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THE TRANSSIBERIAN RAILROAD.

BY HORACE C. HOVEY.

A year ago a card came to the writer from St. Petersburg, which, on being deciphered, proved to be a pass over the entire system of Russian railways.

Maps and special guide books accompanied this favor, and access was also given to official reports. Ours was a geological party, and our errand was to inspect soils, fossils, mines, and quarries; but we could not do otherwise than take an interest in the magnificent iron highways that carried us safely from the western frontier, across limitless steppes, over broad rivers, and beyond the Ural Mountains into Siberia, and then back again to the frontier. As we had a special train, we escaped many of the annoyances usually met with by tourists, and enjoyed every imaginable courtesy and facility for making our trip successful. The paternal oversight taken by our officials was amusing to those of us who were accustomed to American manners, and yet we

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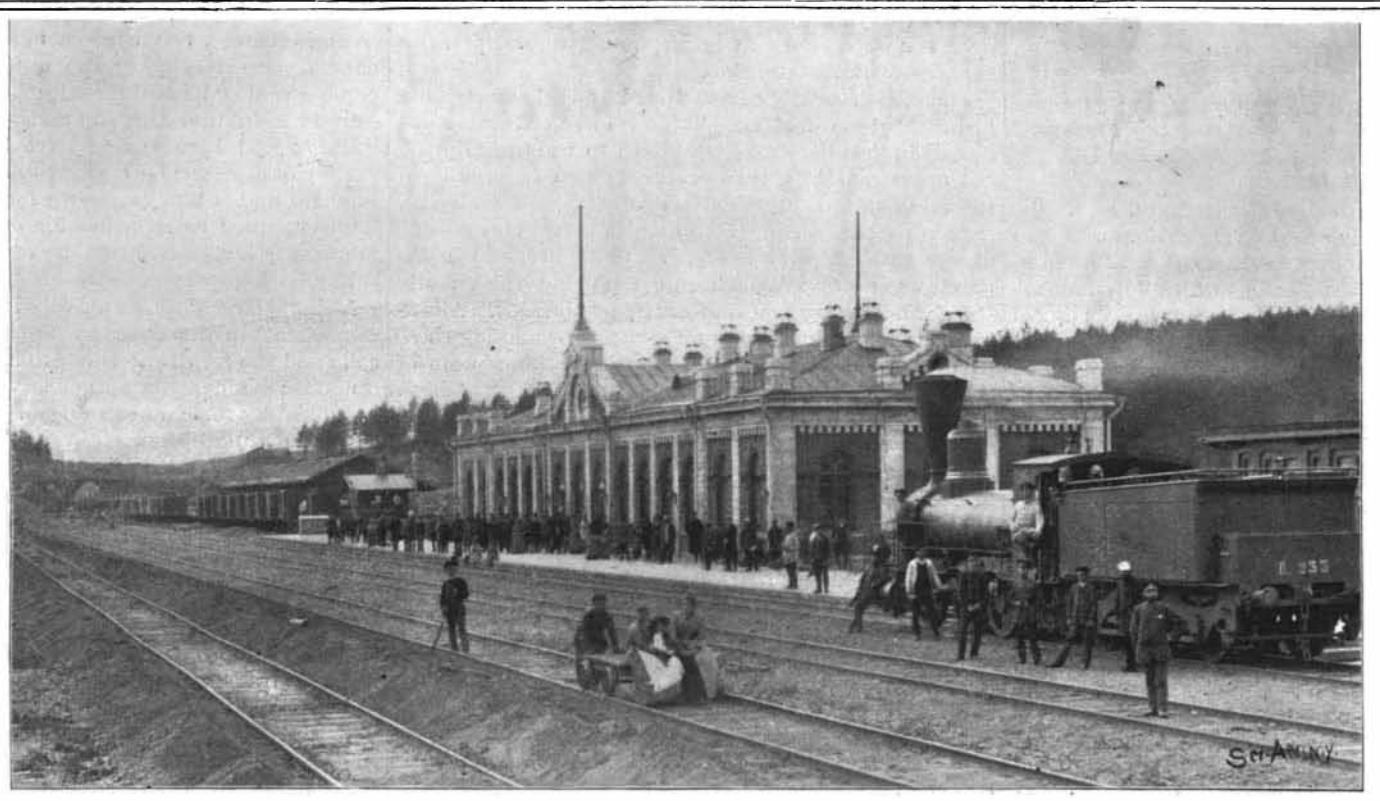
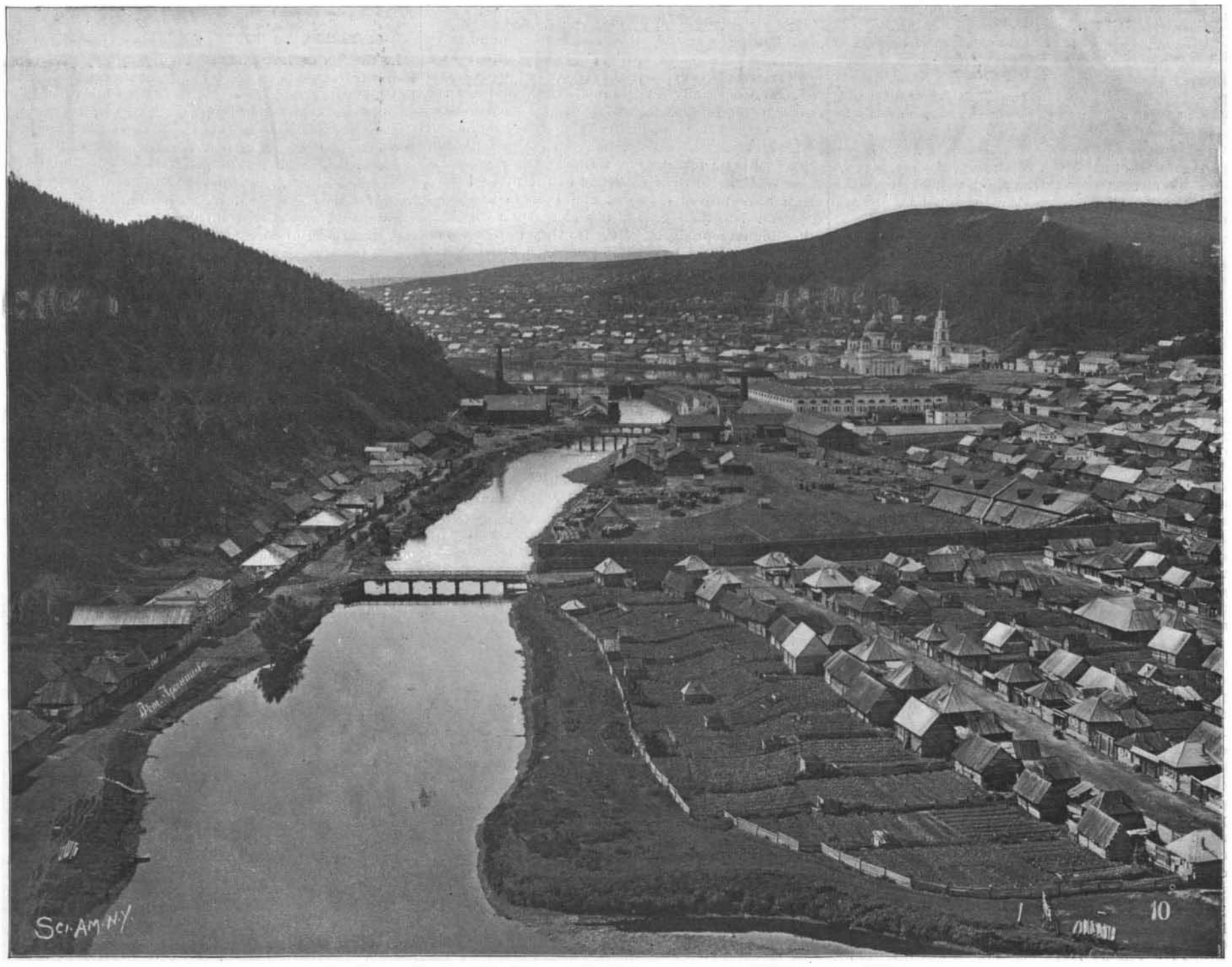


RAILWAY STATION AT ZLATOOST, RUSSIA.



