COPPER MINING IN JAPAN.

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So little is generally known of Copper Mining in Japan, that it is somewhat surprising to find that the metal is produced in considerable quantity, that the Metallurgy is perfectly understood, and at least in one case, viz., the Ashio Mine, the work of winning the ore and extracting the metal is carried on in a thoroughly scientific manner, and with all the up-to-date appliances used in mining and treating copper ores on a large scale.

According to the Mineral Industry, the production of copper in Japan amounted, in 1899, to twenty-seven thousand five hundred and sixty long tons, which shows a steady and continuous increase from 1895, in which year the production was eighteen thousand four hundred and thirty tons.

Japan, at present, stands third on the list of copper producing countries, and in 1899 was responsible for 13·25 per cent. of the total production from all countries, exclusive of the United States.

The following table, compiled from the "Mineral Industry" returns, give the world's production for the past five years.

Country.	1895.	1896.	1897.	1898.	1899.
Australasia	10,000	11,000	17,000	18,000	20,750
Chile	22,075	23,500	21,900	24,850	25,000
Germany	16,531	20,038	20,145	20,085	23,460
Japan	18,430	21,000	23,000	25,175	27,560
Mexico	11,620	11,150	11,370	15,668	19,125
Spain and Portugal	54,815	53,347	54,060	53,225	54,220
United States	172,524	208,760	223,825	239,241	259,517
Other Countries	28,559	29,645	34,050	37,779	38,831
World's Production, in Long Tons.	334,554	378,440	405,350	434,023	468,463

The two largest mines in the Empire are the "Ashio" and "Besshi," and they each produce from fifteen to twenty tons of copper daily; besides these there are numbers of small mines, scattered pretty well all over the main Island, which produce thirty tons, and downwards, monthly.

As a general thing, copper seems to be the principal metal of Japan; some of the mines have been worked for hundreds of years, and the Japanese, for ages, have been noted for their bronze and copper working industries.

During a six month's residence in Japan, the author has visited a number of the mines, and the following notes on the Ashio Mine will probably be of interest to members.

A second mine owned by the proprietor of the "Ashio" (Mr. Furakawa), and situated at the north end of the main Island, showed a novel way of producing copper from the smelter matte, and it would be interesting to know if this is simply a makeshift for the "converter" or not.

No one on the mine could speak English, and the explanation in Japanese was unintelligible, but, from what the author could see, a hole in the ground, lined with fire-brick and fire-clay, takes the place of the converting vessel; it is covered by a dome of fire-clay, and has a working door in front; two twyere pipes enter the receptacle from opposite sides, and the blast from the "blowers" is kept on during the operation. There were eight or nine of these vessels arranged in a long row, all in different stages of relining, stirring, skimming and ladling out the copper, About twenty-seven tons of copper are produced monthly in this way.

The Ashio Mine, which is the largest producer of copper in the Empire, is situated about fifteen miles south-west from Nikko, in the Province of Simotsuke, Japan.

It is stated to have been worked for a period of three hundred years, and probably much longer, but for most of that time in a small way. At present work is done on a large scale and the Company's pay sheets show that about twelve thousand people are employed, that is, including those in the mine treatment works, transport, office employees, and timber, charcoal and flux supply.

Besides this a very large amount of power is developed from adjacent streams, and transmitted electrically to various parts of the mine and works, and a number of horses (over one hundred) and bullocks are used for transport on the numerous tramways. Although the output of ore from the mine is not large compared with the number of hands employed, the fact that labour is cheap, and the surrounding country is so rugged and difficult from an engineers point of view, necessitating a great deal of handling of ore and supplies, the amount of labour employed seems to be justified.

The employeés include men, women, and children; some of the latter being very young and principally employed at light work, such as hand sorting the ore, etc.

As a result of the works having been added to, and extended at various times, and this in a place where suitable ground is limited in extent, a great deal of handling is made necessary; at some of this

work, old women and young children can be seen carrying light loads, such as two or three bricks, a few pounds of ore, etc., in small boxes strapped on the back.

