ELECTRICITY IN THE MINES AT CRIPPLE CREEK.

By Thomas Tonge.

CRIPPLE CREEK is perhaps the only gold-mining district in the world where a miner can go to his work in an electric street-car, descend the mine in an electric hoist, keep his mine dry by an electric pump, do his work by an electric light, run drills operated by electric air-compressors (possibly, in time, to be superseded by direct electric drills), and fire his shots by electricity from a switchboard remote from the point of explosion.

The Cripple Creek district is contained within an area of a little more than six square miles, consisting of rolling hills and small valleys and gulches, at an average elevation of over 9,500 feet, with towns and villages at short intervals, such as Cripple Creek (altitude 9,510 feet), Anaconda (9,450 feet), Victor (9,500 feet), Altman (10,625 feet—the highest incorporated town in the United States), Independence (10,300 feet), etc. Among the intervening elevations are Globe Hill (10,740 feet), Bull Hill (10,780 feet), Battle Mountain (10,640 feet), Beacon Hill (9,720 feet), Raven Hill (10,350 feet), Gold Hill (10,300 feet), etc.

In this limited area there are upwards of one hundred and fifty shipping gold mines, fifteen of which produce over 1,000 tons of ore each per month. The gold production of Cripple Creek, in round numbers, by years, has been as follows:

1891.....	$200,000	1895.....	$8,100,000
1892.....	600,000	1896.....	10,000,000
1893.....	2,300,000	1897.....	12,000,000
1894.....	4,000,000	1898.....	14,000,000

Computations, made by reliable persons at the end of July of the present year, of the amounts paid out in dividends to the shareholders of Cripple Creek mining companies showed that the total had reached over $8,000,000. The total for the present year, at that time, was already over $1,250,000, with probability that the record of nearly

$2,600,000 during 1898 will be exceeded this year. These figures relate only to the dividends actually paid by companies, and do not include the profits of mines owned and operated by private individuals, or the profits made by lessees, which, if they could be accurately ascertained, would very much augment the above amounts.

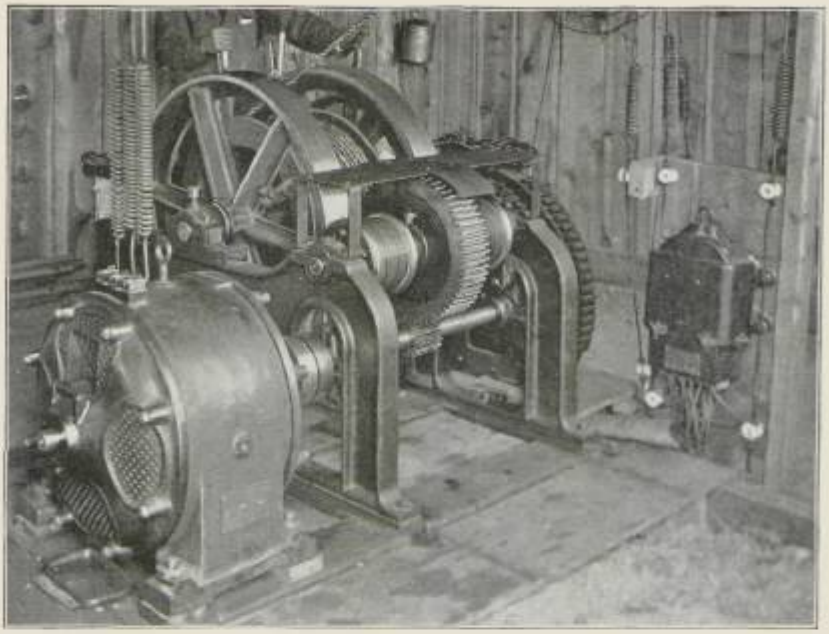
The whole Cripple Creek district, which in 1891 was a remote mountain pasture with less than a dozen inhabitants, has now a population of nearly 50,000.

During 1894 a narrow-gauge line, known as the Florence & Cripple Creek Railroad, forty miles long, was built at a cost of $500,000 of Colorado capital, from Florence on the Denver & Rio Grande Railroad, tapping Cripple Creek from the south; since that time it has been extended so as almost to encircle the limited ore-producing district.

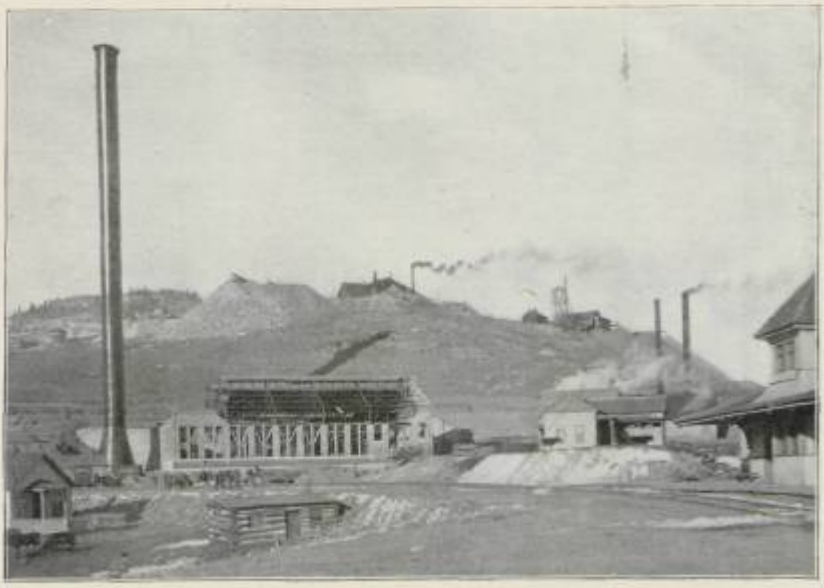
In 1894 also, a standard-gauge line, thirty miles long, known as the Midland Terminal Railroad, was built at a cost of $25,000 per mile, from Divide, on the line of the Colorado Midland Railroad, tapping Cripple Creek from the north, the last fourteen miles being a circuitous route almost circumnavigating the mining district.

