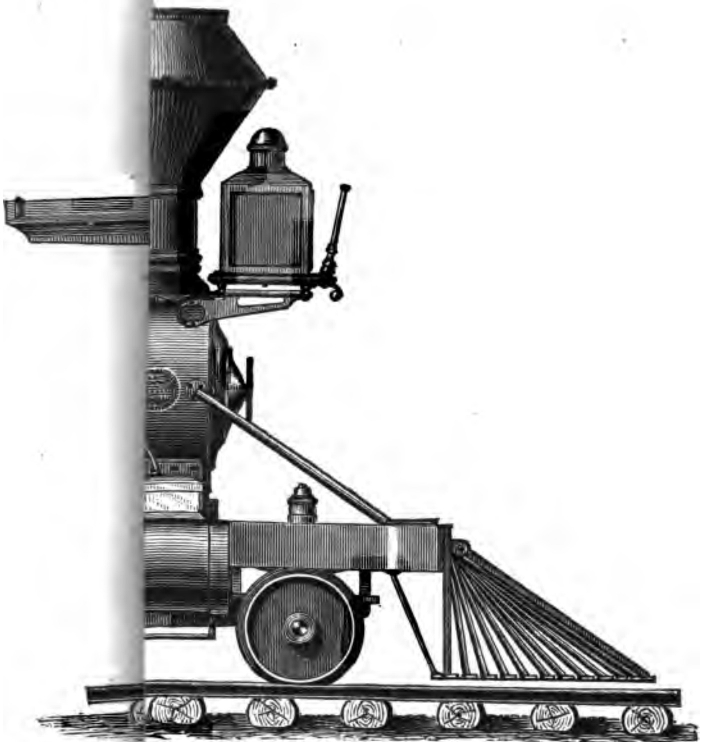
The result of their examination was favorable to the American system, and when the engineers above named, made their report on the construction of a railroad from St. Petersburg to Moscow, an engine upon the plan of the Gowan and Marx, was recommended as best adapted to the purposes of this first great line of railroad in the Empire of Russia, and Eastwick and Harrison were requested to visit St. Petersburg with the view of making a contract for building the locomotives and other machinery for the road.

Mr. Harrison went to St. Petersburg in the spring of 1843, and in connection with Mr. Thomas Winans, of Baltimore, a contract was concluded with the government of Russia, at the close of the same year,



HARRISON, WINANS & EASTWICK'S FREIGHT ENGINE.

Built at St. Petersburgh, Russia, for the St. Petersburgh and Moscow Railroad.—1844.



FREI LOCOMOTIVE WORKS, 1872.

for building 162 locomotives, and iron trucks for 2,500 freight cars. Mr. Eastwick joined Mr. Harrison and Mr. Winans at St. Petersburg in 1844.

Eastwick & Harrison closed their establishment in Philadelphia in 1844, removing a portion of their tools and instruments to St. Petersburg, and there, under the firm of Harrison, Winans & Eastwick, completed, at the Alexandroffsky Head Mechanical Works, the work for which they had contracted. When the work was commenced under the contract of Harrison, Winans & Eastwick with the Russian government, Joseph Harrison, Jr., designed and had built under his own supervision, at St. Petersburgh, the first machine, it is believed, that was ever made for boring out the holes for right-angled crank pins in the driving wheels of locomotive engines. This right-angled boring machine, on precisely the same principle as devised by Mr. Harrison, has since become indispensable in every locomotive establishment. The same idea was partially put in use as early as 1838, when the second eight-wheel engine "Beaver" was built by Garrett & Eastwick for the Beaver Meadow Railroad.

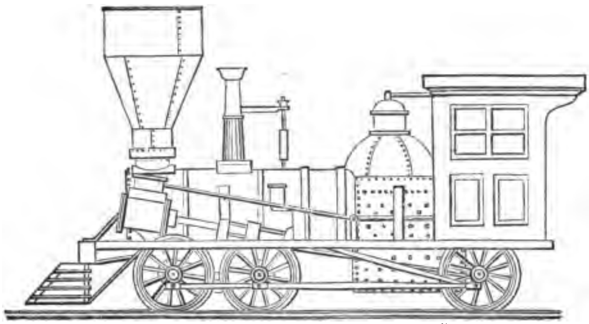
The first contract with the Russian government was closed in 1851, at which time a second contract was entered into, by two members of the firm, for the repairs to the rolling stock of the St. Petersburg and Moscow Railroad, which continued until 1862.

The eight-wheel locomotive of Eastwick & Harrison, made its first reputation as a freight engine. In 1842, two were built by this firm for the Baltimore and Ohio Railroad, which were specially designed for running passenger trains at extra fast speed.

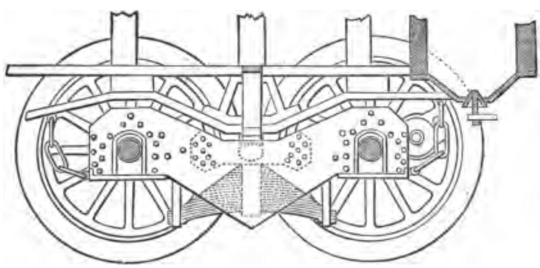
One of these engines, the "Mercury," during the year 1844, ran the large aggregate of 37,000 miles, which, by the annual report of the Baltimore and Ohio road for that year, is assumed to be the largest result on record up to that time.

From what has been here stated, it will be seen that the new system of engine had won fame in both freight and passenger service, but even as late as 1844, it had not established itself in the estimation of some of the best locomotive engine builders in the country. In November, 1838, M. W. Baldwin wrote to a correspondent "that he did not think there was any advantage in the eight-wheeled engine. There being three points in contact, it could not turn a curve, he argued, without slipping one or the other pair of wheels sideways. Another objection was in the multiplicity of machinery and the difficulty in maintaining four driving wheels all of exactly the same size." He however, in 1845, bought the patent-right for this plan of engine of Mr. H. R. Campbell, and the patent for the equalizing beam between the drivers, of Messrs. Eastwick & Harrison, and delivered to the South Carolina Railroad Company, in December, 1845, his first eight-wheeled engine with four drivers and a four-wheeled truck. "With the completion of the first eight-wheeled "C" engine, Mr. Baldwin's feelings underwent a revulsion in favor of this plan, and his

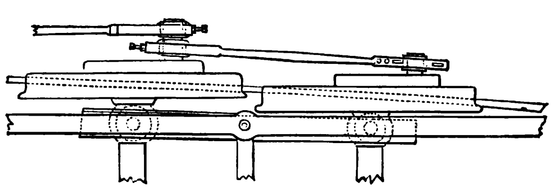
IMPROVEMENTS OF M. W. BALDWIN.