On a first visit to the works, one wonders how all this labour is controlled, but some ticket and book system is employed, by which a record of each person's work is kept, and payments made accordingly, to the satisfaction of both parties.

The rate of wages if of course small and ordinary labourers would get from thirty to forty sen (one sen equals about one farthing) per day, while women and children would receive from ten to twenty-five sen. This rate is for ten hours work per day.

The transport of coke and other supplies from Nikko to Ashio is difficult, as a high and steep main range of mountains has to be crossed en route, and for four months of the year this is covered with snow from two to three feet thick.

From Nikko (the Railway town) to the foot of the range, a distance of five miles, the road is level and in good order; the mine supplies are brought to this point by tramway, bullocks being used for haulage.

This is the receiving station for the two Aerial Cable tramways, which cross the range and descend to the foot on the Ashio side.

They are each about six thousand five hundred yards in length, and some of their spans are long, and very high, having to cross from ridge to ridge over deep gullies.

The gantrys are of timber and the carriers are a simple hook shaped frame suitable for bags of coke, etc.

The Cables are worked by water-power on the Ashio side—flumes pipe lines, and Pelton wheels being employed as usual. From the receiving station on the Ashio side, a horse tramway runs for some miles to the different branches of the property.

The Mine.

Photograph No. 1 shows a general view of the upper part of the Mountain which carries the ore bodies; it will be seen that the country is absolutely bare of vegetation, and the slopes are, in places, steeper than 45°.

On most of these slopes, above the works and township, it has been found necessary to cover them with a complete network of plaited brushwood, firmly pegged down, in order to prevent the continual washing down of the loose surface stone by heavy rains and snow.

The ore deposits consist of true "contact" veins formed between an acid erruptive rock called "leparite," and a hard black slate, known as adinole slate, from the fact that it contains adinole fossils; the former is the "footwall" and the latter the "hanging wall."

Other rocks formed in the locality include pegmatite, aplite, dacite and pyroxene andesite. The ore itself is composed principally of "chalcopyrite," with quartz and occasionally "erubescite." Some of the high grade ore carrys thirty per cent. copper, but the general ore is much

poorer, and the average contents of the dressed ore is about fifteen per cent. copper. There are a number of these veins, large and small, but the principal one is the "Champion" which has been followed by the "Ariki" Adit for about two miles, and averages twelve feet in thickness.

The veins vary in "strike," but it is generally north east and south west, with a slight "dip" to the south east.

The mine is divided into three branches (see sketch map) as follows :—

1. Honzan, where the "Ariki" adit is driven on the "Champion" lode, and the chief treatment works are situated (see photo No. 2).
2. Tsudo, where an adit has been driven a distance of ten thousand feet, till it cuts the "Champion" lode, four hundred feet below the "Ariki" adit.
3. Kotaki where the chief concentration works are situated, and an adit connects with the Tsudo main adit.

The highest point of the mountain is four thousand four hundred feet above sea level, and the Ariki Adit three thousand three hundred feet, so that the latter is some one thousand one hundred feet below the top of the Mountain. The Tsudo Adit is four hundred feet lower than the Ariki, and the main shaft being sunk from the cross-cut west from the Tsudo Adit, to work the Kosei vein, is down one hundred feet, and it is the intention to continue it to one thousand feet if the ore holds good.

The Tsudo Adit is twelve feet by nine feet in the clear, and closely timbered nearly all the way; it carries a double truck line, and a large drainage channel on one side. In its length of ten thousand feet, it cuts fifty separate veins before reaching the Champion, but they were chiefly small veins in the slate, and not the true contact bodies.

