Some Inclined Plane Notes, Etc.

In 1831, I was appointed Senior Principal Assistant
Engineer under my friend and Preceptor, Sylvester
Welch, on the Allegheny Portage Railroad in Pennsylvania.
The other two Principal Assistants were my friends Dano
Brown, W. Roberts, and Edward Miller (deceased).

Surveyed and located eight of the ten incline
planes, and superintended their construction, namely,
Nos. 3, 4, 5, on the Western Slope, and 6, 7, 8, 9 and
10, on the Eastern slope of the Mountain.

Mr. S. W. Roberts surveyed, located, and superintended
the construction of No. 152, on the Western Slope,
and commenced upon the Western half of the road, which
was under his immediate charge.

Mr. Edward Miller's duties were chiefly in the
main office, with Mr. Welch, arranging the plans,
and making the drawings for the engines and
machinery for the working of the inclines.

The inclination of the planes varied from eight
per cent, to ten and a quarter per cent. The longest
plane, No. 8, being 3100 feet, with a rise of 10 44
per 100; being a little less than 6.0*

* The old Pittsburg turnpike, which crossed the Mountain
close by, had grades of 6%, and I made it a point in
establishing the grade of the steepest planes on the Rail-
road, that they should be less steep than the grade of
the turnpike; and it was stated in our reports of that day.
In 1832, in company with Mr. Weld, Chief Engineer, I visited the Inclined Planes on the Morris Canal, in New Jersey, and those on the East End and Honesdale Rail Road, both in New Jersey, and took notes and made drawings for the purpose of aiding us in our studies of the details of the inclined planes we were then building on the State Rail Road over the Allegheny Mountain. Various plans had been suggested for building the planes; but no survey had been made or ordered by the State for a railroad without inclined planes. It is however true that a survey was made across the Allegheny Mountain, between Hollidaysburg and Johnstown, in 1826, about 37 miles, having in view a low grade, which was

George T. Unkefer, C. E., under Canvas White, Chief Engineer, had charge of the field work, and I was a draftsman in his staff. John S. Young of New York State, was one of the draftsmen. In the Canals system, in preference to a railroad system, a deliberately adopted in the Session of 1825-26 by the Legislature of Pennsylvania; and Mr. Canvas White, then Chief Engineer, of the Union Canal, a Canal extending from the Schenectady to the Susquehanna, was affixed by the Legislature to make the connection from the Susquehanna to the Ohio, via the Allegheny, the Ohio, and the Allegheny River in the West.
In 1829, preliminary surveys were made under the direction of Col. S. H. Long (U.S. A.) for a railroad with inclined planes between Hollidaysburg and Altoona. This survey was made for the State of Pennsylvania, under the direction of the Canal Commissioners. Col. Long proposed eleven inclined planes, some of them considerably curved.

In 1830, another set of preliminary surveys was made between the same points under the direction of Mr. Mercereau Robinson (one of the oldest members of this Society) who also recommended eleven inclined planes, but urged that they should be straight.

In the session of 1830-31, the Legislature of Pennsylvania authorized the construction of the railroad, with a gauge of 4 ft. 9 inches, with inclined planes without designating the number. I suggested that it might be practicable to locate a line with five inclines on each side of the Mountain, all straight, although it might involve the expense of retaining walls at a few points, and I was directed to try to locate the line so as to have but five straight inclines on each side, while I succeeded in doing, by leaving one plane (No. 8, the higher one from the summit on the eastern slope) considerably longer than the others, and with the maximum inclination of 10 4/5 ft. per 100.

