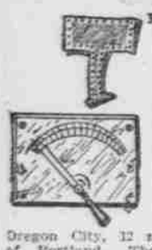
TRANSMITTED POWER

Portland's Factories Will Be Run by Electricity.

THE GREAT ELECTRICAL PLANT AT OREGON CITY

Largest Plant of the Kind Run by Water Power in the World Owned by the Portland General Electric Company.



THE Portland General Electric Company, of Portland, Or., of which P. F. Morey is president, H. W. Goode is manager, and C. H. Canfield is secretary, was organized two years since with a capital stock of $4,250,000, and has purchased the entire water power embraced in the falls of the Willamette river at Oregon City, 12 miles above the city of Portland. The minimum capacity of the river at this point is estimated to be 50,000 available horse power, under a head of 40 feet. The steppe of the falls is composed of basaltic rock, and has a very irregular outline, being worn into fantastic shapes by the action of the water. A dam was thrown across the river some years since, following the irregular lines, and there are numerous factories and mills in operation to which over 4000 horse power of direct water power is now leased.

One of the principal plants that are here operated by water is an electric station, situated on a rocky island near the middle of the river, at which an electric current is generated and transmitted to Portland, where it is employed for lighting the streets and dwellings of the city, and also for the operation of that section of the East Side street railway lying between Oregon City and Milwaukie, a distance of seven miles. For the running of the lighting generators, seven vertical Victor turbine wheels of 300 horsepower each are employed, and one 500-horsepower horizontal wheel of the same type, while one 200-horsepower horizontal wheel drives the railway generators. The loss, it is claimed, in the transmission of the lighting current to Portland, a distance of 12 miles, is only 10 per cent.

The purchase embraces 1600 acres of valuable land in the neighborhood, having a river frontage of about 3½ miles, which takes in all the valuable sites of manufacturing institutions. It also embraces a ship canal and locks on the west side of the river, which were constructed some years since under a subsidy from the state of Oregon of $200,000, the entire cost being about $600,000. By means of the canal and locks, the large steamboats which ply on the river between Portland and up-river points are carried past the falls, the river being navigable for about 75 miles above.

The new power station (Fig. 1) which is now being constructed is located on the west side of the river, opposite Oregon City, and borders the canal, the front wall being a portion of the new concrete wall which has been built for the purpose of widening the canal, and through which the water is to be led to the wheels, and new and substantial bulkhead gates have been installed. The ultimate capacity of the new station is to be 12,000 horsepower; only 6000 horsepower, however, is to be at present installed.

The structure is to be of concrete, stone, iron and brick; is to have an ultimate length, parallel with the river, of 264 feet, and the eaves are 75 feet above mean low-water mark, the width of the building being 38 feet. The water is to be taken from the canal, and after passing through the wheels is discharged into the river below. The accompanying illustration (Fig. 1) presents the river side of the structure, from which it will be noted that the upper floor is lighted from transoms in the monitor roof, and by a row of ordinary windows, while the middle floor is lighted through circular openings in the wall, four feet in diameter, but which terminate on the inside with a bull's-eye sash and glass, three feet in diameter, and made to close watertight, like the bull's-eyes in the sides of ocean steamers. These are designed to protect the interior during periods of excessive high water.

The units of power, of which there are to be 10 in the present equipment, each entirely independent of all the others, are located as shown in the engravings, and consist of a pair of vertical, cylinder gate, improved Victor turbine wheels, of 42 and 60 inches diameter, respectively (Figs. 2 and 3). The large wheel is auxiliary to the other, and is provided for use only at periods of excessive high water, which, according to the records, occurs, usually, every five years. The wheels, it will be noted, are located on the same level, one in the rear of the other, and only about one-half the distance below the level of the water, the theory being that the weight of the water in the discharge or draft pipe is as thoroughly utilized as if it were all above the wheel. The lower end of the pipe being always below the surface of the water in the tail race, it is hermetically sealed, so that the weight tends to form a vacuum next the wheel.