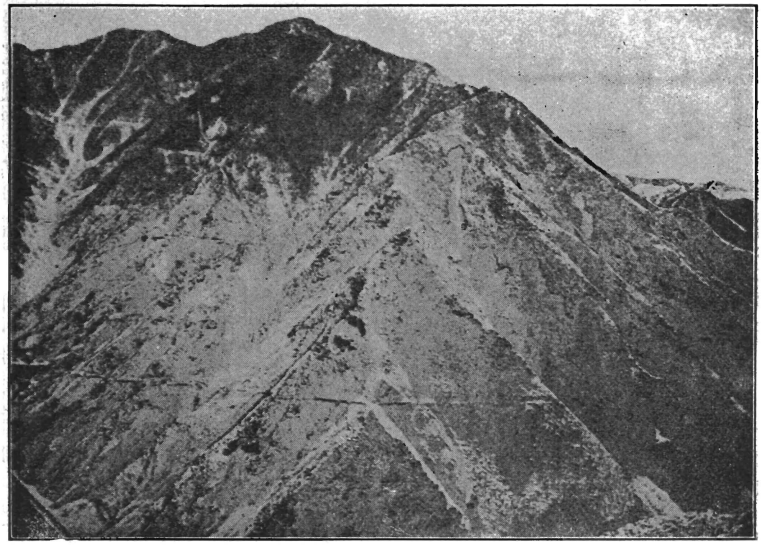
At about three-quarters of its length a cross-cut runs west to meet the Kotaki Adit, and, where it cuts the Kosei vein, a main shaft is being put down; it is now at the first level (one hundred feet) and the reef is being "stoped" at that point; it is four feet wide, well defined, and strikes about east and west.

The shaft is twenty feet by six feet in the clear, divided into four compartments, two for winding, one ladderway, and one for pumping. The timbers are twelve inches square, and the "sets" three feet centres, while the chambers for the pumping and winding machinery are well supported by larger timber.

The winding engines consist of two drums, two meters in diameter, driven by belt gearing from an eighty horse power Electric Motor, supplied with current from the surface. The cages weigh about two tons each, when loaded, and are properly equipped with guides, safety grips, detaching hook, etc.

A considerable amount of water has to be contended with, and a pump is in position at the one hundred feet level. It is an ordinary lift and force pump, with eight inch suction and six inch delivery; it is worked from the main level by rods which are connected to an eighty horse power Electric Motor, the speed being reduced by two sets of spur wheels.

The stroke of the pump is one meter, and it can be worked up to twenty strokes per minute.



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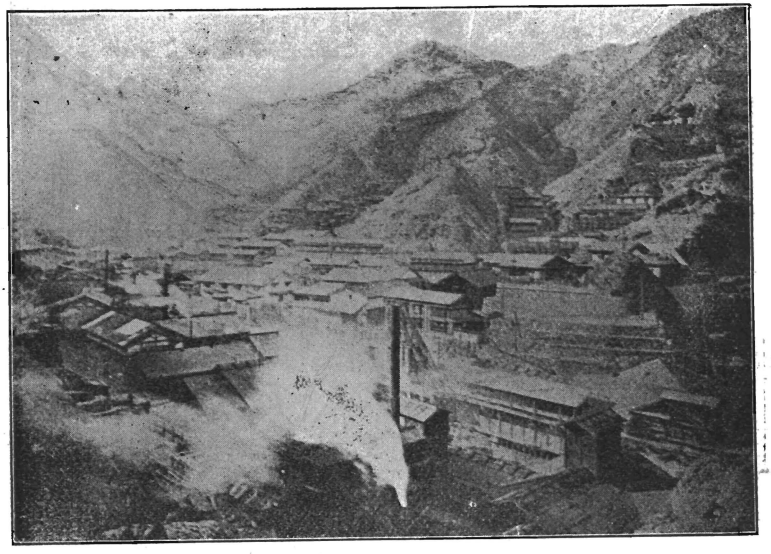

