Progress of Civil Engineering.

Notes on the Philadelphia and Columbia Rail Road. By W. H. WILSON, C. E.

The statistical information furnished by the following article, must prove acceptable, not only to every person who travels the road in question, now the great thoroughfare through the State of Pennsylvania, but to all who take a lively interest in the progress and nature of those great internal improvements whose commencement and rapid march will forever signalize the age in which we live.

We have been surprised, in traveling over the line of Canals and Rail Roads from Pittsburgh to Philadelphia, marked as it is at almost every stage by some of the grandest features of nature, and by the triumph of art over great natural obstacles, that no description of the route has been offered to the public, accompanied with a good map. Were a pamphlet, containing a descriptive and statistical account of the road, including a map, prepared by some one of the Engineers, and kept for sale in the passenger cars, and at the different Hotels on the route, as well as at other places, we could almost vouch for the ample reward which would accrue to the author, or publisher. The same may be said of the Reading, Baltimore, and other Rail Roads. We are surprised, that no publisher by profession, has taken up this subject, and engaged some one of the Engineers, on each of our great rail road and canal thoroughfares, to prepare suitable guide books, a procedure which we find has been effected in England, and doubtless with profit, in relation to the great rail road tracks. G.

WEST HAVERTFORD, DEL. CO., PENN. }
SEPTEMBER 12TH, 1839. }

From the American Railroad Journal.

Having been employed on the Columbia and Philadelphia railway during its construction, a great many notes relative to the character and cost of the different portions of the work, accumulated in my possession. Taking advantage of some leisure time this summer, (the first that has occurred since the completion of that work,) I have arranged these notes for my own satisfaction, and have added some statements relative to the subsequent operations upon the road. The object being merely to give a correct statistical account, I have abstained from giving expression to any opinions or speculations as to the character or merits of the work. In making comparisons of the performances on different railways, I have often felt the want of correct information as to the important features of the roads in question.

Under the impression that the same might be the case with others, I have thought the annexed account might not be uninteresting to your readers. Should you agree in this opinion it is at your service for publication.

Respectfully yours,

W. H. WILSON.

Columbia and Philadelphia Rail Road.

This railway commences at the corner of Broad and Vine streets, in the City of Philadelphia, and terminates at the borough of Columbia on the Susquehanna river, the length being $81\frac{1}{8}$ miles. It has been constructed and is still owned by the State of Pennsylvania.

In the year 1827, surveys of the route were made by direction of the

Legislature, and on the 24th of March, 1828, the construction of the railway was authorised as a State work. The location was commenced immediately after, and early in the year 1829 the grading and bridging of 40 miles of the road were put under contract; different portions of the work were successively contracted for, according to the yearly appropriations made for that purpose. On the 20th September, 1832, twenty miles of single track were opened for traveling; in April 1834, a single track was completed throughout, and in October of the same year, both tracks for the entire length of the road were open for public use. Much incidental work was, however, done after that time, the buildings for depots, workshops, &c. being in an unfinished state and some turn-outs, farm bridges, &c. not constructed.