The generator of each unit is of 600-horsepower capacity, and is located on the upper floor of the building, with the armature in a horizontal position attached to the vertical shaft of the 42-inch wheel, and is 50 feet above the wheel which is designed to run at a speed of 200 revolutions per minute. The shaft of the 60-inch wheel, which is to be employed only at periods of high water, is provided with a horizontal belt pulley, 12 feet in diameter, with a 48-inch face, from which the power is transmitted by a leather belt to a 6-foot receiving pulley on the generator shaft, both being placed 12 feet above the wheel. By this reduction, the large wheel, which makes but 100 revolutions per minute, will drive the generator at a uniform speed of 200 revolutions, the same as the 42-inch wheel. When it becomes necessary to employ the large wheel, the generator shaft is uncoupled from its wheel at a point just above the flume, and the belt is brought into contact with its pulleys by means of the tightener pulley.

In order to support the belt in place when not in use, the pulleys are all surrounded by a shelf and rack, with perpendicular pipe guards, which is also attached to the tightener pulley, and which, by the movement of the latter away from the belt carries the belt with it, and causes it to spring away from the surface of the small pulley, so that it receives no frictional wear while idle.

The most interesting features of the equipment are the bearings (Fig. 4) which are employed to support the weight of the vertical shafts, which in the case of the armature and shaft aggregates 23,500 pounds. The wheel shafts are supported on double step bearings, as is customary in vertical turbine wheels, but these not being sufficient to carry the weight of the shaft and armature extra bearings are provided, and these are of two types: A ring-thrust bearing, similar to those commonly employed on the propeller shafts of steamboats, and an hydraulic oil bearing, which supplements the ring bearing on the generator shaft. Both types are enclosed in cases to which the oil is delivered by hydraulic pressure, and all the cases are water-jacketed for the purpose of absorbing the heat generated by the excessive friction. The ring bearings are adjustable, and so constructed that the oil cannot fly off or run down the shaft. The generator shaft, which is 29 feet in length and 8¾ inches in diameter, while it is an extension of the shaft of the 42-inch wheel, does not rest upon the latter, but the faces of the disk couplings, through which the power is transmitted, are ordinarily about one-half inch apart. The couplings are connected by 12 two-inch vertical bolts, which are tapered at the lower ends, and held firmly into the lower plate by means of heavy nuts, but simply pass through close-fitting holes in the upper plate so that the generator shaft has a slight free movement up or down, and may be readily uncoupled from the wheel shaft by removing the nuts and lifting out the bolts. The extension of the 60-inch wheel shaft is 21 feet long and 5⅝ inches diameter, and is supported by a ring-thrust bearing only. It is designed that the hydraulic oil bearing shall carry the load of the generator shaft under ordinary conditions, but it may all be transferred to the ring bearings when necessary. In the construction of the hydraulic bearing the shaft is encircled by a four-inch ring, which has its lower face inserted in a sealed case which is filled with oil and kept at a constant pressure of 275 pounds per square inch. The thrust bearing cases, it will be noted, are supported in each instance on cast-iron pedestals which rest on the top of the wheel flumes.

Both water wheels are controlled by the same vertical shaft which is provided with a hand wheel on each floor, marked C and B (Figs. 3 and 4), and both are regulated by the same governor (shown in Fig. 4). By the shifting of the beveled gears on the governor mechanism, the gates of either wheel are operated by the one hand wheel and governor as desired. The belt tightener is also controlled from either floor by means of a hand wheel.

FIGURE 1—Exterior of Power Station Electric Long-Distance Transmission Plant.

WATER CONTROL.

Ease of Regulating Supply and the Results Obtained.

THE water is admitted to the penstock from the race by means of head gates operated from a platform alongside of the building, each of which is provided with a small gate which is first opened and which allows the penstock to fill, and so balance the pressure against the main gate when it is readily raised. The penstocks are each 10 feet in diameter, and are constructed of riveted steel plates. The flumes which inclose the wheels have cast-iron heads and steel sides, and are so arranged that the water passes first through the large flume and on through a short penstock to the flume of the 42-inch wheel, and from the wheels it is discharged directly into the draft tubes, which are reunited before reaching the tail race. The draft tubes are thoroughly anchored to the steps of the foundation, as shown.

