# BRUSH

## ELECTRIC GENERATORS AND MOTORS

FOR THE TRANSMISSION AND DISTRIBUTION OF

## · POWER. ·

UNITS OF ONE TO ONE HUNDRED HORSE POWER.

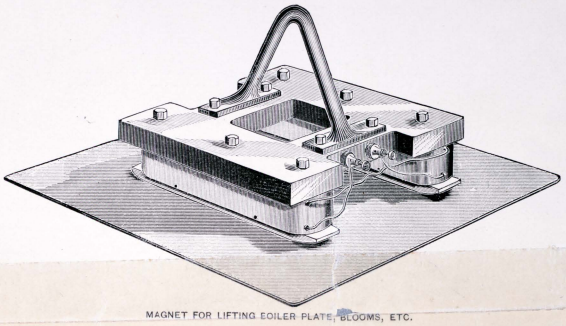
ELECTRIC HAULAGE. ELECTRIC HOISTS.

Dynamo Electric Generators for Central Stations. Stationary Electric Motors.

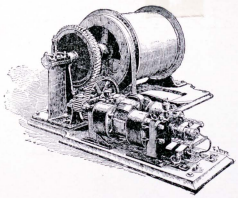
*THE BRUSH ELECTRIC POWER APPARATUS IS THE BEST IN THE WORLD, AND EMBODIES THE ONLY SYSTEM BY WHICH MANY OF THE MOST DESIRABLE APPLICATIONS OF ELECTRIC POWER CAN BE OBTAINED.*

THE BRUSH ELECTRIC COMPANY,

CLEVELAND, - - - - - - - OHIO, U. S. A.



MAGNET FOR LIFTING BOILER PLATE, BLOOMS, ETC.



BRUSH MOTOR AND HOIST WITH WORM GEAR.

# ELECTRICAL POWER TRANSMISSION

## AT VIRGINIA CITY, NEVADA.*

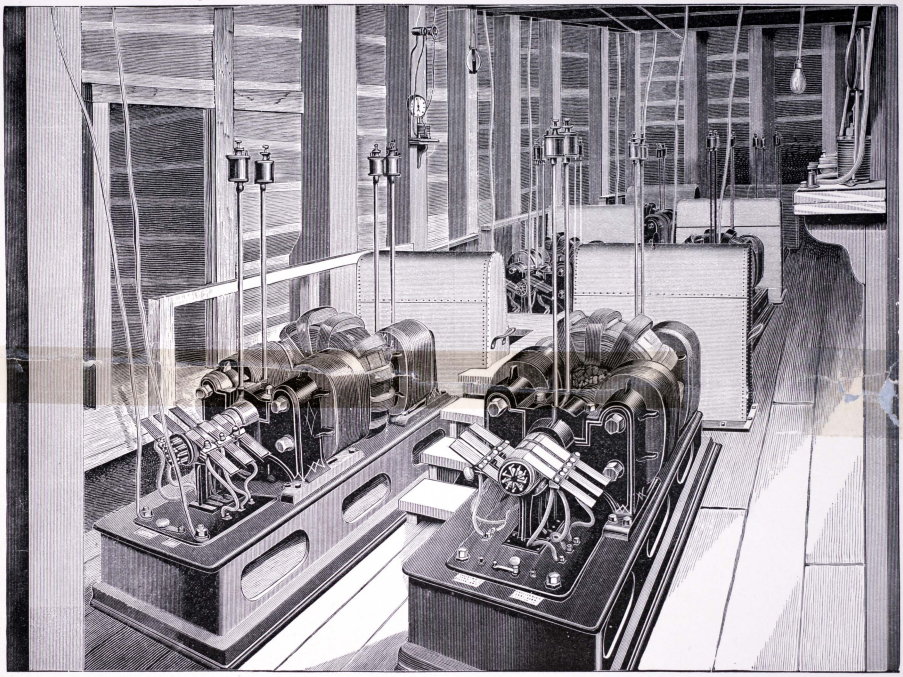
"MORE power, economical power," has been now for several years the imperative demand of the owners of mining properties on the celebrated Comstock Lode, at Virginia City. The problem has been to work the enormous quantities of low-grade ore at a profit. Large sums have been expended in carrying water from streams in the neighboring Sierra Nevada Mountains for a distance of some thirty miles, to be utilized at the mines and mills on the Comstock. But this supply of water is limited and fickle, and by no means meets the demand. Operations have frequently been suspended on this account, causing great loss to the mine owners and hardship to the laborers dependent upon the active working of the ores. The best engineering talent of the country has been called to work on this vital problem of power supply, and new arrangements have been made for increasing the amount of water, but vast powers now within reasonable range are still running to waste, which the use of electricity alone can conserve.