On account of engineering difficulties, these competing steam railroads (running frequent suburban trains) only *encircle* the cluster of gold-bearing hills, leaving a comparatively extensive centre in which steep wagon roads gave the only access to numerous rich mines, employing large numbers of men. The miners employed in such mines, therefore, had either to live in small and unsuitable cabins near their work or, if living in the towns, had the choice of taking a very laborious and exhausting climb to reach their work, or of keeping a saddle horse; many of them chose the latter alternative. Exclusive of the miners, there is very considerable travel by other people to and from the mines.

This condition of affairs led to the organization of the Cripple Creek District Railway Company and the building of an electric street-car line, which, commencing at the north end of the town of Cripple Creek (altitude 9,510 feet), traverses in a meandering course, on account of engineering difficulties, the entire centre of the district to Victor (altitude 9,500 feet) at the south end. The line is a little more than six miles long, and presents a constant succession of grades and curves; at a point known as Midway (10,514 feet above sea level and consequently 1,000 feet higher than its termini at Cripple Creek and Victor), it affords a magnificent panorama of the adjacent hills dotted with mines and waste dumps. The round trip, including



A 10 H.-P. ELECTRIC MINE HOIST.



THE GOLDFIELD ELECTRIC-POWER PLANT, PARTLY COMPLETED.
The mines on the hill are the Golden Cycle and the Theresa.

numerous stops, occupies about an hour. It is made at an average speed of about twelve miles an hour, which it is expected will be increased. The electricity is generated by water power at Lake Moraine (altitude 11,300 feet) on Pike's Peak and transmitted by wire nine miles to a distributing station midway on the line of the electric railway.

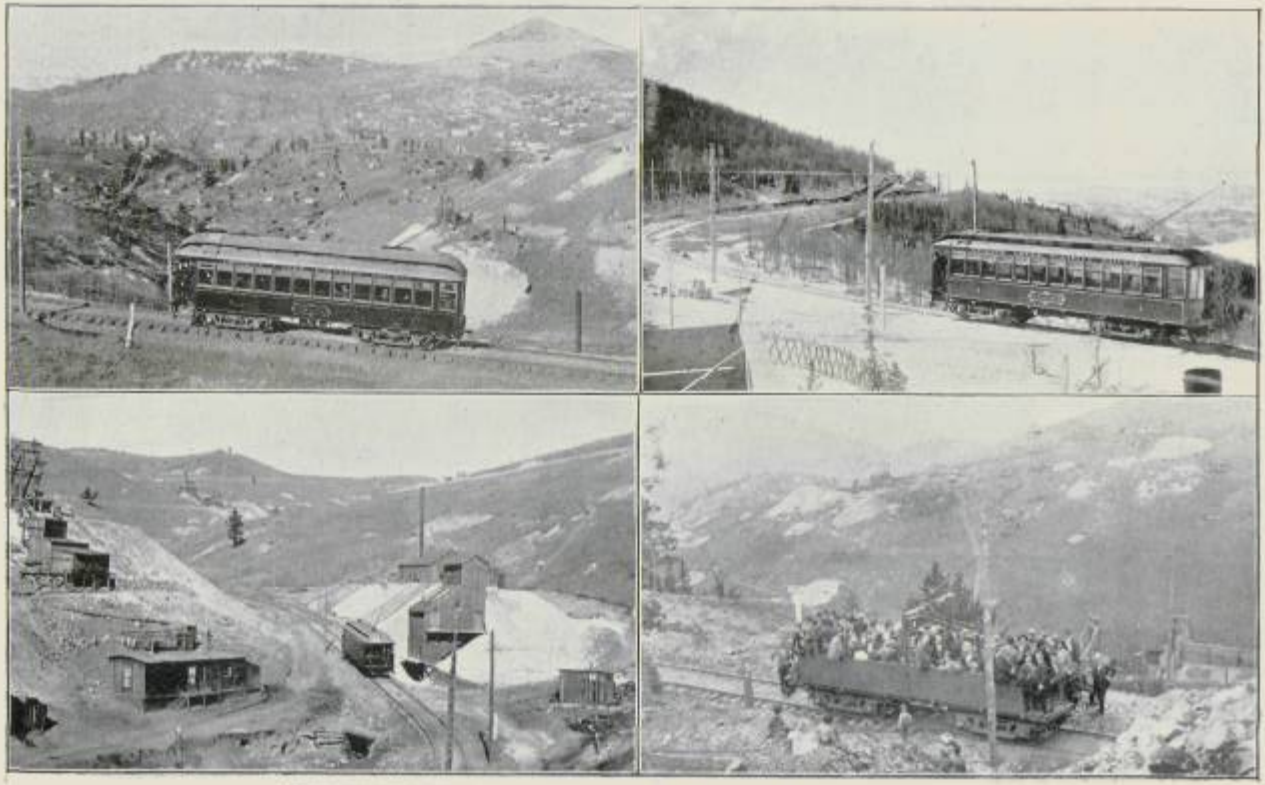
This enterprise recently passed into the hands of a syndicate of capitalists at Colorado Springs, Colo., large owners of some of the most profitable Cripple Creek mines, and it is their intention to make many improvements and extensions, including an extension of the line from Cripple Creek to Colorado Springs, a distance of 32 miles.