My impression is that had the Legislature authorized surveys with a view to determine whether a railroad with or without inclined planes should be adopted, that possibly a location might have been made with a grade of 5 1/2 to 6 1/2 per mile, which c
could not have increased the distance more than fifteen miles. It was not certain at the time that locomotives
would be used on any part of the Mountain Railroad. On a portion of the road, at my earnest petition,
a grade of 32.8 ft. per mile, on a straight track,
for about three miles, between the fort at Platte
10 and Hollidaysburg, was adopted in place of
a line with numerous curves on a grade of 42 \frac{1}{106}
ft. per mile, upon which locomotives were afterward
used. At that period there was quite a Common
impression that locomotives could do very little work
on grades above 30 ft. per mile; and this was the
maximum fixed by Major Wistar, Chief Engineer,
in locating the State railroad, 30 miles long, be-
tween Philadelphia and Columbia; a town on
the Susquehanna, twelve miles west of Lancaster.
This selection involved the location of two inclined
planes which were constructed; one near Phila-
delphia, called the "Schuylkill Inclined Plane," and the
other at Columbia, called the "Columbia Inclined
Plane." These planes had gradients of 8 ft. per
100, and were about half a mile long, each. The
intermediate line—about 76 miles, was located with
the maximum grade of 30 ft. per mile, and numerous
Curves of 13°, or about 439 ft. radius. The "gap sum-
mit" cut, however, proved to be so true above and east,
on account of quirkstone encountered in the excavation,
that it was finished with a grade of about 43 ft.
per mile; and it so remains. (On the Continuation
of this railroad from Lancaster to Harrisburg—37 miles,
I located for a private Company. Then styled the Harmling, Portsmouth, Mount Joy and Lancaster Rail Road Company. I adopted a maximum gradient of 0.75 per 100, or 39 40 ft. per mile. This was adhered to. Afterwards, when the Pennsylvania Rail Road became the purchaser of the State works, they leased their Harmling and Lancaster line; and it now constitutes a part of their main road between Philadelphia and Pittsburgh.

To return from this digression, to the Alleghany Mountain Inclined Planes. In the spring of 1834, the road was regularly opened to the public for traffic. It was literally "opened to the public." Any person could put a car on the road, and travel them, with horses, to the foot of the planes on either side of the mountain, and between the planes. The State transported the same on the planes, by means of stationary engines, one at the head of each plane. This system is a

What time, as the number of cars increased, as are

the sum of 1847.

In 1848, the Legislature of Pennsylvania appointed me the Engineer to survey and report upon a roadway avoiding the "Schuyler's Inclined Planes" near Philadelphia. At the time of this appointment I was engaged in building a Canal in the State of Ohio. I made the survey and report upon a line avoiding the Inclined Planes in the summer of 1848, recommending the line substantially upon which it was afterward constructed, where it runs from New York, terminating, as at Deer Vane, in Westfield, and continuing that branch by a bridge across the Schuyler-where, together with the.

Powers.
as the number of separate parties, leaving Gen. Munson on the road, became exceedingly troublesome.

During that year, 1834, I had charge of the management of the running of the road, inspection, weighing and numbering of the cars, as well as the control and management of the new Inclined Planes.

At the same time, the State having so determined, a second track was laid throughout between the Planes, during that year and duplicate engines were erected at the heads of the Planes. This work was under the charge of Mr. W. H. Roberts.

A large number of Cast-iron Chains were required for this railroad, there being one every three feet on each of the rails, the rail and being of the "edge" pattern - so-called, and weighing 39 lbs. per yard. Added to my other duties, was that of superintending the Manufacture and letting the accounts of the Manufactures of these Castings - which weighed about 14 lbs. each. In the first track, stone blocks 2 ft. square, 1 foot thick, were used as supports for the Chains, which were fastened thereto by means of spikes driven through blocks placed in holes six inches deep, pronnected, drilled in the stone.

In the second track, stone Cross-ties, 7 ft. long, or intended 7 ft. from Centre to Centre were used. This made a very solid and a very rigid road, as may well be imagined. It may as well be here stated that in a few years these stone supports were superceded by the ordinary Wooden Cross-ties.

The "Columbia Inclined Plane" was also avoided about the same time, upon a route surveyed by M. H. Huffmase, C. E., (who had previously been one of my Assistants in the Delaware Canal - who is now deceased).

