40TH CONGRESS, } SENATE. { EX. DOC.
3d Session. } { No. 54.

LETTER

OF

THE SECRETARY OF THE INTERIOR,

COMMUNICATING,

In compliance with a resolntion of the Senate of this date, a copy of the report of the special commissioners upon the Central Pacific railroad of California.

FEBRUARY 27, 1869.—Read, ordered to lie on the table and be printed.

DEPARTMENT OF THE INTERIOR,
Washington, D. C., February 27, 1869.

SIR: Pursuant to a Senate resolution of this date, I have the honor to transmit a copy of the report of the special commissioners upon the Central Pacific railroad of California.

I am, sir, very respectfully, your obedient servant,

O. H. BROWNING, *Secretary.*

Hon. B. F. WADE,
President pro tempore of the Senate.

SAN FRANCISCO, CALIFORNIA, *January* 25, 1869.

SIR: The undersigned, constituting a special board of commissioners appointed by the President of the United States for the examination of the Central Pacific and Western Pacific railroads and the telegraph line, under your instructions of the 15th of October, ultimo, have proceeded to the execution of said service, and, as far as they have been able to complete the same, herewith present their report.

The board have already advised you of the general result of their examination of the Central Pacific railroad and telegraph line, in a brief telegram 3d December, and subsequently in a letter of December 7th, of their method of proceeding in the performance of their duty. This telegram and letter are included in Appendix A to this report. Since the date of that letter Mr. Calvin Brown, the secretary of the board, has again gone over the entire line of the work from Sacramento to the North Fork of the Humboldt river, which includes a distance of about 30 miles beyond the position visited personally by the board, and on which the rails had not then been laid, being in the process of grading, but nearly completed.

On this occasion the secretary has gathered all the essential details pertaining to the object of this commission, as far as the Central Pacific road and telegraph are concerned; the board therefore propose to deal with this portion of their instructions, and to reserve their report on the

Western Pacific road until they shall have had an opportunity for its examination, which has been deferred by the sickness of Mr. Day, one of their number, and by the accumulation of other official duties during his absence on this service. It will be observed that our examination of this road has extended over these stages of its construction, viz: The completed portion in full operation, the part on which the track has just been laid, and about 30 miles of that portion of the line where only grading was going on. The examination of this latter portion seemed to be desirable, as affording an inspection of the manner of the company's proceedings in all the details of construction; judging of the general character of the work in those points which, when completed, are out of sight.

LOCATION.

The general route of the road between Sacramento and Monument Point, at the northern extremity of Great Salt lake, is so nearly direct that, in its whole distance of 662 miles, the greatest deviation of any point thereof from a straight line joining those extremities is but 55 miles, (and only one instance of such,) or, as expressed in proportion to the entire distance, only one-twelfth. This circumstance, considered in reference to the great variety of the topography traversed by the line, including high and rough mountains, and a broad desert plain intersected with numerous ranges of hills, whose crooked cañons afforded the only means of passage, must be considered remarkable among railroad examples as a fortunate result in regard to economy of travel, as well as indicating thoroughness in the selection of the general location. The prospective difficulties of the undertaking could not fail to present themselves to the projectors, and the company was forced by their extent and intricacy to the study of an exceedingly wide range of country in order to reduce them as far as the adoption of the best route could do so. The broad stretch of country traversed by the route seems to have been thoroughly explored, not only by the various national expeditions which have been sent through it and the vast number of emigrants who have passed over it, but by the more minute surveys of the company's engineers, and it may be assumed, as the result of the varied knowledge thus acquired, that the best general location for a great national railroad between these two points is probably the one that has been adopted here.

TRACE OF THE ROUTE.

Commencing at the city of Sacramento, the first object of achievement was to cross the Sierra Nevada mountains over the lowest practicable elevation with the shortest distance, both in entire length and in extent of snow-belt. This range being nearly perpendicular to the general direction of the route, with its nearest pass at an elevation of 6,988 feet above the initial level of the track at Sacramento, within 105 miles thereof, could be overcome only by a persistence in ascending grades, and only such ground as permitted this requirement within the limit prescribed by law could be used.

The point for the passage of this summit which was found most accessible and favorable among all the conditions of the case was Donner Pass, the line of approach thereto from Sacramento being taken obliquely to the slope of the Sierra, in order to secure the distance necessary to avoid any infringement of the established maximum grade. This line was in a general northeasterly direction for 85 miles to the latitude of

the Pass—about 39° 30′—when it turns easterly and continues for 34 miles, passing south of Donner lake to the Truckee river, having crossed the entire summit and snow belt, and avoided the deep and wide cañons with which this range is intersected. This portion of the line is necessarily characterized by a large proportionate distance in curves, this feature being imposed not only by the abrupt and broken nature of the country and its materials of granite and porphyry, but by the necessity of obtaining distance by the grades as above intimated.

The location, however, is rigidly restrained by the legal limits prescribed, both in regard to curves and inclinations. After meeting the Truckee, which is at a point about two miles east of the easterly end of Donner lake, and nearly at the confluence of the outlet of this lake with the Truckee, the line is confined to the valley of this river through the Washoe mountains as far as the Big Bend of the Truckee, where the valley widens and the stream suddenly deflects to the north. This point is 189 miles from Sacramento. On this portion of the route the general alignment becomes of a more favorable character, there being only one stretch thereof, of about 20 miles, where this stream pursues a northerly direction through a narrow and deep cañon, which necessarily diverts the line from its direct course.

The Big Bend marks the westerly edge of the Truckee and Humboldt desert on which the line now emerges. Striking easterly for seven miles to turn the southern extremity of the united Truckee and Nightingale mountains, the line bends to the northeast and continues over a light, rolling and sandy country and alkaline plain for about 40 miles to the Humboldt lake; thence in the same general direction skirting the west side of the lake and its low meadows, and ascending the wide valley of the Humboldt river in a course nearly north, it reaches and crosses the 41st parallel of latitude in 117° 40′ west longitude.

Continuing the same direction for three miles further, it changes to an easterly direction for six miles, and here reaches its greatest departure from a straight line, joining the points of Sacramento and the northern extremity of Great Salt lake. It then bends to the southeast, recrossing the said parallel within a short distance of its intersection with the meridian of 117° 30′ west longitude; also crossing said meridian and proceeding therefrom about six miles, when it resumes its northeasterly direction and again strikes the 41st parallel in longitude 117° 20′ west. From the last-mentioned point the line runs southeasterly 36 miles, when it bends to a more easterly course, which it holds for 18 miles, skirting the northern base of the Shoshone range of mountains. Thence it deflects southerly and passes the cañon of Beowaere Gate in a distance of nine miles; thence running due east 12 miles, passing Gravelly Ford and into Ten-mile cañon, it assumes the general northeasterly direction for 90 miles, passing through various cañons of the mountain ranges of the Great Basin to Humboldt Wells.

Leaving the valley of the Humboldt at this station the line assumes a more easterly general direction, with but one important detour to the south through North Pass in the Trano mountain range, and reaches Monument Point, the most northerly extremity of Great Salt lake, in a distance of 142 miles from Humboldt Wells, making, as before mentioned, a total distance of 662 miles from Sacramento.