It is obvious that the sinking and operating of the mines of Cripple Creek have involved the expenditure of a large amount of power, which for the first seven years of the mining history of the district was derived exclusively from steam and therefore demanded vast supplies of fuel and water. As the mines are usually high up on the steep hill sides or summits the transportation of such fuel and water means very heavy cost.

Within thirty miles to the southward of the Cripple Creek district is the Cañon City coal field, 5,000 feet lower in altitude. The use of steam power, therefore, necessitated hauling the coal by railroad up grade to one or other of the various stations in the Cripple Creek district and thence by wagon up steep roads to the mines.

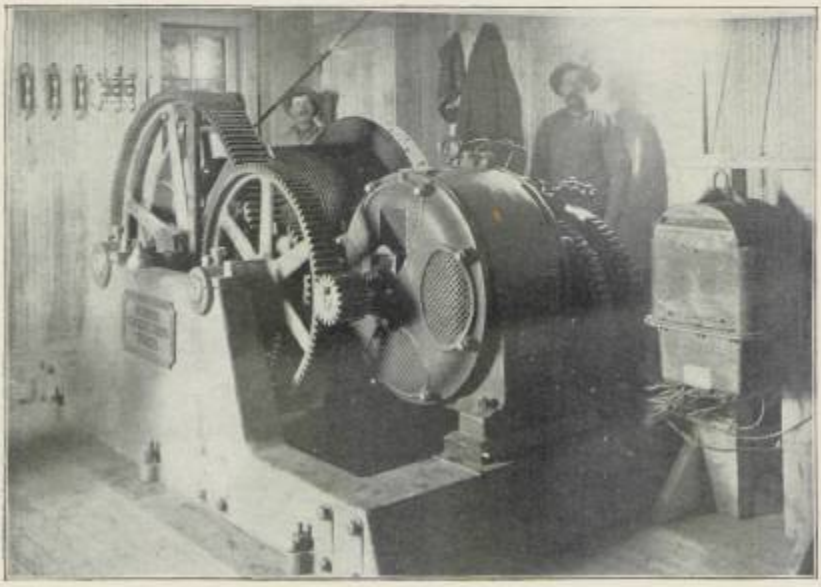
Cripple Creek mines have usually been "dry," and even in the exceptional cases where water has been struck at considerable depth the supply has been unreliable, as the driving of numerous long tunnels at great depth has had the effect of draining the comparatively few mines that had water. Moreover, there are no local streams of volume. Speaking generally, therefore, the steam hoists, etc., of the Cripple Creek mines have been depended upon water hauled by wagon up steep roads to the mines, from springs, etc., in the valleys. The high altitude—averaging 10,000 feet—increased greatly the risk of freezing and consequent stoppage in winter. Moreover, in many cases, the water has cost fully as much as the fuel.

Again, the class of steam mining machinery in general use is somewhat notorious for its consumption of steam, for which reason from one to five boiler horse power are required for every horse power produced by the machinery. The water consumption, as well as the coal consumption, for the power produced, is therefore very high in comparison with the same figures for more modern types of machinery.



VIEWS ON THE LINE OF THE CRIPPLE CREEK DISTRICT ELECTRIC RAILWAY.

The leasing system is very common in Cripple Creek. Prospectors of limited means and lessees for comparatively short terms, with ultimate success uncertain, were not in a position to purchase and put in steam plants with subsequent heavy expense of water and fuel.