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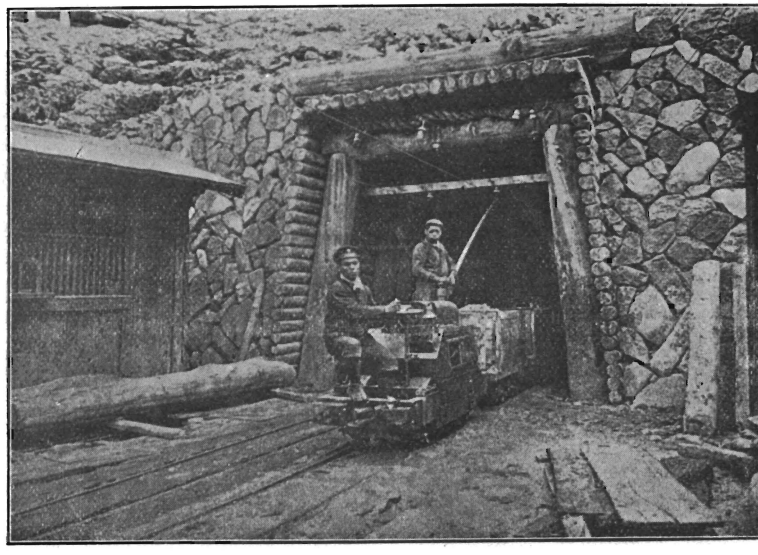

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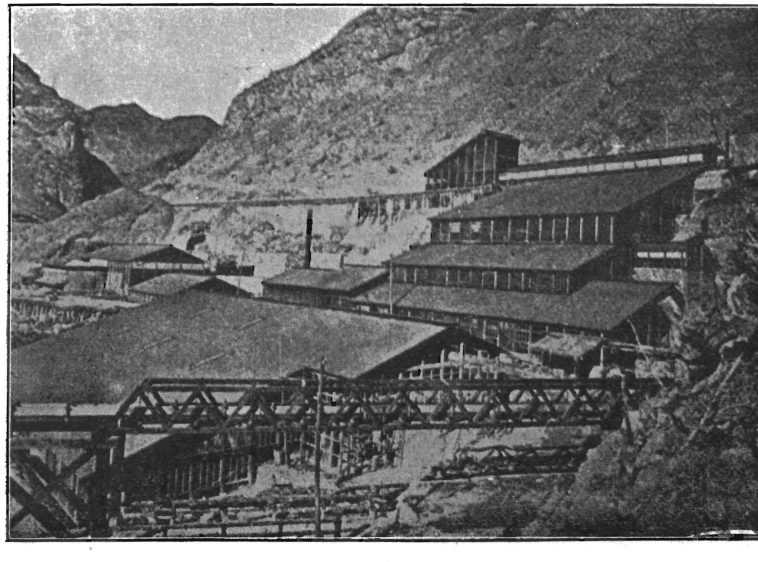

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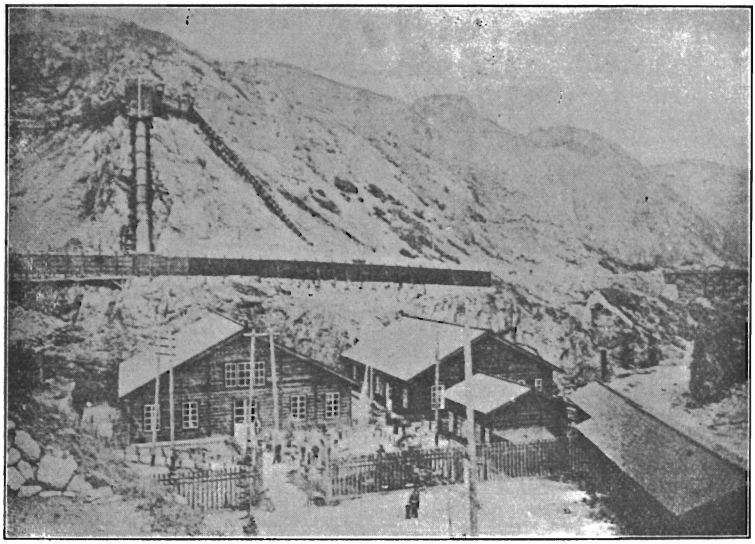

