tween the elevated and the subway, as has been stated, two tracks have been abolished in the subway between Hollis Street and Pleasant Street. The alteration also renders useless the sub-subway which was constructed at Boylston Street to avoid a grade crossing.

Moreover, the entire rearrangement of the surface of Pleasant Street has been rendered necessary. New sewer and water pipes have been built, as well as new surface tracks.

A unique transfer station will be located at the Pleasant Street terminal. Under the new order passengers on the surface line (which will run only to this point) will perform the paradoxical feat of descending to take the elevated.

At the Haymarket Street or north terminus of the subway, the convergence of underground and elevated has been comparatively a simple feat. In this case, the plans of Commission and company were coincident from the beginning, and no drastic change is involved. The elevated simply takes advantage of the slope already existing to run into the subway. Coming south over the new Charlestown Bridge en route from Sullivan Square the elevated train will turn west on Causeway Street, south again at Haverhill Street, to descend directly into the subway. There is no earthwork, but the steel superstructure will be maintained on pillars constantly decreasing in height at a practically continuous grade of 5 per cent. The north terminus will also have a transfer station to be composed of elevated station above and surface platform below.

The type of cars chosen by the Boston Elevated Company, as shown in our illustration, are fitted with the Sprague electric control and with Westinghouse motors. The elevated cars will move in trains of three to five cars, with complete motor equipment on each car; an arrangement that enables them to be run separately if required.

In order to facilitate rapidity, the plans approved by the Railroad Commissioners provide for only a very few stations. The surface cars will furnish accommodation for short distances. It is evident that unless elevated trains can run a considerable distance without a stop, there is no saving in time. As laid out, there will be a reduction of two-thirds of the schedule time.

Under the new regime of combination of subway and elevated, Boston's street railway patrons will travel faster within the heart of the city than they do upon its borders.

THE STEEPEST RAILWAYS IN THE UNITED STATES.

BY WALDON FAWCETT.

The New World enjoys the distinction of possessing the pioneer mountain-climbing road as well as the steepest. The line referred to is the railway which ascends Mount Washington, in the White Mountains, New Hampshire, the highest peak east of the Rockies in America. The Mount Washington road, the construction of which occupied the three years from 1866 to 1869, has the exceptional ascent of one foot in 2.67 feet. In point of steepness of grade the nearest approach in this country is the Pike's Peak Railway, another American mountain-climbing road, which has a grade of one foot in four. The Pilatus, the most nearly perpendicular of the European roads, has a grade of 48 in 100.

The trip to the summit of a mountain via a railroad equipped with modern safety devices is fraught with very little danger. Indeed, in the third of a century that the Mount Washington road has been in operation, not a single passenger has been injured. All the mountain-climbing railways in which American engineers take such pride are of the type known as the "cog road." The trains, each consisting of a locomotive, tender and one small passenger coach, run on three rails, two of the ordinary pattern and a "cog rail," in the center of which runs the cog wheel of the locomotive, thus propelling the train. The application of the cog principle to the propulsion of cars up an inclined railway was the invention of Sylvester Marsh, who had to undergo the vicissitudes that proverbially come to inventors. When, after months of work, he finally made a model of his proposed road and exhibited it to the New Hampshire Legislature, to which he had made application for a charter, one skeptical lawmaker sneeringly proposed giving him a charter for a road to the moon. It was eight years later that the first diminutive snorting engine reached the summit of Mount Washington, 6,291 feet above the level of the sea, and the achievement represented an expenditure of fully $150,000; but when the success of the innovation was assured, Swiss and German engineers hurried to America, and it was decided forthwith to adopt the principle in the construction of a road up Mont Riga.

The hump-back locomotives which drag the dumpy little passenger coaches up the great, rocky hillside are unquestionably the queerest appearing engines in the world. The first engine constructed, which, by the way, was one of the greatest curiosities at the World's Columbian Exposition, in Chicago, in 1893, had the upright type of boiler suspended on trunnions, as it was thought it must be kept vertical, but owing to the changes in grades, it would oscillate and form a dangerous opening in the footboard. Worse than all was the fact that there was no device for feeding water to the boiler, so that the only plan to pursue was for the train crew to fill it up before starting, go as far as they could with safety, and then let the steam down again and fill up the boiler from pails of water. Still, it was this certainly crude machine that demonstrated to the world the practicability of the mountain-climbing locomotive.