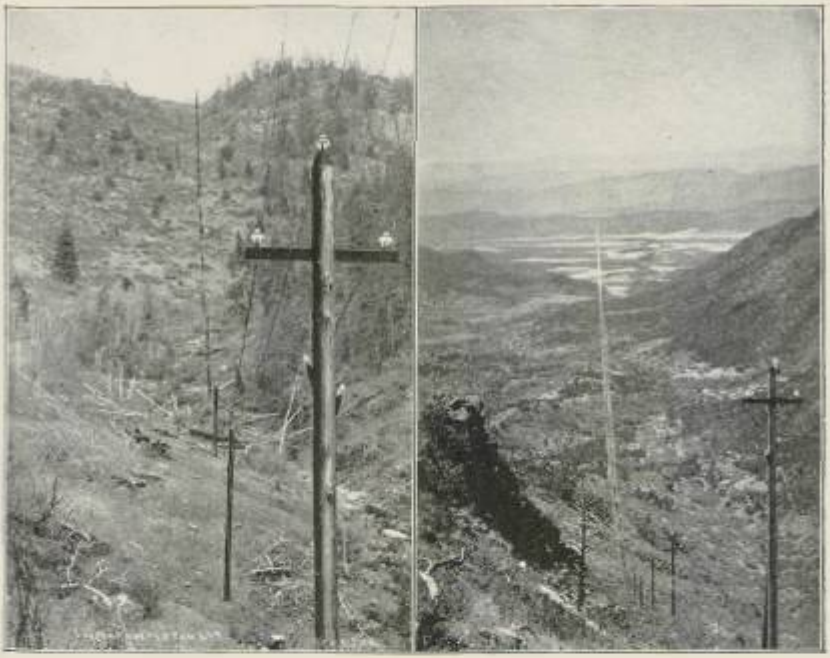


30 H.-P. MOTOR AND HOIST, MATOA MINE.

The space occupied is less than one tenth of that required for the corresponding steam plant including water tanks, coal bins, etc.

In July, 1888, the first electric hoist for mining purposes was started up in connection with the Western Tunnel, Aspen, Colo., and is still in operation. It was afterwards connected also with an adjacent shaft for hoisting purposes, the power for this and for additional motors subsequently installed being supplied from Hunter Creek, where a generator of 60 h. p. was first placed, and later another of 125 h. p. Early in 1893 another plant of nearly 500 h. p. was established on Maroon Creek, Aspen. To-day there are at Aspen electric motors, operated by water power, aggregating over 700 h. p. They are utilized for almost every mining and ore-treatment purpose and have replaced the steam engine. The success achieved at Aspen led to the establishment of larger electric-power plants in connection with various other mines in Colorado, notably at the Virginius mine, Ouray County, the Silver Lake mine, near Silverton, etc.

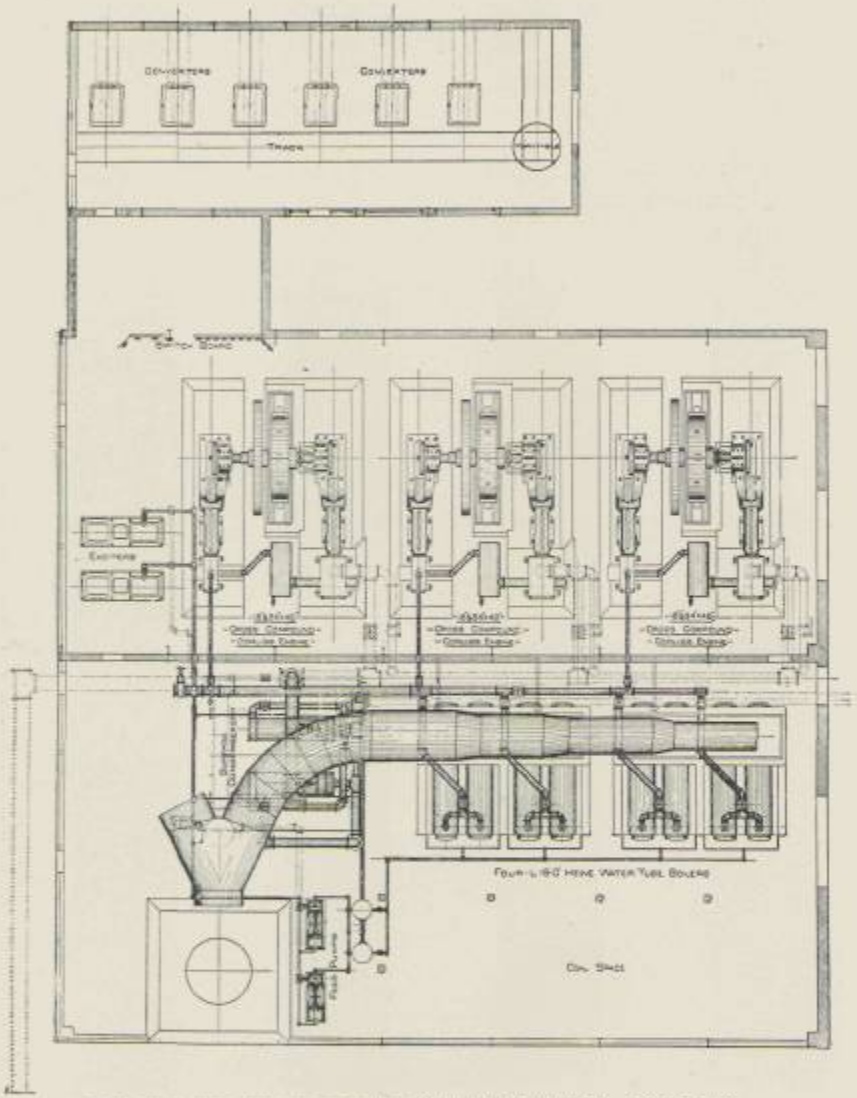
The above-described conditions at Cripple Creek, therefore, naturally resulted in the establishment of two electric-power plants, viz., that of the Colorado Electric Power Company at Cañon City, nearly 30 miles south of Cripple Creek, and that of the La Bella Mill, Water, & Power Company at Goldfield in the Cripple Creek district itself. In each case, the electric power is produced from steam generated by the same quality of coal, from the same Cañon City coal field; the special difference between the two plants being that the Colorado Electric Power Company generates the power at the coalfield and transmits it 27 miles by wire to the gold mines, while the La Bella Mill, Water, & Power Co. (practically composed of the owners of the Florence & Cripple Creek Railroad) carries the coal to, and generates the electric power in, the gold-mining district itself, thus constituting a competi-