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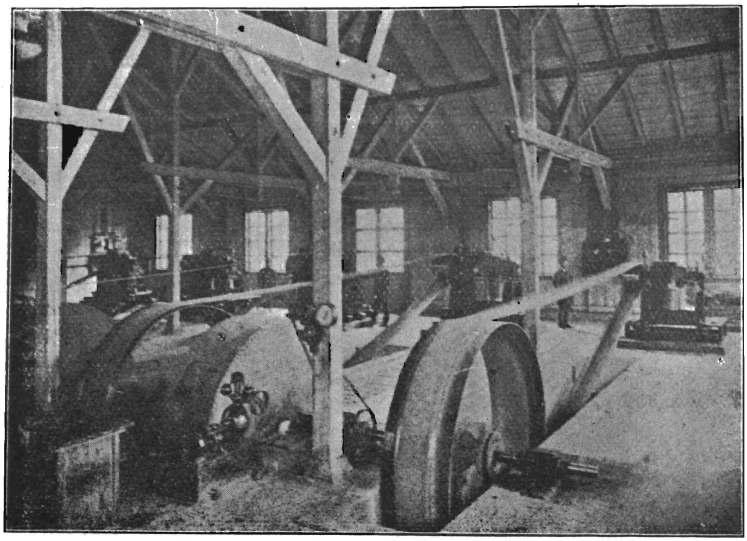

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As the mine water contains $CuSO_4$ in solution, all the pipes, pump, etc., are made of brass.

Single handed drilling is used throughout in driving, "stopeing," etc., the drills used being two-thirds of an inch diameter; as an average, two-and-a-half feet are drilled in six hours, and miners are paid at per foot depth, fifteen sen in soft rock, and forty sen in hard. Dynamite is used for blasting, and is fired by fuse made locally by the villagers. In sinking, electric firing is employed. A Japanese who does not know what a chair is, seems specially suited for mining work, especially with narrow veins; miners usually have a bag hanging behind and strapped round the waist; with this to sit on, they squat about in any position, and can stay like that for hours. In drilling bottom holes, the drill is held at the hole by the toes of one foot, besides being supported by one hand; this keeps the drill much firmer and stops splashing from the hole. Altogether in the three mining districts, two thousand four hundred men are employed; their wages average sixty-five sen per day, and the daily output is one hundred and seventy short tons.

In the Tsudo Adit, horses are used for trucking, but in the Ariki and Kotaki adits, electric motors are employed, with an overhead wire system; there are twenty of these in use, and each one is capable of hauling eight trucks, each holding half a ton of ore.

The timbering throughout the mine is good, as can be judged from Photograph No. 3, which also shows one of the electric motors in use.

TREATMENT.

The ore treatment comprises the following four stages:—

1. Concentration.
2. Roasting.
3. Smelting.
4. Bessemerising.

CONCENTRATION—Small works are situated at both Honzan and Tsudo, but the main ore dressing establishment is at Kotaki, and is shown in Photograph No. 4. Here the ore is first sent to trommels to size it, from there it passes to endless belts about fifteen inches wide, where it is hand picked by girls; it is then elevated to the top floor of a main building and crushed in three Blake machines; from there to trommels and four revolving disc tables, where it is again sorted by women. These different grades pass on to three sets of Krom rolls, where it is crushed finer, trommelled, and passed to two rows of coarse jigs; these are of ordinary type with stepped ore beds. The waste material from these jigs is fine crushed in four Huntingdon Mills, and passed to Spits-Kasten, five jigs, and lastly to seven convex buddles. The waste water from these works is agitated with lime water to neutralize the free sulphuric acid. The power for these works is obtained from a fifteen inch diam. pipe with a head of sixty feet, and five inch nozzle working on a Pelton wheel.