At the Stamp Mill of the Nevada Mill and Mining Company, water power was obtained at the level of the mill from a reservoir on the side of the mountain. The Mill contains 60 stamps with their complement of pans, settlers, agitators, rock-breakers, etc. The water power readily available was entirely inadequate for the operation of the Mill.

The problem was submitted to The Brush Electric Company, through its agents, The California Electric Light Company, of San Francisco. A solution was speedily offered and the plans were accepted by the owners of the Nevada Mill and Chollar Mine. The shaft of the latter is close to the Stamp Mill. It was proposed to collect the waste water from the surface wheel at the Mill, convey it in

* Reprinted from "ELECTRIC POWER," issue of June, 1889.

pipes to the shaft of the Chollar Mine, and thence down the shaft until a sufficient head should be obtained to produce the power required. The scheme was novel, and presented many difficulties. However, experts pronounced the plans feasible, and work was begun last winter.

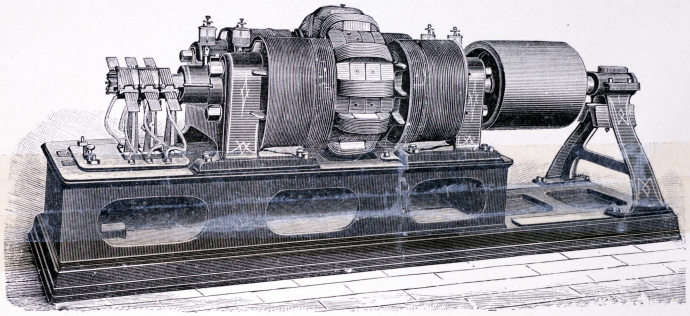


SUBTERRANEAN DYNAMO ROOM AT THE 1650 FOOT LEVEL OF THE CHOLLAR MINE, VIRGINIA CITY, NEV.

At the 1650 foot level of the Chollar Mine a subterranean chamber was excavated out of solid porphyry for the reception of the dynamo electric generators and waterwheels. This chamber is 50 feet in length, by 25 feet in width and 12 feet in height, clear of all timbers. From the tank containing the waste surface water two wrought iron pipes are led to the subterranean chamber, one ten and one eight

inches in diameter. At the bottom of the shaft a Y unites these two pipes into a single one fourteen inches in diameter, out of which six six-inch pipes run to the nozzles of the waterwheels provided to drive the large Brush dynamo electric generators.

The underground electrical station is of the most interesting character and is shown in our illustrations. The large Brush primary generators, of which there are six, are adapted to the conditions by a few mechanical changes from the standard pattern. They are mounted on a heavy cast iron base, and are provided with an extended shaft and outer bearing. On the armature shaft and between two bearings the Pelton wheel is mounted, and enclosed in a water-tight cover. The cut of the generator is made from