Major John Wilson had charge of the operations on this line as Chief Engineer, from the commencement of the preliminary surveys, until a short time previous to his death in the spring of 1833, after which time the work was placed under the direction of Edward F. Gay, Esq. The following description will afford some general idea of the prominent features of this railway. From Broad street the line takes a northwesterly course passing near the Fairmount water works, and from thence runs nearly parallel to the Schuylkill river, which it crosses at the distance of about three miles from the city, the grades being undulating, to conform to the inclinations of the streets which are crossed. Immediately west of the river is an inclined plane of 2805 feet in length and 187 feet in height; this plane is straight and its inclination uniform. From the head of the inclined plane, the line is continued on the dividing ridge between waters flowing into the Delaware and Schuylkill, for about 19 miles, to a point near the intersection of the West Chester railway, where it attains an elevation of 543 feet above high tide; the grades on this portion of the road are varied and undulating, but generally ascending westward. The road now descends the northern slope of the South Valley hill into the Great Chester Valley, and after crossing Valley creek, comes to the East or Big Brandywine, at Downingtown; for nearly the whole distance, (about 11 miles,) the descent is at the rate of 29 feet per mile. The height of railway above high tide at Brandywine bridge is 250 feet. From East to West Brandywine, a distance of about 7 miles, the grades are generally ascending, the whole rise between those points being 121 feet. After crossing the West, or Little, Brandywine near Coatesville, the line ascends the Southern slope of the North Valley hill, until it reaches the summit of the Mine ridge at the Gap. According to the first location, an excavation of 37 feet was required at this point, but upon removing a few feet of the surface, the material below was found to be quicksand; after losing a great deal of time, and incurring heavy expense, in efforts to work down this cutting, it was deemed advisable to raise the grade so as to reduce the depth of excavation to 23 feet; in consequence of which, the grade now stands at 45 feet per mile, descending each way from the summit for three fourths of a mile, and then at forty feet per mile, for one-fourth of a mile, when it meets the original inclination of thirty feet per mile. The Gap summit is 553 feet above high tide at Philadelphia. From this point the road descends, and after crossing Pequea creek, Mill creek, and Big Conestoga, enters the city of Lancaster; leaving which, it is conducted across Little Conestoga, towards the head of the inclined plane at Columbia. This plane is 1800 feet in length and 90 feet in height; it is straight and its inclination uniform. From the foot of the plane, the road continues along the margin of the river

Susquehanna, in front of the town, to the outlet lock and basin of the Pennsylvania Canal. It is graded along the edge of the basin, sufficiently low for the convenient transfer of articles from one mode of conveyance to the other.

The passage of a law to authorize the construction of this railway by the Commonwealth, met with serious opposition, and even after the work had been commenced, it was for some time a matter of doubt whether operations would not be suspended. Under these circumstances, it was the earnest desire of the friends of the road, that as much economy should be used in the construction, as was consistent with a due regard to the utility of the work, when completed. Previous to commencing the location, it became necessary for the Engineer to determine upon its governing principles, and in order to establish these, recourse was had to the experience gained upon works of a similar kind already in operation. It must be recollected that this was in the year 1828, previous to the opening of the Liverpool and Manchester railway, when there were but few railways of any extent in use, and those of very imperfect construction. It was also prior to the successful use of the locomotive engines; it is true that these machines were then operating upon some of the English railroads, but their use was attended with so many objections, that very few were sanguine enough to anticipate their general adoption. After the most mature consideration of the subject, the maximum grade of the Columbia and Philadelphia railroad, was fixed at 30 feet per mile, and its minimum radius of curvature, at 631 feet, these being the limits to which it was thought prudent to go, with an eye to economy of construction on one hand, and the useful effect of the road on the other. The principles here laid down have been adhered to with one exception, which is the increase of grade in surmounting the Mine ridge at the Gap; the distance however for which the grade has been raised is so short, that the difference is scarcely felt by trains passing over the road. It may be proper to observe here, that in references made to this railway by companies prosecuting rival works, or by others interested in representing it in the most unfavourable light, the minimum radius of curvature is stated at 500 feet; there is a curve of this radius 7 chains in length, at the termination of the road, but it is in the streets of Philadelphia, beyond the point at which the locomotive engines are stopped and the trains separated, and ought no more to be taken into view, when referring to the road, than ought the numerous abrupt curves through the Northern Liberties, to be considered as parts of the Trenton Railway. The inclined planes on this road being a source of expense and delay to the transportation, every possible effort has been made to avoid them. A new route of six miles in length has been located, and is now nearly completed, by which the plane at Columbia will be dispensed with; the distance is about the same as the part of the old line to be abandoned, and the grade 35 feet per mile. Several routes have been surveyed for the purpose of avoiding the inclined plane near Philadelphia, but as yet no alteration has been adopted by the State. Two roads have been commenced by chartered companies for this purpose. The West Philadelphia railway is about 8 miles in length, its maximum grade 57 feet per mile, and its average grade $43\frac{3}{16}$ feet per mile; the grading of this road is principally done, but the work is now suspended for want of funds. The other route is by the Valley and Norristown railroads; the distance by the Valley road is $20\frac{1}{2}$ miles, and then by the Norristown road $13\frac{1}{2}$ miles, making a total of $33\frac{1}{2}$ miles or $2\frac{1}{2}$ miles more than the portion of the State road to be avoided; the maximum grade of the