From Monument Point the line skirts the northerly shore of Salt lake, crossing the salt flats at the head of Spring bay, and thence bears in a general easterly direction to the summit in the promontory range, which it crosses through a low and very favorable pass, and skirting the southerly slopes of that range, reaches the valley of Salt lake about

10 miles north of Bear River bay; thence running slightly south of east in a direct line for 20 miles, it reaches the foot of the Wasatch mountains, in latitude about 41° 33′, and deflecting to the right, follows the foot-slopes of those mountains in a southerly and very direct course for 33 miles, to the mouth of Weber cañon, making a total distance from Sacramento of 752 miles.

In crossing the Great Basin the valley of the Humboldt river necessarily determined the route of the road towards the northern extremity of Great Salt lake. From the evidence furnished by the records of the various national explorations which have been made over this unsettled area, and by the surveys of the company's engineers, the commissioners are satisfied that no means have been left untried for the determination of the shortest and best route across the basin.

In addition to the uses of the road as a line of continental transit, observation shows that its location must open for disposal an extensive tract of public land, which, though hitherto unknown except to a few explorers, and the emigrants who have passed over it, is likely to be found of greater agricultural and mineral importance than was previously supposed. The immediate bottom of the Humboldt has long been known as affording good pasturage and hay crops. Its ample supply of water, connected with its forage, suggests its future development as a grazing country at least, while from the facility with which its higher portions can be artificially irrigated from the river, there are reasons to believe that a more varied agriculture can be successfully undertaken. In some of the smaller tributary valleys, on soils of the same general nature, cultivation has been already commenced, the neighboring mining settlements and to some extent the military posts of the United States being supplied therefrom.

The remoteness of this region, and the uncertainty of peaceful relations with its Indian population, until the building of the railroad, have not only made it undesirable for settlers, but excluded all inducements to the study of its capabilities. It was known only as an unavoidable route by which the emigrant had laboriously travelled to more inviting prospects, and was therefore dismissed as useless for any other purpose. The construction and operation of the road opening this region to observations of a different nature, must tend to a study of its real capabilities. The road, by requiring permanent establishments at various points, which will become the residence of its employés, facilitates this result in fixing germs of settlements where cultivation will be more or less undertaken, and should success attend these experiments, a demand for these lands may be expected to follow.

The line, at different points, opens upon naturally favorable branch routes that connect it with remote and important places, both to the north and to the south. In the former direction we have Oregon, Idaho, and Montana; in the latter, Arizona and the country beyond, which can be reached by a favorable valley route intersecting the central portion of Nevada, and skirting in its passage the mining region of the mountain range which embraces the rich white pine district.

All the branch routes, over which we believe railroads with the facilities afforded by the present road can be comparatively cheaply constructed, combine to enhance the prospective importance of the arterial line of communication.

ALIGNMENT.

In referring to the details of the aligument and grades of the road, we have selected the portion visited by us on which the track was laid,

making an entire distance of 450 miles from Sacramento, as an ample indication of the character of the work in these respects, since all its difficult portions are therein included. In this distance the total lengths are as follows, viz:

	Miles.
Straight lines	$264\frac{4}{10}$
Curved lines	$185\frac{6}{10}$
Minimum lines (573 feet radius)	$2\frac{96}{100}$

In which it appears that the proportion of entire curve to straight line is 0.413, and that of minimum curve 0.0066, nearly.

GRADES.

The grades from Sacramento to the summit of the Sierra Nevada are as follows, viz:

Total length of level	11.2	miles.
Total length of level, 105 feet per mile	20.9	"
Total length of level, 116 feet per mile (maximum)	9.55	"
Longest plane, 116 feet per mile (maximum)	3	"
Average grade to summit, 66.97 per mile	105	"

The grades from the Sierra Nevada summit to the 450th mile are as follows, viz:

Total length of level	15.4	miles.
Total length of 95 feet per mile (maximum)	3.3	"
Average grade from summit to Big Bend of Truckee, 35.12 per mile	83.69	"

Beyond the Big Bend the grades partake of a lighter character, the heaviest being but 52.8 feet per mile. At a few points in the narrow cañons of the Humboldt, the minimum curve of 573 feet radius is introduced.

The limits as to curves and grades prescribed by law, with the conditions of the topography of the country, appear to us to have enforced the location of the road as we have found it established. The elevation to be overcome in the passage of the Sierra Nevada, the difficulties thereof from the bold, broken, and cañon-intersected country, were unusual, and of themselves sufficient to task engineering skill to the utmost to obtain any route whatever practicable by the locomotives, while the law imposed still further requisitions which, in order not to transcend them, made necessary the most thorough examination of all the ground and points which offered a chance for a location. The line as here established has involved the heaviest and most costly work, and though, as far as mere appearance is concerned, it might possibly have been changed at one or two points, it would have been done at the sacrifice of a heavy expense without practical benefit. The essential demands of the road in respect to its alignment and grades seem to have been steadily kept in view, the grades having been compelled by the nature of the locality, leaving no alternative of change. As a relief to the labor of traction involved by the conjunction of these grades and numerous curves, we find short tangents in all cases introduced between each pair of curves where their direction is reversed, though often at much expense.

Along the valley of the Humboldt the route passes over a more favorable country for alignment and grades. The lower bottom lands have been avoided as subject to overflow, and affording a less firm material for the road than the more elevated plains skirting them. The occupa-

tion of these higher rolling plains, without incurring long and deep cuttings for the light grades, which on this part of the route have been adopted, necessitated such courses as would carry the line economically over them; but we find that its curves are of favorable character, safely passable at the highest speed that is likely to be demanded on any road.

CONSTRUCTION.

The embankments on the ballasted portion of the road, originally 14 feet wide at the grade line, with slopes of one and one-half base to one rise, have been somewhat rounded off by the two years' wear, but are firm and sound at a safe distance from the ends of the ties.

At several points along the passage of the Sierra Nevada they are supported by massive stone retaining walls, which we find in total length to be about 2,500 feet, some portions being 75 feet high. Where these embankments lie along the edge of streams they are amply protected from the wash by proper slope walls, the total length thus defended being about 5,000 feet.

It was observed along some portions of the embankments, more especially on that portion of the road east of the Truckee, that although they were originally left full 14 feet at the grade width, a portion of their material at the edges had been taken away at the time of track-laying for the purpose of a partial ballast about the ties.

This was done as an expedient for temporarily securing the track for provisional use in the construction of the road beyond, and will be provided for in the final ballasting.

Under the proper head in the accompanying deficiency estimate will be found the cost of this reparation.

EXCAVATIONS.

The excavations in earth cuttings are in width from 18 to 20 feet, depending upon local conditions. The slopes are from one base with one rise to one and a half base with one rise.

In indurated material, whose character resists abrasion in the sides of the cut, the widths are made from 16 to 18 feet with slopes of one-half base to one rise. In solid rock, below the level of the snow belt, a few cuts are made 14 feet, though in most instances they are left 16 feet wide. Through the snow belt the excavations are left 18 feet wide at the grade line, with side slopes of one quarter base to one rise. At all proper places ditches were cut above the upper edges of the side slopes to intercept the flow of water over them.

TUNNELS.

There are 15 tunnels on the whole line of the road, all of which are included in the passage of the Sierra Nevada. They measure in total 6,262 lineal feet, the longest being 1,659 feet, and the shortest 92 feet. Their clear dimensions are 16 feet wide by 19 feet in height. Two are timbered throughout; three timbered in their approaches, and internally to such extent as was required by the nature of the material; and 10 left entirely untimbered, the material being of the hardest and most enduring granite and trap rock. Ample ditches are provided in all these tunnels for drainage.