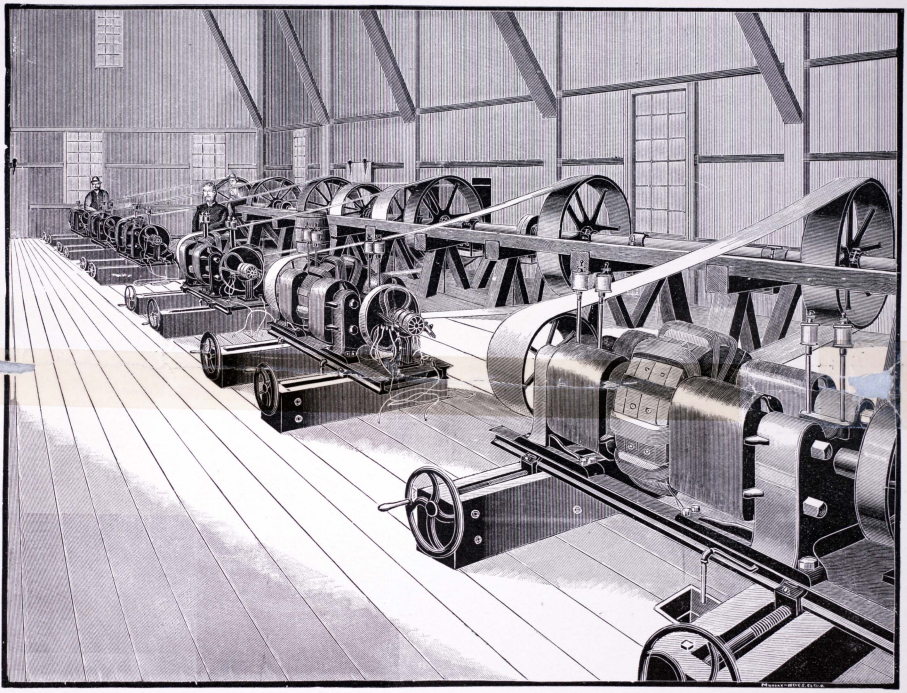


BRUSH 130 HORSE POWER ELECTRIC GENERATOR.

a photograph taken at the Brush Electric Company's works at Cleveland, before shipment, and shows a pulley on the armature shaft, arranged for testing runs at the factory. The waterwheel is attached to the armature shaft at the place occupied by this pulley, and a coupling is provided for detaching this entire end of the shaft carrying the wheel from the other end carrying the armature. These Brush generators are each of one hundred and thirty horse-power capacity, and are compound wound for constant current. The electrical curve from these machines is almost ideally perfect and they require no regulator whatever. The current remains of constant strength under all conditions of load.

The head of water at the underground chamber is 1680 feet. It has never before been attempted to run a waterwheel under such enormous pressure. This was, indeed, one of the most serious problems involved in the remarkable installation. From the various excellent forms of waterwheels, the "Pelton" was selected as best adapted to work under the special circumstances. This wheel is the outgrowth of the

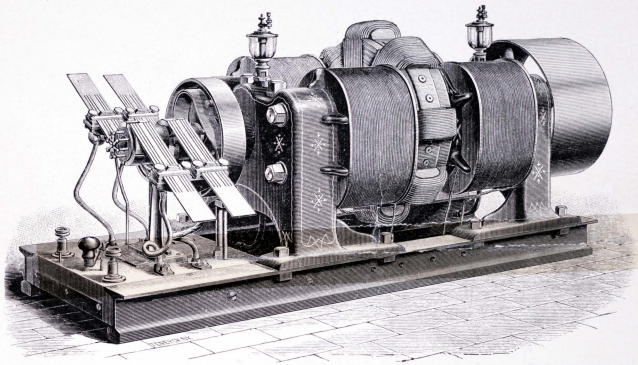
old hurdy-gurdy form, and, as will be seen from the illustration, its buckets are provided with a very ingenious wedge-shaped partition, by which the stream of water is divided and sweeps out through the curved sides in such a way as to produce a reactionary effect in addition to the impact. By the peculiar



ELECTRIC MOTOR ROOM AT THE NEVADA MILL, VIRGINIA CITY, NEV.