ROASTING.—The ore is subjected to a preliminary roasting, the rich lump ore in stalls, and the dressed ore in long reverteratories. The latter are one hundred feet long, ten feet wide, and have twelve working doors. Six of these furnaces are used, each roasting twenty-four tons per day, to seven per cent. sulphur. Three tons of firewood are used per day for each furnace. Both of these operations leave the ore in a more or less fine condition, as no clotting is carried out, so that about eighteen per cent. of flue dust is formed by the blast furnaces, this is made into brickets and charged back into the smelters.

SMELTING.—There are nine water-jacketed blast furnaces, five having eight tuyeres on each side, and of twenty tons daily capacity, and four smaller ones. Fore-hearths are used in each case, and slag and matte are drawn off continuously, the former being granulated and run off with water and the latter run into sticks and thin cakes; some of the slag is run into pots for brick making. The matte runs fifty per cent. copper, and the slags carry off one-half per cent. The ore being silliceous, a limestone flux is used, this has to be brought about eight miles by horse tram. The charge to a smelter consists of ore, coke, limestone, and slags from the converters, etc. Six No. 6 Root's Blowers supply the blast, and they are run by a Pelton wheel.

CONVERTING.—Four converters are in use, of one-half to three-fourths of a ton capacity per charge, supplied by one remelting furnace. They are supplied with air at a pressure of ten pounds per square inch, by an air compressor of a vertical type, built entirely at the mine workshops, and worked by a Pelton wheel. A Fraser and Chalmers' steam horizontal compressor is kept in reserve. The operations are carried out in the usual way, and when a charge is finished it is poured into a receiver, which is wheeled to a circular revolving table carrying the moulds, and the metal poured. These converters turn out about twenty tons of 98·8 per cent. copper per day; each bar is branded "F.A.B.C." (Furakawa Ashio Bessemer Copper) "made in Japan." A main flue from the roasting furnaces, smelters and converters, leads to a series of dust chambers, and an arrangement like a Glover tower; as the gases and fumes pass up the tower they meet a spray of lime water falling. This is done to neutralize the free H_2SO_4 which was said to be causing trouble to farming properties down the river.

MAIN ELECTRIC POWER STATION.

The power for driving the generators is derived from a pipe about four feet diameter, with a head of water of one hundred and ten feet. Branches from this main drive, four Pelton wheels, two large and two small. The waste water then passes to two turbines, with a head of eighteen feet.