BALDWIN'S SIX-WHEEL CONNECTED ENGINE.—1842.



FLEXIBLE BEAM TRUCK.—1842.



HALF-PLAN OF FLEXIBLE BEAM TRUCK.

partiality for it became as great as had been his antipathy before. Commenting on the machine, he recorded himself as more pleased with its appearance and action than any engine he had turned out."

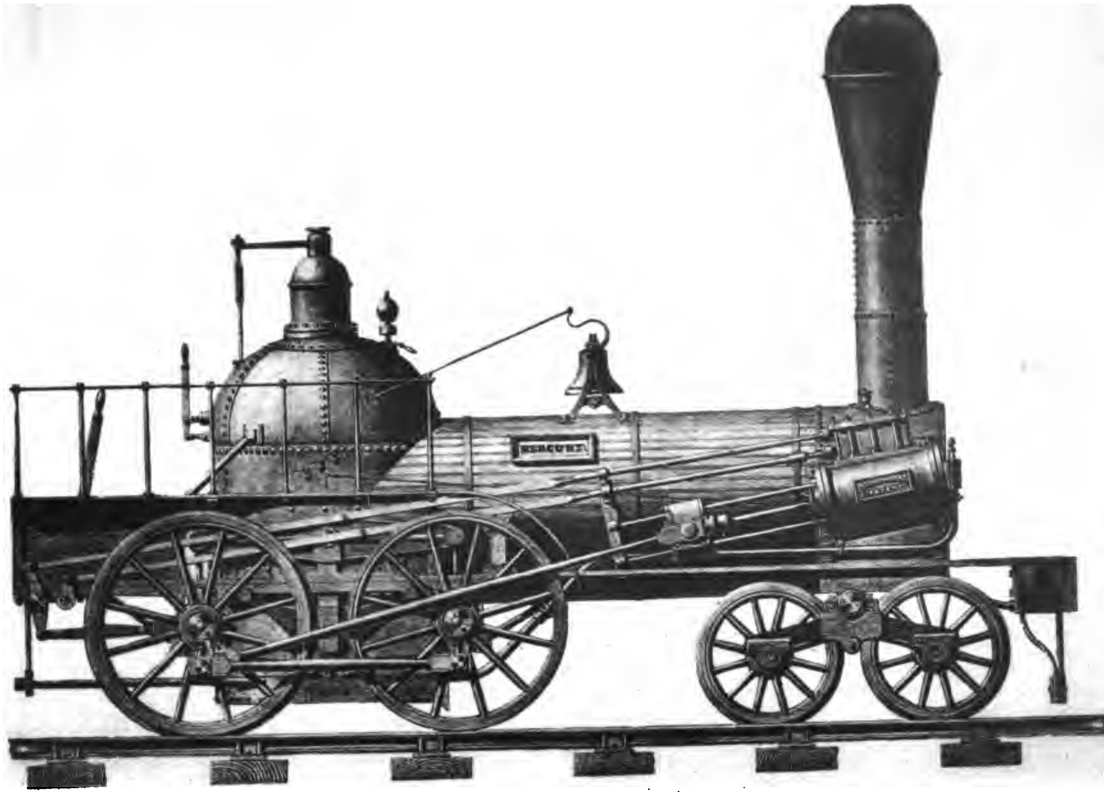
In the "Mercury" was introduced for the first time, the single long spring, forming the side pieces of the forward truck frame, with journal boxes for the axles at the ends, and journal bearings in the middle of the springs, fitted to, and vibrating on the ends of a wrought iron bolster, with the whole weight of the forward part of the engine resting on the centre of the bolster.

The locomotive of the "Hercules" type, and those that immediately followed it from the same makers, is the standard passenger engine in this country, no other being now used, and it has been introduced in Europe for the same purpose. It is no longer generally used as a freight engine. In the years immediately succeeding the making of the Gowan and Marx, it was found that much more than nine tons distributed on four driving wheels was needed for adequate adhesion to the rails, and hence the introduction of six, and even eight connected driving wheels sometimes used with the addition of the forward truck.

Following the early efforts of Baldwin, Norris, Campbell and Eastwick and Harrison, other Philadelphia engineers and machinists entered the field in the manufacture and improvement of the locomotive. Mr. Henry R. Campbell built several very creditable six-wheel engines. James Brooks & Co., aided by Mr. Samuel Wright, a fellow apprentice of Joseph Harrison, Jr., in the workshop of Hyde & Flint, Kensington, a young man of good practical skill, constructed a locomotive which had several new points worthy of notice. Its running gear was after the type of the six-wheel engine of Baldwin, with one pair of driving wheels behind the fire-box, and with outside cylinder connections. The cross-head slides were made in the form of a cylinder, bored out and arranged to serve the purpose of feed-pumps, the cross-head forming the piston of the pump. The connecting-rod entered the lower or open end of the slide, which was large enough to allow clearance at the angles of the rod. The usual valve chamber was placed at the upper end of the slide and thence a pipe led to the boiler. This mode of arranging a feed-pump was more ingenious in design than useful in practice, and was not repeated in a second engine built by the same makers.

Another new point in the Wright engine was the mode of reversement, which was the same in principle as the Costell plan. The slide valve was open through the top, from the exhaust cavity underneath, and terminated in a cylindric form in which was fitted a metallic spring-piston closing up the opening through the valve. When the engine was going forward, steam from the boiler entered the steam chest, and the slide valve acted in the usual manner.

When going backward, by the peculiar arrangement of a slide valve which acted also as a steam or



LOCOMOTIVE "MERCURY," BUILT BY EASTWICK & HARRISON,
FOR THE BALTIMORE & OHIO RAILROAD, 1842.

throttle valve, the steam from the boiler, by a process similar to a two-way cock, was turned under the cylinder slide valve and into the cavity of the exhaust, forcing the piston in the top of the valve, upward and against the evenly planed under surface of the steam chest lid, the exhaust pipe becoming the steam chest, and the steam chest the exhaust pipe, and *vice versa*, when the movement of the engine had to be changed.

This mode of the throttle valve and reversement valve in one, combined with the piston slide valve, was a most simple and certain arrangement. It had, with Costell's, the same defect in the matter of the lead of the slide valve as the "Eastwick" mode of reversement.

Eastwick & Harrison made two locomotives in 1838, with vibrating valves moving on faces on the side of fixed cylinders, reversing Costell's plan. In these two engines the throttle valve and reverse were combined in the same manner as in the Wright and in the Costell engine, by the movement of a slide valve moving over three openings.