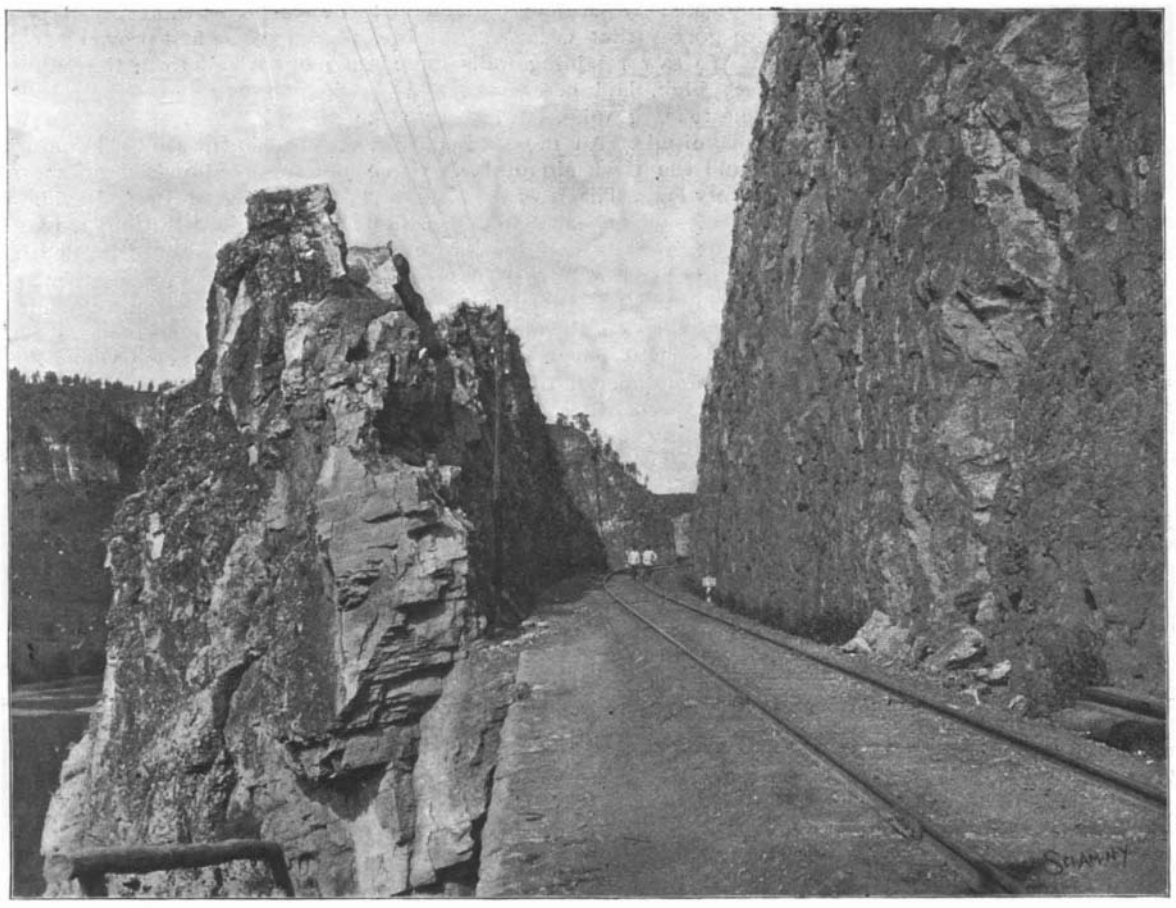
ZLATOOST, RUSSIA—WESTERN TERMINUS OF THE TRANSSIBERIAN RAILWAY.

THE TRANSSIBERIAN RAILROAD.