construction of the buckets all the water is also thrown down and out of the way of the wheel. The six Pelton wheels are each forty inches in diameter, are made of phosphor bronze and weigh 220 pounds. They drive the generators at a speed of 900 revolutions per minute. The compact arrangement of combined dynamo-generator and waterwheel makes it almost impossible for the visitor to the under-

ground chamber to realize the enormous amount of power here at work. The machines are placed in parallel rows of three, and the swift revolving armatures are all that can be seen in motion as evidence of the 800 horse-power generated. The chamber is brilliantly lighted by 36 Swan incandesence lamps, operated in multiple series from one of the Brush generators, and there are several of the same lamps in the incline. Each generator circuit is provided with a dead beat ammeter of the Brush pattern, and a Brush voltmeter is also at hand which is capable of measuring up to three thousand volts. The generator circuits are led to a switchboard in the same dynamo room, where any generator can be thrown on to any one of the outgoing motor circuits.



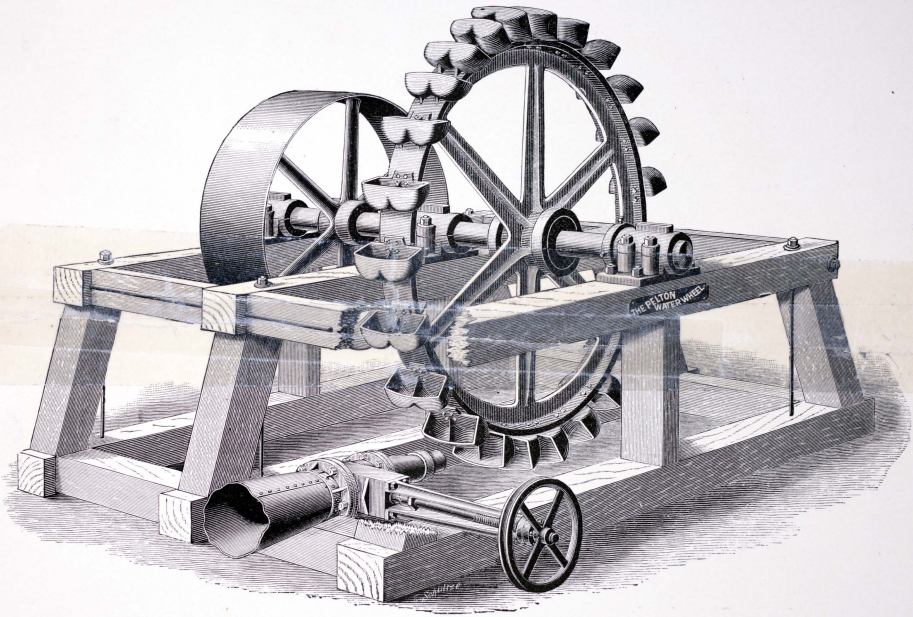
BRUSH 80 HORSE POWER ELECTRIC MOTOR.

Leaving this subterranean power station and ascending the Chollar shaft are the circuits of copper wire, one to each generator. At one point these circuit wires pass through a shower bath of spray, but the insulation is so perfect that no leakage has yet developed. The wires issue from the mine shaft and are carried above ground to the electric motor room at the Nevada Mill. The total length of each circuit is a little more than a mile.

The electric motor room is shown in one of the large illustrations. The six motors are of the regular Brush constant current type, each of eighty horse-power capacity, and are arranged in a single row parallel with the main driven shaft to which they are all belted in the ordinary manner. The surface water-wheel is also connected to this same shaft. It will be noted that there is here a very novel and interesting feature. This surface wheel uses the water in the first instance and furnishes part of the power

to drive the main shaft. The waste water after this primary use is carried down the Chollar shaft to the underground chamber, where it drives the dynamos that generate and send back the electric current to energize the electric motors above ground, which in turn furnish additional power to the main shaft.