The following table shows the number and character of the tunnels:

No.	Material.	Length.	Finish.
		Feet.	
1	Conglomerate	500	Approaches timbered.
2	....do	300	Timber throughout.
3	Trap rock, very hard......	280	Untimbered chamber, natural surface.
4	....do........do	92	Do. do.
5	Granite, solid, hard	130	Do. do.
6	....do........do	1,659	Do. do.
7	....do........do	99½	Do. do.
8	....do........do	375	Do. do.
9	....do........do	223	Do. do.
10	Conglomerate and breccia.	525½	Do. do.
11	Granite	570	Timbered half its length.
12	....do	342	Timbered about 50 feet.
13	Conglomerate and lava....	870	Timbered throughout.
14	Trachito, hard............	200	Untimbered chamber, natural surface.
15	Soft granite..............	96	Do. do.
	Total length.........	6,262	

CULVERTS.

The total length of the road provided with masonry culverts is 375 miles. They are generally of stone, though west of the Sierra a few are of brick, laid in hydraulic cement. They are all of ample width, with paved bottoms, many being left uncovered as conveniences for cattle passes. Those under high embankments appear to be strongly covered, some being laid in cement-mortar and turned with heavy arch stone. It was observed generally that wherever a proper stone material could be obtained for these works within six or seven miles, it was used. On the remaining 75 miles of the road no permanent culverts have yet been built. This portion being across the desert and on the plains of the Humboldt, where no suitable stone at any reasonable distance could be found, where the embankments are exceedingly light, and where, as our observation showed, there could be no wash from rain, openings lined with wood have been left across the roadway, which material is to be replaced by stone, forming proper open culverts, when the completion of the road towards its eastern terminus will admit of the employment of means for its transportation. The cost of supplying this deficiency will appear under the proper head in the estimates.

BRIDGES AND TRESTLING.

The proportionate extent of bridges in the 450 miles of the route appears to be unusually small in comparison with many other railroads, being only 4,807 lineal feet, or less than one mile. This favorable result is due to a careful study in location, with a desire to avoid, as far as possible, the crossing of large streams, and to carry the line over solid ground, wherever this could be done. The trestling and such framed works as were deemed necessary for the passage of deep cañons and ravines, and for the approaches to the bridges proper, extend in a total length to 9,661 feet, of which, however, more than one-half pertains to the single crossing of the bottom-lands of the American river, whose extraordinary floods, inundating this whole area, precluded the use of an embankment. Experience has shown the futility of an attempt to cross this overflowed bottom with a solid embankment, since during the last winter the one that had been built on the right or eastern bank of

the river for a distance of 2,500 feet was entirely swept away. There then remains but 4,575 lineal feet of trestling along the remaining portion of the road, some of which is now being replaced by truss bridges, while other portions, being temporarily adopted on account of the total absence of filling material within any reasonable cart-haul, except it were blasted from solid ledges, are proposed to be replaced by embankments filled by means of cars. The design of the larger bridges is the Howe truss, strengthened, in the maximum spans, (which are 204 feet,) with strong timber arches springing from the abutments. The smaller spans of the Howe pattern, down to that of 75 feet, are built without this arch, according to the practice of the original inventor. Bridges below the last-mentioned span, with two exceptions, which are of the "Burr" truss, are simple trusses, but all are built in a thoroughly workmanlike manner, of the best timber known in this region, and secured by the best iron fastenings. The trestling is strongly framed, braced, and tied, with a sufficient number of bents or supports (from 15 to 16 feet centres) to the roadway stringers, which are in all cases doubled for sustaining any load that is possible to be carried over them. Compared with ordinary practice in railroad work of this kind, the dimensions of the bearing parts are greater than usual, and the material and workmanship are of the most desirable quality.

The following is a tabular statement of the bridging and trestling, with location, &c., of each, taken in order from Sacramento:

Location.	Pattern of bridge.	Longest span.	Total length.
		Feet.	*Feet.*
American River	Howe truss	*	700
American River	do	†	
Dry Creek	Burr truss	‡	210
Antelope Creek	do	§	514
Long Ravine	Howe truss	150	428
Sec et Town	—— truss	40	280
Lower Cascade		204	364
Upper Cascade		204	244
South Yuba		84	84
Drivers' Creek		50	50
Coldstream		126	422
Little Truckee		105	105
Proser Creek		105	195
First crossing of Truckee		204	204
Juniper Creek		73½	73½
Alder Creek		40	40
Truckee, second crossing		150	300
Truckee, third crossing		204	204
Truckee, fourth crossing		204	204
Truckee, fifth crossing		204	204
Humboldt, first crossing		129	150
Humboldt, second crossing		150	205
Mary's Creek		50	50
Maggie's Creek		50	50

* 2 of 192 feet each. † 2 of 150 feet each. ‡ 4 equal spans. § 1 span.

With the exception of the bridge at the American river, all the above have masonry abutments, the one at Secret Town now having them put in. The foundations of that at the American river crossing are prepared for masonry piers and abutments. The bridge masonry in all cases is built with first quality of material and workmanship, the whole being laid in

hydraulic cement mortar, with hammered beds and builds. Where arches are introduced in the bridges, such portions of the abutments as take their thrust at the skewbacks are strongly dowelled. At the time of the commissioners' visit the masonry of some of the bridges, as well as the bridges themselves, were in course of construction, and at the present time it is believed that all the work is finished.

The following is a table of the trestling, showing location, length, &c.:

American river bridge approaches south side, 2,196 feet long; American river bridge approaches north side, 2,890 feet long; Arcade, 12 feet high, 195 feet long; New Castle, 66 feet high, 528 feet long; Auburn, 35 feet high, 416 feet long; Station 450, 40 feet high, 568 feet long; Station 470, 40 feet high, 496 feet long; Clipper Gap Station 606, 50 feet high, 464 feet long; Clipper Ravine Station 667, 70 feet high, 450 feet long; Long Ravine, 70 feet high, 450 feet long; Secret Town, 60 feet high, 660 feet long; Butte Cañon, being replaced by truss, 70 feet high, 448 feet long. Total, 9,661 feet long.

The trestling is invariably placed on stone foundations, permanently bedded beyond displacement.

BALLAST.

From the bend of the Truckee, at the 189th mile eastward, the track has, with a few exceptions, been ballasted with the same material of which the road-bed is composed, being the sandy, gravelly soil of what is termed the desert. This is composed of the detritus and sedimentary deposits from the mountains surrounding and jutting into the plains of the Great Basin. A great portion of this material is from volcanic and metamorphic formations, granite, porphyry, lava, and sandstone, more or less changed and indurated by heat, and yielding a loose material, fine and coarse, the greater portion of which seems to be silicious. At intervals the road is cut through spurs that yield a coarse gravel or broken stone, exactly suited for ballasting purposes. From these deposits, should it be necessary to replace the present ballasting, an ample supply can be had. The question whether the ordinary surface material of the desert (excluding, of course, all boggy material) may be safely used for ballast is of some importance, for the reasons that it greatly facilitates the speedy construction of the track and lessens its cost—an item to be especially considered in view of the probable construction of branch roads to the mining settlements in the Great Basin. The rapid laying of track resulting from the competition between the Central and Union Pacific roads has required such a constant use of the track for trains going to the front with iron, cross-ties, fuel, contractors' supplies, and telegraphic material, that a series of ballast trains along the track would greatly interrupt and delay freight trains; whence the use of the ordinary material of the desert for ballast.