(Continued from first page.)

must say that it was agreeable and even necessary under the circumstances.

My object, however, is not to give incidents of travel, but to describe briefly the railroads themselves, especially the gigantic one that is now binding Europe and Asia together by bands of steel. As usual, the ubiquitous Yankee is in evidence, and undoubtedly had much to do with the introduction of railroads into Russia. This helps to explain the fact that many conveniences are found there which we look for in vain in other parts of Europe. But we were struck by one fact so decidedly unlike the American way that we sought an explanation, namely, that the road never hits any except the large cities, the station being usually several miles from the town or village whose name it bears. The explanation is that when two American engineers laid before a former Czar carefully drawn plans for a railroad from St. Petersburg to Moscow, touching at intervening cities, his majesty took a ruler, drew a straight line between the two capitals, saying like the autocrat that he was, "Build it there!" Of course it was done, and the example thus set was followed elsewhere throughout the empire.



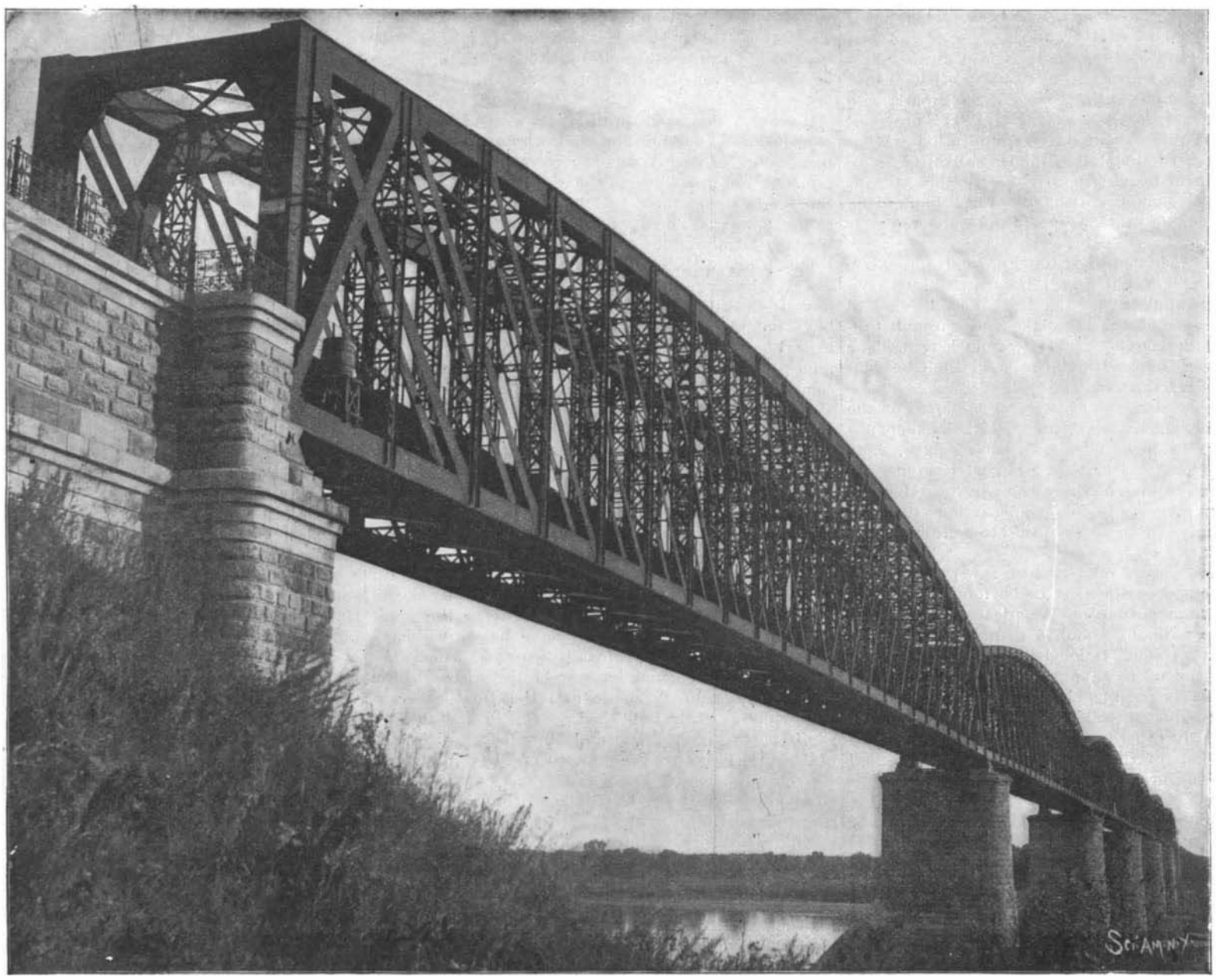
A RAILWAY CUT AMID THE URALS.