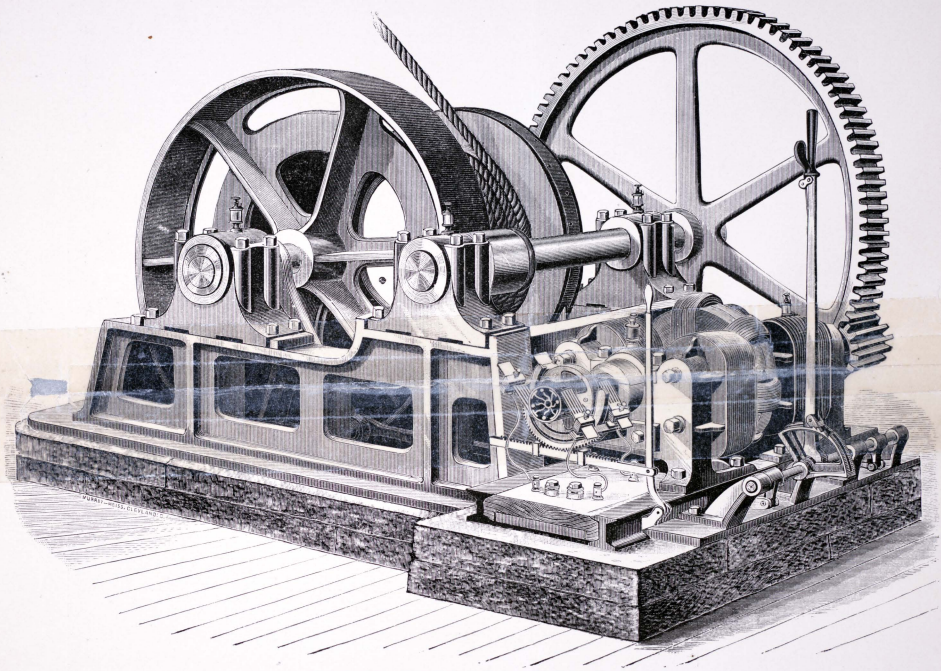
Each electric motor has its own independent circuit fed from one of the generators. The well known Brush centrifugal governor, with which each motor is fitted, regulates the speed sensitively, and all or any




THE PELTON WATER WHEEL

number of the motors work perfectly in a battery together or with the waterwheel. In the motor room there is also an ammeter for each electric motor to show at all times the current flowing in each circuit. The motors run at a speed of 850 revolutions per minute. Some difficulty was anticipated in operating the motors together on one shaft in the manner described, but none was encountered. The motors have not given a moment's trouble or annoyance of any kind from the start.