The engines now in use have the ordinary type of locomotive boiler, but are somewhat shorter owing to the steepness of the track. The boilers are set in the frames with the front ends a foot and a half lower than the back, so as to strike a medium between the flat and sharp grades. To eliminate all danger, all the locomotives have double driving shafts and gear. Not to burden the reader with a technical description, it may be explained that each of these iron horses has two pairs of cylinders, each pair being connected with a toughened steel crankshaft. The dozen teeth of the crankshaft bite against the sixty-four teeth on the main or driving axle. On this axle, too, is the main cog wheel, which meshes in the cog rail in the center of the track and sends the locomotive forward six feet at each revolution.

Like the wiry little burros which they have displaced, these bantam engines have wonderful power. Imagine a building 3,700 feet in height, if such a thing were possible, and a block of granite on the ground, weighing eighteen tons. If such a piece of stone could be lifted to that height in a little over an hour, the engineering world would stand aghast, and yet this is practically what each of these little locomotives does on every trip. At the steepest part of the Mount Washington road, the famed Jacob's Ladder, the track has a rise of nearly two thousand feet to the mile, and during a test on this part of the line a locomotive was found to transmit to the cog wheels more than five hundred horse power.

In coming down the mountain no steam whatever is used, gravity alone doing the work and the machinery holding back. The time consumed in making the trip from the base of the mountain to the summit is about one hour and fifteen minutes. At the beginning of the trip the passengers are all seated at open windows reveling in the bracing mountain air, but before the ascent is half completed the windows are all closed, for the atmosphere is decidedly sharp, even though the cities below are sweltering in heat. The mountain trains move very slowly, so slowly, in fact, that any person could easily step on or off the car while it is under full headway.

While not so steep, the Pike's Peak Railway, in Colorado, is of considerably greater length than its counterpart in the eastern part of the country, and carries passengers to an elevation of fourteen thousand feet, where in midsummer they are often caught in a fierce snowstorm driven by a fifty-mile-an-hour wind. The line up this most remarkable peak of the Rocky Mountains was first projected about sixteen years ago, but was abandoned. Actual grading commenced in 1889, and the golden spike was driven in 1890. The average grade is about sixteen per cent, although in places it is as steep as twenty-five per cent.

As in the case of the Mount Washington road, already described, there is fastened to the cross ties, between the rails, a unique type of rail, into the notches of which roll the teeth of a huge steel cog wheel, drawing the train forward, literally inch by inch, until the entire nine miles of the ascent is covered. The roadbed is from fifteen to twenty-five feet wide, and has been cut from solid granite. Nearly two hours is required to travel the length of the road in either direction, and that this form of mountain climbing is somewhat expensive may be appreciated when it is stated that the members of a farmers' convention which recently chartered the four trains or, in other words, six passenger coaches for a trip up Pike's Peak, paid $2,700 for the privilege.

Even the traveler making the ascent on this road would scarcely appreciate the amount of study devoted to the difficult problem of its construction by the best engineers and mechanics or the perils and hardships which attended the survey and the actual work of laying the metal highway. Camping out, climbing over mountains covered with fallen timber and jagged rocks, the occasional intense cold, terrible snowstorms often attended with high wind and the difficulty of getting provisions, made the obstacles to this undertaking almost insurmountable. A feature of the Pike's Peak line is that there is no trestle work whatever, the four short bridges being of iron, resting on solid masonry. To prevent the moving or sliding of the track—a contingency which is, of course, the remotest of possibilities—owing to its enormous weight and the effect of varying temperature upon iron and steel, nearly one hundred and fifty anchors are embedded into the solid rock or masonry at varying distances along the route.