To understand the railway system one must first glance at the river system. The streams of European Russia mainly rise in the Valdai plateau, parts of which are 1,500 feet above the sea level, whence they sluggishly flow to the Arctic, Black, Baltic, or Caspian Sea. This immense river system, aided by canals, makes Russia in Europe accessible to St. Petersburg by 33,000 miles of navigable water, carrying last year 81,000 vessels and 140,000 rafts. Imagine a vast plain stretching for 1,800 miles from the Baltic Sea to the Ural Mountains, and for double that distance from the Arctic Ocean to the Caucasus, including vast forests, the rich black zone of "tschernoziom," then barren, treeless steppes, beyond which is the saline desert formerly the bed of an immense sea of which the Caspian and Aral are the remnants; and it is evidently a region favorable to the railroads which are now being built over it in every direction, to meet the varied wants of 115,000,000 inhabitants.

The Siberian river system, however, is different. All large streams, whether rising near the Urals or the Pacific coast, flow northward to the Arctic Ocean. Yet here, as in Europe, there are immense plains, so that the waterway from the river Ural to the mouth of the Lena, a distance of 6,000 miles, is interrupted by only two short portages. Hence this Asiatic region also favors easy railroad building, with the exception of the rugged hills and deep volcanic fissures around Lake Baikal, where the obstacles can only be overcome at a great outlay of money and labor.

From the times of Peter the Great to these days of Nicholas II., the great problem of Russia has been that of getting free access to the outside commercial world. The ports along the White and Arctic Seas are blocked by ice most of the year; the Caspian is landlocked; egress by the Black and Baltic can only be had by the friendly permission of other nations. Hence arose an imperative demand for a transcontinental railway that should wind over the steppes of Orenburg, the Ural plateaus, the plains of western Siberia, climb or pierce the hills below Lake Baikal, cross Transbaikal to the valley of the Amur, thence down to Vladivostok, on the Japan Sea, and ultimately to Port Arthur and the open Pacific Ocean.

This most extraordinary railroad undertaking could not all be done at once. Nor is it clear to every writer where the Transsiberian Railway actually begins. In 1878 the Ural line was built as far as Ekatherinburg. Four years later Ostrovski made surveys that met governmental favor, outlining a road from Perm to Tobolsk and thence to Irkutsk, his object being to open the mining regions. A line was also projected from Moscow across the tschernoziom belt to Oufa, where our Russian friends drew our attention to the splendid lattice girder steel bridge, over the river Bielaia, which is a subject of illustration, as a specimen of the work



TRANSSIBERIAN RAILWAY—STEEL BRIDGE AT OUFA, OVER THE BIELAIA RIVER.

being done on their Transsiberian road. They likewise spoke of the charming city of Zlatoost as the starting place for that great railway. No more lovely situation can be imagined than that held by this busy mart and manufacturing city of 40,000 inhabitants, the last European station of any importance before crossing the boundary line into Asia. It is in the picturesque valley of the river Ai, whose waters here expand in a lake. But, so far as the Siberian part of the road is concerned, it is proper to speak of it as starting from Tcheliabinsk, where are the offices and works. But, after all, when ultimately completed, the main termini will be St. Petersburg and Vladivostok or Port Arthur.