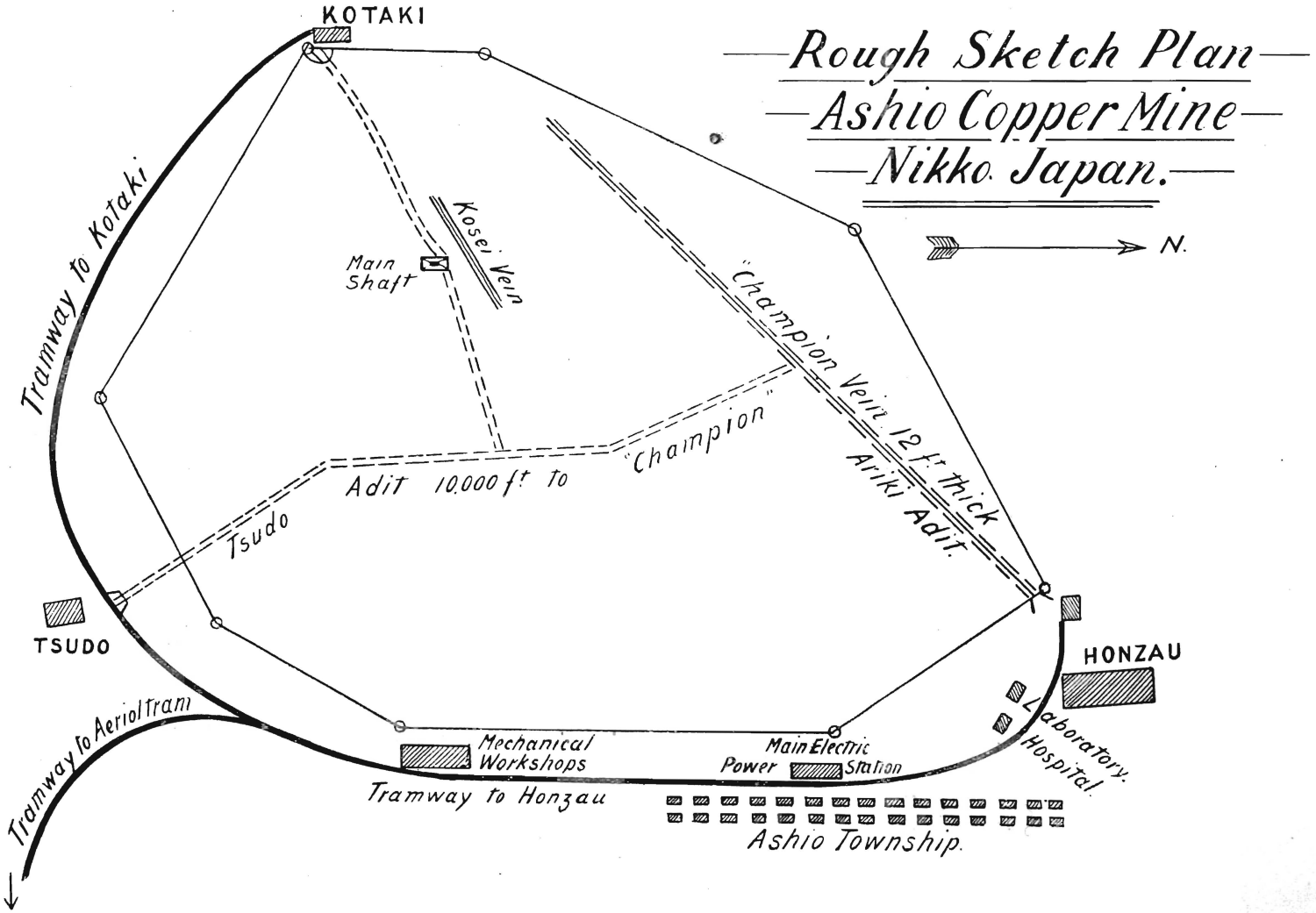
The two large wheels drive three Siemen's Halske dynamos of eighty horse-power each, equalling two hundred and forty horse-power, while the two smaller ones drive two more dynamos of fifty-six horse-power each, equalling one hundred and twelve horse-power.

The turbines develope about one hundred horse-power and drive a large and small dynamo, so that altogether we have four hundred and fifty-two horse-power developed from the one pipe.

Photograph No. 5 shows an exterior and Photograph No. 6 an interior view of the station.

The mine is also equipped with a chemical laboratory and a staff of chemists ; a small library with reading rooms, containing all the best scientific mining literature in English, German and French. There is also a very good hospital and school for the village.

The whole of this property is controlled and managed solely by Japanese and there is not a foreigner employed, and it is only a few of the heads of departments that can speak English, although a number can read both it and German and French.


KOTAKI
Rough Sketch Plan
Ashio Copper Mine
Nikko. Japan.
N.
Tramway to Kotaki
Kosei Vein
Main Shaft
"Champion Vein 12 ft thick
Ariki Adit.
"Champion"
Adit 10.000 ft to
Tsudo
TSUDO
HONZAU
Tramway to Aerial Tram
Mechanical Workshops
Main Electric Power Station
Laboratory.
Hospital
Tramway to Honzau
Ashio Township.