Valley road is $35\frac{7}{10}$ feet per mile, and of the Norristown $37\frac{4}{10}$ feet per mile; the latter road is graded for two tracks, and has one track now in use; on the Valley road the grading is partly done. On no other route yet surveyed for avoiding this plane is the grade less than 40 feet per mile.

The following is a summary of the straight lines and curves on the Columbia and Philadelphia railway.

		Miles.	Chains.	Links.
Straight line,	.	56	62	54
Curve of 3782 feet radius,	.		75	25
" 1981	"	5	24	16
" 1513	"		57	00
" 1260	"	6	16	73
" 968	"		8	42
" 946	"	6	29	04
" 841	"		0	67
" 757	"	3	61	29
" 631	"	1	25	95

Grading.—The width of road is 25 feet in the excavations, and by the original design it varied on the embankments from 22 to 25 feet according to the supply of material, but at this time the top width of embankments generally exceeds 25 feet. The deepest cuttings on the line are between 30 and 40 feet, and the highest embankment is 80 feet.

Inclined planes.—The inclined plane at Schuylkill river is 2805 feet in length and 187 feet in height; at the head of the plane is a building composed of two wings built of stone, connected by a wooden structure over the roadway. Each wing is calculated to hold a stationary steam engine of 60 horse power; only one, however, has been put up. The rope is an endless one, of nine inches circumference when new, and cost about \$2,800. The first rope used was $6\frac{3}{4}$ inches in circumference, cost \$2,100, weighed $5\frac{1}{4}$ tons, and lasted about one year. The inclined plane at Columbia is 1800 feet in length, and 90 feet in height. The engine house at the head of plane is built of brick, and designed to accommodate two steam engines of 40 horse power each, one of which is put up. On both of these planes double tracks are laid, and cars are passed up and down at the same time.

Culverts.—The culverts are all built of stone, and the masonry is either hammer dressed, or rubble work; they are 75 in number, with spans varying from 4 to 25 feet, and contain 31,161 perches of masonry.

Bridges.—The number of railway bridges, or viaducts, is 22; they are constructed with stone abutments and piers, surmounted by wooden structures, and contain 61,425 perches of masonry, and 7,212 lineal feet of wooden platform. Two of these bridges, supported on small stone piers and wooden trestles, have lately been replaced by embankments. There are 33 bridges across the railway for public and private roads. The following are the most important viaducts.

Schuylkill viaduct.—The superstructure is composed of wood, with four distinct trusses, formed of arch pieces, king posts, and braces, being a modification of Burr's plan. The whole width from out to out, is 49 feet 8 inches, which admits of three separate passages, two of $18\frac{1}{2}$ feet each, in the clear, and one of four feet; the latter is intended for foot passengers, one of the former for two railway tracks, and the other for common carriages. The spans are seven in number, and their lengths in clear, between the piers are as follows; two of 122 feet each, three of 135 feet each, and two of

137 feet each. The eastern abutment and four piers are founded upon solid rock; the remaining abutment and piers, upon hard gravel. The masonry is coursed and hammer dressed. Five of the piers were built in the river and required coffer dams; one of which stood in 26 feet depth of water. The whole length of wooden platform is 1,045 feet, and the number of perches of masonry 19,100. The height of the bridge floor above the usual water line, is 38 feet. The total cost including painting inside and outside, was \$133,946.57.