The relation held to this continental enterprise by the reigning Czar is interesting. While Czarovitch he explored Siberia, went on to China as the guest of Li-Hung-Chang, and made himself master of every available source of information concerning the projected railway. The result was an imperial rescript, March 17, 1891, ordering work to be begun at several points simultaneously. The formal inauguration of it was by the Czarovitch, who wheeled away the first barrowload of soil and laid the first block of stone at Vladivostok. The Emperor also made him the first president of the road, a relationship which the latter continued to hold after he became the reigning Czar. The actual work of construction, however, was put in the hands of a committee in June, 1893, which is a branch of the Department of Ways and Communications; having only administrative power, the Emperor himself retaining executive authority.

The committee of construction divided the main line into seven sections, and estimated the cost of each as follows, although subsequent modifications were made both in the sections and estimates:

1. Tcheliabinsk to Ob, 1,328 wersts, cost 47,000,000 rubles.
2. Ob to Irkutsk, 1,745 wersts, cost 73,000,000 rubles.
3. Irkutsk to Misovskaia, 292 wersts, cost 22,000,000 rubles.
4. Misovskaia to Srjetensk, 1,009 wersts, cost 53,000,000 rubles.
5. Srjetensk to Khabarovsk, 2,000 wersts, cost 117,000,000 rubles.
6. Khabarovsk to Grafskaia, 347 wersts, cost 18,000,000 rubles.
7. Grafskaia to Vladivostok, 382 wersts, cost 17,000,000 rubles.

Thus the total distance between the Siberian termini would be 7,112 wersts (4,742 miles), and the total estimated cost 347,000,000 rubles (about $173,000,000)—although this cost will be much exceeded. At the time of our visit to Siberia we were informed that more than 5,000 miles of steel rails had been laid, at a cost of about 350,000,000 rubles, and the close of the year 1897 saw the road open as far as Nijni Udinsk. Now Irkutsk has been reached on a tributary of the Yenissei, the most important place in Eastern Siberia, and 3,780 miles distant from St. Petersburg. It is promised that by 1899 direct railroad communication will be open between St. Petersburg and Vladivostok, with the exception of ferrying across the treacherous currents of Lake Baikal, a body of water 466 miles long and about 55 miles wide, supposed to be the reservoir of numerous subterranean rivers.

The ferrying will be by a steamer of 4,000 tons, carrying the trains. Ultimately, this hazardous bit of navigation will be obviated by the track now being laid around the south shore of the lake and through tunnels, one of which will be 12,500 feet in length. The imperial order is that the entire road shall be completed between 1902 and 1905.

In 1895 the department reported as employed on the West, Middle, Transbaikal, and Ussuri divisions 36,629 navvies, 13,080 carters, 5,851 surface men, 4,310 carpenters, 4,096 stone masons, and 2,091 riveters—62,000 men in all. But such was the eagerness for the speedy completion of this undertaking that, in the following year, there were said to be fully 200,000 men at work.

The portion of the road that we saw was rock ballasted and equal to the best to be found anywhere in Europe; though, from our American point of view, the rails are too light, about 75 pounds to the yard, for the heavy traffic. Colonel Waters, of the British embassy, is quoted as saying, "The work done has been remarkably good, and in point of quality the line, when completed, will be equal to the Canadian Pacific." On the other hand, we were told, concerning certain portions of the road, that the ties were laid directly on the grass or sand, and that the work is being pushed along too rapidly. All agree, however, that the road, when finished, is to be as substantial as possible in every respect, and that it is to be equipped with every modern appliance for safety, comfort, and convenience.