With the second engine of James Brooks & Co., also designed by Samuel Wright, an attempt was made to secure the adhesion of the forward swivelling truck wheels in combination with one pair of driving wheels behind the fire-box, which worked with fair practical success. This same idea was carried out by Mr. Baldwin at, or near this period.

James Brooks & Co. did not continue the building of locomotives after this second trial.

About this time, Messrs. Charles and Escoll Sellers, of the firm of Coleman Sellers & Sons, of Philadelphia, built a locomotive somewhat after the plan of the Baldwin engine. It is not remembered that this engine had any specially original points except in the arrangement of the draw-link between the engine and tender, whereby the point of attachment to the engine could be raised or lowered, so as to bring more or less of the weight of the tender for increasing the adhesion of the driving wheels.

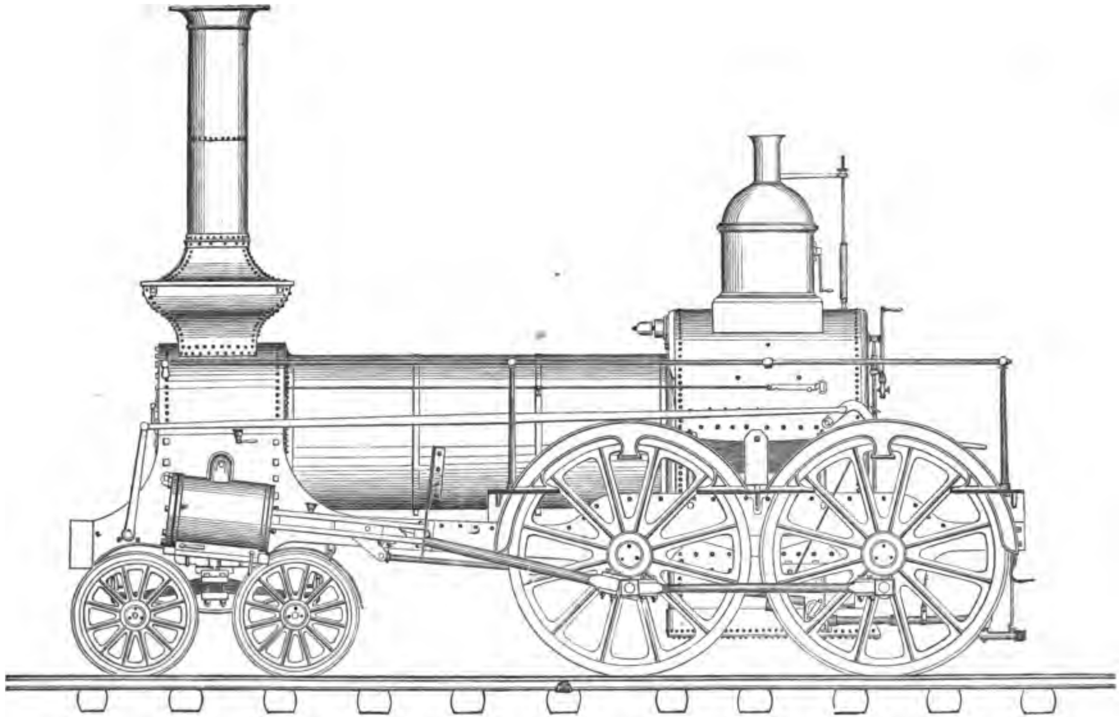
Mr. Escoll Sellers, some years later than this, invented and patented the plan of central rail, with vertical friction rollers, the same as has been used up to a recent period on the "Fell" railroad crossing, Mont Cenis, before the completion of the tunnel.

Edward Young at Newcastle, Delaware, and Leonard Phleger, Philadelphians, also made improvements in the locomotive.

In 1846, Septimus Norris, a brother of Wm. Norris, patented a ten wheel locomotive with six driving wheels, combined with swivelling truck forward. Several of these engines were built for the Philadelphia and Reading Railroad.

It is true that from amongst all these pioneers in the manufacture and improvement of the locomotive engine, the Baldwin Locomotive Works only remains in Philadelphia at this time.

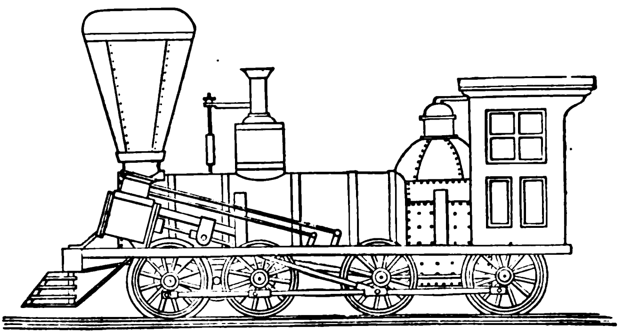
But the fact, that the smaller establishments exist no longer, should not cause the workers in the early day to be forgotten. They helped to attract the attention of the railway world towards Philadelphia as the



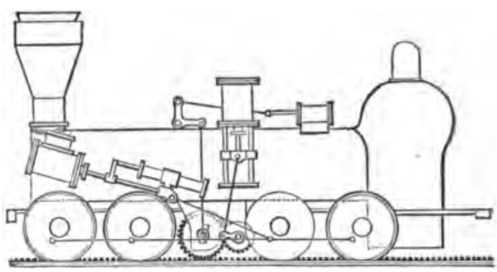
HARRISON, WINANS & EASTWICK'S PASSENGER ENGINE.

Built at St. Petersburgh, Russia, for the St. Petersburgh and Moscow Railroad.—1844.

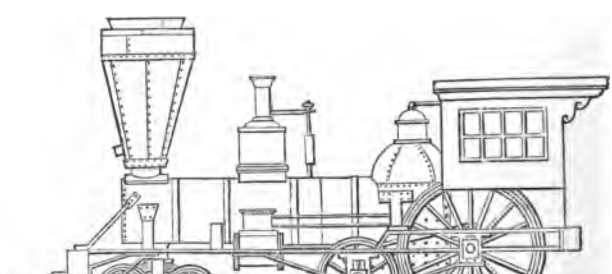
IMPROVEMENTS OF M. W. BALDWIN.



BALDWIN'S EIGHT-WHEEL CONNECTED ENGINE.—1846.



BALDWIN'S ENGINE FOR RACK RAIL.—1847.



BALDWIN'S FAST MESSENGER ENGINE. 1848.

great source of supply for railroad machinery, and in this they helped also to make it possible for us to have to-day, the great locomotive establishment, which is now the pride and boast of Philadelphia.