Valley Creek viaduct consists of four spans, each 130 feet in clear between the piers. The piers are built of rubble masonry, and vary from 56 to 59 feet in height. The original structure was on Burr's plan, having two trusses, with a clear width of $18\frac{1}{2}$ feet, and cost, including stone work, \$22,254.21. The wood work was destroyed recently by fire, and replaced by a lattice bridge (lowered so as to admit of the railway being carried over the top,) at a cost of \$17,218.13.

East Brandywine viaduct has four spans, two of 88 feet 8 inches each, and two of 121 feet 7 inches in the clear. The superstructure is on Burr's plan with a clear width of $18\frac{1}{2}$ feet. The whole length of platform is 477 feet, and the height of floor above water in the creek, 30 feet. Cost \$17,523.20.

West Brandywine viaduct has a wooden superstructure, resting upon abutments and piers of coursed masonry with rustic faces, commonly denominated rock work. The length of the bridge platform is 835 feet divided into six spans; its greatest height above the water is 72 feet. The whole cost of stone and wood work is \$57,916.00. The plan is similar to that of the bridge over East Brandywine, except that the superstructure is lowered for the railway to pass over its top. This and the new bridge at Valley Creek, are the only two of the principal structures, on this line, in which the usual form of roof is dispensed with.

Pequea viaduct is a single span of 130 feet, on Burr's plan, and cost \$8,735.50.

Mill Creek viaduct is built on Burr's plan; the whole length of wooden platform is 550 feet, and its greatest elevation from the water 40 feet. Cost \$9,273.18.

Big Conestoga viaduct is 1,412 feet in length, and is elevated 60 feet above the water. The piers are built of rubble masonry, and the superstructure is lattice work on Town's plan. Whole cost \$31,503.57. The longest span of this bridge is 120 feet.

Little Conestoga viaduct.—The piers are built of rubble masonry and the wood work on Burr's plan. The flooring is 804 feet in length, and is elevated 47 feet above the water of the creek. Cost \$15,359.00.

Railway superstructure.—The length of road being, as before stated, $81\frac{6}{10}$ miles, there are $163\frac{2}{10}$ miles of single track; of which six miles are laid with granite sills plated with flat iron bars, 18 miles with wooden string pieces plated in a similar manner, two miles with stone blocks and edge rails, having stone sills extending across the track at every 15 feet, and $137\frac{2}{10}$ miles with stone block and edge rails, (having wooden sills extending across the track at intervals,) except on some of the embankments, where the edge rail is secured, to cross sills of wood, supported by mud sills.

Granite Track.—The trenches are dug in the direction of the road, two feet in width, and 22 inches in depth, measuring from the level of top of sill. Broken stone is then placed and compacted in layers of 3 inches each.

Upon this are laid granite sills varying in length from 3 to 12 feet, and one foot in depth and width. Holes are drilled into the stone (to correspond with the holes in the bars, and to suit the width and position of the track) three and a half inches in depth, and $\frac{5}{8}$ of an inch in diameter. Into these holes, plugs of locust wood are driven, to receive the spikes which secure the iron bars, which are 15 feet in length, $2\frac{1}{4}$ inches in width, and $\frac{5}{8}$ of an inch in thickness. The inner edge of the sills, is chamfered off for a width of two inches, and the outside is backed up with broken stone. Horse power being used on the road when this track was laid, a horse path was formed of broken stone or gravel 6 inches in depth. The average cost for one mile of this track, including the trimming and dressing off half the width of roadway was \$10,179.20.

Wooden Track.—The trenches are dug across the road, four feet apart, eight feet in length, one foot in width, and 16 inches in depth (making 24 inches to top of wooden rail.) Into these, broken stone is rammed in layers, upon which are laid sills of chestnut or white oak, seven and a half feet long and seven inches square. The sills are notched to receive a yellow pine string piece 6 inches square, which is secured in its place by wooden wedges. Flat iron bars are then spiked on similar to those used on the granite track; the horse path is also similar. This track cost \$5,604.48 per mile.