The rack or cog rails are each less than seven feet in length and very heavy. The teeth were cut from the solid piece by machines especially constructed for the purpose. So particular were the constructors, that the contract for making these rails required that each tooth be within the fiftieth part of an inch of the specified size. On the Pike's Peak road there are two cog rails set a couple of inches apart. As in the case of the other American mountain-climbing railway, the locomotive pushes the car in ascending and precedes it when descending.

On the summit of each of the mountains reached by rail the United States government maintains an observatory and signal staion. The observatory on Pike's Peak is the highest in the country. The first building, erected in 1876 and which afforded the first signal officers shelter, is quite small and was abandoned in 1882 for the more commodious stone house built in that year under the direction of Chief Signal Officer Gen. William B. Hazen. At the summit of Mount Washington there is also a hotel, heated by steam, and capable of accommodating two hundred persons. It is frequently crowded to its capacity by the people who remain on the summit over night to witness the sunset and sunrise. On the summit of Mount Washington also is the office of Among the Clouds, the only newspaper printed on the summit of any mountain in the world. For more than a quarter of a century this novel publication has appeared regularly. Two editions are printed daily during the summer months in as complete a little printing establishment as a person could expect to find anywhere. The copies of the paper, which are to be mailed to all parts of the country, are taken down the mountain on "mail trains," sled-like vehicles which coast down the steep stretches of the mountain railway at terrific speed.

Automobile News.

Alfred C. Harmsworth, the London publisher, owns no less than eleven horseless carriages, eight being driven by gasoline motors, two by steam and one by electricity. He also employs a number of steam trucks for transporting magazines and newspapers from his various publishing houses.

The Automobile Club of America has taken up the subject of placing substantial signposts upon the leading highways. Automobilists, as well as others using the country roads, have complained for a long time about the lack of adequate signboard information. In many cases the old signs are allowed to decay or the information becme illegible. The State and county authorities do not seem inclined to give attention to the matter. It was unanimously decided by the delegates of various automobile clubs to erect signposts of a uniform character, pointing out clearly the best roads between the principal points. The signs are to be like those used in France, made of iron, and practically indestructible. The route from New York to Boston will first be provided with these signs. Other routes, such as those from New York to Albany and possibly from Albany to Buffalo, and those on Long Island, will probably be attended to first. It is hoped in a short time, with the aid of these posts, it will be possible to travel with ease from Niagara Falls to Boston.

One of the heaviest automobile vehicles which has yet been constructed in France is the great hauling wagon built for the Say sugar refinery, to be used between the works and the railroad stations. It is an electric vehicle, and has been built at the Postal-Vinay works at Paris; it made its debut last year at the automobile fête at Vincennes, and since then has made good service in hauling heavy loads. The average load of merchandise is 11 tons, and as the vehicle and accumulators weigh as much as 13 tons, a total of 24 tons is reached. The electric motor, of special design, develops 20 horse power at normal running, but for heavy pulls may reach as high as 40 or 50; its speed is considerably slower than for the ordinary electric automobile. The vehicle travels at an average speed of 3 to 4 miles an hour on level road, this being considerably greater than the mean speed made by horses in like case. Even on grades it has proved very efficient and powerful; in one case a test was made on the well-known grade of Corbeaux, reaching 10 per cent, and it climbed up without difficulty at a speed of 2 miles an hour. During the month the registering instruments showed a consumption of 200 amperes at 155 volts, making 31,000 watts, or 40 horse power. The Say refinery is quite satisfied with the new system, and estimates that the vehicle gives an economy of $4,000 a year over horse vehicles; this figure includes the maintenance of the accumulators.

Science Notes.

Johann Faber, the founder of the famous lead pencil factory, died January 15, at Nuremberg, at the age of eighty-four years.

At Hohkönigsberg, in Alsace, the remains of an early mediæval castle are to be restored by the German Emperor in the same way in which Pierrefonds was restored by Viollet le-Duc.

Large numbers of gold and silver medals have been awarded at the Paris Exposition, but the expense has evidently frightened the government to such an extent that only bronze medals will be given. Gold and silver medalists can have their medals struck in precious metals, provided they will pay for the same.