TWO VIEWS ON THE TRANSMISSION LINE FROM CAÑON CITY TO CRIPPLE CREEK.
The trail is cleared 30 ft. wide, to prevent trees falling on the line.

tion between modern electrical transmission and the older system of fuel transportation.

The Colorado Electric Power Co. (representing $500,000 of capital, mostly from Pittsburg, Pa.) completed its plant at Cañon City in

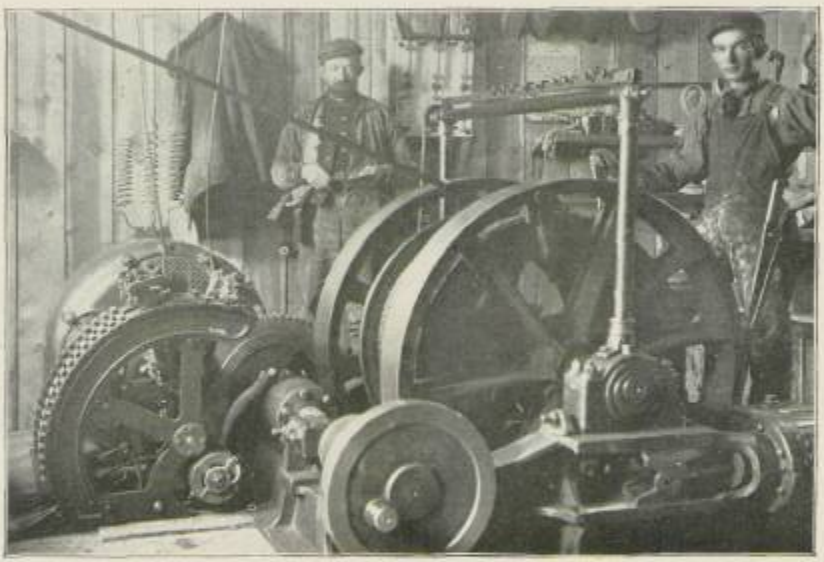


PLAN OF POWER HOUSE, COLORADO ELECTRIC POWER CO., CAÑON CITY.

August, 1898. It has a capacity of 2,250 h. p. The method pursued is to generate power at 500 volts, transform to 20,000 volts, and transmit at this voltage 27 miles to Cripple Creek. The transmission line consists of three No. 3 bare copper wires arranged in a triangle on 30-foot poles, one wire being at the top of the pole. The two wires of a

telephone circuit are also carried lower down on the same poles. At Cripple Creek there are two distributing stations, one on Gold Hill and the other on Battle Mountain, at which the current is transformed from 20,000 to 500 volts and distribution is made at the latter voltage.

The Colorado Electric Power Co. has already seventy consumers in the Cripple Creek district, representing an aggregate of about 1,200 h. p., the list comprising both mines and ore-treatment plants, by whom the power is utilized for hoisting, pumping, operating air compressors for drills, lighting, and, in the case of the ore-treatment plants, operating crushing and other machinery. Thus the Colorado



MOTOR RUNNING A HOIST FORMERLY OPERATED BY STEAM.
The plant is that of the Lafayette mine. The disconnected steam cylinder is seen on the right.

Ore Reduction Co. takes 150 h. p. for crushing machinery, etc.; the Lillie Gold Mining Co., 100 h. p. for hoist and air compressor; the Moon-Anchor Gold-Mining Co., 100 h. p. for pumping from a depth of 600 feet; the Taylor & Brunton Mill, 75 h. p. for crushing machinery, etc. The needs of the majority of the consumers range from 75 h. p. down to 5 h. p. A hoisting plant of 15 h. p. will suffice for a shaft 450 feet deep; when this depth is exceeded it is usual to put on 30 h. p., sufficient for 800 feet; for still greater depth 75 h. p. and 100 h. p. are installed.