The eight-wheel engine of Campbell,—first built by him in 1836, and with the added improvements of Eastwick and Harrison in 1836 and 1837, subsequently copied by Baldwin, Norris and all other makers, is to-day, after more than thirty years of trial, with but little change except in minor detail, and in its greatly increased weight,—the passenger locomotive of this country.

Baldwin, Norris and others, did much toward the improvement of the freight engine, and have earned a well-merited reputation in its construction. These improvements in the freight and passenger engine culminated, in a great degree, about 1843, and little has since been done, tending towards important changes in the present system. It is however fairly possible, notwithstanding the improvements that have been made in the freight engine since 1843, in the increase of its number of driving wheels and its greater weight, that the locomotive engine that is to do the heavy transport of the world, has not yet been made. It would seem that but little improvement can be looked for in the present system. If improvements of any great importance are to be made in this class of locomotive in the future, they must be looked for in a "new departure" which may in no small degree ignore nearly all that has been done heretofore.

In tracing this history from the date of Colonel

Long's first effort to the period at which the loco motive has reached its present perfection, it cannot but be noted how persistently and tenaciously Philadelphia mechanics and engineers clung to the early idea of making an engine that should have important original traits, and it is further remarkable that in no single instance has there been even a desire to merely repeat what had been done elsewhere.

Take the best locomotives now made in the United States, and it will be difficult to find one that has not upon it some distinct impress of a Philadelphia mechanic, and it may be fairly claimed that they have made a mark upon this most important and useful machine that is eminently Philadelphian.

In the long future when the story of the locomotive is inquired into and rehearsed by the curious, as it will be, Philadelphia's honor, fairly earned, will not be overlooked, nor should the names of those who have aided in earning this honor be forgotten.

The story has now been told of what Philadelphia engineers and mechanics have done at home, in the early and later day, in the development and improvement of the locomotive engine. This record would not be complete without some reference is made to that which they have done outside of Philadelphia.

These workers can be found everywhere, and for nearly forty years Philadelphia skill has been sought for to fill responsible places in all parts of the United States, in the West Indies, in South America and in Europe, and even in British India.

It is not only in the improvement of the locomotive that Philadelphia engineers and mechanics excel, but they are widely known and appreciated as the designers and manufacturers of all other kinds of railroad machinery. They are particularly noted for perfection in machines and instruments used in building the locomotive engine.

The ordinary observer, in looking at the perfect locomotive of the present day, and the perfect means in material and in instruments, which render it now so easy to make it what it is, bestows little thought upon the amount of labor, both of brain and body, that has been expended in bringing it to this perfection. It is plain from the record, that there was no Royal road to the end attained.

The story of the railroad, has been told in part in this history, and it is shown in how little estimation it was held up to near the close of the decade ending with 1830. Its present value is patent to every one, and it looms up as something so vast as almost to disarm discussion. But this value remained almost entirely latent from the time the first iron rail was laid down in Great Britain until the "Rocket" fired this dormant spark in 1829. From that time the railroad took the place it fills to-day, a result only made possible by the little machine that we now see glinting in the sunlight as it crosses field and meadow with its lengthened train,—that we hear in the darkness of midnight, and that even now is threading its way through the dark recesses of the Alpine tunnel, with a mile of rock above its head, making it possible to change the dreary cold of winter to the summer glow of an Italian sky, in less than one short hour. It is this little machine which never tires in its work, and which we never tire in the looking at; towards which the student turns from his books, the ploughman stays his team,—and the mechanic,—the mother and the playful child, stop in their pursuits, to gaze and wonder as it passes by,—not once or twice,—but ever, as it speeds along, they stop and wonder as at something new and strange, and never seen before,—it is this wondrous steed,

> "With iron nerves, and lungs of fire,"

that has made the railroad what it is, that has won this triumph over Time and Space.

Philadelphia, Dec., 1871.

APPENDIX.

Lines to a Locomotive.

WRITTEN ABOUT 1840.

By Hon. Wm. D. Lewis, of Philadelphia, and first published in the first number of the Philadelphia Evening Bulletin.

Sublimest courser of the plain,
  Whom toil can neither daunt, nor tire,
Onward thou bear'st thy lengthened train,
  With IRON nerves and lungs of FIRE.

Boldest exploit of daring man,
  Whose restless and impatient mind,
Infringes NATURE's general plan.
  And leaves with thee the WINDS behind.

No match for thee in airy race,
  The EAGLE, borne on sounding wings,
Envying he views thy LIGHTNING pace,
  Most wondrous of EARTH's wondrous things.

As some bright METEOR of the sky,
  Or some unsphered and shooting star,
Thou, LOCOMOTIVE, seems to fly,
  Beheld by dazzled eyes afar.

Science and skill their aid impart,
  Trained, hills to level, valleys rear,
Thy pathway smoothed by laboring art,
  To urge thee in thy swift career.

On then, MAJESTIC, MIGHTY STEED,
  Speed thy fast flight from clime to clime.
To thee, the glorious task decreed,
  To cancel SPACE, to vanquish TIME.

OCEAN STEAMSHIPS *versus* SAILING SHIPS.

It seems natural that a comparison should be made between the practical value of the steamship for transport on the ocean, and the Locomotive for transport on land. The value of the latter, nay, its absolute necessity, in the onward march of human progress, needs no argument at this day to render it patent to every civilized mind. Can so much be said of the ocean steamers, now so rapidly taking the place of the sailing ship? Let this question be examined for a moment. The boundless ocean, illimitable in its capacity as a highway between continents and nations, had met all the wants and had done its share of the world's work well, from the earliest dawn of maratime trade, up to the period of the advent of the ocean steamer. Its roadway, always in order, except when disturbed by storms,—the power needed for the movement of fleets which, with scarce a stretch of the imagination, might be in the future almost counted as numberless, was furnished by nature's lavish hand, without cost or stint. Necessity, did not demand a better mode as in the case of transport on land, than had been secured by the modern improvements in the sailing ship, making it almost a perfect thing of its kind. So perfect, that even to-day with the steamship altogether in the ascendant, and the best class of sailing ships gone almost entirely out of use, the sailing ship is still the cheaper mode of ocean transport, when all things are taken into the account. And what is the great result that the ocean steamer has achieved? A reduction of a little more than half the time, with greater certainty of arrival, is all that has really been won over wind and sails. It may be a question whether this greater speed, and this greater certainty of arrival is worth what it costs. The rapid exhaustion, and the rapidly increasing ratio in the exhaustion of the coal fields of the world, may, in the not long future, answer this question in the negative.