The wheel guide, or case, is shown in Fig. 5. The paddle-like openings are the intake chutes, which are closed by means of a hollow cylinder gate which fits the openings closely all around. The turbine is mounted within the gate, which, on being raised, allows the water to pass through the chutes on all sides, when it comes in contact with the curved buckets of the wheel, and passing through is discharged at the under side of the wheel, so that the force of the water is practically applied to the wheel at two points, first by impact against the buckets, and second by the reaction of the discharge. The cylinder gate is raised or lowered by means of the beveled gears shown in the figure, and is balanced by means of a wire rope and weight operated over the grooved pulley shown on the opposite side of the wheel case from the gears. Ordinarily the Snow governor is employed for the regulation of the Victor turbine wheels, but more recently a combined electrical and mechanical governor has been devised for use in electrical power plants, which has proved sufficiently sensitive to readily conform to the widely fluctuating loads that are characteristic of electric-power plants.

The auxiliary power equipment of the station consists of a set of pumps, including a hydraulic pump for supplying oil to the thrust bearing cylinders, and a duplex water pump for keeping up the circulation in the water jackets about these cylinders.

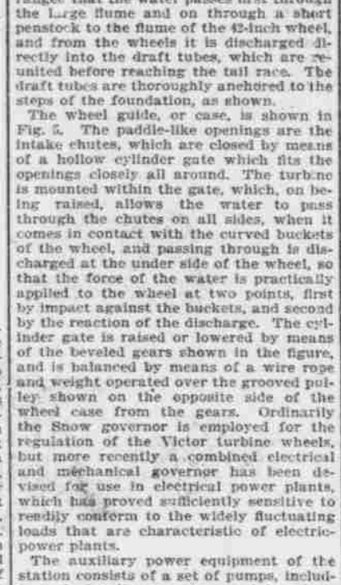


FIGURE 3—New Upright Victor Wheel Complete, Showing In-Take Sheet.

The pumproom occupies the first, or left-hand, section of the building, and the pumps are operated by means of two 15-inch horizontal Victor turbines, inclosed in the same flume, one of which operates the duplex power pump for supplying the cylinder jackets, and the other the hydraulic oil pump. The oil is first delivered to the accumulator, the plunger of which is weighted so that the pressure is kept uniformly at 275 pounds to the square inch. The arm of the accumulator is connected with a governing mechanism, and automatically regulates the supply of oil in the cylinder. The pipes connecting the pump with the accumulator are provided with check valves, so that, in case there should be a break in the pipes at any point, the pressure would not be reduced in the supply pipes or cylinders.

Another chamber, which occupies the center portion of the building, or the first one to the right of the first 10 units, is known as the exciter-room, and is provided with a pair of vertical turbine wheels and generators. The wheels are each 48 inches in diameter, and operate a pair of exciters of 400-horsepower capacity at 125 revolutions per minute, each of the armatures of the exciters being attached to the vertical shafts of the turbines in the same manner described for the generator armatures, both shafts being provided with ring and hydraulic thrust bearings. In this case the shafts are not bolted together as in the generator-room. The turbines are controlled by hand wheels from both floors. Ordinarily it is expected that one exciter will be sufficient to energize the fields of all the generators, but two are provided in case one is idle from any cause. Adding the capacity of the exciting generators to that of the power generators, the ultimate electrical capacity of the station will be 12,800 horsepower, divided into 22 separate units.

An electric overhead traveling crane of 12 tons capacity is provided in the generator-room for the purpose of handling armatures and other heavy parts. This crane has a longitudinal movement of about 300 feet, and a cross movement of 21 feet 6 inches. The switchboard is to be located near the center of the station, and supported against the columns which carry the crane.

STATION B.

The New Generating Plant on the West Side.