The two kinds of superstructure just described, have been in use on this road about seven years, but during the last year, they have been traveled over only by a few cars drawn by horses, being so much out of order as to be unsafe for locomotive engines. The wooden sills and string pieces have become decayed, and in both cases the iron bars are constantly working loose. In many places these bars have been broken, or split, by the heavy weights passing over them, particularly on the stone track. It is intended to renew this portion of the road with edge rails; a short distance has already been done.

Edge rails on stone blocks and sills.—The trenches are dug in the direction of the road, 28 inches wide, and 24 inches deep, (from top of block;) at every 15 feet these are connected by a cross trench 16 inches wide. Broken stone to the depth of 12 inches, is well rammed in layers; the blocks and sills are then settled in their places by heavy rammers, and backed up to their tops with broken stone. The blocks are of granite, or other hard stone, 20 inches long, 16 inches wide, and 12 inches deep; the sills are of the same material, six and a half feet in length, and one foot square, placed across the track at every 15 feet; the blocks are so arranged as to give a support to the rails at every three feet. Cast iron chairs weighing 15 lbs., are secured to the blocks and sills, by bolts driven into cedar plugs previously inserted into the stone; there are two bolts to a chair, weighing 10 ounces each; between the stone and chair, a piece of tarred canvass is inserted. The rails are of rolled iron, 15 feet long, three and a half inches deep, parallel at top and bottom, and weigh $41\frac{1}{4}$ lbs. per lineal yard. The rail is secured in the chair by two wrought iron wedges, one on each side, weighing 10 oz. The horse path for this track is formed of broken stone and gravel nine inches deep. Average cost of one mile \$12,568.85.

Several miles of track were laid in a similar manner to the above, omitting the stone sill, and substituting in its place two blocks, at a cost of \$10,927.88 per mile. This kind of track was found so liable to spread, particularly in the spring of the year, when the ground was soft, that wooden sills have since been put in at intervals, connecting the two rails of the track.

Edge rails on stone blocks and locust sills.—This kind of track is similar to the edge rail track already described, with the following exceptions: instead of stone sills, locust are used, placed 15 feet apart on the straight lines, and nine feet apart on the curves; to suit which, some bars were rolled in lengths of 18 feet; the stone horse path is dispensed with, the tops of the blocks and sills being level with the graded surface of road. The average cost of one mile on this plan is \$13,240.92; the excess over the cost of the track where stone sills were used, is owing to a rise in the cost of iron, from \$41 to \$50 per ton (delivered in Philadelphia.) On newly formed embankments the following plan was adopted; longitudinal trenches were dug, 22 inches wide, and 22 inches deep; broken stone to the depth of 6 inches, being rammed in, string pieces of white oak or chesnut were laid, 12 inches deep by 10 inches wide; these being notched to the depth of 2 inches, cross sills of the same material, 6 by 8 inches, were secured to them at every 3 feet by pins or wedges. On these sills the iron chairs, rails, etc., were placed. The trenches were connected at intervals, by cross trenches, running out to the edge of the embankment, for the purpose of carrying off any water which might collect. This description of track cost \$12,905.35 per mile.

This road having been designed and constructed with a view to the use of horse power, a system of turn-outs and side tracks was adopted with particular reference to that kind of traveling. Turn-outs were placed at intervals from one track to the other, and side tracks were constructed, adjacent to each of the main tracks, at the distance of one mile and a half apart, for the whole length of the road; these side tracks measured as follows; 160 feet in length parallel to the main track, and 70 feet at each end, curved to the intersection with outside rail of main track. They afforded a space of about 200 feet in length for cars, and as the cars always entered in the same direction after both tracks were completed, only one movable switch was used. The castings were according to J. Elgar's plan, and were made under his direction. Upon the introduction of steam power upon the road, the numerous castings were found very objectionable, and useless; nearly all of them were consequently taken up, and most of the side tracks were also removed. Wherever it has since been found necessary for the accommodation of business to have turn-outs or crossings, new castings have been made use of, better adapted to the present mode of traveling.