J. H. Jr.

Report on Eastwick & Harrison's Eight Wheel Locomotives.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination, Messrs. Eastwick & Harrison's Eight-Wheel Locomotives, Report:—

That these engines possess two peculiarities of an important character, one in the arrangement of the driving wheels, and the other in the mode of maintaining the fire draught.

It is well known to engineers, that the efficiency of the locomotive engine depends, first, upon the quantity of steam which the boiler may be capable of generating in a given time, and secondly, on the amount of friction, or, as it is technically termed, adhesion, between the driving wheels and the road. As the adhesion increases with the weight, it is evident that the engine becomes more effective by increasing its weight, and by throwing a greater proportion of this weight on the drivers.

But a limit to this increase of weight arises from the incapacity of the road to sustain the great pressure thus thrown on a small bearing surface.

To obviate this difficulty, engines have been made with all the wheels coupled so as to constitute them all drivers, and thus distribute the *adhesive* pressure over a greater extent of the road.

Engines of this description are used for heavy and slow draught, but are considered unsafe, from their liability to be thrown off the track at curves.

Another plan, patented a few years back by an engineer of this city, Mr. Henry R. Campbell, was to use four drivers, and at the same time to carry the front end of the engine on a guide truck, as in the six-wheeled engine. But here a new difficulty arose in consequence of the engine having three points of bearing in the line of the rails, on which its weight could not be properly distributed, unless the road was entirely free from irregularities of surface; a condition not to be found on any of the roads which have come under the notice of the Committee.

The improvement invented by Messrs. Eastwick & Harrison is designed to obviate this difficulty, by giving to the eight-wheel engine only two bearing points, one on the guide truck, and the other on a frame supported by the driving wheels. The axles of the drivers are placed one in front, and the other behind the fire-box, and are confined between pedestals of the usual form, fixed to the main frame of the engine, which allow vertical play, but prevent any horizontal motion.

The bearing pins instead of abutting against springs fixed to the frame in the ordinary manner, are jointed to the extremities of horizontal beams of cast iron, one of which is placed on each side of the engine.

To the centre of these beams or levers, are jointed wrought iron rods, which pass down through the engine frame, and carry the springs which support the weight of the engine. The connecting rod of the piston is attached to the hinder wheel, and this communicates motion to the front driver by a coupling rod attached by a ball and socket joint.

It is evident that this arrangement will allow to each driving wheel, an independent vertical motion, with the advantage that the engine will partake of only one-half the vertical motion of either wheel, in consequence of being suspended at the centre of the horizontal sustaining beam.

The front drivers are without flanches, in order to avoid any difficulty in turning curves.

The peculiarity in the means of maintaining the fire-draught, is an apparatus for equalizing the effect of the exhaust steam in the smoke stack, somewhat similar to Gurney's contrivance.

Instead of exhausting directly into the stack, the exhaust steam enters two copper chests, one connected with each cylinder, and escapes from these into the chimney through a number of small tubes.

With the aid of this contrivance, the anthracite fire is kept in a state of intense activity, and generates an abundance of steam, without the annoyance and danger arising from the smoke and sparks of a wood fire.

The heat of the anthracite fire has been found so great as to melt down the grate bars of cast iron which were used in the first experiments with this fuel.

Messrs. E. & H. have since substituted grooved wrought iron bars, which are protected from the action of the fire by a coating of clay placed within the grooves.

A trial of one of these engines on the road between Broad Street and Peter's Island, was witnessed by several members of the Committee on the 25th of April last.

It happened unfortunately, on that occasion, that the business of the road did not furnish so many cars as were desirable for a fair experiment.

The particulars so far as made known to the Committee, were as follows:

Weight of engine, 28,350 lbs.	Weight on drivers, 18,059 lbs.
Cylinders, 12 inches diameter.	Steam, 90 lbs. to square inch.
Length of stroke, 18 inches.	Driving wheels, 44 inches diameter.

The train consisted of 32 loaded cars, estimated at 5 tons each, 2 empty cars weighing 9800 lbs., and tender, 5 tons, making a total of 169 tons. This train was started with great ease on a rising grade and drawn to the foot of the inclined plane, the distance being about 3 miles, with several short curves, and the road in such bad condition as to keep the sustaining beam in continual vibration.

A few days after this experiment, one member of the Committee had an opportunity of witnessing a more decisive trial of the power of the engine.

On the latter occasion, the train consisted of 34 single cars, estimated at five tons each; 4 double cars, 10 tons each; one of Mr. Dougherty's iron boats, 50 tons, and the tender, 5 tons; total, 265 tons.

This train was started without difficulty, on the same rising grade, and drawn over the short curves with apparent ease, with steam blowing off during the whole trip.

This highly interesting experiment was brought to a close somewhat abruptly after proceeding about 2 miles, by the breaking down of one of the cars near the middle of the train.

Although this accident abridged the trial of the power of the engine for draught, it afforded an opportunity of displaying another excellent trait in its performance, this was the facility of reversing* while under way.

As soon as the accident happened, a person stationed on the after part of the train passed a signal to the engineer,

*For a report on this mode of reversing, see Journal of Franklin Institute, vol. xviii., p. 179.

the latter immediately reversed the engine and brought the enormous moving mass to a stand, before it had run half its own length. The satisfactory character of the experiments detailed above is sufficient to enable any one who is conversant with transportation on rail roads, to form a correct opinion of the merits of this engine, The impression of those members of the Committee who witnessed the trials, is that it is well adapted for the use of anthracite as fuel, and for very heavy draught; with less tendency to injure the road or to receive injury on a bad road than engines of the usual construction.

By Order of the Committee.

WILLIAM HAMILTON, *Actuary.*

May 9, 1839.

At the request of Messrs. Eastwick & Harrison, the Committee insert the following letter from A. Pardee, Jr., Esq., Engineer of the Beaver Meadow Railroad in reply to their letter requesting information relative to the construction of the road and the performance of their engines upon it. COM. PUB.

Hazleton, Pa., June 8*th*, 1839.

MESSRS. EASTWICK & HARRISON,

Gentlemen.—I have received yours requesting information as to the construction, &c., of the roads in this region, on which your eight-wheeled locomotives are employed.