Now comes the question whether this ballast is fit to remain as the permanent ballasting of the road. This will depend very much upon the proportion of argillaceous and decomposed vegetable material in this soil, to be acted upon by the rains and frosts of winter. No sufficient and reliable previous experience on this particular material has been had either by directors, engineers, or contractors, or the members of this commission, as far as we could learn. The ballast looks as though it would answer its purpose. The present winter, combined with the ample use of the track by passenger and heavy supply trains, will test the question.

We have, therefore, not thought it necessary to recommend any change

until a subsequent observation of the action of frost and rain should indicate what is needed. In this connection it may be well to note that but a small amount of rain, comparatively, falls upon the Great Basin, and hence its desert character.

The deficiency estimates include an amount for the completion of the unballasted portions of the road.

CROSS-TIES.

The dimensions of the sawed cross-ties are generally six inches by eight inches, and eight feet long, though many of them are larger. This is the minimum size, but a large portion of the ties are hewn, and considerably exceed these dimensions. They are of tamarack, red spruce, sugar pine, yellow pine, and redwood, and are the most durable timber that is to be found in the country, the quality admitting of firm spiking for the rails. The number used per mile is from 2,260 to 2,640, depending upon the character of the alignment and grades.

RAILS, CHAIRS, ETC.

The T rail, of the American manufacture, is used, varying in weight from 56 to 66 pounds per lineal yard. The maximum weight is laid upon 40 miles of the Sierra summit portion of the road, or through the snow-belt, where the extra weight is partly distributed in the web, in order to raise the top of the rail above the ordinary clearance of the car wheel-flanges and above the accumulation of ice upon the track. The rail of minimum weight is laid upon 300 miles of the road, and the remaining 110 miles are laid with 60-pound rail.

The fish-joint method of connecting the rails has been adopted on 355 miles of the track, and chairs are used on 115 miles, these having been contracted for before the advantages of the fish-joint were understood.

The spiking of the rails to the ties varies according to the character of the alignment. The size of the spikes is $\frac{9}{16}$ inch square, and from $5\frac{1}{2}$ to $6\frac{1}{2}$ inches long. On tangent and light curve lines there are four spikes to each point, and four spikes to each intermediate tie, except the middle one, which has six spikes. On sharp curves the number of spikes is from 50 to 100 per cent. greater, the sharpest curves having eight spikes to each tie. The track has been laid in a careful and workman-like manner, the rails along the curves being accurately bent, with a rigid regard to conformity with the exact trace of the course.

SIDINGS.

The sidings appear to be judiciously distributed along the whole distance of the road, and occupy a total length of a little more than 36 miles, or about 8 per cent. of the main tract as far as it is laid. They are permanently laid and properly maintained with requisite switches, &c. Turn-tables are also constructed at various stations in connection with the sidings.

SNOW-SHEDS AND GALLERIES.

The deep snows to which the passage of the higher portion of the Sierra Nevada exposed the track—generally from 10 to 13 feet—determined the company to provide for its shelter through this region. Accordingly, we find extensive structures for this purpose entirely covering the track where it is laid through the heavy snow-belt range, embracing a distance of about 25 miles. From this point of Blue Cañon

to Emigrant Gap, about six miles, as no difficulty in previous winters had been experienced in keeping the track on the embankments and light cuts clear with snow-ploughs, sheds have been built only through the deeper cuttings where the snow tends to accumulate to the greater depths. From the last-mentioned point to Lower Cascade Bridge, about five miles, nearly all the cuts and lighter embankments are protected by the sheds, the deeper embankments being left uncovered. The covering is continuous from Lower Cascade to a point near Coldstream tunnel, where it entirely ceases, as beyond or east of this point no difficulty from snow is anticipated. The total length of shed covering from Blue Cañon to Coldstream is, therefore, 21 miles, and that for any one piece of continuous covering is 12 miles.

GALLERIES.

These structures, in distinction from the snow-sheds, which are built over only such portions of the track as are not exposed to snow-slides, are built at such points as are thus exposed, as a defence against such occurrences, and in design and workmanship embrace a disposition and strength which seem ample for the purpose, the principle being to extend the roofing or covering up to the mountain slopes where these slides are likely to originate, and thus to lead them over the work in their descent. The strongest framing has here been necessary, and it is tied to the rocky sides of the mountain with strong iron rods. The galleries have been built on that portion of the road between the summit tunnel and tunnel No. 2, a distance about one and one-third mile, exclusive of the tunnel portion. It is to be remarked that, as an additional defence against the efforts of snow-slides, massive walls of granite have been constructed at several points where there seemed a possibility of their occurrence. The total length of such walls is about 1,000 lineal feet.

The detailed description of the snow-sheds and galleries will be found in Appendix B to this report.

EQUIPMENT, ROLLING STOCK, ETC.

The total number of locomotives now provided for the road is 162. Of these 98 are already at work in the regular business of the road, and in its construction.

We are informed by the officers of the company that 36 additional locomotives are shipped and on the way, and that 28 more are contracted for.

A table of these locomotives is given in Appendix C, by which the power of each may be estimated. They are all from the establishment of first-class builders, and in every respect equal in style and capacity to the best engines in use on American railroads.

CARS.

The first-class passenger cars, 10 in number, in style and workmanship are of good quality, manufactured at a well-known eastern establishment. Of the combined passenger and baggage cars there are two, and of baggage, mail and express cars combined there are eight. There are 294 box or house freight cars and 1,400 platform cars, making 1,694 freight cars now in use. The platform and freight cars being manufactured at the company's shops are being daily increased, eight per day being the present rate of addition. There are 95 dump cars, 68 hand cars, 60 section cars, and 30 track cars. There is also one family passenger

car of high finish, fitted with extra accommodations for sleeping. The equipment in cars is sufficient for the present business of the road, but as soon as the two roads are joined and the travel from the Atlantic side begins, a large addition will be required to the passenger cars; and sleeping cars will also be needed. The company's shops are being rapidly fitted for its future demand.

SNOW PLOUGHS.

For the clearance of the tracks on such portions thereof as are not covered by the sheds and galleries six large snow ploughs are provided; this number being considered sufficient for any emergency.

BUILDINGS, MACHINERY, ETC.

In the earlier construction and operation of the road wooden buildings of a temporary character were put up, but they are now being replaced by others of a more permanent nature, some of which are completed and others very nearly so. The following is a general description of these buildings, a statement of their machinery and fixtures being given in Appendix D to this report.

MACHINE SHOP AT SACRAMENTO.

This is a brick building of one story, 100 feet by 205 feet, with tracks for building or repairing 11 locomotives at once. The space occupied by its machinery is 50 by 205 feet. It is well adapted to its purposes, and exhibits a careful study in its design and arrangements. In addition to this establishment, the company owns in Sacramento a foundry and machine shop, which was purchased, with their equipments, to supply the demands of business at a time when other means could not be adequately supplied; this is a brick building and of good capacity.

CAR SHOP AT SACRAMENTO.