A bill is before the Kansas legislature asking for an appropriation of $10,000 with which to purchase poison to exterminate prairie dogs in Western Kansas. They are destroying thousands of acres in the western part of the State. Prairie dog wardens are to be appointed for each township to scatter the poison in the prairie dog towns.

The stereoscopic fluoroscope, a description of which was published in The SCIENTIFIC AMERICAN some time ago, has undergone one or two improvements. The most important is in the motor mercury break, which can be used with any coil. This break will work any current from 12 to 100 volts, and by its utilization the brilliancy of the image on the screen is considerably increased, and the flickering entirely obviated, which is a valuable desideratum. By the use of the Mackenzie Davidson break, the time of exposure is also considerably lessened if high voltages are utilized.

The plan of furnishing farmers who live in the State of New York with desirable reading matter is being carried out by the College of Agriculture of Cornell University under the provisions of the Nixon Bill. The plan is to furnish each farmer with a series of lessons bearing upon certain fundamentals of agriculture, for instance, the formation and cultivation of the soil, how the plant grows, and the nutrition of the animal. The lessons deal with principles; they incite thought and study. They are accompanied by questions which the reader is expected to answer and return to the College. These lessons form excellent material for discussion at grange, institute and club meetings. Applications may be addressed to the College of Agriculture at Cornell University, Ithaca, N. Y.

The Royal Botanical Society of Great Britain proposes to establish a large botanical institute at their gardens at Regent's Park, London. The work will be commenced in April next. At present the buildings of this society in the metropolis comprise a museum, lecture theater, a small library and herbarium. Probably the new building will resemble somewhat the institutions of the society already in existence at Dublin, Edinburgh, Oxford and Cambridge. Its necessity has been felt for some time past, especially by intending emigrants, who at present go to Germany to acquire their instruction, but would stay in London were there a proper establishment. Endeavors are to be made to affiliate the new institute with the London University, so that it may become one of the teaching schools incorporated with that body.

While excavating for a cellar in Marietta, O., a few hundred feet from the famous Mound Cemetery, the workmen dug into a mound builder's grave, which was supposed to be 2,000 years old. The grave was covered with three layers of heavy stones with 3 inches of fine white sand between each layer. When the third stone was raised, the bones of a large man were discovered. In the bones of each hand were solid copper axes. The bones crumbled on exposure for an hour. Large bits of charcoal were also found in the grave, as were the bones of wild animals supposed to have been deer. The grave was walled in on all sides, and also the top and bottom, with heavy stones. The body of the mound builder sat in an upright position, with the hands in a position as if supporting the body. The grave was 2½ feet wide by 2½ feet long and 5 feet deep, and the stones surrounding it were easily broken with the fingers, as they were very soft.

The pearl fishery off the coast of Tuticorin, which commenced on March 12 last and continued until the 28th of the same month (work having to be suspended, owing to the unwillingness of the divers to continue the fishing), has resulted in a dismal failure. This result is partially due to the immaturity of the oysters and the low prices realized in their sales. It was estimated that the net profit resulting from the fishing would aggregate about $43,600, instead of which only about $670 were realized. The government incurred no loss, but the work proved disastrous to the fishermen. The merchants combined, and thus succeeded in keeping down prices, and when it was discovered that the oysters were immature, and pearls were consequently scarce, a panic set in, and the cessation of work followed. If the fishery had been postponed a year, more profitable results might have ensued, but the oysters were only four years old and too young to be fished.

Engineering Notes.

The monumental gateway of the Paris Exposition with its surmounting statue has been sold for $2,000 to a dealer in scrap iron.

A large Milwaukee concern recently made a casting weighing 110,000 pounds, to serve as a bedplate for a blowing engine for the Carnegie Steel Company, Pittsburg, Pa. About 125,000 pounds of metal were poured in the process of founding.

The Chicago and Northwestern Railway, in order to enter Peoria, Ill., from Sterling has purchased the entire village of Pottstown, and will move all the houses in order to occupy the site of the town with tracks.