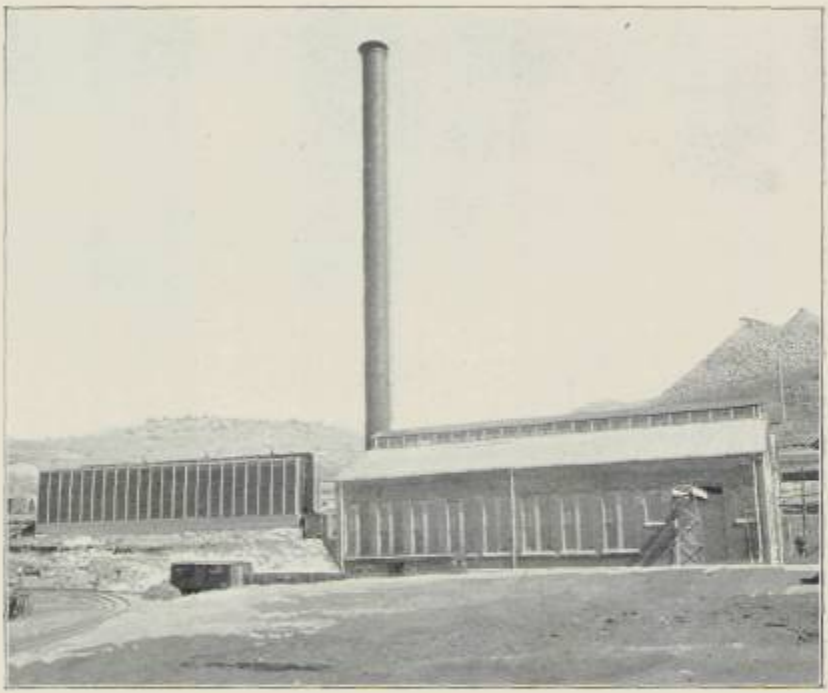
The company rents to a lessee or prospector a small hoist, say

from 5 h. p. to 30 h. p., thereby enabling such lessee or prospector to put practically the whole of his capital into development work, avoiding the necessity of purchasing a plant. If, however, he finds ore in paying quantities and desires to purchase the electric-power plant he has rented, the company in the first instance gives him an option on it, the rent applying on the purchase price.

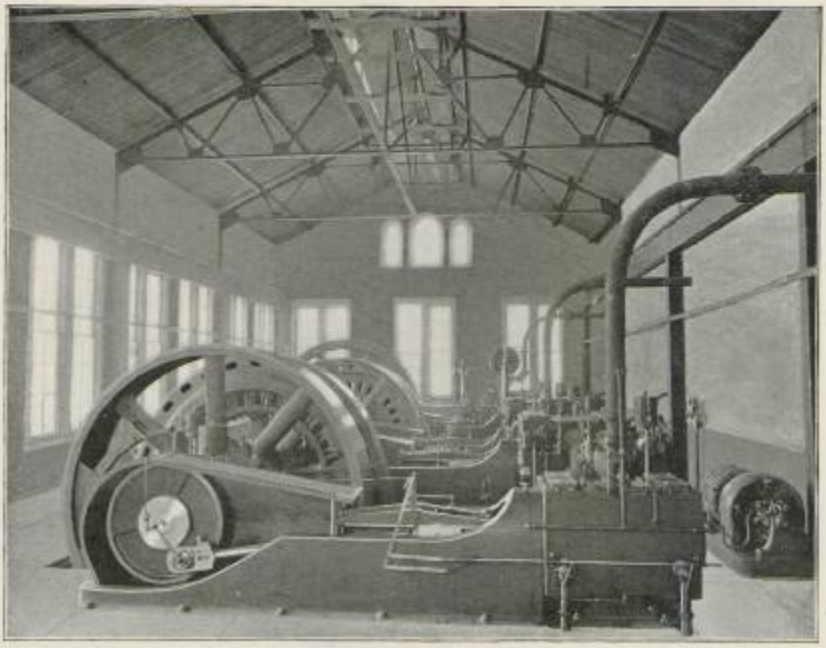
The minimum rent for a 5 h. p. plant is $50 per month, including rent and power supply; from that sum the charge ranges upwards according to the amount of power used. Plants from 15 h. p. to 30 h. p. range from $65 to $200 per month for rent of motor, etc., and power supply, depending on tonnage and depth of shaft.

The company has $60,000 worth of machinery so rented out and is preparing to extend its plant generally.

The following information as to the recently completed plant of the La Bella Mill, Water, & Power Co. at Goldfield has been furnished by Mr. L. L. Summers, of Chicago, who designed and superintended its construction and is now the consulting engineer. It has a capacity of 3,000 h. p., viz., 2,250 in electric power and 750 in com-



THE GOLDFIELD PLANT AND THE COOLING TOWER.



ENGINES, DYNAMO AND COMPRESSOR PLANT. LA BELLA MILL, WATER, AND POWER CO.

pressed air. It is one of the largest compressed-air distributing plants in the country, having ten miles of underground lines by which the air is distributed from the station to the various mines in the locality, including the Victor, Golden Cycle, Gold Knob, Granite, Rigi, Independence (of the Independence T. & M. Co.), Vindicator, Longfellow, Last Dollar, Union, Christmas, Jefferson, Ocean View, Anaconda, Ophelia Tunnel, etc. Some of these are as far as two miles from the station, while electrical power is transmitted five miles.