At about 1850, the State railroad between Philadelphia and the Susquehanna River was freed from Inclined Planes, and having no grade now about 40 or per mile.
The delivery of the material along the line for the second track, and for the duplicate engines at the station, added to the general transportation of freight and passengers, with only a single track Company between the planes, demanded daily attention on the line, as there were questions constantly arising, in the use of the road, which I was daily called upon to settle - and the telegraph was not yet born. In fact railroading such as we see in the world to day had no existence.

The machinery which worked the plane was simple. An endless rope of about three inches diameter passed around a horizontal double-ground fixed wheel at the head of the plane, and a smaller horizontal double-ground movable wheel at the foot - between the two tracks, where the slack, when necessary, was taken up. The motion was transmitted from the engine by a geared cog wheel. The engine was double cylinders, of sizes proportioned to the particular plane. There were two systems of brakes for leading and stopping: one the ordinary iron band friction; the other a water cylinder, with a regulating valve, which by closing checked the speed, and which when entirely closed stopped the motion. I often let train down a plane by the water brake alone, without using any steam; and sometimes I let a loaded train of four cars bring up several empty cars, by means of the water-brake alone. Engine rated at 30 and 40 horse-power.

The ropes were hempen, at first, though some grass ropes were tried, and announced tolerably
well. The cars usually weighed about three to nine and a half to one-fourth of a ton each, and were four-wheeled. The passenger cars were also four-wheeled, and large enough to seat about 25 persons inside, and about two or sometimes more on top. We sometimes sent the passenger cars through, from Philadelph to Jefferson, or vice versa, in less than six hours, and occasionally in considerably less time. It depended very often upon delays arising from the number and position of the freight trains.

Upon one occasion, at Plane No. 10, when the engine was out of order, I carried the business of the road by means of one of Mr. Norris' locomotives, which weighed I think about twelve tons, by running it up the plane empty, and then attaching it to the endless rope on the ascending track, pulling on steam, and thus pulling up a train on the ascending track; then detaching the engine at the foot and running up as before. The name of a similar engine was run up on the planes on the East side of the Mountain by its own steam for ever during the season of 1834. The grade of No. 10 plane was 84 per cent on the 422' per mile 100', and about half a mile long. The steepest plane 541' per mile, per mile. The plane was 10' 4' per t' per 100', and 3100 ft. long. The grade between the planes were very light, generally, not exceeding 0.140' per t' per 100', or 27.12' per mile.

* My opinion at the time the engine was run up a grade of 541' per mile, that it was near the limit of grade at which an engine by its own resistance could be run up by steam power.
The cars running up and down the plane was attached by means of stopper ropes, and the men at the plane. It was wonderful the extent of hitching and unhitching; or that when a train of four cars came to a plane, either ascending or descending, it was unloading passed with very little loss of time. Occasionally a defective hitch would cause a car or off of a car or train, doing considerable damage. Mr. Welch, the Chief Engineer, suggested the use of a two-wheeled car with a hose running along the rail. Whilst I was drawing a plan from which to have one constructed, as an experiment, it occurred to me to make one with only two wheels, which would be very much lighter, and more easily handled by the men at the head and foot of the plane. The idea being approved, I had one built under my direction in downtown. It was tested on Plane No. 1, by allowing a car of iron ore or fire iron to slide it with a new of some feet down the plane. It stopped the car at once. This car was then utilized and followed by others, and they were henceforward used at one of the planes on the Railroad. The plane was copied and introduced on the State Indiana Planes at Philadelphia and Columbia, and used for many years. Accidents from the breaking of the main rope, or the hitching rope, were thus rendering comparatively harmless.

There was one other incident at Plane No. 10, the lowest on the Eastern side of the Mountain, which may
not in uninteresting. The head of the plane was at an elevation of nearly 200 feet above a mountain stream called Blair's Gap Run, upon the top of a very compact slate rock formation, with no flaking stream nearer than the new one just mentioned. The foot of the inclined plane was carried ten feet below the old bed of the stream, in order to keep the grade down to 5.8 ft. per mile. This was managed by culverting the stream under the limestone, some distance above the foot, and excavating a new channel bringing it in and passing it under the grade of the railroad half a mile or so below the plane.