Station A of the Portland General Electric Company, located on the east bank of the river, was erected in 1889 by the Willamette Falls Electric Company, of which the former company is the immediate successor. This was the first plant erected at the site of the falls for the transmission of electricity to Portland. Station A at the present time furnishes the power for running the electric-lighting system of Portland. This system includes the electric lights used for street illumination and for commercial purposes, and also the incandescent lamps used here for interior illumination. The extent of this system can be appreciated from the statement that there are today in use in Portland 1000 arc lights and 15,000 incandescent lights. In addition to running the electric lights of Portland, power for operating the East Side electric railway between Milwaukie and Oregon City is also supplied by station A.

For running the incandescent-lighting system of Portland, the company uses both the dynamos of the Thomson-Houston and the Westinghouse patterns. The capacity of each of these dynamos is 1500 lamps of 16 candle-power each, and each dynamo generates sufficient electricity, when delivered at Portland over the long circuit, to run 1200 lamps of the above capacity. The conductors used by the company are No. 4 B. & S. gauge, weather-proof wire, and the loss in transmission between Oregon City and Portland is about 29 per cent. The arc-light machines in use are of 100 lights capacity each, and each machine transmits to Portland over a circuit of No. 4 wire sufficient electricity to run 55 arc lamps, the loss in the arc transmission over these wires being only about 5 per cent.

All the incandescent and arc circuits run into the distributing station in Portland, located at the corner of Water and Montgomery streets. From this point the general distribution of all the lighting, both arc and incandescent, throughout the city is handled and regulated.

It is the intention of the company to continue the operation of station A, and to use station B, now being constructed on the west side of the river, simply for supplying the power and lights that may be demanded from the new business that will naturally come to the company on the completion of its great plant at Oregon City. The ultimate capacity of station B will be about 12,000 horsepower. The foundation and ground work for station B has all been done with the view of supporting a structure that will be capable of supplying this limit of power, but the first installation of water-wheels and electrical machinery provides for furnishing 2000 horsepower only. The plans of the company contemplate adding new water-wheels and dynamos as the increase of the business of the company may demand this extension of its plant.

In the erection of station B the Portland General Electric Company has met with many difficulties, especially in the construction of a sound foundation. These difficulties have all been overcome, however, and the plant is now ready for the rest of the electrical apparatus. This plant would have been started on the first of the present year had not the disastrous fire in the Albina yards last September destroyed a large lot of machinery which was on the cars in the yards ready to be shipped to Oregon City. The plant will be in successful operation, however, some time in March or April next. All the foundation work of the station is now completed, and the work is so far advanced that high water cannot interfere in the least with the progress of work in finishing the plant. The completion of the additional sections of the station and the installation of additional water-wheels and dynamos as they may be required will be a simple and comparatively inexpensive operation, which will not interfere in the least with the running of the plant while these changes or additions are being made.

The electrical plant of station B will ultimately consist of 20 600-horsepower three-phase generators and two 350-horsepower direct-current generators or exciters. The installation of the plant, however, which will be ready by April 1 next, will consist of four 600-horsepower machines. The generators are placed in the upper story of the power station, and the armatures are coupled direct to the vertical shaft of water-wheels and are run in a horizontal plane, instead of vertically as in the ordinary dynamo. Each generator weighs 64,000 pounds, of which about 22,000 pounds is in the armatures. The speed of the armature is 200 revolutions a minute.

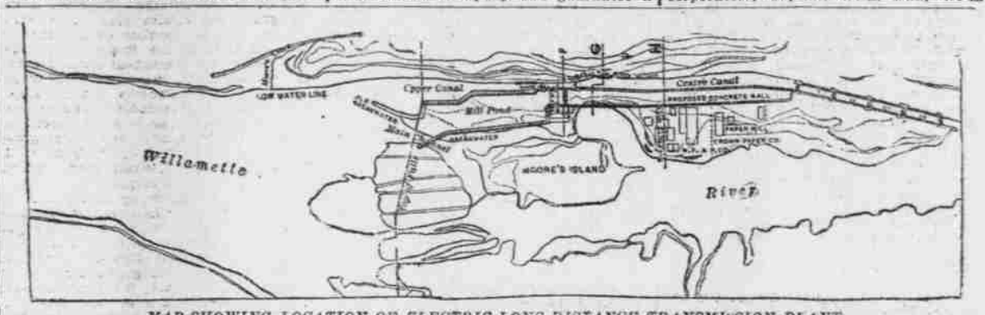
IN PORTLAND.