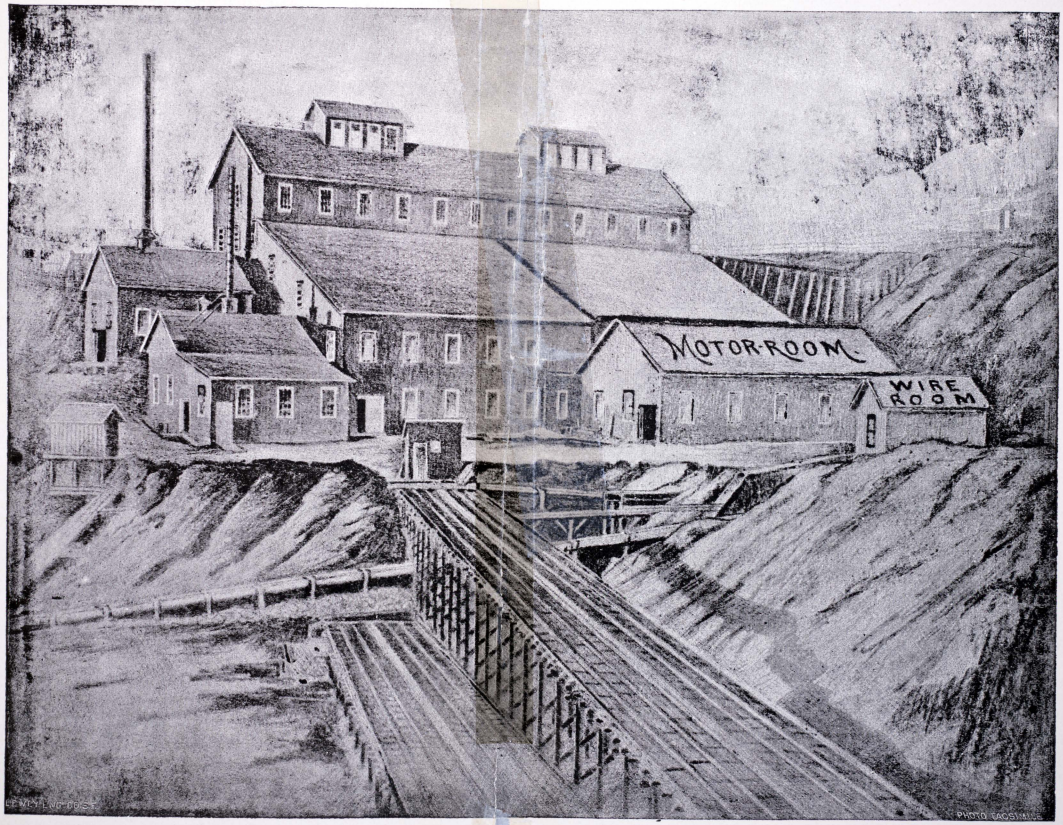
Some idea of the economic value of this electric power plant to the mine owners, may be got from a statement of the saving effected by it. The surface wheel alone requires 312 miner's inches of water to develop power sufficient to drive 40 of the 60 stamps with which the mill is equipped. Moreover, this



BRUSH ELECTRIC HOIST WITH SPUR GEAR AND FRICTION.

amount of water is seldom available. Two of the electric motors, working in addition to the surface wheel, will perform the same service with but 72 miner's inches of water, thus effecting a saving of about 77 per cent.

The net commercial efficiency of the plant, taking into account all elements of loss, including that in the conducting wires, is about 70 per cent. In other words, 70 per cent. of the power applied to the shafts




THE NEVADA MILL, VIRGINIA CITY N[illegible] WHERE THE ELECTRIC POWER IS APPLIED.

of the generators in the underground chamber is delivered for work at the main line shaft in the mill. The waste water from the 1650 foot level of the Chollar mine is piped into the Sutro tunnel. It is now proposed to use this water a third time at a lower level for other work by means of a similar application of electrical machinery.

It was expected at the outset that many difficulties would be met in an installation of such novel and original character, which was also BY FAR THE LARGEST EVER ATTEMPTED. The projectors, The Brush Electric Company, and their agents, The California Electric Light Company, who assumed charge of the details of the erection, were very greatly pleased to find that their forethought had eliminated the troubles anticipated and predicted in almost all respects. Two purely technical difficulties were encountered when the plant was started experimentally, which caused some delay and anxiety. They were first the lack of any governing appliance for the waterwheels, and second, the damage to the primary generators caused by the extreme heat and dampness in the underground station.

The Brush Electric Company in its original plans and specifications stipulated that the waterwheels should be governed within reasonable limits, but this requirement was not met and the first generator and motor, started up experimentally, showed the necessity of this provision. The Brush Company was surprised to receive by telegraph the first intimation that the makers of the waterwheels had wholly neglected such an important matter, but was fortunately able to close the breach at once. A waterwheel governor, invented and sketched out by Mr. W. B. Devereux, the eminent mining engineer, of Aspen, Colorado, had been placed in the hands of the company some time previously, and working drawings of it had been made at Cleveland. These were at once sent to California, the governors were quickly made, and this source of trouble was overcome. Mr. F. E. Smith, the electrical engineer in charge of the installation, made several modifications of the governor, after watching its performance, which proved of much value, and it has worked perfectly in practical service. We expect to be able to present our readers with illustrations of this waterwheel governor in a later issue.