A well was begun at the head of the plane, and a few sticks were set, but was started and sunk. It had to be dry, that the water for boring purposes, the case of the use of winding engines at the head of the plane, had to be hauled up the plane. After it had been sunk some feet below the bed of Blair's Gap Run, I proposed to get water— at least temporarily— by laying wooden pipes from a point in the run about 1 1/2 miles up, which was found to be high enough to allow the water to flow to the head of the plane by gravity, and this was done. Meanwhile the boring went on to 700 and 800 feet, without ever finding a drop of water excepting what was found into it at the top. It was then abandoned.

The slate rock formation, through which much of the inclined plane was excavated, dipped into the mountain spur on which it was located, at an angle of about 30°. It turned out to be very compact, as far down as the above deep boring, as to be equivalent to hard rock, no water whatever percolating through it, to that depth.
In 1806, Mr. W. Norris invited me to meet a number of gentlemen and himself, to witness a special performance of one of his locomotives. He said he would take a passenger car with 50 passengers in it up the Schuylkill Inclined Plane, near Philadelphia, at the rate of two miles an hour. The first time he went up, he found that the time malicium plane had gained on the track, which prevented the test that morning, but soon after when the time had been removed he did take up a passenger car with 50 passengers at the rate of ten miles an hour. A careful record was made and printed in pamphlets, but I have not seen it for many years. One of the passengers was an English officer, who, as Mr. Norris afterward told me, when he related the occurrence in England, was not convinced. The railroad savants at that time having decided that the limit of locomotive possibilities on grades stopped far short of 1422 feet per mile, which was the grade of the Schuylkill Plane, with a length of about half a mile. (I write entirely from recollection.) Mr. Norris was the time building several locomotives for me to be used on the Cumberland Valley Road between Harrisburg and Chambersburg, which was opened in 1836-37. One of those locomotives, the "Nicholas Price", continued running on that road for many years. I think it ran about 38 years. It had only two drivers of five feet diameter.

*Passenger Car with 8 wheels were then in use, but they had not been raining in use, for some period between 1833 and 1836, Mr. Norris took one from his shop on Bush hill over to M'r Andrews' shop, where I examined the first 8-Wheeler car I had seen, and pronounced it - "Not the thing, for the Cumberland Road"
After the Pennsylvania Railroad Company had built their Railroad over the Allegheny Mountain between Altoona and Johnstown, and after the Allegheny Portage Railroad with its Inclined Planes had been in use for about twenty years, the legislature of Pennsylvania directed surveys to be made by my friend Robert Faris C.E., who was then in the State service, and to ascertain the feasibility of a gradeless road without inclined planes with a maximum grade of 75 feet per mile. The legislature appointed Edward T. Gay, C.E., Robert Faris C.E., and myself, as Commissioners to examine and report upon the advisability of retaining all or some of the Inclined Planes, or of constructing a gradeless line without inclined planes. Accordingly, the said Commissioners made the necessary examinations in the summer of 1853 or 4. We were unanimously of opinion that it was better for the State to abandon all the Planes and construct a new line on the route recommended by Mr. Faris, and the road was built by the State upon the route recommended by the Commissioners, having a maximum gradient on the Eastern side of the Mountain of 95 feet per mile, and on the Western side of about 52.8 feet per mile. The new State Railroad and the Pennsylvania, come the Mountain within less than a mile of each other, both having tunnels; the tunnel of the Penn. R.R. Co. being something over 3900 feet, and that of the State road about 1850 feet or about half the length of the other. The two roads are in sight of each other on the
eastern side of the Mountains for several miles before reaching the summit, and on the Western slope of the Mountains they can almost be by filed for some miles, and both pass down the Valley of the Conemaugh to Johnstown.