This establishment is of brick, consisting of a main part, which is 90 by 230 feet, two stories high, and an L, which is 45 by 90 feet, of one story. On the first floor there are conveniences for setting up 22 freight cars at once, with an additional space of 70 by 140 feet for the preparation of materials, which is occupied by wood-working machinery. The second floor is appropriated to pattern-making, upholstering, &c., and for offices. The engine house, with its boiler room, is attached to the car-shop, and is of brick, one story high, and 35 by 40 feet. The engine furnishes power for both the car and machine shops.

Both the car and machine shops are so arranged in their construction and location that they can be enlarged when the necessities of business demand it.

Wooden car-shop.—The dimensions of this building are 300 feet by 60 feet, of one story. A machine shop, also of wood, has been here built, and also a smithery, boiler, tin, and paint shops. These several buildings, all in present use, cover a total area of about two and a third acres, having been enlarged from time to time to meet corresponding demands.

LOCOMOTIVE OR ROUND HOUSES.

There are two permanent buildings of this kind now erected, one at Sacramento and the other at Rocklin. That at Sacramento is of brick

and one story high, with stalls for 29 locomotives. It is semicircular in plan, with an interior front of 410 feet length and an exterior of 610 feet, and is 64 feet wide. Its central turn-table is of iron, Sellers's patent, and 56 feet diameter.

The round-house at Rocklin is of granite, one story high, with 28 locomotive stalls, its plan being similar to that at Sacramento. Its interior front is 386 feet in length and the exterior 587 feet, and it is 64 feet wide. Its turn-table is of wood, and 51 feet diameter. This house is also used as a repair shop, and is furnished with machinery, as stated in Appendix D.

The brick and stone buildings above named constitute the permanent establishments for the purposes designed, as far as at present undertaken. They are of the first class and completed, or so nearly so that all of them will probably be occupied before this report will be received. Both the locomotive houses are completed and in use.

Along the line engine houses are distributed at Cisco, Summit, Truckee, and Wadsworth, the latter incomplete; at Summit there are stalls for 12 locomotives and at Truckee for 16. At Truckee and Wadsworth there are also repair shops, of wood, though that at Wadsworth is expected to be soon replaced by a more spacious building, the timber being nearly ready. At Winnemucca and Carlin it is also intended to have repair shops erected very soon, the materials now being prepared. This arrangement enables the company to operate the separate divisions of the road independently of any temporary obstruction by snows in the mountains.

Other buildings, of a temporary nature, have been erected at various points along the road, to meet its requirements during its rapid construction.

Freight houses of wood have been built at various stations along the route as specified below, with their approximate lengths, their widths being generally about 40 feet:

Sacramento section, 400 feet in length; Junction section, 60 feet in length; Rocklin section, 60 feet in length; Pino section, 60 feet in length; New Castle section, 60 feet in length; Auburn section, 100 feet in length; Clipper Gap section, 200 feet in length; Colfax section, 300 feet in length; Gold Run section, 100 feet in length; Dutch Flat section, 200 feet in length; Alta section, 300 feet in length; Emigrant Gap section, 100 feet in length; Cisco section, 500 feet in length; Summit section, 150 feet in length; Reno section, 1,200 feet in length; Wadsworth section, 300 feet in length; Brown's section, 150 feet in length; Winnemucca section, 200 feet in length; Argenta section, 200 feet in length.

PASSENGER HOUSE.

Temporary passenger houses have been built at several stations, generally from 50 to 150 feet long, except that at Sacramento, the length of which is 250 feet. These are all plain buildings, with no pretension of finish, but they answer the present needs of the travel. Nineteen of the principal stations are thus finished.

WOOD SHEDS.

The wood sheds already built have a storage capacity of 20,000 cords, and are being rapidly extended; their total length is about 7,500 lineal feet.

DEPOT AND OTHER GROUNDS.

The company has purchased land at various stations on the road, amounting in the aggregate to 460 acres, for their depots, and for other uses, the principal establishments being at Sacramento. Their wharf establishments at the city will have, when completed for landing purposes, an area of 100,000 square feet, with a quay frontage on the river of 1,150 lineal feet. There are to be furnished for this wharf eight merchandise cranes, with one additional for heavy material, all to be arranged for operating with steam power, if necessary; 800 feet of the frontage of the wharf is finished and provided with five merchandise and one extra heavy crane for landing and handling materials, freight, &c., which are now in operation. The remainder of it is now advancing towards completion.

WATERING STATIONS.

There appears to be no lack of properly provided watering places along such portions of the road as are naturally supplied with water. Across the "desert," however, and along a considerable distance in the Great Basin, where the line is too far from the river to admit of water being taken therefrom, the stations are supplied at present by means of portable tanks transported in the trains. The company is now engaged on this part of their road in boring for water, and hope soon to establish the fact of its existence and ready supply. A well of this kind on the Truckee desert, being bored by steam power, is now down 280 feet—thus far through a bed of chalk.

Having in view your instructions, the requirements of the act of Congress in relation to the standard of construction for the Pacific railroads, and the printed report of the board appointed to determine the same, the commissioners desire to conclude their report with a review of the character and condition of this work so far as they have examined it.

In reference to the location of the road we have already, in connection with its description, expressed our convictions as to its character and to its local relations to the country through which it passes, and to its facility of connections for branch roads to more remote places. The direct advantages of its location imply a proper study of all the conditions involved in the case, and good judgment in determining its establishment, for its main purposes, while its incidental benefits in relation to its connection with the future extension of any system of railroads over this region enhance the importance of the general result. It would be impossible, without an especial instrumental examination of the country, to show wherein the line could be improved without involving an expense incommensurate with any advantages to be gained; and we are satisfied from the manifestations of the builders of the road to obtain good lines without regard to their cost, especially in crossing the Sierra summit, where no less than fifteen tunnels have been pierced through solid rock in order to secure them, that they have endeavored to locate it in the best manner throughout.

On the desert there appears at first glance more curvature than a country so open and level would justify; but upon more careful scrutiny it is found that the curvature is demanded to avoid the river bottoms and miry places, and to place the road-bed upon firm ground.

The general character of the construction of the work, in regard to its road-bed, is well indicated in those portions that have been longest in operation. In riding over these portions the smoothness of the track,

and hence the uniform solidity of its bed, becomes apparent, showing that the road-bed is of good material, and since the work was originally done has been kept in good repair, and that the rails were of the best quality, although they were laid with chairs instead of the fish-joint, which would have been an improvement.

This older portion of the road well illustrates the remarks of some of the engineers in the pamphlet, setting forth the standard of construction—to the effect, that "railroads do not ordinarily spring at once into perfection of track and equipments. In respect of solidity of road-bed, on which smoothness of track chiefly depends, completeness and extent of shops, station buildings and rolling stock, railroads rather *grow* into the condition described by the term 'first-class.'"

The newer parts of the road, beyond the summit, have had less time to consolidate, and, of course, the higher degree of firmness on the bed is not yet reached; yet on this portion the track shows no deviation from a true alignment, even though a heavy freighting and construction business is being done upon it; and an experiment made by us in reference to the smoothness of locomotion over it showed its adaptation to a speed of more than 40 miles per hour with safety.

The dimensions of the embankments and excavations are generally up to the standard, and their drainage is well provided for. The ballast on the finished portion of the road has been selected from good materials and is of sufficient depth for its purposes; the conditions of climate at various stages of elevation, in respect to cold and moisture which affect this matter of ballasting, appear to have been properly regarded, and there appears to be no delicacy in its quantity.