The branches connected with this railway which have been completed for use are, the West Chester railway 10 miles in length, intersecting about 22 miles from Philadelphia, and the Harrisburg railway 40 miles in length, connecting at Lancaster, 12 miles from the western extremity. On the former of these roads, horse power is used; on the latter, steam power;—both belong to chartered companies. The following table exhibits the cost of the Columbia and Philadelphia railway as nearly as can be ascertained. From the commencement of the work to the time of its being opened for public use, the gross amount of the appropriations for purposes of construction could easily be obtained; but since that period various sums have been appropriated yearly to this road, some of which properly belong to the item of construction, while others have been applied to objects not connected therewith.

All the documents relating to this subject have been carefully examined and the result is believed to be as correct as can possibly be obtained.

Total cost of Columbia and Philadelphia Railway.

Grading,	-	-	-	-	-	\$649,158	69
Culverts,	-	-	-	-	-	74,113	94
Railway bridges or viaducts,	-	-	-	-	-	327,695	80
Road and farm bridges,	-	-	-	-	-	42,055	00
Fencing,	-	-	-	-	-	65,410	86
Railway superstructure,	-	-	-	-	-	2,181,156	25
Buildings and machinery,	-	-	-	-	-	111,787	12
Engineering and superintendence,	-	-	-	-	-	133,934	31
Damages,	-	-	-	-	-	54,833	29
Repairs,	-	-	-	-	-	42,451	76
Incidental,	-	-	-	-	-	11,980	18
Alteration to accommodate the city of Lancaster,	-	-	-	-	-	60,000	00
						<hr/>	
						\$3,754,577	20

Cost when the road was open for use in 1834; after which the following additional expenditures were made.

Locomotive engines,	-	-	-	-	-	327,203	41
Additional buildings, turn-outs, &c.,	-	-	-	-	-	37,511	16
Retained per centage on old contracts,	-	-	-	-	-	5,134	08
Engineering,	-	-	-	-	-	4,741	25
New ropes at inclined planes,	-	-	-	-	-	11,584	34
Embankment at Maul's bridge,	-	-	-	-	-	1,796	34
Renewal of wooden track,	-	-	-	-	-	18,907	48
Rebuilding Valley creek bridge,	-	-	-	-	-	17,218	15
New road to avoid Columbia inclined plane,	-	-	-	-	-	118,123	53
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						\$4,296,796	92

The following particulars in relation to the working of the Columbia and Philadelphia railway, are compiled from the annual reports of the officers of the road, up to October 31st, 1838, the date of the last report.

	Road expenses.	Motive power expenses.	Road tolls.	Motive power tolls.	Total expenses.	Total tolls.
	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.
From commencement of travel, to Oct. 31, '35.	41,973 13	55,246 27	185,560 67	43,790 55	97,219 40	229,351 22
From Oct. 31, 1835 to do. '36.	75,311 32	184,878 84	173,837 12	90,969 12	260,190 16	264,806 24
From Oct. 31, 1836 to do. '37.	59,024 95	114,859 76	211,324 16	137,338 67	173,884 71	348,662 83
From Oct. 31, 1837 to do. '38.	44,033 23	133,820 90	233,588 75	164,052 74	177,854 13	397,641 49
	<hr/> 220,343 63	<hr/> 488,805 77	<hr/> 804,310 70	<hr/> 436,151 08	<hr/> 709,148 40	<hr/> 1240,461 78

All the cars used on this road belong to individuals or companies, but the motive power is furnished by the State, except in the case of the West Chester cars and some few others, which are drawn by horses. Every thing connected with the management of the motive power is entrusted to an officer styled "Superintendent of motive power;" the repairs of the road are attended to by a Supervisor; these officers are independent of each

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other, appoint all persons employed under them, and report annually to the Board of Canal Commissioners on the state of their respective departments. There are five offices for the collection of tolls, the incumbents of which are appointed by the Board of Canal Commissioners. Separate accounts are kept by the collectors, of the tolls received for the use of the road, and for motive power; the latter constitute a fund, out of which all expenses in that department are paid; for the repairs of the road, yearly appropriations are made by the Legislature.