Moscow is probably the worst paved city in the world. Great cobblestones driven by hand into a loose bed of sand form a roadway which is always dusty in summer and muddy in autumn, and in many of the roads there is no attempt at a roadway of any kind. The streets are badly watered and cleaned. The yearly expenditure for these two operations is only about $155,000.

The Manufacturers' Association of New York recently appropriated the sum of $2,000 for an industrial scholarship, including the cost of tuition for four years and incidental expenses. The purpose of the association in providing means for the industrial education of a young man of Greater New York is to encourage young men to qualify themselves for leadership in industrial pursuits by adding to the dignity of labor the advantage of trained hands directed by developed minds. A commission has been appointed to arrange the details and to conduct the examination of the candidates.

In 1900 the Baldwin Locomotive Works built 1,217 engines, of which 363 were exported to foreign countries; 426 were of the Vauclain compound system; 48 were electric, and 6 were compressed air locomotives. The total weight of the product alone was 192,777,900 pounds, says The Railway Review, involving the consumption of 52,000 pounds each of forgings and castings, and the consumption of 90,000 tons of coal. Assuming that the average length over all of each locomotive and tender is approximately 60 feet, the year's product would form a continuous train nearly 40 miles in length. The average weight of the locomotive and tender for 1900 empty was 158,500 pounds, the average weight of the locomotives and tender empty for 1890 was approximately 106,000 pounds.

India affords a splendid ground for the sale of calcium carbide, inasmuch as there are no native producers of the article, and acetylene gas is in great favor, while its developments are limitless. At the present time the calcium carbide is being sold retail at less than twelve cents per pound. Considering that the English company, which has a large export trade with India, cannot retail the article at less than 25 cents per pound, it is evident that the country is being exploited by some producers, who are desirous of encouraging the employment of acetylene gas by flooding the market with immense quantities of carbide. By this means it would be possible to transport the article from a European country and to sell it at a very low price, the producers recouping themselves upon the large quantities disposed of.

For some time past complaints have been made regarding the inadequacy of the dock accommodation of the port of London. Steamers arriving in the Thames often have to wait days before they can approach the docks to have their cargoes discharged. Attempts are being made to improve the insufficiency of berthing space, etc., but the alterations are not being carried out with a speed commensurate with the rapid development of the traffic of the port. The Thames Conservancy, which is responsible for the administration and welfare of the river, are engaged upon the construction of a channel from the Nore to Gravesend 1,000 feet in width by 26 feet in depth; from Gravesend to Grayfordness, 1,000 feet wide by 24 feet deep; from Grayfordness to the Royal Albert Dock, 500 feet wide by 22 feet deep, and from the Royal Albert Dock to Millwall Docks, 500 feet wide by 18 feet deep. The work is completed as far as Gravesend, and rapid progress is being made with the rest of the work. It is intended to bring the River Thames up to the same standard of efficiency as the Mersey and the Tyne. At present, there are only eight vessels that cannot come up the river at all tides. The reason that the improvements have not been carried out before is due to the want of funds. To defray the cost of the present extensions it is estimated that an additional income of $750,000 per annum will be necessary. Extensions are also being carried out at the Surrey Commercial Docks on the south side of the river; $3,000,000 has already been expended, and another $1,250,000 will be necessary to complete the work. The new dock will cover an area of 21 acres, with an entrance lock from the river 550 feet in length by 80 feet wide, and a depth on the sill of 33 feet.

Electrical Notes.

Prof. Fleming, of London University, is now conducting important experiments in connection with the transmission of electrical energy. It is said that the professor has discovered means by which power can be distributed without wires by utilizing ether.

Shower baths are being put in the Paris telephone exchanges for the use of the telephone girls. It is thought that this will aid them in keeping their health. In America the girls in many telephone exchanges have long enjoyed this comfort.

A gutta percha substitute has recently been patented. It consists of a mixture of pulverized peat and resin oil. The peat is dried thoroughly and is then pulverized and sifted until it is about the fineness of flour. It is then mixed with equal parts by weight of resin oil and two per cent of amyl acetate. It is then stirred and worked until it forms a smooth dough-like mixture. It can be worked into shape, and is semi-hard like gutta percha.

