

**THE JUNGFRAU RAILWAY.**

BY THE LONDON CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

A few weeks ago the new Eigerwand station on the electric railway which is being constructed to the summit of the Jungfrau (13,670 feet) was opened for traffic.

At the present moment four stations are open, and it is expected that the next—the Eismeer (10,355 feet)—will be opened before very long.

The line starts from the Scheidegg station (6,772 feet)—the highest point on the Wengern Alp rack-and-pinion steam railway, which runs between Lauterbrunnen and Grindelwald. One of our photographs shows the Wengern Alp station on this line (6,160 feet). Trains are made up of one car and one engine only, and the rack-and-pinion system used is that of Riggenbach.

From the Scheidegg to the first station, Eiger Glacier (7,645 feet), the line is in the open, with the exception of a



The Eiger Where it is Passed by the Jungfrau Road.

short tunnel 92 yards long. From this point a splendid circular view is obtained.

“To the south the northern slopes of the giants of the Oberland—the Eiger (13,040 feet), Mönch (13,465), and Jungfrau—with their glaciers stretching down along the rocky walls; to the west the snowy summit of the Blümlisalp, Breithorn, and Tschingelhorn; to the north the Laubhorn, Tschuggeu, Männlichen, Faulhorn, and the Schwarzhorn; and to the east the great Scheidegg, the Titis, Mettenberg, and the Wetterhorn.”

The Eiger Glacier station is 1¼ miles from the starting point and the train has mounted 259 meters.

After skirting the face of the cliff the train enters the great tunnel, and for all the rest of the way it is underground. Galleries will be cut at each station (similar to those of the Ascensitpasse on the Lake of Lucerne) to allow passengers to obtain views of the magnificent scen-



Eigerletscher Station. Altitude 7,645 Feet. The Jungfrau in the Background.



The Rothstock Station (Located Back of the Star). Altitude 8,270 Feet. The Dotted Line Shows the Course of the Road Through the Rock.



A Steep Grade on the Jungfrau Railway. The Silberhorn in the Background.



The Rothstock Station-Tunnel. Altitude 8,270 Feet. A Gallery Has Been Blasted Out of the Rock in Order that the Passengers May View the Landscape.

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ory. The Jungfrau tunnel will be 10 kilometers in length.

#### THE TUNNEL.

The tunnel is 3.70 meters wide and 4.35 meters high. Electric boring machines are used. The number of shocks amounts to 380 a minute, the force employed being about 5 horse power per machine. Each weighs about 75 kilogrammes and they are worked by Thomson-Houston motors.

Nobel's nitro-glycerine is the explosive used; this has to be constantly thawed, as temperatures from 10 deg. to 27 deg. C. below zero are encountered.

The second station is the Rothstock (8,270 feet), 2 miles from the starting point. A transverse shaft, or gallery, 25 feet long, leads to a platform, open to daylight, projecting from the vertical side of the Eiger; one can ascend the Rothstock 8,753 feet and attain a fine view over the Lauberhorn to the lakes of the Swiss plateau and to the far-off mountain chains of the Jura, the Vosges, and the Black Forest.

The third station, lately opened, is the Eigerwand (9,405 feet).

This (and the same arrangement will be adopted in all the following stations) is constructed out of the rock; it consists of a large excavation; the walls, vault, and floor have a wood lining. There is a restaurant, waiting room, bedrooms for tourists, apartments for the officials, etc. All the rooms are lighted and heated by electricity.

As at the Rothstock station, a gallery has been cut to allow of views of the mountain ranges.

Beyond the Eigerwand station the tunnel, now in course of construction, takes a curve to the next station, Eismeer (sea of ice) (10,355 feet), to the south of the Eiger.

Here the traveler will command a grand panorama—the lower saddle of the Mönch, the Bergli, the Walcherhorn, the Grindelwald Fiescherhörner, and the Finsteraarhorn.

Beyond Eismeer the line takes a westerly direction; and there is a stiff gradient here up to the next station, Jungfraujoch (11,090 feet).

Still mounting, the line eventually reaches the terminus station, Jungfrau (13,428 feet). Hence the passenger may ascend to the summit of the great mountain, with her dazzling shroud of eternal snow, either by a lift 242 feet high, or by a winding staircase on the outside.

The total length of the line will be  $7\frac{3}{4}$  miles.

The first section (Scheidegg to Eiger Glacier) was opened to traffic on September 19, 1898; the second section (Eiger Glacier to Rothstock) on April 2, 1899, and the third (Rothstock to Eigerwand) was opened during this last summer.