The rates of toll for the use of the road vary from six mills to four cents per ton (of 2000 pounds) per mile; there are 12 different rates, the average of which would be two cents per ton per mile. The lowest rates are for coal, stone, iron ore, vegetables, lime, manure and timber; and the highest are for dry goods, drugs, medicines, steel and furs. On the United States Mail, the toll is one mill per mile, for every ten pounds; on every passenger one cent per mile. In addition to these rates, a toll is levied, of one cent per mile on each burthen car, two cents per mile on each baggage car, and on every passenger car one cent per mile for each pair of wheels. The motive power toll is, for each car having four wheels, one cent per mile, for each additional pair of wheels five mills, for each passenger, one cent per mile, and for all other kinds of loading, 12 mills per ton (of 2000 pounds.) The owners of cars now charge \$3.25 for every passenger, and \$7.50 for every ton of merchandize conveyed the whole length of the road, they paying all tolls: which is at the rate of four cents per mile for a passenger, and $9\frac{14}{100}$ cents per mile for a ton of goods. Taking the length of the road at 82 miles, the average number of passengers to an eight-wheel car at 30, and the load of a four wheel burthen car at three tons, we have the following results:

Road toll on an eight-wheel car,	-	-	4 cents per mile.
" " 30 passengers,	-	-	30 " "
Motive power toll on car,	-	-	2 " "
" " 30 passengers,	-	-	30 " "

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Total toll for 30 passengers, - 66 " "

or $2\frac{2}{10}$ cents per mile for each passenger, leaving $1\frac{8}{10}$ cents per mile to the owners of the car for every passenger.

Road toll on a four wheel burthen car,	-	-	1 cent per mile.
" " three tons of dry goods,	-	-	12 " "
Motive power toll on car,	-	-	1 " "
" " three tons of goods,	-	-	$3\frac{8}{10}$ " "

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Total toll on three tons of dry goods, $17\frac{8}{10}$

or 58-100 cents per ton per mile, leaving 328-100 cents per ton per mile to the owner of the car.

In making comparisons between the working of this and other railways, the error has generally been committed, of taking the motive power expenses (given in the reports of the State officers) as the whole cost of transportation; it must be recollected, that the State merely furnishes the moving power; the owners of cars have to provide their own workshops, and depots for receiving and depositing good; they are also obliged to send agents with their cars and have to take the risk of all accidents. The duty of the State agents who accompany each train, is to regulate the motions

of the train, and to see that proper returns are made to the collectors, of the passengers and freight conveyed.

Details of Motive Power expenses for the year ending October 31st, 1838.

Expended at workshops,	-	-	-	-	\$14,102 05
" " inclined planes,	-	-	-	-	16,942 90
Superintendent, clerk, and car agents,	-	-	-	-	8,022 00
Car inspectors,	-	-	-	-	1,196 00
Conductor of State cars,	-	-	-	-	407 50
Engineers of locomotives,	-	-	-	-	10,786 00
Firemen,	-	-	-	-	6,662 87½
Watermen,	-	-	-	-	6,825 00
Woodmen,	-	-	-	-	8,212 22
Wood,	-	-	-	-	27,889 33¾
Coal,	-	-	-	-	10,732 67½
Materials for engines,	-	-	-	-	20,720 91¼
Oil,	-	-	-	-	6,568 85
Miscellaneous,	-	-	-	-	852 62
					<hr/>
					\$139,920 94
Add amount of debts contracted,	-	-	-	-	5,600 00
					<hr/>
					145,520 94
Deduct stock on hand, fuel, iron, oil, &c.,	-	-	-	-	11,700 00
					<hr/>
					\$133,820 84

During the same year, the number of passengers conveyed, was 103,336 way and through, equal to 75,612 through; the number of tons of freight transported was 87,180, and the whole number of miles traveled was 260,-400.