Convict labor has been used on a large scale in the central section of the road, the terms being that eight months of railroad work should offset one year's imprisonment: and special offers of registration as peasants were held out as an inducement to exiles. Free labor was paid for usually at the rate of from 50 cents to $1 a day, according to skill required and the nature of the work to be done. Many, however, received less than this amount. It is not easy to estimate the great variety and quantity of labor needed for building this thoroughfare. For instance, the bridges involve very difficult engineering problems. They must be protected by peculiar skill against the tremendous ice gorges that occur at the breaking up of winter. We saw retaining walls more than one hundred feet high, laid in cement. The deep cuts through limestone, granite, and other rocks are of enormous magnitude. An illustration is given of a deep cut amid the Ural Mountains. Some of the bridges are very long. That over the Volga is 4,500 feet in length, and is said to be the longest steel bridge in the world. The river Ob is spanned by a bridge 2,500 feet long, and the Yenessei by one 3,000 feet long. The manner of testing these massive structures is to let four or more locomotives with a loaded train of cars stand on a bridge for several hours, and then to run them back and forth a number of times at a constantly increasing rate of speed, till the maximum is reached. The fuel used on the engines has been wood and crude petroleum. Coal has been found along the road near Pavlodai, allied to anthracite, and some of the seams in the Selenga valley are said to be thirty feet thick.

In December, 1896, the Cassini treaty was published, securing the right to build a Transmanchurian branch, leaving the Siberian road at Onon, entering China, running through Manchuria for 1,280 miles, and joining the original line at Nikolskaia on the Ussuri section, thus shortening the route about 350 miles. The significance of the Cassini treaty is that it really means a Russian administration of the affairs of Northern China, and that it will make the actual eastern terminus, not Vladivostok, but Port Arthur. This occupation of Port Arthur has been regarded as a Russian trick; but in reality it was a commercial necessity. As Count Muravieff claimed last February, "It is natural that Russia should wish to have an outlet for her commerce on the coasts of the North Pacific." But he added, "Any such port would be open to the ships of all the great powers, and open to the commerce of all the world." We are apt to forget that 4,000 miles of Russian frontier touch China, and it is inevitable that the two nations should combine for the mutual protection of that long stretch. At all events, Russia, in March, 1898, formulated its final demand for the permanent lease of Port Arthur and Talienwan, as requiting her for her services in clearing the Japanese from China, and her claim was granted. As remarked by an English writer, "Had Port Arthur been called Fort Arthur, certain mistakes would have been avoided. It is a military point, and is to Talienwan what any fort would be to a port that it covered and commanded. The latter is destined to be the Russian Liverpool, the terminus of a railroad costing $250,000,000; and Russia must protect such an emporium of world wide commerce."

Of course this transcontinental railroad will enormously affect the transportation of Eastern goods of high value, as well as passenger travel and immigration. It is estimated that the revenue from duties on the single item of tea will be increased by 9,000,000 rubles a year. There will be a great output of all kinds of farm produce, and we should remember that Russia is one of the greatest agricultural regions on the globe. Mining products also will feel the stimulus and have such a development as will astonish those who have not given the matter due attention. Our geological party were impressed by the conviction that the mines of Russia are but very imperfectly worked, as compared with those of our own country, and are capable of yielding many fold what they now produce. And as to passenger rates, it is officially announced that the time from St. Petersburg to Vladivostok will be less than fourteen days, and possibly as low as ten; and that when all plans are worked out, the time from London to the Far East will not exceed eleven days, instead of the thirty now consumed by the trip via Brindisi and the Suez Canal. A ticket by the latter route now is sold for $428; but by the Transsiberian route it will cost only $119, first class, and other classes lower in proportion. Plainly this will be the great highway of the nations, and England herself will have to send her Australian mail via Moscow and Talienwan.

The reader is referred, for more full statistics, to the official report on "Siberia and the Great Siberian Railroad," recently published at St. Petersburg, by the Department of Trade and Manufacture. Ministry of Finance; also to the reports of M. Chilkov, the Russian Minister of Communication. This latter authority confidently predicts that, early in the twentieth century, the diligent "globe trotter" can girdle the earth from St. Petersburg around to St. Petersburg again in thirty-three days.

LAVA streams that have flowed out of Vesuvius during the last three years have deposited 105,000,000 cubic meters of lava on the sides of the mountain. A cone of lava 330 feet high has been formed, out of which fresh streams are flowing. The valleys on either side of the observatory peak have been completely filled.