The average gradient is 17 per cent, the maximum being 25 per cent. The gage of the track is 39 inches; the weight of the rails is 42 pounds per yard and these are bonded and cross-bonded. The sleepers are of steel, of the usual Continental type, and the rails are fixed by means of bolts and clamps.

The rack system employed is that invented by M. Emil Strub, author of "Les Chemins de Fer Funiculaires Suisses."

A rail of the ordinary Vignoles type is employed, the teeth being cut in its head, which is made higher than is usual in such constructions.

The rack rails are made of soft steel, which is rolled solid, the teeth being cut afterward in the cold bar.

The curve of minimum radius is 100 meters.

#### THE POWER STATION.

The motive power for working the line is derived from waterfalls on the White Lütschine, which furnish 2,650 horse power.

The power house, some 6 miles from the railway, contains three sets of turbines:

1. Two Girard turbines of 500 horse power each, supplied by Ruter & Co., of Winterthur.
2. Two Francis turbines of 800 horse power each, supplied by Escher, Wyss & Co., of Zurich.
3. Two subsidiary turbines of 25 horse power each, from Ruter & Co., of Winterthur.

The turbines are directly coupled to three-phase alternators which generate at 7,000 volts.

There are at present two 500-horsepower alternators with a periodicity of 38 and making 380 revolutions, and one of 800 horse power. The supply conduit as well as the pressure conduit consists of pipes made of steel sheeting. The high-pressure current is transformed to current for the line supply at 500 volts in sub-stations, in each of which there are two 200-kilowatt Oerlikon transformers.

At the railway stations there are also 30-kilowatt transformers which transform the current to 200 volts direct for lighting and heating purposes.

The transmission line is carried on impregnated wooden poles, 100 feet apart, to the Eiger Glacier station, where it divides into two, one down the line and one up. The three copper wires are 7.5 millimeters in thickness.

Beyond the Rothstock station the high-tension current is placed within the tunnel.

The trolley lines, of which there are two, the rails being used for the return, are 9 millimeters diameter, carried on span wires 13 feet above the track, and are double insulated throughout.

#### ROLLING STOCK.

The rolling stock consists of electric locomotives, with Brown, Boveri, and Oerlikon motors. Each has two three-phase induction motors, in the former case of 150 horse power each and 760 revolutions per minute; the latter are 120 horse power, revolutions per minute 750, and periodicity 38 per second.

Trains are made up of a locomotive, a trailer coupled directly to it, and another trailer. Such a train weighs 28 tons and the rate of speed is 8.5 kilometers an hour on a gradient of 25 per cent.

The current is collected by four trolley poles, two for each phase. On each motor spindle there is a small six-pole direct-current generator giving 150 amperes at 25 volts, which forms an exciter for the three-phase motors in going down-hill, so that they become generators. The current thus produced is absorbed by resistances cooled by means of a small fan driven by a little induction motor.

A double belt brake can be applied by the tension of a strong spring upon the barrels resting on the axles of the motors.

The locomotive is incased in an inclosure with windows and doors. The first carriage is coupled on to the engine; its front rests upon a bogie, while the rear part is suspended by springs from the frame of the locomotive. The conductor's place is in front in an inclosed compartment. A complete train holds 80 passengers.

#### INFLUENCE OF HIGH ALTITUDES ON PASSENGERS.

The promoters of the Jungfrau Railway have not forgotten to take into consideration the important question of the influence of the high altitudes on the health of the traveler of this great mountain line. Mountain sickness is a most disagreeable complaint from which many mountaineers suffer, and one might reasonably expect that an ascent to a height of over 13,000 feet would seriously inconvenience those who attempted it, by reason of the diminution of atmospheric pressure and the breathing of the rarefied air.

According to Capt. Spelterini, the well-known aeronaut, such fears are groundless. He has ascended in his balloon to over 12,000 feet with persons of various constitutions, and he mentions that never have they experienced any difficulty in breathing or any other indisposition afterward.

He explains this by referring to the fact that a person carried up in a balloon remains stationary as far as his bodily functions are concerned, and that the heart is not required to do more work than under ordinary circumstances. We believe that a medical man will be in attendance at a certain height, to inform travelers whether they would be well advised or not in going on to the summit of the mountain.

The journey up to the top is calculated to occupy one hour and forty minutes, and thus the passengers will be able to more or less accustom themselves to the altered conditions. If they feel any ill effects from the rarefied air, they may rest for some time at the different stations and proceed on their journey by easy stages.

It may be stated that a short stay at an altitude of 13,000 feet has no weakening or unsettling effect upon the organism of a healthy person, provided this height be attained without any great bodily exertion.