List of persons employed in Motive Power Department.

Superintendent of motive power, at	-	-	-	\$4 00 per day.
Clerk,	-	-	-	2 00 "
2 car inspectors, each,	-	-	-	2 00 "
Manager between Philadelphia and inclined plane,	-	-	-	2 50 "
4 agents for passenger trains each,	-	-	-	2 00 "
5 " " burthen, " " " " " "	-	-	-	1 50 "
Conductor of State cars,	-	-	-	1 25 "
Master Machinist,	-	-	-	4 00 "
2 Foremen of workshops, each,	-	-	-	2 00 "
18 Machinists, pay varying from 1 00 to	-	-	-	2 00 "
9 Smiths, " " " " 1 50 to	-	-	-	1 92 "
9 Assistants, each,	-	-	-	1 25 "
Engineer of stationary engine at workshop,	-	-	-	1 16 "
Watchman,	-	-	-	1 16 "
2 Managers, at inclined planes, each,	-	-	-	2 50 "
2 Engineers " " " " " "	-	-	-	2 00 "
2 Firemen " " " " " "	-	-	-	1 25 "
2 Riggers " " " " " "	-	-	-	1 50 "
11 Signal men, and assistants, " " " " " "	-	-	-	1 25 "
26 Engineers of locomotives, " " " " " "	-	-	-	2 00 "

33 Firemen of locomotives, each,	-	-	-	1 25	"
19 Watermen,	-	-	-	1 00	"
33 Woodmen,	-	-	-	1 00	"

The superintendent in his report dated October, 1837, states as follows: "The heavy locomotives now used for the transportation of freight are capable of drawing thirty-five cars, each with a load of three tons, or one hundred and five tons, exclusive of the cars, engine, and tender. If their weight be added, the whole will be one hundred and ninety tons." "The average number of cars to each engine, actually hauled during the season, falls far short of the number just given; this is owing to the irregularity and decrease of business which prevailed, and to the rule, which for the accommodation of the trade was adopted, of starting a train whenever one of sufficient size to justify the expense had accumulated, without delaying, and increasing the expense of the transporters by waiting for a full one.

The number of locomotive engines on the road at the date of the last report was thirty-six, of which, twenty-seven were in good order. The daily duty of the engines is to run from the head of one inclined plane to the head of the other, a distance of seventy-seven miles; between the foot of the Schuylkill plane and Philadelphia, a distance of three miles, two engines are generally kept employed in taking the trains to and fro: from the Columbia plane to the canal basin, horse power is used, the distance being only one mile.

On Steam Engines, principally with reference to their Consumption of Steam and Fuel. By J. PARKES.

This is the second and concluding communication on this subject. In the former, the generation of steam was more particularly considered (see *Athenæum* No. 601); in the present, its application when generated. These are distinct questions, as it is the economy of steam which constitutes the dynamic perfection of a steam engine, whereas it is the economy of heat in supplying that steam which constitutes the perfection of the boiler as an evaporative vessel. These economic properties are totally independent of each other; they may co-exist in a maximum degree, or in very different degrees, and the degree of perfection which any particular class of engines, or which the particular engines of any class, possess, is known from the weight of fuel burnt, of water evaporated, and the mechanical effect realized. As long as engines were constructed with but few varieties, or identical in their forms, the performance of one was a sufficient indication of the performances of all; but new forms of engines and new modes of practice being now introduced, a comparison of the performance on the several systems is a matter of deep practical and scientific interest. With the view of effecting this object, the author has collected all the authentic facts within his reach, and reduced them to common standards of comparison.

The effective power of steam engines may be ascertained either from the resistance overcome, or from the load upon the piston by means of the indicator: the former method being applicable to pumping, the latter to rotative engines. But the effective power of steam in pumping engines, as thus ascertained, is far below the real effective power of the steam, and no exact comparison can be made by these means between the effective power of the steam in the two classes of engines. The useful effect is not synonymous with a true measure of effective power, since the duty is the true use-