Central Station of This Company in the Metropolis.

Before station B at Oregon City will be ready for operation, the substation of the company at the corner of Water and Montgomery streets, in this city, will have been removed to the corner of Seventh and Alder streets, the present headquarters of the Portland General Electric Company. The Company recently purchased here a full lot, 100x200 feet, on which it has since erected a central station and office building. This adjoins the palatial Oregonian building, and is conveniently located for handling the immense business the company now enjoys. The Portland headquarters consist of a basement 60x100 feet in size and 18 feet high, and the office floor above of the same size. The floor on which the offices are arranged affords ample room for conducting the business of the company in an effective and expeditious manner. In the basement will centralize all the wires from both the old and the new stations at Oregon City, and also all the wires for conducting electricity for both power and lighting purposes in Portland. These lines will all be under the control of the man in charge of the central station. The rotary transformers for changing the alternating current into a direct current for railway and power purposes will also be located in the central station. Two of these rotary transformers, of 500 horsepower each, will be installed immediately, but foundations have been arranged in the basement for six machines. Each of the rotary transformers weighs 25 tons. The switchboards in the central station will be entirely of marble, and when completed the entire plant will possess an interest and an attractiveness which will appeal strongly to visitors.

It is the intention of the company to furnish power for all purposes. It can supply energy for running anything from the largest factory down to the operating of small ventilating fans or sewing machines. It will also supply lighting for residences, public buildings and stores, and at a less cost and with a guarantee of more efficient service than lighting can be done for by the adoption of any other methods. The completion of the great plant of the company at Oregon City will be of the most signal benefit to everybody in Portland. It is the intention of the Portland General Electric Company to put into effect a scale of prices both for lighting and for furnishing power that will place electric lights and electric power within the reach of everybody, and with the adoption of the most approved modern methods of conducting this power to Portland the company can guarantee a service that is not available today in any city in the United States.

All the water-wheel apparatus was furnished by the Stilwell-Bierce & Smith-Valle Company of Dayton, Ohio. The electrical appliances are from the works of the General Electric Company of New York.



MAP SHOWING LOCATION OF ELECTRIC LONG-DISTANCE TRANSMISSION PLANT.

FIGURE 4—Hydraulic and Thrust-Bearing Cylinders to Carry Generator Shaft.

Sources of Aluminum.

The presence of aluminum in clay, says the Age of Steel, has led to wild notions as to its available quantities. Men have looked on a clay bank and indulged in visionary estimates of the wealth that was simply waiting for a large shovel and a roomy wheelbarrow.

It is, however, stated as a cold scientific fact by a member of the United States geological survey that until some radical change is made from the present method of reducing aluminum, bauxite must continue to be the chief source from which the metal is obtained. This mineral, according to geological researches, is at present located in Arkansas, and in the southern part of the Appalachian valley, extending from Adairsville, Ga., to Jacksonville, Ala. The continuity of these deposits is not yet demonstrated, and the possibility or probable supply is an unknown quantity. That science will ultimately devise efficient and economical methods of reducing aluminum, by which the ubiquitous white metal can be more generously used, is simply a matter of time.