The second difficulty was met with equal promptness and likewise overcome. The temperature of the subterranean power chamber is about 72 degrees F. The atmosphere is almost saturated with moisture—78 per cent. Any piece of metal taken into it begins immediately to "sweat." The generators when placed in this chamber were soon covered and saturated with moisture, and began to show leaks, while the motors above ground were absolutely free from any trouble.

The Brush Company was at once notified of this unanticipated source of difficulty, and Mr. Brush speedily devised a method of insulation which would certainly and completely resist the moisture of the atmosphere. Since its application the generators have worked admirably, and the entire plant is now at work regularly, performing its expected duty, and economizing the power available as stated above.

The achievement of The Brush Electric Company in connection with this plant on the Comstock is a very notable one and of the greatest interest to mining engineers. The plant is by far the largest electrical power plant in the world. The company is making a specialty of powerful generators and motors for power transmission and distribution, and is taking large orders for them, not only in this country but also for foreign shipments. The latest contract announced is one with the Calumet and Hecla Mining Company, for five of the large Brush generators of 130 h. p., and five of the 80 h. p. Brush motors. A power station will in this case be built above ground for the generators, and the motors will be used for driving pumps underground. The plant goes to the great copper mine at Calumet, Michigan.

# BUY BRUSH CARBONS FOR ARC LAMPS

THEY ARE:

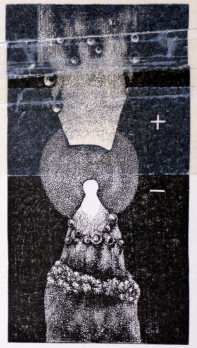
(1) THE PUREST IN MATERIAL,

(2) THE MOST BRILLIANT IN BURNING,

(3) THE LONGEST IN LIFE,

(4) THE MOST EVENLY COPPERED,

(5) UNIFORM THROUGHOUT ALL SEASONS.



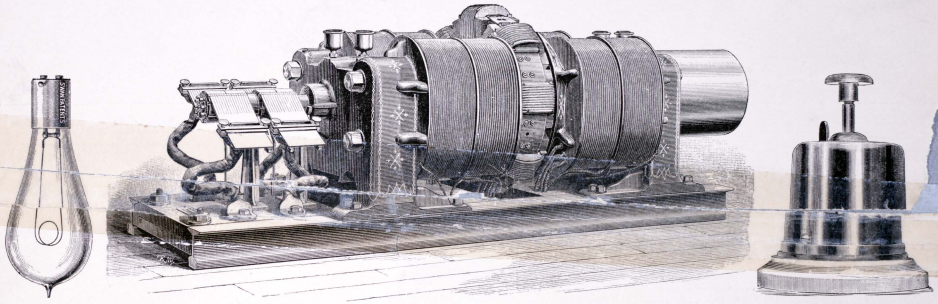

*THE ENTIRE MODERN PROCESS OF CARBON MANUFACTURE IS THE INVENTION OF MR. BRUSH AND HIS ASSISTANTS. THE EXPERIENCE OF THE BRUSH ELECTRIC COMPANY AND THE EXTENT OF ITS MANUFACTURING FACILITIES ARE UNEQUALLED IN THE WORLD.*

THE BEST IS THE CHEAPEST.

# INCANDESCENCE

## OR GLOW LAMP ELECTRIC LIGHTING.

**For MILLS, MINES, FACTORIES, RESIDENCES, BUSINESS BLOCKS, STEAMERS, ETC.**



SWAN LAMP. BRUSH DYNAMO FOR INCANDESCENCE LIGHTING. WALL SWITCH.

THE BRUSH DYNAMO is automatic in its regulation, and therefore the simplest, easiest and most reliable to operate. No resistances, regulators or other complicated paraphernalia.