In 1881 the Savoy Theater was lighted with electricity, and was probably the first public building to be so lighted. The public seemed to feel that there was great danger in the new illuminant. Mr. D'Oyley Carte showed that the pilot light of the gas chandelier was always kept burning, so that the auditorium could be flooded with gaslight at a moment's notice. He then smashed an electric lamp bulb to show that there was no danger from this source. The audience was invited, after the performance, to go behind the scenes to see the electric lighting on the stage.

The new plant of the Natural Food Company will be located at Niagara Falls. It will control the business of the Shredded Wheat Company, Worcester, Mass. The building will have many unique features. It will be five or six stories high, and will be built entirely of enameled brick, steel and glass. There will be a roof garden on the roof. The plant will be run by electric power furnished by the Niagara Falls Power Company. Niagara Falls is a center of railway communication, and the cheap power and the number of visitors which are sure to come each year will doubtless make the move of the company very successful.

Two inventors of London have devised an instrument, upon the penny in the slot principle, to be employed in connection with telephones. The apparatus consists of a small box, fitted with the ordinary receiving hook. This hook is locked in position, until the insertion of a coin, when it is automatically released by the action of the coin falling within the box. For the benefit of commercial houses, where the insertion of coins, whenever a call is desired, might occasion inconvenience, the inventors have devised an alternative arrangement. Instead of placing a coin in the machine to release the receiver, it is only necessary to detach the receiver from the hook in the ordinary way, but in so doing a small ratchet wheel within the box revolves one notch, the notch being equivalent to the coin's value. Should the person who rings up be unable to establish communication, the operator at the exchange can, by pressing a button, which, by means of an electric current, causes the ratchet wheel in the box to return one notch. The English Government are inaugurating their State telephone system upon the Toll system, and probably this contrivance will be given a trial, since it will obviate the necessity of recording every call at the exchange.

The Gustav Constanz Electric Company of Hamburg have recently erected a plant consisting of a windmill, a dynamo, a battery of accumulators and electric motors at Wittkiel, near Kappelin, for the electrical utilization of wind power to generate the electric light for the town of Wittkield. The wind motor, which has been designed by Mr. C. P. Neumann, of Wittkield, is 39 feet in diameter, has a wind area of 1,000 square feet, and develops more than 30 horse power. Its average speed is 11 revolutions per minute, which is governed by an automatic adjustment of the vanes. The dynamo is shunt wound, and when the wind velocity is 8 feet per second, makes 700 revolutions per minute, generating an electromotive force at 160 volts of 120 amperes. The positive field terminal is permanently joined to the battery pole, while the negative field terminal is attached to the switch of the regulating cells in the charging circuit. It is stated that the dynamo requires no manual regulation, nor is there any attachment supplied for automatically disconnecting the dynamo, since the motor apparently maintains its speed satisfactorily. An automatic switch is provided, however, in the discharge circuit in order to maintain the voltage at 110 volts. Large electric motors are directly connected with the dynamo with starters and speed regulators inserted in the connections. This plant was experimentally installed, simply to ascertain whether the wind power could be employed for electrical generation, and the trial proved so eminently successful that the erection of a larger plant, consisting of several wind motors and dynamos, is contemplated.