The Beaver Meadow Railroad, where one of those engines has been in use two years, has an iron plate rail of $2\frac{1}{4}$ by $\frac{5}{8}$ inches; the wooden rails or string-pieces are oak, a portion 5×7, the remainder 5×8 inches; where the 5×7 rails are used, the cross ties are placed three feet from centre to centre, where the 5×8 they are four feet. The cross ties are laid on plank mud-sills, 2½ inches thick by 10 to 12 inches wide. The shortest curve has a radius of 300 feet; length about 200; but at the foot of the inclined planes, there is a curve around which the engines now daily pass, the radius of which is 250 feet, the length about 300. The heaviest grade is 96 feet per mile, at two points about ¾ mile each, there is an average grade of 80 feet per mile, for 5 miles—on the heaviest grade the shortest curve is 550 feet radius, the length about 400 feet. The Hazleton Railroad, on which two of your eight-wheel engines are now in use, has a plate rail 2¼ by ⅝ inches, the string pieces are yellow pine 5×9 inches, the cross ties 4 feet apart, from centre to centre, the mud-sills 2½ by ten to twelve inches. The heaviest grade is 140 feet per mile for 1½ miles; this part of the road was not intended when made, for the use of locomotive power, but it was found in practice that by doubling our trips we could use the engines with more economy than horse power. In regard to the effect on the road, so far as my experience goes, and I have seen the two classes of engines in daily use for more than two years, I would say that the eight-wheel engine was easier on the road than a six-wheel engine of the ordinary construction, with the same weight on the two driving wheels as on each pair of the driving wheels of the eight-wheeled.

There are now in use on the Beaver Meadow and Hazleton Railroads, seven locomotive engines with horizontal tubular boilers, in which anthracite coal is exclusively used as a fuel, after the first fire in the morning, and that we continue to use it when we can have wood for the cost of cutting, is sufficient evidence that we find it to our advantage. We have the Hercules at work and so far, she performs well, running around the curves with great ease.

Respectfully yours,

A. PARDEE, JR.

Statement of the Performance of the Locomotive Engine, "Gowan & Marx," built by Messrs. Eastwick & Harrison, Philadelphia, on the Philadelphia and Reading Railroad, with a train of one hundred and one loaded cars, February 20th, 1840.

Gross weight of train, including cars and freight, but not including engine or tender, 423 tons of 2240 lbs. Net weight of freight, 268½ tons of 2240 lbs. The freight consisted of 2002 barrels of flour, 82 barrels of whiskey, 459 kegs of nails, 19 tons of bar iron, 22 hhds. of meal, 5 hhds. of whiskey, 4 hhds. of oil, and sundry other articles, making a total of 268½ tons.

Distance from Reading to the foot of the Inclined Plane on the Columbia Railroad, 54½ miles. Running time of the engine with train, five hours thirty-three minutes; rate 9.82 miles per hour. Coal consumed, red ash anthracite, from Schuylkill County, 5600 lbs. Water evaporated, 2774 gallons.

GRADES OF ROAD.

The total fall from Reading to the point where the train was stopped near the Columbia Railroad is 214.5 feet, being an average fall of 3.94 feet per mile. There is no ascending grade from Reading to the Columbia Railroad, with the exception of about 2100 feet at its lower termination, graded at 26.4 feet per mile, upon which grade the train was stopped; the other grades vary from 19 to 15 feet per mile; there is only one three miles graded at 18 feet, and one at 19 feet per mile.

The total length of DEAD LEVEL line from Reading to the Columbia Railroad is 27 miles and 4200 feet; of this, the longest level is 9 miles and 500 feet long, between Norristown and the Inclined Plane; the others vary from 1550 feet to 4 miles and 1600 feet in length.

State of the Track.

Owing to the frost coming out of the ground at this season, the track was in worse order than at any other time of the year; this, however, did not materially affect the performance of the engine, as the embankments were all in nearly as good order as at other times, and at comparatively few points in the deep cut was the track sufficiently out of line or level to offer increased resistance to the train.

The superstructure of the road consists of a T rail, 45 lbs. to the yard, laid upon sills 7 feet long and 7 by 8 inches square, 3 feet 1½ inches apart from centre to centre, and laid on broken stone.

State of the Rails.

For the first twenty miles the rails were in very bad order, the morning was cloudy, and the fog of the previous night had left sufficient moisture on the surface of the rails to diminish considerably the adhesion of the engine; for the remainder of the distance the weather was clear and the rails in good order.

Working of the Engine.

On three different occasions the engine started the whole train on a dead level, and when on a dry rail, without the wheels slipping. The steam ranged from 80 lbs. to 130 lbs. per square inch, to which latter pressure the safety-valve was screwed down. The draught of the engine was created by the escape steam passing into, and from a tubed exhaust box, no other draught was used while running. At the water stations, "Reilley's Patent Fan" was used when fresh coal was thrown on the fire, but at no other time. The speed of the train was noted when passing through some curves of 819 feet radius on the 9 mile level, and found to be 9.8

miles per hour; on a straight line, on the same level the engine attained a speed of 10.5 miles per hour. So little was the engine affected by her performance on the 20th, that on the 23d she drew, on her return trip, 88 burden cars, 9 of which were loaded, and a locomotive engine, making a gross weight of 163 tons of 2240 lbs., not including engine or tender, up a grade of 18.4 feet per mile. The train had a strong head wind against it during the whole trip, which, owing to its length, 1206 feet, was sensibly felt at some exposed points of the road, and must have proportionably affected the power of the engine.

WEIGHT AND DIMENSIONS OF THE ENGINE, "GOWAN & MARX."

Weight when empty, 21,640 lbs.; in running order, with fuel and water, 24,660 lbs.; on four driving wheels in running order, or with water, fuel and two men, 18,260 lbs. Cylinders 12⅜ by 16-inch stroke; 8 wheels, four of which are driving wheels, coupled, 3 feet 4 inches diameter; truck wheels, 2 feet 6 inches diameter. The weight of the burden cars averaged from 1.5 to 1.65 tons of 2240 lbs. each; they were all four-wheeled—wheels 3 feet diameter, and 4 feet 6 inches apart from centre to centre. The above performance of an 11 ton engine, is believed to exceed any on record in this or any other country.

G. N. NICOLLS,

Superintendent Transportation, Phila. & Reading R. R.

Reading, February 24th, 1840.

Letter from Charles Moering, Esq., Engineer to Messrs. Eastwick & Harrison, Locomotive Builders, corner of Twelfth and Willow Streets, Philadelphia.

Gentlemen:—In complying with your request to give you my opinion about your Locomotive Engines, I feel called upon to state the grounds that make this opinion what it is.

I do this in view of the interests of science, not intending to pass a mere encomium upon the productions of your establishment. Every engineer is, no doubt, conversant with the fact, that the power of a locomotive engine not only depends on the harmonious proportions of boiler and cylinders, and on the clever mechanical arrangement to work the pistons and transfer motion to the driving wheels; but every engineer must be also aware of the importance of another fact, viz: the manner in which this power is made available in order to draw a maximum load, at a maximum speed, on a railroad.