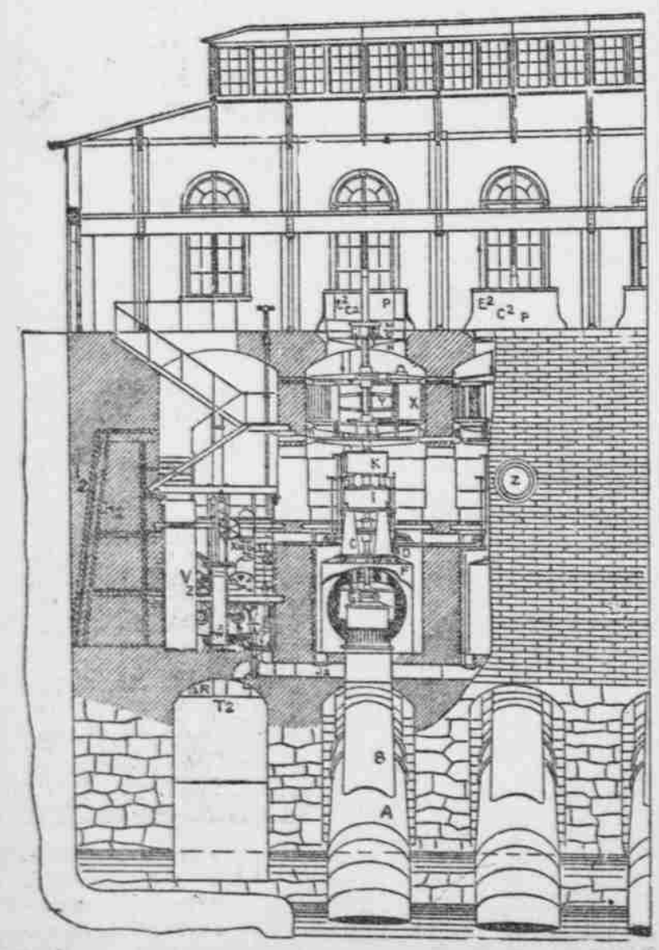


FIGURE 6—Longitudinal Elevation of the Up-Stream End of Power Station, Showing Part in Section.

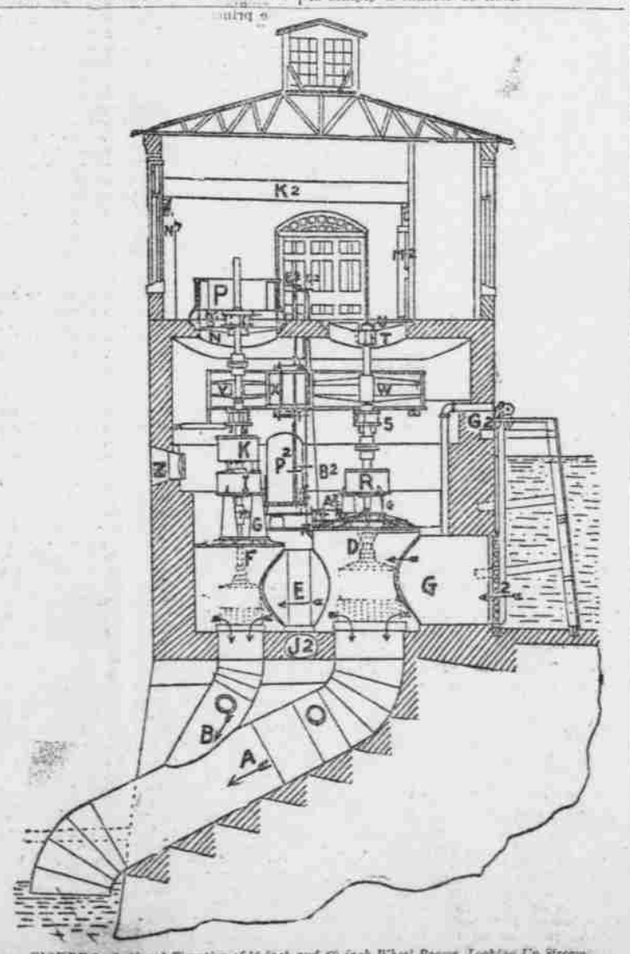


FIGURE 2—Sectional Elevation of 42-inch and 60-inch Wheel Rooms, Looking Up Stream.

ELECTRICITY AND GAS

EFFICIENT SYSTEM OF LIGHTING ADOPTED IN PORTLAND.

First Gas for Illumination Purposes Made in the City—The Electric Lights.