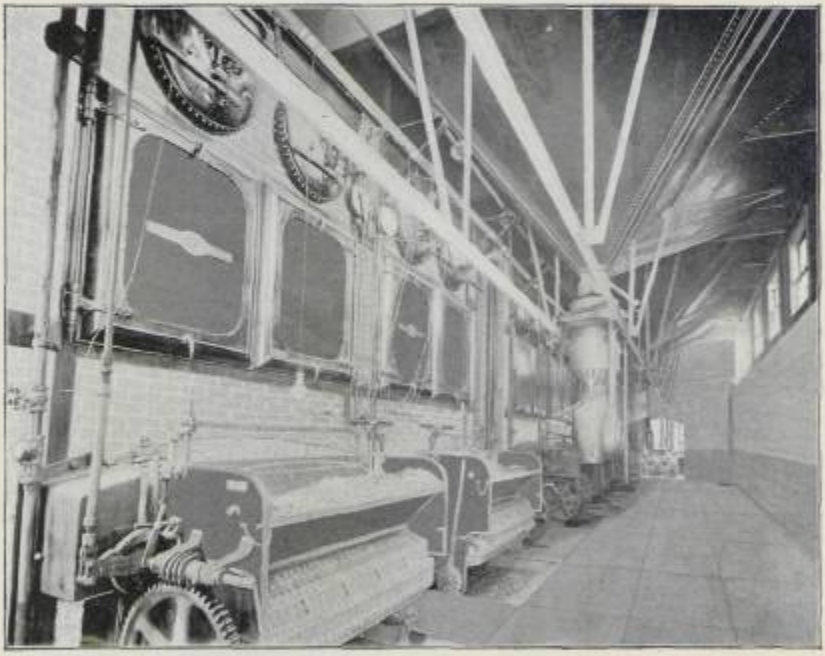
The loss in transmission of compressed air has received a great deal of attention by the engineers of the company and convenient tables have been prepared showing the loss by friction and by leakage.

As before mentioned, the capitalists composing this company are also practically the owners of the Florence & Cripple Creek Railway, and by this alliance the energy is distributed from the coalfield (by low fuel-freight rates) to the local power plant and thence to the mines, at a minimum rate.

The plant is modern in design and equipment, the machinery being obtained from the works of the leading representative firms of the United States. The specifications are said to have been most exact-

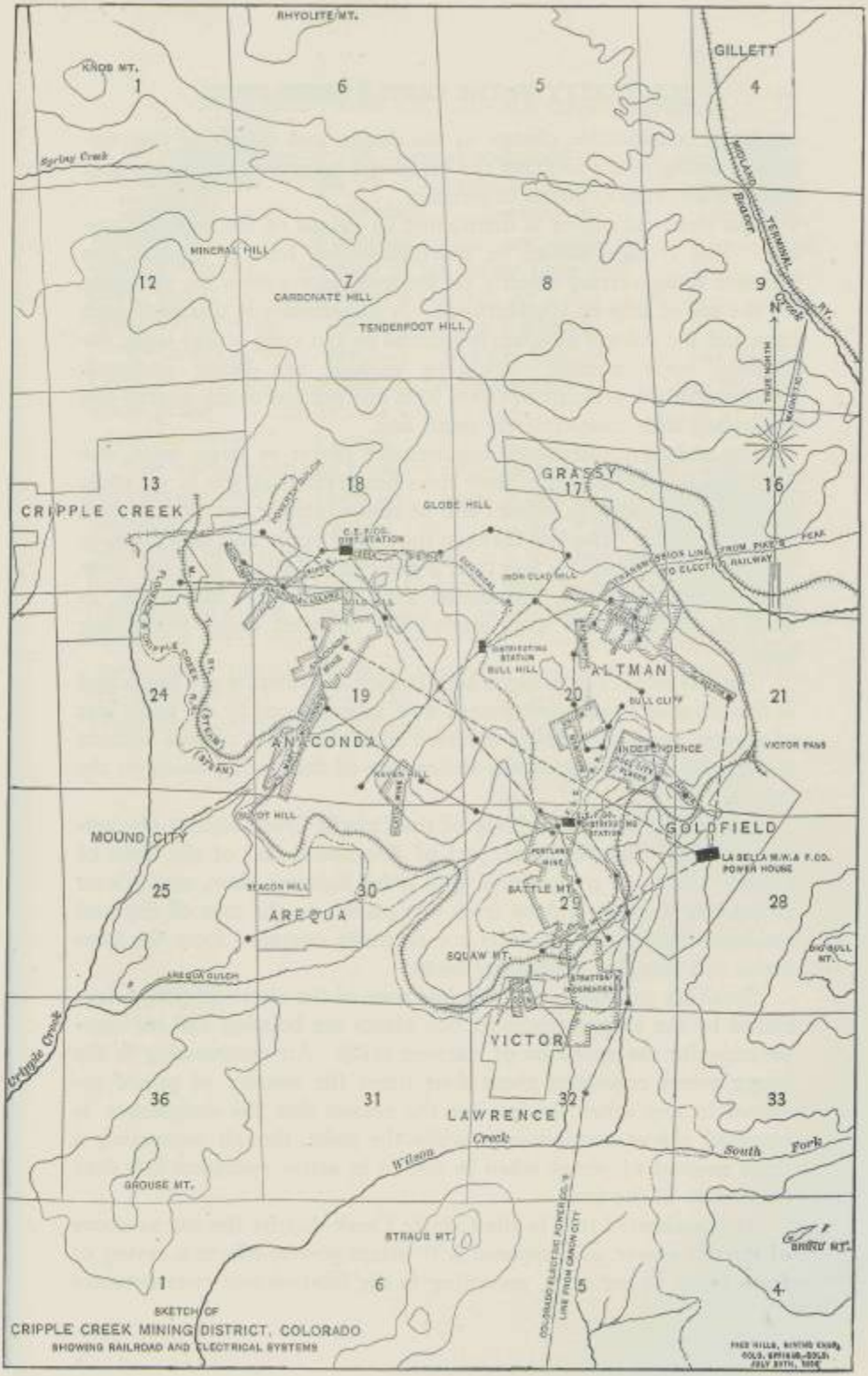
ing with respect to efficiency and economy. Automatic machinery is used throughout, the coal being dumped directly from the cars into overhead bins, whence it is fed by gravity to automatic stokers, the ash being handled by conveyers and placed on board the railroad cars to be used for filling purposes. This automatic handling of the coal and ash reduces to a minimum the number of employees and materially keeps down the wage account. The boilers are of the water-tube type, 150 pounds of steam being carried, while the engines are of the compound condensing type with the most modern auxiliaries.