Shortly after the completion of the new State Rail Road, and the abandonment of the old Allegheny Portage Rail Road, the State Public Works were sold, and the Pennsylvania Rail Road Company became the owner of the Columbia Rail Road, the old Allegheny Portage, the new State Rail Road on the Mountains, and the State Canals between Columbia and Pittsburgh. Their Company soon after took up the rails, from the new State Railroad and applied them on the line between Pittsburgh and Fort Wayne and Chicago; and to ended the last vestige of State railroads in Pennsylvania.

I was personally present at the birth of Pennsylvania State Railroads, arrived there in their youth and manhood, and witnessed their funeral obsequies; all in a period of about twenty-one years.

In December, 1857, I visited Brazil, and on Company with several other gentlemen made a Contract with

* About the time that the Conarees referred to were engaged examining as already stated, I received a letter from my friend Mr. J. Edgar Thomson, President of the Pennsylvania Rail Roads, to the effect that their Company entertained delusions of building an inclined plane railroad over the Mountain for their freight business. It was not however built. It is a question for calculation and discussion.
the Dem Pea Secunda Railway Company to build their railway difficult and costly, that it had to go across the Serra, back of the City of Rio Janeiro. It was regarded at the time as the most difficult and expensive railway that had at that time been undertaken. More difficult and more costly works had since been carried through in Europe, and in the West Coast of South America.

The limit of grade and curvature adopted was the same as had been used on the Pennsylvania Rail Road Mountain Division above Altoona, namely, 90 ft. per mile ascent, and 8 degrees of deflection per 100 feet. This involved a number of tunnels - 13 in the distance of nine miles, one of which at the summit was 7200 feet long (another nearly half a mile long, the others about one mile long, totaling together 3-1/2 miles of tunnel in the nine miles of line.

About 1863, the road being well advanced on the eastern slope of the mountain, and considerable force was west of the summit, it became obvious that time and money might be saved by the construction of a temporary track over the mountain around the Tumee Grande, or Big Tunnel, and the Company agreed to allow about $125,000 towards building it. It was built with grades of about 238 ft. per mile, with curves of only 230 ft. radius. The summit of the Sierra which had to be surmounted was about 500 ft. above the grade of the railway at the eastern Portal of the Big Tunnel. The road
The temporary road was about three miles long on the Eastern side and about two miles on the Western, making a total length of about four miles.

This was used about two years, during which a large amount of material for the Western side was carried over, and much freight, especially Coffee, and many passengers were daily transported, without any accident. The locomotives, were built by Baldwin & Co. of Philadelphia, moguls, weighing 47 tons each. They turned the corners very wide, and usually took one baggage car, passenger car, American, 8 wheeled, and four or five freight cars. They were limited to a slow speed, about five or six miles an hour, though they could have gone faster had it been desired; but absolute safety was deemed to be an essential element in the management of a great railroad unaccustomed to such work.

Annoyed at a people, many of whom had declared that they "would never ride through the Big Tunnel under the Serra."

The Emperor of Brazil, Dom Pedro Segundo, was not chosen one of that class (as the people of the United States and of many other countries have since had opportunities of knowing). He visited the railroad several times at Merced, and inspected every part of the works carefully and intelligently, descending the iron shafts of the Big Tunnel—140 feet deep, without the slightest hesitation; and when the time came for blowing away the cars remaining few feet of
granite rock to effect a Centennial Passage through this tunnel he was there. The Emperor walked up to the face of the rock, listened to the blow of a hammer on the other side about four feet of timber intersecting, saw the long holes loaded and partly loaded, then stepping back a few hundred feet behind a safety barricade waited the firing which took place a few minutes later, and was then the first man to pass through the space which the blasting had made. The writer accompanied him through, where he was met and cordially and the debris of the rock by W.T. Boyd the foreman on that side.