The deficiency in the widths of the tops of the embankments at several points of the work, caused by taking their material for ballast, has already been noticed, and it is also to be remarked in this connection that the manner of finishing the ballasting gives an appearance of nonconformity to the construction standard in this respect. It is rounded from the centre of the track at the level of the top of the ties outward to the sides of the bank, leaving the ends of the ties partially exposed to the air, instead of completely bedding them throughout to their upper surfaces. This method was adopted with the view of securing a more rapid and effectual drainage of the track than a wide flat top surface would admit, and by the partial exposure of the end of the ties to the atmosphere, it was believed there would result a quicker evaporation of the moisture they might imbibe from the rains and ground, which would tend to their longer preservation from decay.

That this method of disposing the ballast is effectual for the permanence of the track is sure, from the fact that the older portions of it, which have been in operation under the pressure of a heavy business more than four and a half years, remain in a thoroughly good condition, the alignment of the rails remaining true and their wear uniform. Such evidence must be taken as demonstrative of the quality of the work, both as to its materials and workmanship; and, although the more recently constructed portions cannot now offer this sort of testimony, we have no reason to believe that it will be wanting after the road shall have been in use for a year or two.

The bridging, as has already been stated, is of the butt character for the wooden material used, and the trestling is placed only at points where solid embankments may be considered inadmissible by their exposure to the destructive effects of powerful mountain torrents, which pour through the cañons over which the route lies, during the snow-melting and the rainy seasons. The maintenance of these structures in a thor-

oughly good condition seems to be the practice of the company, a careful watch always being placed over them with a constant and ready supply of water at hand in case of fire.

The character of the masonry is generally good in regard to strength and durability. In the bridges and more important culverts it is of first class, both as to materials and workmanship, of natural faced work, laid in cement, a superior quality of granite found in the Sierra Nevada being in most instances used. In some of the lighter culverts along the line on the Great Basin, an inferior stone, the only quality to be found within many miles from the road, has been used, but its value remains to be seen by its wear. It was also noticed in some of the larger open culverts, although the work was strongly laid up with large and hard stone, that copings of the wings were left in an unfinished condition, and the beds and joints were not as close as they should be, giving rather an unworkmanlike aspect and an indication of the haste in which the work was left at these points. In other parts of the road, however, where either permanent or occasional streams existed, the culverts were laid with due care, especially under the heavier embankments. Along the desert and Great Basin, at points on the line where there are no indications of the existence of running streams at any time, but only depressions of the ground wherein water from rains or melting snows might possibly accumulate above the embankments crossing them—if it did not sink in this porous soil—the culverts were left open, the track crossing them on longitudinal stringers. In most of these instances the work being done with a stone inferior in appearance and facility of workmanship to the granite used at other points, contrasts unfavorably in these respects; but in the most essential requisites will answer its purposes. The number of these water-ways seems to be sufficient. No points where they were required, so far as our observation in the dry season could show, have been neglected.

The protection of the track from the heavy snows on the summit of the Sierra is all that could be desired, and although not demanded by law, the company has spared no expense to overcome this formidable obstruction. In this particular the company has gone beyond the usual precedents in railway practice, and shown their intention to have a road to be relied on for punctuality as well as stability.

Indeed when we see how easy it is, too, for a traveller to surmount the Sierra with the facilities provided by the road, and the comfortable hotels, dwellings, mills and workshops, which everywhere along the line in the mountains give evidence of thrift, energy and development, we forget how it loomed up in the early history of the enterprise, as an almost insurmountable barrier; and begin to look upon it as a great auxiliary to the work, sending out its supplies of timber for ties, bridges, fuel, house-lumber, also ice and building stone, hundreds of miles into the desert plains, and furnishing abundant water-power for the reduction of ores which can be brought to it by the railroad and its branches.

The above is a general statement of the construction of the road, as far as the track was laid at the date of our examination, near the end of November. It appears to us that the work on the older portion, as far as the bend of the Truckee, is well done in respect to all the conditions required by the law, and the demands of private commerce and public service; regard being had to the fact that a single track only was intended to be provided for. On this portion a regular transportation business is being done, and it has had the advantage of time, rain, frost and repairs for its consolidation, and is maintained in good condition.

The newer completed portions, of course, are in that state which is

inseparable from the want of the action of weather and time required for their perfection, but even here no reasons appeared for an inference contrary to what was seen as the result in the older divisions of the road.

The protection of the road from floods, snow-falls and slides seems to be complete. The structures where they consist of wood-work, as in bridges, trestle-work, snow-sheds, &c., are sufficiently strong and durable, and of the best qualities of timber the country afforded.

The equipment of the road is ample for its present business, as will appear by the lists of locomotives, cars and machinery, in the appendix, and with the means in reserve, both in the provision of locomotives under contract and those on the way and with the facilities which the company has for the manufacture of cars in their shops, we see no reason to apprehend any future deficiency. The completion of the construction, which will be soon effected, will release a large amount of rolling-stock, which will then be available for the regular business of the road.

In order to present in a more graphic form than any words can do, the external appearance of the bridges, snow-sheds, heavy trestle-work, and other important structures of the road, we have attached to these sheets a series of photographic views selected from a large number taken at the expense of the company.

In judging of the deficiencies of the road, as well as in estimating the cost of their supply, the board are compelled to express their conviction in reference to the circumstances under which the work was done, and to their instructions. Having in view the "standard of construction" to which we are referred, which requires "a substantial and complete work and the highest perfection of track reasonably attainable on a new road," we recognize certain immediate demands which we regard as absolute, and for which we have estimated the cost, amounting in all to $310,000, as expressed in the detailed estimate hereinafter given. On the other hand, and in consideration that the present operation of constructing and perfecting the more indispensable details of the work requires the application of all the company's attention, and that future developments of business will better determine what is further required, we feel that no adequate statement or estimate can be made as to such demands, and we can therefore but intimate what they may be.

ESTIMATE FOR PRESENT DEFICIENCIES.

Finishing out embankments	$65,000	
Ballast	100,000	
Culvert masonry on Great Basin	35,000	
		$200,000
Ten first-class passenger cars, at $5,000 each	50,000	
Ten second-class passenger cars, at $3,000 each	30,000	
Baggage and express cars	30,000	
		110,000
		310,000

While recognizing the propriety of the requirements that "the engine-houses and repair shops at the principal stations must in all cases be of stone or brick, with good stone foundations," and with fire-proof coverings, we have been obliged to make our estimates somewhat vague for this item, in consequence of the difficulty of determining, in the crude and shifting state of mining enterprise in the State of Nevada, the precise

points where "the principal stations" must necessarily be. No fact is better known among miners than that the bustling and populous camp of to-day, the mushroom growth of a new discovery of rich mineral leads, may be in two years deserted by all who have money enough to get away; and that even two-thirds of the houses may also be taken down and removed to some new field of discovery. Under such a state of society to build with wood is wise.

We have, however, assumed that four repair shops may be established on the divisions examined by the board, in addition to those at Sacramento, and the engine-house at Rocklin. We have estimated for engine houses at Cisco, Summit, Truckee, Reno, Wadsworth, Winnemucca, and Argenta, with repair shops at Cisco or some place near the summit, Truckee, Wadsworth, and Winnemucca. Substantial freight and station houses will be wanted at these points, and we have allowed an average of $30,000 for each of the seven points, although some will need more and some less than that amount; making a total of $210,000. This is for buildings alone, no estimate being made for the machinery, because the company is already making a liberal provision in this respect.