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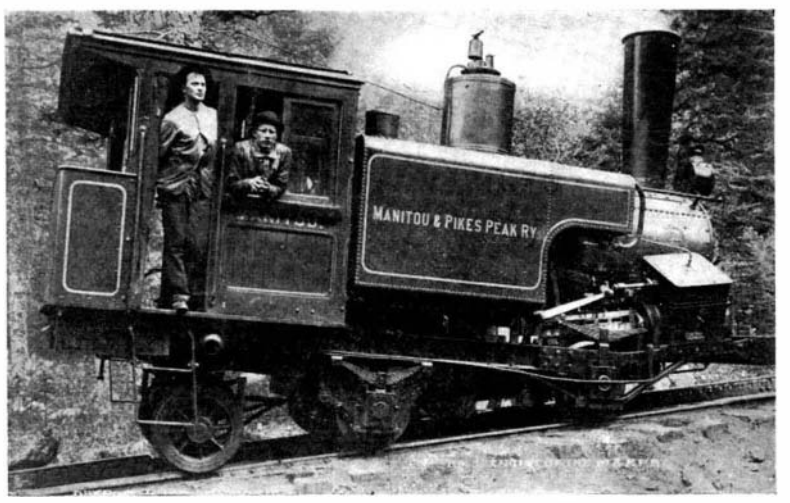
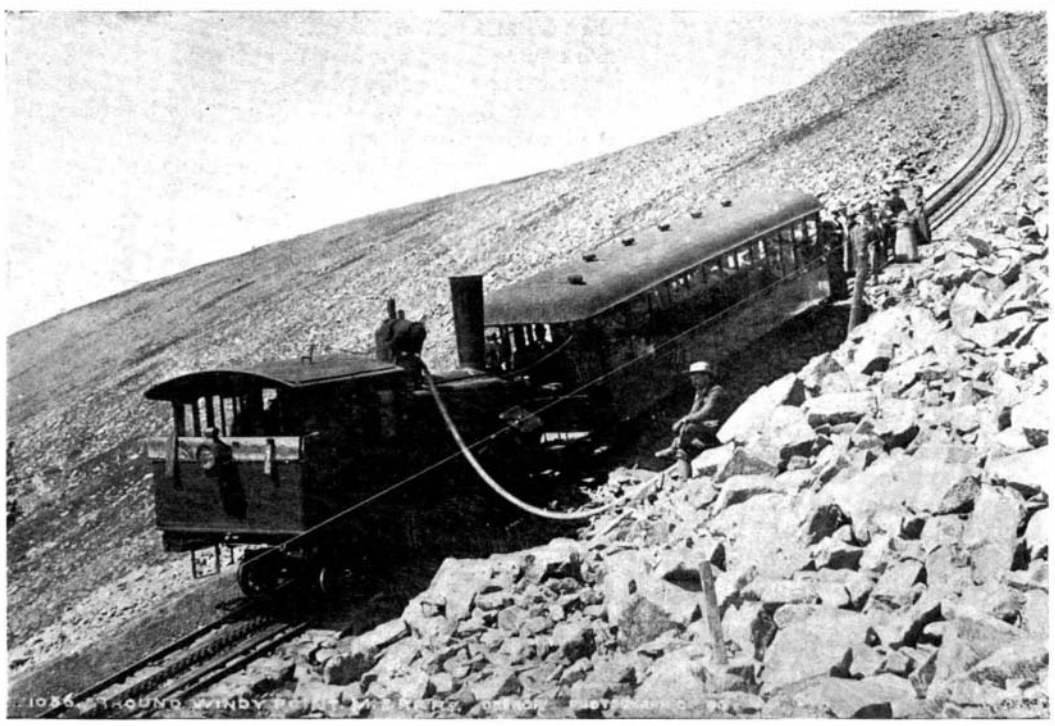
Around Windy Point—Manitou and Pike's Peak Railway.