The temporary track on the Mountain was used for a long time after their occurrence, for strange to say, this granite Mountain, where it was the highest on the line of the tunnel—500 ft. above grade, instead of being very hard, as was anticipated. Construction was accomplished granite subject to heavyCaving and requiring cutting at many places. Their of Caving delayed the opening of the tunnel and indicated its Cost. Its construction occupied about seven years. The credit of the admittance Management of these difficult work belongs largely to Jacob Mumbrue, now of Cambelland Maryland, who had previously had experience upon time of the difficult tunnel on the Baltimore and Ohio Rail Road.
The use of heavy grades has been more complete than elsewhere and upon a heavier grade than any I know of, our whole freight and passenger have been regularly carried. Until it was mentioned at the last meeting I was not aware that as portion of the grade over the temporary track at Kenwood Tunnel was so great as 10 per cent. I was under the impression that the grade there was about 96 feet per mile as at first idea, and that that was the heaviest in the Baltimore & Ohio road. I have
recently seen Mr. Latrobe's admirable paper on the subject, published in the "Rail Road Gazette" of Dec. 5, 1874, which gives all the particulars, with maps, and profiles, with at the Kenwood," and "Board Tree Tunnel."*

In regard to "Parr's Ridge," Mr. Latrobe wrote:

"The occasions referred to were not indeed the first upon which locomotives had ascended steep inclines, for one of the little 3-ton grasshopper engines of the Baltimore and Ohio Railroad had mounted and ascended the original grade of that road across Parr's Ridge, (one which was 360 feet per mile), since superseded by one of 32 feet. An engine of some 10 tons, built by the late William Norris, had also ascended the old Schuyler inclined plane near Philadelphia, and no doubt these experiments upon a small scale encouraged them upon a more extensive one which I have given the preceding account."

* During the fall of 1874, I was in Europe, and my Railroad periodicals to accumulate up to the end of that year, that I made them all a present to a young friend, and thus I missed Mr. Latrobe's excellent paper.
The letter of Mr. Lasalle, already mentioned, is the most
interesting and satisfactory presentation of experience on
steep grades I have ever seen. It should be read by
every one who feels an interest in that subject.

At Kinigwood Tunnel, on the N.C. & O. R.R. the top of the Ridge
was 210 ft. above level grade ground at East end of Tunnel.
Temporary track on the East side reached Summit
in 3, 400 ft. Grade first 2200 ft. not uniform—steeper
average 216 ft. per mile. Remaining
1200 ft. distance, at 120 ft. height of slope, in a curve
g of 180° with radius of 300 ft. and 400 ft. One in ten on
a Curve of only 300 ft. radius is a Considerable Great
less than 10° per 100 ft. in a Straight track.
The average ascent of the whole 3,400 ft. on the
East side, was at the rate of 33 ft. per mile.
An engine of 25 ton (56,000 lbs) tender 34,000 lbs. Car
yement other materials, at 30,000 lbs. total 120,000 lbs.
or 60 ton y 2000 lbs. taken up a grade of 528 ft. per
mile through a Curve of 300 ft. radius. The grade on
the West slope was much lighter than in the East slope—
falling 305 ft. in 7000 ft., averaging 1 in 23, or 230 ft.
per mile. The steep grade was used about two
months, in 1852. Afterward an improved line was used
the grade from 528 ft. to 230 ft. per mile.

At Boone Tree Tunnel, on the N.C. & O. R.R. there was also
a temporary track on the Ridge, with a grade of 1520, or 204
ft. per mile, coming 328 ft. with two switch backs on
the East and five on the West side. Max. grade left
in 100, or 31% ft. per mile, other reaches 44% per 100
or 211 ft. per mile. Engine 36,000 lbs. tender 34,000 lbs. two
locomotives 30,000 lbs. each—total 157,000 lbs. or 713
tons. When some another Car-Tunnel was added, and
still another. Mr. Lasalle refers to a pamphlet published
by the late Charles Ellet, C.E., in 1856—"Mountain Top Tracks."