In regard to the injunction that the tunnels should be of a width sufficient for a double track, it must be remembered that when the tunnels were commenced, and indeed all the time, only a single-track road was contemplated. Then the speed of construction was in many respects, especially for the mining interest of Nevada, paramount to the provision of a double track, which might be far in the future. As the fact now stands it would scarcely be politic to interrupt travel and traffic at present, to widen the tunnels until a double track shall be actually needed. Nevertheless, heeding the recommendation, we have made an estimate of $390,000 for this item, of which $120,000 is for temporary tracks for the accommodation of travel during the stoppage of the tunnels.

As the larger and deeper cuts on this road are generally on steep grades where drainage is easy, we have made no estimate for widening the excavations.

In conclusion, we recognize with pleasure the energy, liberality, and good faith manifested by the company in the construction and equipment of the road. Such deficiencies and defects as we have noticed seem not to result from a niggardly and false economy, but from the haste in construction demanded by the public, stimulated by a wholesome rivalry with the Union Pacific company.

The construction of the telegraph line has kept equal step with the laying of the track. The wire is of the best quality—No. 9, $\frac{3}{16}$ of an inch in diameter. The posts at present used are sawed lumber, of pine, fir, or tamarack, nine inches square at the bottom, five inches at the top, 26 feet long, four feet in the ground, and set 165 feet apart, or an average of 32 per mile. The insulators now in use on this line are Brooks's patent paraffine insulator, one of the latest and best inventions. The cross-arms are fitted with two insulators each; are capable of holding four if necessary, and are covered with a preparation for protecting them against the weather. On the Sacramento division, the offices are established at an average of 15 miles apart; on the Humboldt, 25 miles. Experts in telegraphic matters testify that the line ranks as one of the best built in the country.

Respectfully submitted:

R. S. WILLIAMSON,
Brt. Lieut. Col. U. S. A., Major of Engineers.
LLOYD TEVIS.
SHERMAN DAY.

APPENDIX A.

SAN FRANCISCO, *December* 3, 1868.

The Central Pacific railroad is well and substantially built to Wadsworth, or the Truckee river, 189 miles from Sacramento, except two bridges nearly finished. Grades and curves are within the limits, and location satisfactory. Rails, 56 to 64 pounds, fish joints; ties, 2,400 per mile; sound timber, full size; track firmly laid and ballasted; culverts and bridge foundations of heavy granite masonry; bridges of Howe truss, well framed and ironed; tunnels, 16 feet wide. About 20 miles on the summit are covered with snow-sheds. Passenger trains can run from 15 to 30 miles per hour safely and smoothly.

Equipment of rolling stock, engine-houses, and machine-shops fully equal to the demands of the traffic. Seventy-nine locomotives running on the road, 80 more on the way.

On the new portion of the road through Humboldt valley, ties, bridges, and rails are up to standard. Some minor defects, not of vital importance, exist in culverts, drains, width of embankment, and ballast, but these can be remedied at small cost when the hurry of pushing forward the road is over. Heavy trains of rails, ties, and fuel are running safely to the extreme end of the road, 445 miles from Sacramento. The road is being constructed in good faith, in a substantial manner, without stint of labor, materials, or equipment, and is worthy of its character as a great national work. The telegraph line is first-class.

SHERMAN DAY,
R. S. WILLIAMSON,
Bvt. Lt. Col. U. S. A., Major of Engineers.
LLOYD TEVIS,
Special Commissioners.

Hon. O. H. BROWNING,
Secretary of the Interior, Washington, D. C.

SAN FRANCISCO, CALIFORNIA, *December* 7, 1868.

SIR: The board of commissioners appointed by you for the inspection of the line of the Central Pacific and the Western Pacific railroads on this coast received from you at Sacramento, through Sherman Day, esq., one of their board, two telegrams concerning the object of their duties. Mr. Day replied to the one of date 1st December from Sacramento, and on the 3d instant he telegraphed a longer reply by the commissioners, a copy of which is here enclosed.

The commissioners thought it better to be explicit as to the particulars which met their approval, as well as those not approved, rather than give a wholesale approval in two or three lines, in so important a matter.

The board of commissioners left Sacramento in a special train, furnished by the Central Pacific Railroad Company, and accompanied by the general superintendent of the road, Mr. Charles Crocker, and the chief engineer, Mr. Montague, and ex-Governor Bigler, of the other board of commissioners. As Mr. Tevis was not professionally an engineer, he thought it best, with the assent of the board, to take with him Mr. Calvin Brown, an experienced civil engineer, well known to the Department of the Navy. This gentleman was afterwards elected secretary of our board to work up the statistics, and collect the detailed information necessary for its final report.

Having inspected the track-laying at the end of the route, on the 25th November we returned more slowly over the line, stopping at all the important structures, such as culverts, bridges, turn-tables, machine shops, and other points requiring our personal examination.

Several miles of the track, including the whole of the summit portion, were traversed on foot, thus giving opportunity for the most critical observation of the construction, both generally and in detail. At the office of the company in Sacramento were collected full details of construction and equipments, statistics, drawings, &c., for a comparison with actual operations, and for the more speedy completion of the final report.

Mr. Brown has been left in charge of the completion of the inspection of the track, the noting of deficiency thereon, and the making such measurements, and gathering such information as may be necessary for an estimate of the cost of supplying them.

Presuming his labors may require some 10 or 12 days more, we would state that upon their completion our report will be finished and forwarded as early as possible thereafter.

Very respectfully, your obedient servant,

R. S. WILLIAMSON,
Bvt. Lieut Colonel U. S. A., Major Engineers.
LLOYD TEVIS.

Hon. O. H. BROWNING,
Secretary of the Interior.

P. S.—The confinement of Mr. Day by sickness prevents his signing the above.

After recovery I approve and sign the above copy of letter.

SHERMAN DAY.

APPENDIX B.

CONSTRUCTION OF SNOW SHEDS.

The posts constituting the side framing of the sheds and the support of the roof are of straight timber, mostly of red fir and tamarack, generally from 10 to 18 inches diameter at the smaller end, none being less than 8 inches, and 16 feet in height above the top of the rails. They are placed from five to eight feet apart, according as strength is required to support the known weight of the snow at different points. The footing of these posts is upon thick plank laid down at a depth below the surface of the soil that secures a solid foundation beyond the reach of frost, with a firm, lateral resistance.

The plate, which is five by eight inches, is firmly fastened to the posts with wrought-iron spikes. The roof is half-pitch, the rafters being five by eight inches, spiked strongly to the plate and tied together by double collar beams gained into and spiked to each side of them. The rafters are four feet apart generally. The whole structure is braced laterally by strong, round, spur shores of the same size as the posts, which extend diagonally from the ground to the rafter, being locked and spiked to the posts and to the rafters immediately below the collar beam. These spur shores sustaining the entire thrust of the snow in its tendency to push over the shed, are carefully planted and secured at their footing. Longitudinal girders are spiked to the posts about six feet from the ground. The plate is also supported between the posts by diagonal struts stepped

into them and securely spiked. The frame is covered with one and a quarter inch board, an opening of one foot in width being left at the peak of the roof for escape of smoke. In the deeper excavations, instead of a pediment a shed roof is built by extending the rafters until they reach the side of the cut, thus preventing the accumulation of snow on the sides of the shed and obviating the danger of its pressure against them. Wherever a siding occurs the sheds are 31 feet wide in the clear, and built in the same general manner, with the addition of a post eight by eight between the tracks, reaching to a lower set of collar beams connected with the roof.