THE SWAN LAMP is the most brilliant and durable Incandescence Lamp made in America or Europe. Its use is universal.

The details of the Brush Incandescence System, (i. e.) Switches, Junctions, Cut-Out Boxes, Ammeters, Voltmeters, Lighting Arresters, Safety Appliances, etc., are unequalled.

**SOME REPRESENTATIVE BRUSH INCANDESCENCE INSTALLATIONS:**

| | |
|---|---|
| The Patent Office Building at Washington | 1,200 lights. |
| The new Cincinnati Chamber of Commerce, Cincinnati, Ohio (and 50 H. P. in Generator and Motors) | 1,000 " |
| The U. S. Steel Cruiser, "Boston" | 350 " |
| The New York Life Insurance Co's Buildings at New York, Montreal Kansas City, Omaha and St. Paul | 7,000 " |
| The State Penal Reform Institutions of New York, Pennsylvania and New Jersey | 4,000 lights. |
| The Providence Line, Long Island Sound Steamers | 1,100 " |
| The Detroit and Cleveland Line Steamers | 1,250 " |

Hundreds of Mills, Factories, Residences, Office Buildings, etc.

SEND FOR CATALOGUES.

THE BRUSH ELECTRIC COMPANY,

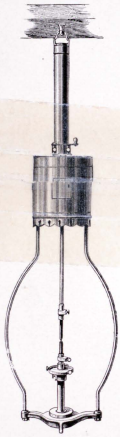
*AGENCIES EVERYWHERE.* CLEVELAND, OHIO.

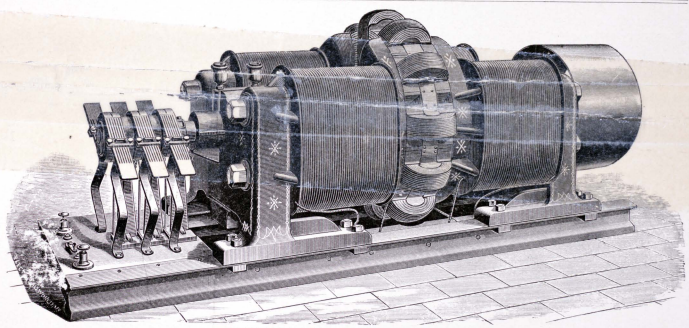
*The Brush Light shines in every civilized country of the world. It lights the palace grounds of the Emperors of Japan and Brazil, and can be seen in the streets of the great cities on every continent.*

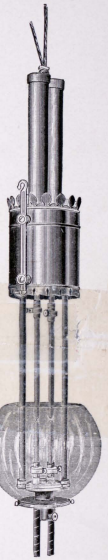
SIMPLICITY IN STRUCTURE AND OPERATION,
BEAUTY AND STEADINESS OF LIGHT,
RELIABILITY UNDER ALL CONDITIONS,

ARE CHARACTERISTICS OF

# THE BRUSH SYSTEM OF ARC LIGHTING.







BRUSH ARC LIGHTING DYNAMO MACHINE.

It is the universally recognized Standard System of Series Arc Lighting the world over.
The Brush Arc Lights in use far outnumber all others.

**READ THIS:**

PHILADELPHIA, May 2, 1888.

*The Brush Electric Company, Edward W. Tisdall, Esq., Special Agent.*

DEAR SIR:—In reply to yours of the 25th ult., we are using 355 arc lamps of 2,000 candle power, and eighty incandescent lamps of your make, all of which are satisfactory.

The durability of the dynamos, the goodness of their running power, and few repairs necessary, put the Brush system at the head of all others in our esteem. Yours truly,

JOHN WANAMAKER.

**THOUSANDS OF SIMILAR ENDORSEMENTS.**

*If you contemplate Arc Lighting send for Brush Catalogues and investigate the System thoroughly.*

THE BRUSH ELECTRIC COMPANY, Cleveland, Ohio, U. S. A.