The workmen are for the most part northern Italians, who live in a big building near the Eiger station. Each man has a separate sleeping place and there is a common room and infirmary; they have board and lodging free and are paid about four shillings a day, besides special money grants according to the rate of progress of the tunneling. Fresh bread is baked every day and there is also a smithy, carpenter's shop, and machine-tool shop. The resident officials are the engineers-in-chief, the electricians, the doctor, and the local secretary. All the necessaries of life, as well as the explosives and other materials required for the prosecution of the work, have to be taken up early in the winter, and the men live comfortably enough in their chilly winter quarters. From October to April the little colony is almost completely shut off from the lower world, the only visitor being a stalwart climber who arrives at occasions with letters, newspapers, etc. The list of the winter's stores includes such items as 20,000 pounds of flour, 6,000 pounds of frozen meat, and 4 000 pounds of potatoes; 25 tons of coal, 900 boxes of tobacco, and 50,000 cigars.

A word must be said as to the effect which the Jungfrau Railway will have on the beauties of the neighborhood. At first sight one might be tempted to say that the charm and glory of the Jungfrau range will have vanished forever when the line is built. But it must be borne in mind that for the greater part of the way the railway will run in tunnel and will thus remain invisible. The first portion of the line up to the Eiger Glacier is above ground, and of course the sight of overhead wires, trains, and hordes of tourists will

annoy the man who goes to Switzerland in search of beauty, peace, and freedom from society.

But there are compensations. As has been pointed out, members of the Alpine Club will be enabled to reach the summit of the Eiger from the Eiger station in a comparatively short time. Similarly, being saved the exertions of a difficult ascent and starting from the Jungfrau in a southwesterly direction, they will have a much better chance for the grand glacier tour across the Aletsch Glacier out to the Eiggischhorn.

#### The Lebaudy Airship Record.

The Lebaudy airship made a record trip on November 12. In one hour and forty-one minutes it covered the forty-six miles between Moisson and the Champ de Mars, Paris. The average speed was about  $27\frac{1}{4}$  miles an hour. The maximum altitude reached was 984 feet. M. Juchmes the aeronaut, who steered the balloon, had this to say about the trip:

"I left with Rey, my machinist, and one hundred and twenty kilogrammes of ballast. I did not take more, as the heavy rain had weighted the airship to the extent of ninety kilogrammes. The screws were turning at the rate of eight hundred revolutions per minute. We went in the direction of Saint-Martin-la-Garenne, Dennemont, Gassicourt and Mantes, entering the town from the western side, making the tour of the cathedral, passing over Limay and returning to the railway station of Mantes.

"At this point, the wind becoming stronger, at a height of two hundred and fifty meters, I increased the revolutions of the screw to one thousand a minute. I thus easily moved against the wind, and steered for the Chateau de Rosny. On arriving above the park I maneuvered the airship in every direction. It obeyed its helm perfectly. Then I steered for the balloon shed, at Moisson. The landing took place just before the door. The airship was put into the shed without any trouble.

"The journey may be summarized as follows: Start in the rain at a quarter to nine A. M.; route, Moisson, Lavracourt, Saint-Martin, Dennemont, Gassicourt, Mantes, Limay, Rosny, Guernes, Sandraucourt, Méricourt, Mousseaux and Moisson, landing at half-past ten A. M. Evolutions above Limay, Mantes and Rosny.

"Distance covered, thirty-seven kilometers; maximum altitude, three hundred meters. This altitude is explained by the drying of the balloon when the rain ceased. From this moment the ventilation worked without stopping to replace the escaping gas. We were acclaimed by the population all along our route."

#### Gordon McKay's Harvard Endowment.

The will of Gordon McKay, inventor of the McKay sewing machine, was recently filed for probate. By its terms Harvard University is made the chief legatee. The amount of the property left by Mr. McKay to Harvard at present amounts to \$4,000,000, and will eventually surpass even that figure. After paying certain annuities, 80 per cent of the balance of the estate—the remaining 20 per cent being held as a reserve fund to cover any future possible deficiency in the annual income—will be invested by the trustees until such accumulations reach the sum of \$1,000,000. The sums thus collected are then to be paid over to Harvard College. After this sum has been paid over, the will directs that 80 per cent of the income, after paying the existing annuities, shall be given annually to Harvard. The net income of the endowment will be used to promote science. The will states that special care should be taken that the "great subject of mechanical engineering in all its branches and in the most comprehensive sense be provided for." The salaries attached to the professorships are to be liberal, so that able scientific men will be attracted.