SNOW GALLERIES.

The structures are generally 15½ feet wide and 18 feet high above the rails, clear dimensions. They are built exclusively of square timbers, strongly framed together. At points where the greatest accumulation of snow occurs they are built 26 feet high, in order to give a proper pitch and greater strength to the roof and thus to meet the additional pressure of the snow depth. The posts are 12 by 14 inches, and where they rest on the embankments a sill is used at their footing; at other points they rest on the solid rock. The caps are of the same size, framed to the tops of the posts and braced underneath by struts framed to both. The rafters are 12 by 12 inches, and extend with a pitch of one-quarter from the outside of the road-bed until they meet the opposite side of the cutting or the hillside above the track. The principal rafter is strengthened by strut braces, and where rafters extend beyond the road they are supported by posts at distances from 6 to 8 feet wherever a good footing can be obtained for them. The whole frame is strongly bolted together and is also anchored or tied to the solid rock on the upper side of the track or road-bed, with iron rods two inches in diameter, the rod starting from and passing through the plate, extending across the work to holes drilled in the rock to the depth of 10 and 12 inches, where their ends, being split and supplied with fox wedges, are inserted and driven home and further secured by means of a mixture of sulphur and sand melted and poured in around them. Other rods of the same size and secured in a similar manner running diagonally from the tops of the rafters to the rock, furnish additional security to the structure. The roof is covered with 5-inch plank, fastened with 9-inch boat spikes and draft bolts. The side is left open to a height of 6 feet above the rails; above this height it is enclosed with 2-inch planks, an opening of one foot wide being left at the top.

APPENDIX C.

Number and capacity of the locomotive engines and the names of manufacturers.

Number of engines of each class.	Number of drivers.	Diameter of drivers.	Diameter of cylinders.	Length of stroke.	Manufacturers.	Number.
		Feet.	*Inches.*	*Inches.*		
2	2	4.6	11	15	Norris & Sons	12
2	4	5.6	16	24	McKay & Alders	47
47	4	5	16	21	Grant Locomotive Company	2
4	4	5	16	22	New Jersey Locomotive Company	2
8	4	5	15	24	Schenectady Locomotive Company	24
3	4	5	15	22	Danforth Locomotive Company	28
40	4	4.8	15	22	Rhode Island Locomotive Company	19
1	4	4.6	15	22	Rodgers Locomotive Company	16
3	4	5	14	24	Globe Works	4
2	4	4.6	14	21	Mason Manufacturing Company	7
25	6	4.6	18	24	Booth & Company, San Francisco	1
4	6	4	18	21		
2	6	4	16	24	Total number	162
4	6	4	17	24		
3	6	4	17	22		
8	6	4	18	22		
2	6	4	16	24		
2	6	3.9	17	22		

RECAPITULATION.

Number of engines with 2 drivers	2
Number of engines with 4 drivers	110
Number of engines with 6 drivers	50
Total number	162

APPENDIX D.

SUMMARY OF MACHINERY IN THE MACHINE-SHOPS OF THE CENTRAL PACIFIC RAILROAD COMPANY AT SACRAMENTO.

One 60-horse power Corlis engine, 1 30-horse power Corlis engine, 1 25-horse power Corlis engine, 1 15-horse power portable engine, 1 double-wheel lathe, 6 feet swing, 18 feet bed; 1 engine lathe, 60 inches swing, 15 feet bed; 31 engine lathes, 20 to 38 inches swing, 10 to 21 feet bed; 9 engine lathes, 12 to 18 inches swing, 5 to 8 feet bed; 3 square, arbor lathes for brass fitting; 5 drilling lathes; 4 axle lathes; 6 planers, 24 inches to 72 inches, planing 6 feet to 21 feet; 1 valve-seat planer; 5 shaping machines, 10 upright drilling machines, 2 suspension machines, 3 boring machines, horizontal, car wheel, and cylinder; 2 upright slotting machines; 2 Cotter and Key seat machines; 1 wheel quartering machine; 1 large punching machine; 1 large punching and shearing machine; 1 iron straightening machine; 1 hydraulic car wheel press; 1 hydraulic locomotive driving-wheel machine; 4 blowers, or fans; 1 trip hammer; 44 black smith's forges, and an ample supply of bolt cutters and nut tappers, borers, punches, shears, rollers, &c., for boiler-makers' use; tongueing and grooving, mortising, tenoning, sawing, planing, moulding, and grinding machines in the woodwork department of the car shop, and a great variety of small tools for all kinds of work both in iron and wood.

MACHINERY IN MACHINE SHOPS OF THE CENTRAL PACIFIC RAILROAD COMPANY IN ROCKLIN.

1 10-horse-power engine, made by J. C. Hoadley; 1 24-inch engine, lathe, 12 feet bed, made by New Haven Tool Company; 1 24-inch planer,

planes six feet, made by New Haven Tool Company; 1 12-inch shaping machine, made by Pacific Iron Works, San Francisco; 1 upright drilling machine, made by D. L. Harris, Springfield; 2 blacksmith's forges and fixtures.

MACHINERY IN THE MACHINE SHOP OF THE CENTRAL PACIFIC RAILROAD COMPANY IN WADSWORTH.

1 12-horse-power engine, made by J. C. Hoadley; 1 large engine, lathe swing 96 inches, 18 feet bed, made by Amoskeag Company; 1 36-inch engine lathe, 15 feet bed, made by New Haven Tool Company; 2 24-inch engine lathes, 12 feet bed, made by New Haven Tool Company 1 14-inch double shaping machine, made by New Haven Tool Company 1 24-inch planer, planes 6 feet, made by Industrial Works, Philadelphia; 4 blacksmith's forges; 1 hand-punch for boiler works, made by Pacific Iron Works; 1 hand-shears for boiler works, made by Hudson River Works.

MACHINERY IN THE CAR SHOPS OF THE CENTRAL PACIFIC RAILROAD COMPANY.

1 25-horse power engine, made by J. C. Hoadley; 1 No. 3 double surfacer, made by Wordworth; 1 No. 1 planing, tongueing, and grooving machine, made by Wordworth; 1 improved planing machine, 24 by 40, made by Daniels; 1 No. 6 power mortising machine, made by Lane & Bodley; 1 new patent square power mortising machine, made by C. H. Smith; 1 combination car-truck boring machine, made by Lane & Bodley; 2 horizontal boring machines, made by R. Ball & Company; 1 scroll saw, made by Wright; 1 No. 1 upright shafting machine, made by R. Ball & Company; 1 large size No. 1 tenoning machine, made by R. Ball & Company; 1 No. 3 tenoning machine, made by C. H. Smith & Company; 2 iron-bed double saws, made by R. Ball & Company; 2 large size four-side moulding machine, made by R. Ball & Company; 1 cross-cut saw, ev. 20, 26, 20, 16, 12-in., made by Central Pacific Railroad Company; 5 rip saws, made by Central Pacific Railroad Company; 1 tenoning machine, made by Central Pacific Railroad Company; 1 ganing machine, made by Central Pacific Railroad Company; I grinding machine, made by Central Pacific Railroad Company.

SHERMAN DAY,
R. S. WILLIAMSON
Bvt. Lieut. Col. U. S. A., Major of Engineers,
LLOYD TEVIS.