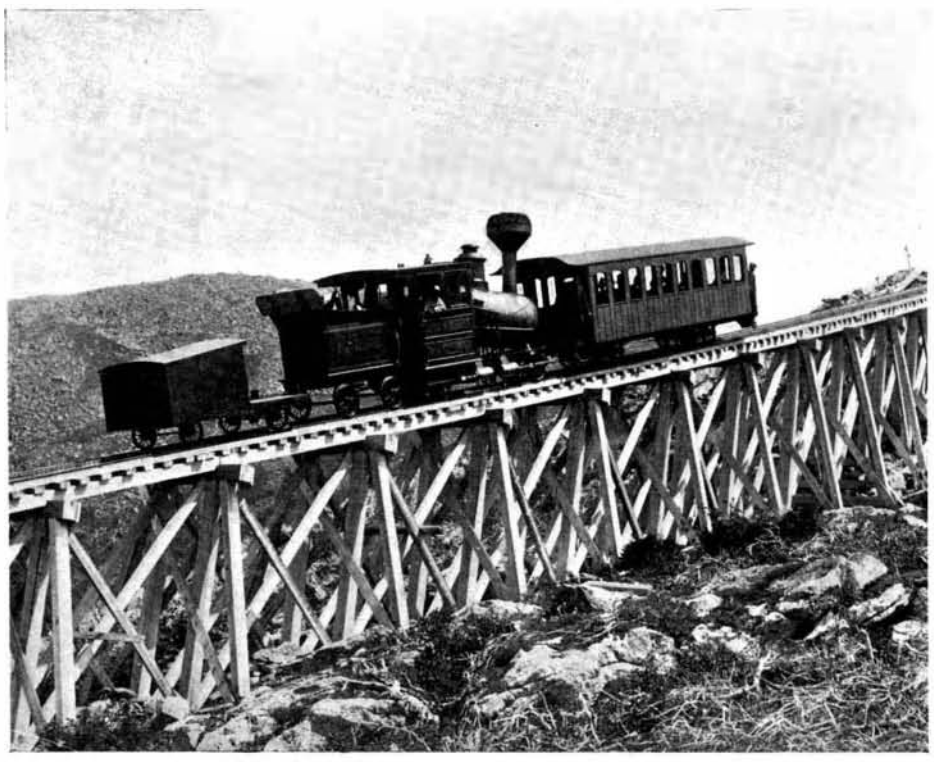


Engine, Manitou and Pike's Peak Railway.

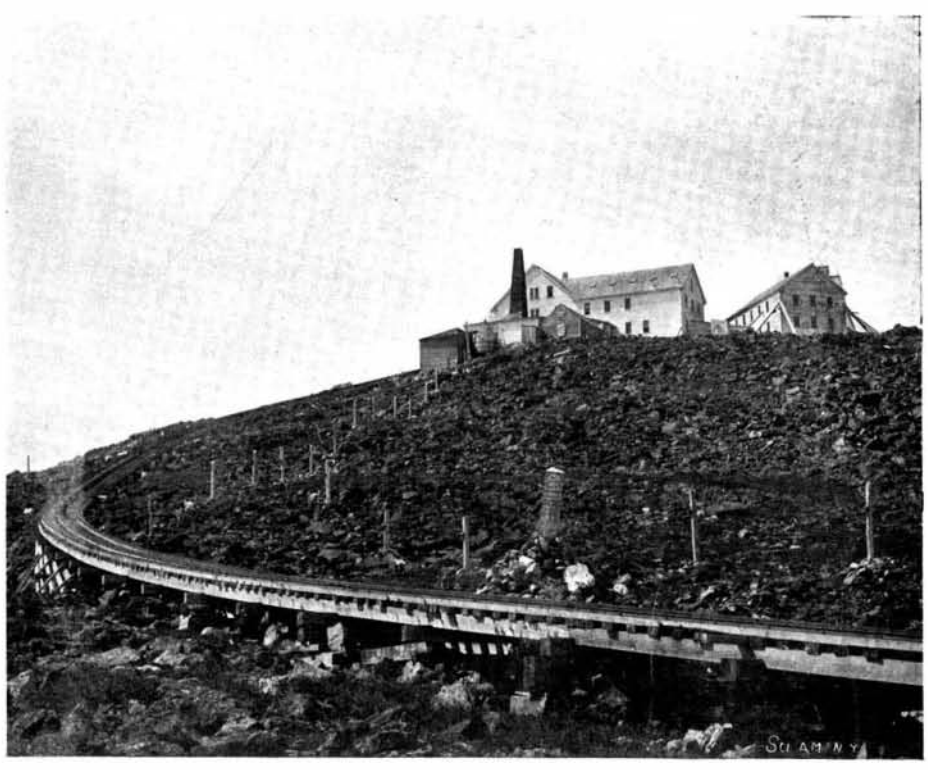


'Taking in Water, Windy Point—Manitou and Pike's Peak Railway.

Steep Incline, Mount Washington Rack Railway.



"Jacob's Ladder"—Mount Washington Railway.



Summit House, Mount Washington.

THE STEEPEST RAILWAYS IN THE UNITED STATES.—[See page 70.]