THE legislative assembly of the territory of Oregon, on January 7, 1859, granted to the late Henry D. Green a perpetual right to manufacture and sell gas in the city of Portland. By the terms of this act, Mr. Green was to enjoy the exclusive right to conduct a gas works in this city for a period of 15 years after the act went into effect.

At that time there were but two gas works in operation on the coast, one at San Francisco, the other at Sacramento. In the same year that he obtained this charter from the legislature, Mr. Green commenced the erection of buildings in Portland in which his proposed gas works were to be located. In May of the following year gas from these works was first turned into the city mains. The day when the gas jets in the city were first lighted was one of great rejoicing. It was a gala occasion for the entire population of Portland, and everybody regarded the establishment of gas works here as one of the great events in the history of the city.

The first subscribers for gas from Mr. Green included six of the leading business houses of the city. The rate established was $3 per 1000 feet. In 1862 Messrs. John Green, H. C. Leonard and Henry D. Green incorporated what was known for years as the Portland Gas Light Company, with a capital stock of $250,000. The subscribers to the stock were the three incorporators, Captain W. L. Dall, W. L. Leonard and Major R. W. Kirkman. On December 11 of the same year the stockholders held their first meeting. At this meeting John Green was elected president, H. C. Leonard secretary and H. D. Green superintendent.

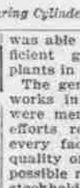
By 1876 the consumption of gas had so increased in Portland that it was found necessary to enlarge the plant and to provide for a further extension of the mains. At a meeting of the stockholders held November 27, 1885, it was again decided necessary to further enlarge the plant of the company. The capital stock of the company was increased to $1,000,000. It was decided to greatly improve the plant and to purchase the latest improved machinery and all modern appliances for the easy and successful manufacture of illuminating gas on a large scale. These changes and improvements were made under the direction of Homer Bloomfield, a thoroughly competent gas engineer. On the completion of the new plant, Portland was able to boast of one of the most efficient gas-producing and distributing plants in the United States.

The gentlemen at the head of the gas works in the early history of Portland were men of great enterprise, and their efforts resulted in affording Portland every facility for obtaining the highest quality of illuminating gas at the lowest possible rates. In the summer of 1892 the stockholders of the gas company decided to retire from active business. The interests of these stockholders in the old company were purchased by Charles F. Adams and A. L. Mills, prominent young men of this city. The transfer was made on August 1, 1892. The property transferred included about 20 miles of gas mains with a gas plant having a producing capacity of 700,000 feet a day. The purchase price was $950,000. The new owners immediately incorporated what is now known as the Portland Gas Company. Many of the leading men of Portland subscribed for stock in the new company, and it is today one of the strongest corporations in the Pacific Northwest.

Since the retirement of the old company from this field the gas works and the distributing system have been greatly improved. Larger mains have been laid on the west side of the river, the old East Portland gas plant has been purchased and a main has been carried across the Burnside-street bridge for supplying gas to the East Side residents direct from the works in Portland. An ammonia plant has also been added to the old plant here. The rates for gas have been reduced from time to time from $3 per 1000 feet in 1890 to $2 50 per 1000 feet at the present time. Not only is the company giving a rate of $2 50 per 1000 feet to consumers, but special discounts are allowed where certain conditions are complied with. Gas is furnished by the company both for illuminating and cooking and heating purposes. The plant of the company, as before stated, is a complete one in every respect, and it is fully capable of meeting every demand of a city of much larger population than Portland for gas of a high quality.

ELECTRIC LIGHTS.

The Present System of Illumination by Electricity.



THE first contract for arc lighting by the city of Portland was made about 10 years ago with the United States Electric Light & Power Company. The contract for electric light was renewed by the city every two years after that time until the service had increased from 25 arc lamps of 2000 candle-power to 619 lamps of the same capacity and 706 incandescent of 25 candle-power each.