In examining this point, we find that a fulcrum is required to enable the steam power to act upon the weight, or the load to be drawn. This fulcrum in the locomotive engine, is evidently the grip of the driving wheels on the rails, meaning the friction between both, or adhesion, as it is technically called.

Let a locomotive engine be ever so powerful, but take away the aforesaid friction, and the wheels will slip, the engine will draw nothing. This adhesion, derived from the pressure of the weight of the engine, must, therefore, bear a certain proportion to the latter. Its maximum will be obtained by throwing the largest, its minimum by placing the smallest amount of the engine's weight on the driving wheels. The minimum, however, has at no time been a desideratum, as the largest amount of adhesion is required for enabling an engine of a given power to draw a maximum load at a maximum speed.

In the six-wheeled American engine (the true offspring of American mechanical talent, as possesing a fore truck, which affords a most opportune facility for turning curves), there is but one axle to bear the aforesaid proportion of weight; and this axle is the driving axle. On its position, therefore, depended the amount of weight to be made available for producing friction. As it was found impossible as well as improper in practice to place this single driving axle under the centre of gravity, for the purpose of equilibrating the entire weight of the engine, there remains but two other positions, viz: behind and close before the fire-box.

To illustrate the effect in both cases, let us suppose two engines, A and B, each of twelve tons weight in running order, with cylinders, boilers, and driving wheels of the same dimensions, and performing the same amount of duty, on two roads of exactly the same kind.

In the engine A, with the driving axle behind the fire-box, it was found that only half of its weight was brought into action for the purpose of producing friction, amounting in this case to $\frac{12}{2} = 6$ tons.

In the engine B, with the driving axle before the fire-box, two-thirds were found available for the same purpose, equal to $\frac{2 \times 12}{3} = 8$ tons. The ratio of adhesion is, therefore $A : B = 6 : 8$, meaning that the engine B possesses a surplus of two tons in its adhesive power, and, consequently, in its capability of drawing loads.

In further examining our subject another question arises, concerning the effect of the given ratio of adhesion on the rails. In the engine A, we have, as mentioned, six tons on the driving axle, and therefore, three tons on each driving wheel. In the engine B, however, we find eight tons on the driving axle, and, consequently, four tons on each driving wheel. The proportion of weight on the rails is accordingly, A : B = 3 : 4.

Supposing these two engines to run at the same speed, S and assuming the stress by impact upon the rails to be represented approximately by the speed multiplied into the weight imposed upon each driving wheel, then each line of rails would be percussed by A, with S x 3 = 3 S, and by B, with S x 4 = 4 S.

This gives a ratio of impact A : B = 3 S or A : B = 3 4; meaning, for the sake of practical illustration, that the engine B will ruin the rails, take them to be thirty-eight pounds per yard, after the lapse say of nine years; whilst the engine A, will produce the same deterioration only after the space of twelve years, supposing the amount of traffic and other conditions to be the same in both cases.

Although no actual observations of this nature have been made with regard to the rails, yet the average duration of the wrought iron tires on the driving wheels, proves the above proportion not to be an incorrect one. The duration of tires on engines, with the driving axle behind the fire-box, has been found to exceed the duration of those on engines with the driving axle before the fire-box; and taking the latter to be nine months at an average, the duration of the first has been found to amount to from twelve to fourteen months.

Wrought iron rails being manufactured in the same way as tires, it can be but a fair assumption, that the duration of rails will admit of the same proximate scale given in the above proportion of impact. This brief exposition, backed by the ratio of tractive power, A: B = 6: 8, and by the proportion of duration, A: B = 3: 4, makes it obvious why the diminution of impact in the engine B, possessing a superior power of traction was found of such great importance, and has thus constantly occupied the attention of the American machinists and engineers. In pursuance of this notion, the eight wheeled engine was started with two driving axles, one before and the other behind the fire-box.

Supposing such an engine C to weigh twelve tons, in running order, and of the same dimensions as A and B, the weight on the two driving wheels was found to be also two-thirds, or eight tons, yet pressing upon the road on the four points of contact, only with $\frac{8}{4} = 2$ tons.

The proportion of adhesion or tractive power, is therefore, $A : C = 6 : 8$, $B : C = 8 : 8$, $A : B : C = 6 : 8 : 8$. The ratio of impact, or deterioration of the rails, being $C : A = 2 : 3$, $C : B = 2 : 4$, $C : A : B = 2 : 3 : 4$.

From this we may infer that rails lasting but nine years under the performance of the engine B, and twelve when traveled upon by engine A, will not meet with their ulterior destruction before eighteen years, when engines of the kind C are running upon them under the aforementioned suppositions.

I can, therefore, but applaud your resolution of building systematically, no other engine but those with eight wheels; four driving and four truck wheels. However, I feel myself called upon to impress you with the advantages that must necessarily result when the number of driving wheels can be augmented to six or eight, without losing that beautiful characteristic of the American engine, viz: the free vibrating truck, which in its office of piloting the engine along the track, I think invaluable for the American railroads, with their sharp turns and light superstructure.

An engine D, with three, and an engine E, with four driving axles, lending an opportunity to make their whole weight available for adhesion, which then would be that due to the maximum weight of twelve tons, in the given case, would certainly possess the greatest tractive power, and yet injure the road in a much less degree. The proportions of adhesion or tractive power, would be the following ones, supposing in every case that the engine possesses sufficient power to slip her wheels in pulling against a fixed point, A : B : C : D : E = 6 : 8 : 8 : 12 : 12; and the proportions of impact or deterioration of the rails, B : A : C : D : E = 4 : 3 : 2 : 2 : 1½. I am aware of all the difficulties attending what I propose, but I feel, nevertheless, confident that "flexible coupling rods," permitting all the axles, with the exception of the main driver, to conform to the radii of curves, are within the pale of practical feasibility. Only on this condition should I think myself justified in preferring engines with a greater number of driving axles than two, were I even inclined to overlook the greater complication that such a mechanical arrangement must require. I reckon simplicity to be one of the cardinal virtues in any mechanical apparatus, and of the most absolute necessity in the locomotive engine.

After this digression, permit me, gentlemen, to come back to the eight-wheeled engine, C, as the subject of my disquistion. Great as the improvement promised to be, in introducing the aforesaid engine, the advantages derived therefrom for the preservation of tho rails, were however, nearly lost. The difficulty consisted in the stiff connection of the fire-box, boiler, smoke-box, and pedestals of the driving wheels with the frame, which acted like a lever. Whenever one pair of driving-wheels was raised by some irregular elevation in the track, resulting from its bad condition, the other pair, in consequence of the springs not acting quick enough to force them down, were momentarily lifted up by the frame, consequently without bearing their due proportion of weight; and on the contrary, when one pair was passing over a depression in the road, the other again, for the same reason had to sustain nearly the whole amount of weight originally allotted to both driving axles, the truck wheels always acting as a fulcrum, and the frame with its fixed pedestals and the axles therein revolving, as a lever.