Coral Reef Investigation.

In order to test the values of different theories entertained for the origin of coral reefs, borings have been made in islands supposed to be situated in regions of submergence. Reports have already been given in The Independent of those made by Prof. Agassiz, at Key West, and by Prof. Sollas, off Australia. The first proved the true coral rock to be comparatively thin; the second was a failure, because of accident to the boring tools. A committee of the Royal Society of England is continuing the work of boring in the atoll of Funafuti, one of the Ellice Islands, about five hundred miles north of the Fijis, under the direction of Prof. David. This is a circular island, rising solitarily from a plateau 2,000 feet deep. This boring had reached the depth of 653 feet, as reported by Prof. Bonney, November 25 last. The material to the depth of 200 feet corresponds very well to the ordinary reef. For 170 feet thickness lower down the cores represent substances produced in the vicinity of a reef. From 370 to 643 feet the rock is more like that first passed through. Work is still being prosecuted at this locality. Meanwhile, Prof. Alexander Agassiz has reached the Fijis with all the facilities for boring, and the intention of sinking a well at Suva, presumably to confirm the results attained by Prof. David. From a letter dated December 15 last, published in The American Journal of Science for February, it appears that Prof. Agassiz has made discoveries rendering another boring unnecessary. According to Darwin and Dana, it is impossible to find a better series of islands than the Fijis to illustrate the changes brought about by subsidence, there having been first an original volcanic island around which a fringing coral reef grew: next after sinking appeared the barrier reef; then an atoll; and, finally, one where there is only a more or less circular reefing.

After traveling some thirteen hundred miles throughout the archipelago, Prof. Agassiz has discovered that it is a region of elevation instead of subsidence, as he found numerous examples of elevated reefs at various levels up to 800 feet. Those are described in detail over about three-fourths of the archipelago. Not only are the reefs elevated, but they have been deeply eroded, producing gorges, separated by sharp, serrated ridges, thus bearing witness to the great length of time that has elapsed since their elevation. The conclusion is, therefore, that the corals of to-day have played no part in the shaping of the atolls among the Fijis, nor can the building up of the barriers be explained by submergence. The accumulations gathered by recent corals can form only a crust of very moderate thickness upon a base either of an eroded elevated reef or a substructure of volcanic material. The theory of Darwin and Dana cannot be applicable to the islands and atolls of the Fiji group; but we must rather accept the views of Murray, as illustrated in the reports of the "Challenger" expedition, which agree essentially with those of Agassiz. There may, however, be no general theory of the formation of coral reefs of universal application. With such divergent views as have been given us by the ablest naturalists, it would seem as if different regions might have been acted upon variously.

A Brazilian Indian Telephone.

Mr. José Bach, in a narrative of his travels among the Indians of the regions of the Amazon, describes in L'Illustration an instrument by means of which these people communicate with each other at a distance.

These natives live in groups of from one hundred to two hundred persons, and in dwellings called "malocas," which are usually situated at a distance of half a mile or a mile apart.

In each malocca there is an instrument called a "cambarisa," which consists essentially of a sort of wooden drum that is buried for half of its height in sand mixed with fragments of wood, bone, and mica, and is closed with a triple diaphragm of leather, wood, and India rubber.

When this drum is struck with a wooden mallet, the sound is transmitted to a long distance, and is distinctly heard in the other drums situated in the neighboring maloccas. It is certain that the transmission of the sound takes place through the earth, since the blows struck are scarcely audible outside of the houses in which the instruments are placed.

After the attention of the neighboring maloccas has been attracted by a call blow, a conversation may be carried on between the cambarisas designated.

According to Mr. Bach, the communication is facilitated by the nature of the ground, the drums doubtless resting upon one and the same stratum of rock, since transmission through ordinary alluvial earth could not be depended upon.

We have here an ingenious improvement upon the process employed by Indians for perceiving distant noises (such as the gallop of a horse), and which consists, as well known, in applying the ear to the earth. This method was formerly much used by the people under consideration during the course of wars of one tribe with another.