The first 25 arc lamps were run by power furnished by the electric plant located in the works of the Portland Hydraulic Elevator Company. These lamps were placed at only a few points in the city where it was deemed that concentrated light of great power was needed. Under the present contract the city is thoroughly lighted from one end to the other. On the West Side the distribution of lights commences at the cemetery or Fulton Park, and reaches north to the Willamette Heights. On the East Side all of East Portland, Upper and Lower Albina, Sellwood, St. Johns, Woodstock, Waverly, Sunnyside, Piedmont, Woodlawn and Portsmouth are fully covered by arc lights.

The second contract made with the United States Electric Light & Power Company, in 1886, was for 546 incandescent lamps of 16 candle-power and 45 incandescent lamps of 32 candle-power. These lamps replaced the arc lights and coal oil lamps then in use here. The contract for 1887 was a duplicate of that of the previous year. In 1889 the first power from Oregon City for supplying the arc lamps of the city was received here. The price of the first arc lamps put in here was $25 each per month. This price has been reduced each year since that time, and under the new contract which will go into effect in April next the price for arc lamps will be $8 62½ each. The first price for incandescent lamps was $1 10 each. The price has been reduced until the charge today is $1 72½ each per month.

For street lighting in Portland the Thomson-Houston double-carbon lamps are used. An important feature of the arc lights furnished in Portland is the steadiness of the light. This steadiness, so experts say, is due in a measure to the long-distance transmission. It is the claim of the company supplying these lamps that the location of the power plant at Oregon City, 13 miles distant, insures a better service than could be given by any plant established in Portland. The poles for carrying the wires of the electric lamps throughout the city are from 50 to 70 feet in height, and all the line work within the municipal limits has been done after the most approved methods. The difference between the appearance of the pole lines in Portland and in other cities of the continent of the same size is certainly to the credit of this city.

In 1891 the old municipal government of East Portland bought an electric lighting plant which was located in the East Side pumping station. This plant was operated successfully until after consolidation by East Portland, when it was turned over to consolidated Portland. This plant supplied a service of 150 arc lamps of 2000 candle-power each. The city finally, on April 1, 1893, transferred its interests in this plant to the Portland General Electric Company for $27,000, an amount representing about what had been the actual cost of the plant to the city. Under the management of the city the cost per arc lamp on the East Side circuit was about $12 30 each per month. The Portland General Electric Company has given equally as efficient a service at the contract price of $9 50 a lamp for the lights already installed and $9 00 a lamp a month for new lamps required. The boilers and building formerly occupied by the old East Side lighting plant were not included in the transfer to the electric company, as they were part of the pumping station of the East Side Water Company, which is still being operated by the city.

In addition to purchasing the old East Portland plant, the Portland General Electric Company also in November, 1892, acquired possession of the electric plant of the Albina Light & Water Company. All the street and commercial lighting in Albina, as well an considerable commercial lighting in East Portland, had been supplied from this plant. The plant is now shut down, all the lights in Albina being operated from Oregon City.

All the electric lights used in Portland, with the exception of those run by plants installed in some of the great office buildings of the city, are run by power supplied by the Oregon City plant. The Portland General Electric Company gives a 24-hour service on all its commercial circuits. The city lighting contract provides for lights to run all night, from twilight until daylight the following morning.

The following interesting table will show the relative expense of arc lamps in Portland and in the other leading cities of the coast:

CITY AND DURATION.	Price for each 2000 c. p. lamp per year.....
Portland—All night and every night	$105 50
Spokane— " " " " "	114 00
Seattle— " " " " "	119 40
Helena— " " " " "	180 00
Butte— " " " " "	186 00
San Francisco— " " " " "	200 75
Los Angeles—Moonlight schedule....	138 00
Oakland— " " " "	175 20
San Diego— " " " "	180 00

The city of Tacoma owns its plant, and not only lights the streets, but also does commercial lighting. Under this arrangement, after allowing for interest and depreciation, it has been found that the cost to the city of each 2000 candle-power arc lamp on the streets of Tacoma is about $144 per year. It may be explained, too, that municipality finds it necessary to transfer from the general tax fund to the light fund the sum of $12 a month for each street light; in other words, it pays itself for its own lighting.