#### Necessity of Trade-Mark Registration in Japan.

News comes from Japan that the pirating of trade marks in that country has caused no little injury to the business interests of the merchants of California and the Pacific coast. The San Francisco agent of a large eastern manufacturing company is said to be authority for the statement that some of the most famous American trade marks have been appropriated and registered in Japan by dishonest Japanese pirates. The moral is obvious: American manufacturers should themselves register their marks in Japan.

#### Cody's Kite-Drawn Boat.

Mr. S. F. Cody, whose kites have been described in the columns of the SUPPLEMENT, succeeded in crossing the Channel from Calais to Dover in a collapsible boat drawn by a kite in thirteen hours. A similar attempt failed on October 10. The collapsible boat weighed four tons. A combination steering gear was used, which manipulated both kite and rudder.

Bridge Commissioner Lindenthal on November 10 awarded the contract for the steel superstructure for the new Blackwell's Island Bridge to the Pennsylvania Steel Company, whose bid was \$5,132,985.

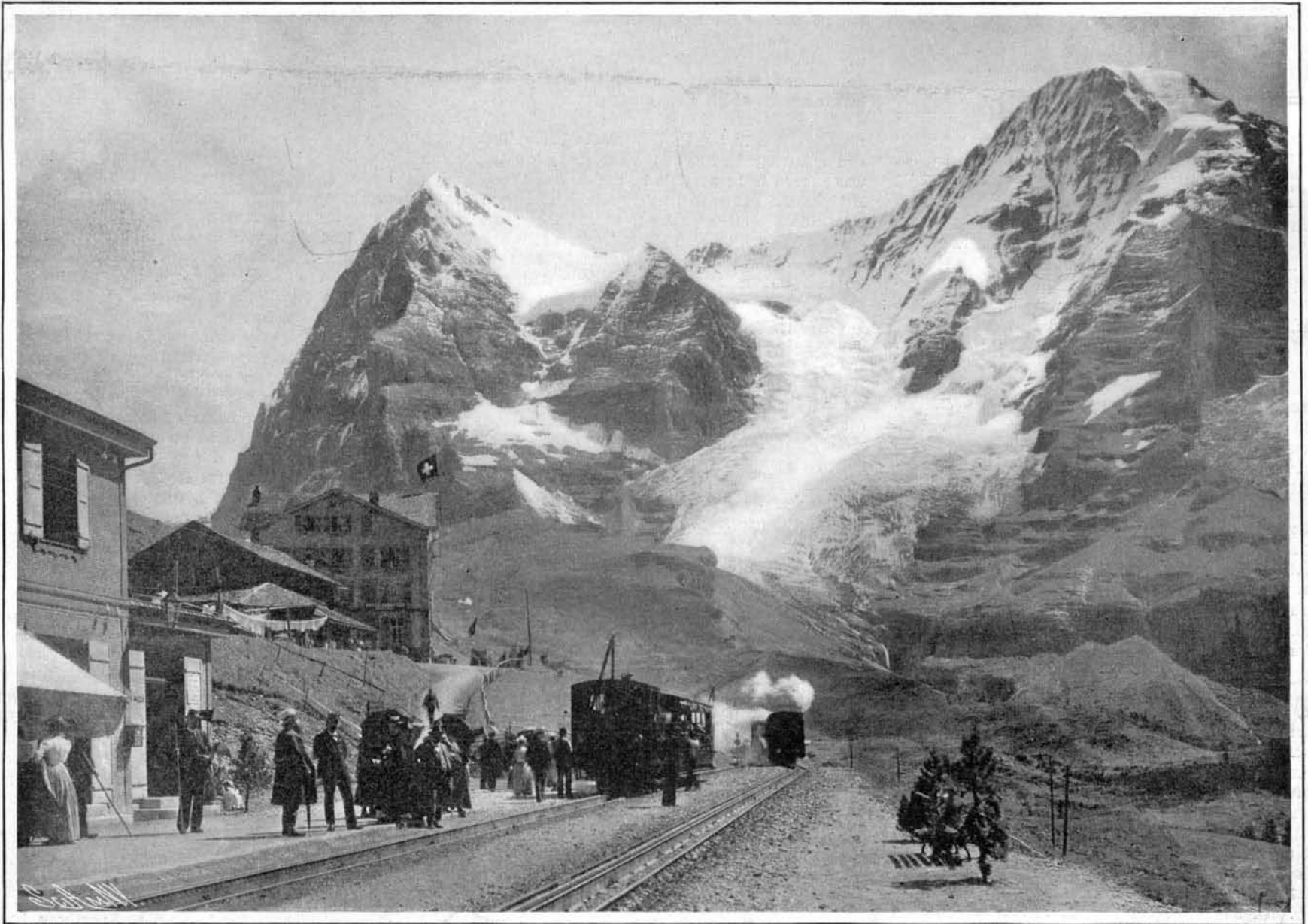
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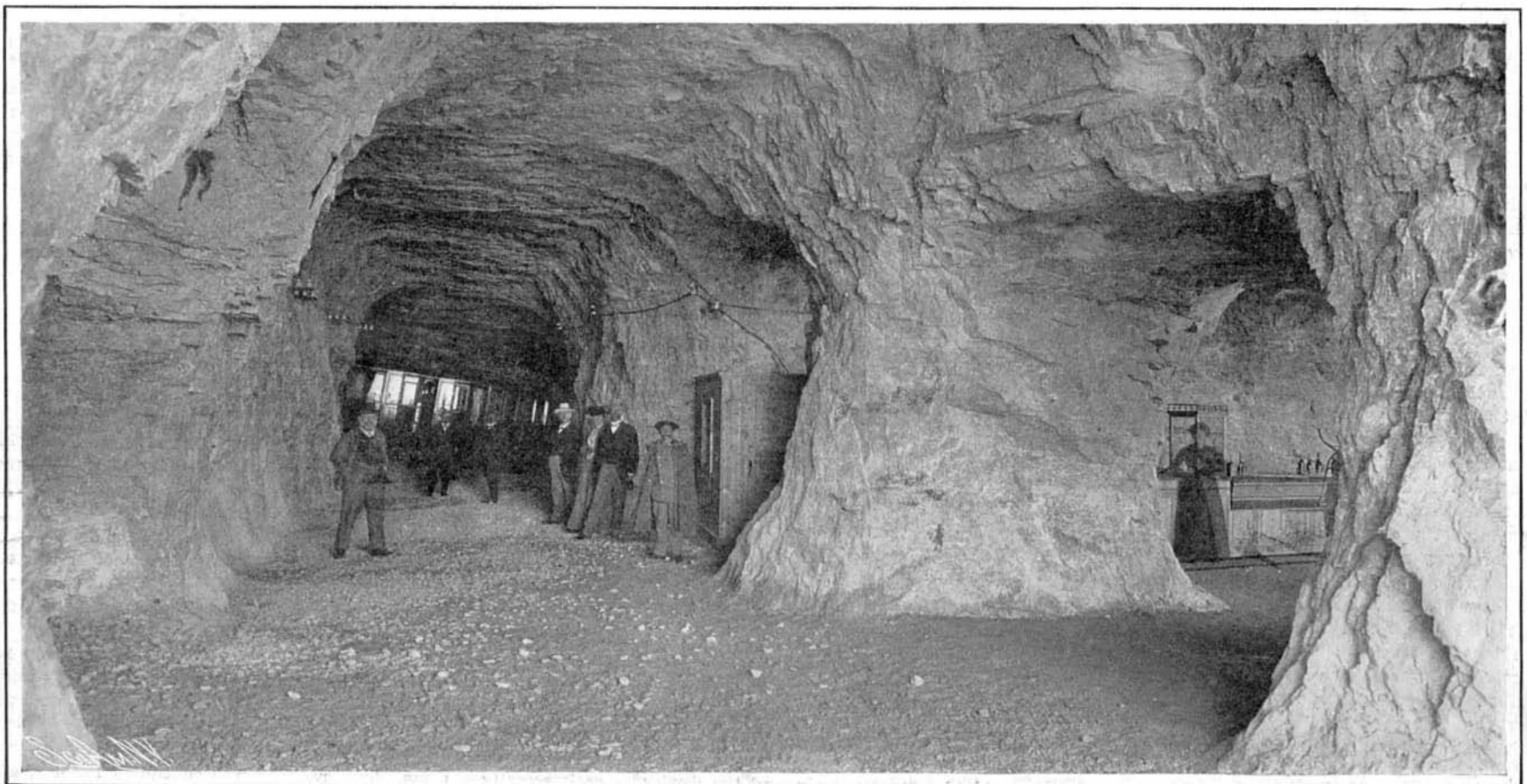
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The Wengern Alp Station of the Jungfrau Railroad.



The Eigerwand Station, Blasted Out of the Solid Rock. Altitude 9,405 Feet. From the Tunnel a Gallery Leads, Whence a Fine View of the Alps is Obtained.

THE JUNGFRAU ELECTRIC RAILWAY.—[See page 369.]