This could not help injuring the road nearly in the same degree as the engine B; nay, the effects was still more injurious to the engine C itself, as in the case of the main driving axle being suspended by the frame in one of the aforesaid elevations, or depressions of the other driving axle, the former received its rotary motion from the pistons without its fulcrum, or adhesion to the rails.

It is but just to say, gentlemen, that you have saved the eight-wheeled engine from becoming a mere notion, and that owing to your exertions, it has been brought to such a state of perfection as ought to make the old six-wheeler of the kinds A and B, quite obsolete. It is furthermore but justice to state, that your special adaptation of the lever, or the balancing beam to the use of locomotives upon railways, obviated the aforesaid difficulties in such a manner as to leave but little to desire; and here I regret to say, that some of the northern railroads in Germany, notwithstanding the unqualified recommendation of so able an engineer as Mr. C. E. Detmold, have not adopted engines with your improvement.

I consider the balancing beam, supported in its centre by a vertical shaft, resting on springs that are attached by the pedestals to the frame, and stayed on its ends by two vertical pins abutting against the two driving axles, as possessing in an eminent degree the two indispensable qualities, first, of equalizing the weight on both driving axles, in whatever condition the road may be, and therefore, producing in an eight-wheeled engine of twelve tons a constant and equal adhesion of eight tons, yet pressing the rails with but two tons; and second, of furthermore diminishing the very ratio of impact as given above, the weight of the engine being suspended in the middle of the lever beam, causing it to fall only half the depth of any of the driving axles in their passage over any short or sudden depression in the track, while the engines A and B must go down the whole depth as supported by one axle alone, which by increasing the height of fall, must add to the power of the percussion, and therefore, ruin the road even in a shorter period than the proportionate number of twelve or nine years.

But this is not alone what distinguishes your engines; the balancing beam of your arrangement being now used by nearly all the engine builders of note in the United States, after having purchased the patent right from you, which at once bespeaks the great merit and usefulness of your improvement.

It is, besides, the very simplicity of your engines, that must engage the attention of even the least observing. Instead of four eccentrics, four eccentric rods, four latches, and a complicated arrangement to put them in and out of gear, by an extra hand lever, thus making three hand levers altogether—you have but two eccentrics, two eccentric rods, no latches, and a simple arrangement of the reversing valve; the whole to be handled by one and the same lever, and this too, by moving it in exact accordance with the required movement of the engine.

It is true that in reversing you lose in speed, as the lead of the slide no longer takes place; but this loss I think of no moment, as it only happens when the engine is backing. Besides the position of your forcing pumps is such as to prevent the freezing of the water, an advantage of great importance with locomotion in northern climes.

Gentlemen, this is my candid opinion about your eight-wheeled engines, and you are welcome to make any use of this document. Permit me to avail myself of this opportunity, to thank you for your readiness, and the frank and open way in which you satisfied my desire for information; and allow me to assure you that the modest and unostentatious manner in which you spoke of your engines,—trusting more to their own merits than to puffing and boisterous recommendations—has most favorably impressed me with your own personal character.

I am, gentlemen,

Yours, respectfully,

(Signed.) CHARLES MŒRING,
Captain of Engineers in the Austrian Army,
No. 342 *Chestnut Street.*

Philadelphia, September 1*st,* 1840

[Reprinted from "Journal of Franklin Institute" for March, 1842].

Philadelphia, February 12, 1842.

MESSRS. BALDWIN & VAIL:

Gentlemen.—I send you inclosed, a statement of the performance of your new six-wheeled, geared engine, which you will perceive is in every way satisfactory. The train weighed 108½ tons, of 2,240 lbs., more than that hauled by your "Hitchens and Harrison" engine in February last, on our road.*

Statement of the performance of a six wheeled-engine, built by Messrs. BALDWIN & VAIL, *on the Philadelphia, Reading and Pottsville Railroad, February* 12, 1842.

This engine has six wheels and outside connections. The large drivers (forty-four inches in diameter), are behind the fire-box, and connected with the four truck wheels, (thirty-three inches in diameter), by cog gearing, in such a way as to obtain the adhesion of the whole weight of the engine, with little additional friction, and at the same time allow the requisite play in curves.

Her weight, in running order, is 30,000 lbs.; on her large drivers, 11,775 lbs.; or, 5,887 lbs. on each. On the truck wheel, 18,225 lbs.; or, 4,565 lbs. on each, and her cylinders are thirteen inches diameter and sixteen inches stroke.

This engine hauled, on the above date, a train of 117 loaded cars, weighing in all 590 tons, from Reading to the inclined plane, on the Columbia Railroad, fifty-four miles, in five hours and twenty-two minutes, being at the rate of over ten miles per hour the whole way.

*See the number of this Journal for May, 1841, page 319.

She consumed $2\frac{6}{10}$ cords of wood, and evaporated 3,110 gallons of water, with the above train. Weight of freight, 375 tons, of 2,240 lbs.; consisting of 259 tons of coal, twenty-two tons of iron and nails, and ninety-four tons of sundry other merchandise, including fifty-three live hogs, ten hhds. of whiskey, 188 bbls. flour, ship stuff, butter, &c. Weight of cars, 215 tons, making a total weight, not including engine and tender, of 590 tons of 2,240 lbs.

Whole length of train, 1,402 feet, or eighty-two feet over a quarter of a mile. The above train was transported in the ordinary freight business of the road, and was run without any previous preparation of engines, cars or fuel for the performance. The engine was closely watched at all the starts of the train, and not the least slipping of any of her wheels could be perceived. She worked remarkably well throughout the trip, turning curves of 819 feet radius, with ease to her machinery, and no perceptible increase of friction in her gearing. Her speed with the train on a level, was found to be nine miles per hour.

Whole length of level, over which the above train was hauled, twenty-eight miles; longest continuous level, $8\frac{1}{10}$ miles; total fall, from the point where the train was started to where it stopped, 210 feet.

The above train is unprecedented in length and weight, in Europe or America.*

G. A. Nicols,

Superintendent of transportation on the Philadelphia, Reading and Pottsville Railroad.

U. S. Gazette, Feb. 14th.

*See Appendix, page 73, performance of Locomotive "Gowan & Marx" on same road, February 20th, 1840.