An interesting feature of this plant is the fact that condensing engines are used at a point 10,000 feet above sea level, where water is comparatively scarce in the absence of natural water courses, and the limited supply from springs more or less unreliable. In order that



BOILER ROOM OF THE GOLDFIELD ELECTRIC-POWER PLANT, SHOWING AUTOMATIC FEEDING AND STOKING APPARATUS.

condensing engines may be used under these circumstances, provision has been made to cool the water by means of cooling towers, when it is again used in the condenser. This is the first application of the cooling tower in Colorado, and the results in so large a plant are being watched with considerable interest. The elevation of 10,000 feet ne-


RHYOLITE MT.
KNOB MT.
GILLETT
MINERAL HILL
CARBONATE HILL
TENDERFOOT HILL
GRASSY
CRIPPLE CREEK
GLOBE HILL
ALTMAN
BULL HILL
BULL CITY
INDEPENDENCE
VICTOR PASS
ANACONDA
MOUND CITY
BEACON HILL
AREQUA
AREQUA GULCH
GOLDFIELD
LA SELLA M.W.& P.CO. POWER HOUSE
BATTLE MT.
SQUAW MT.
VICTOR
LAWRENCE
Cripple Creek
Wilson Creek
South Fork
GROUSE MT.
STRAUB MT.
SKETCH OF
CRIPPLE CREEK MINING DISTRICT, COLORADO
SHOWING RAILROAD AND ELECTRICAL SYSTEMS

cessitated considerable change in the design and details of the condenser, owing to the fact that the barometer pressure at that elevation is only about twenty inches of mercury.

The electrical power is distributed by means of the triphase system. The voltage carried on the distributing lines is 6,600. The pressure being carried directly on the generator avoids the necessity for the use of step-up transformers. A transformer is placed at each mine and the voltage of 6,600 is reduced to 110 volts or 440 volts, depending upon whether lights or motors are being operated. By means of the pressure of 6,600 volts any portion of the district can be reached with comparatively small loss.

The company distributes considerable power in large units, one hoist motor operated from their lines being rated at 300 h. p., while 200-h. p. and 100-h. p. motors will be comparatively common, as well as smaller sizes. The loss between the power house and this 300-h. p. motor, a mile distant, is less than 2 per cent. In this way, the pressure on the service is maintained with comparative steadiness, in spite of the fact that large motors are operated under fluctuating loads.

The advantages of modern high-tension distribution are illustrated in this plant in a most pronounced way as evidenced by the small loss of energy, and lights can be operated from the motor circuits without disagreeable flickering or any indications of fluctuating loads on the circuit.

A great part of the lighting of the Cripple Creek district (including Goldfield, Independence, part of Anaconda, part of the town of Cripple Creek, in competition with older lighting plant, and Victor in the near future) is done from this plant. In the case of city and residence lighting the circuits are normally operated from the generator not carrying fluctuating loads.

Speaking generally, the principal uses of the electrical power furnished by the above-mentioned two plants are hoisting and air compressing for the operation of machine drills. Air compressing in the larger mines consumes about four times the amount of power required in any other service, for the reason that the compressor is operated almost continuously, while the hoist, though consuming a large amount of power when in use, is in active operation less than one-fourth of the time.

It is estimated that in the Cripple Creek district the use as above of electric power, as compared with steam power, effects a saving of from 15 to 50 per cent., according to the location and circumstances

of the mine, irrespective of reduced wage account, and also irrespective of its greater reliability and convenience, as unaffected by frost.

Drills of German manufacture, operated directly by electricity, without the invention of an air compressor, have for some time past been in successful operation in the Silver Lake mine, near Silverton, Colo., and it is evidently only a question of a short time when similar drills will be in use in the Cripple Creek district.

Electrical power is revolutionizing the mining industry at Cripple Creek in reducing expenses, increasing profits, and making available lower-grade ore, hitherto discarded or ignored as incapable of being mined and treated at a profit.

The whole movement is one of those, most characteristic of modern engineering work, in which an advance in any department extends its influence to, and re-energizes, other branches. The effect of the introduction of electric power is not only to cheapen production in mines already profitable, but to bring into working deposits which could not be mined to advantage under the older methods. The net result is a great increase of activity and labor-employment, and new openings for the utilization of capital, not only in the mining field, but in the manufacture of the electrical and mechanical appliances which have so greatly facilitated mining work.