SCIENTIFIC AMERICAN

[Entered at the Post Office of New York, N. Y., as Second Class Matter.]

A WEEKLY JOURNAL OF PRACTICAL INFORMATION, ART, SCIENCE, MECHANICS, CHEMISTRY, AND MANUFACTURES.

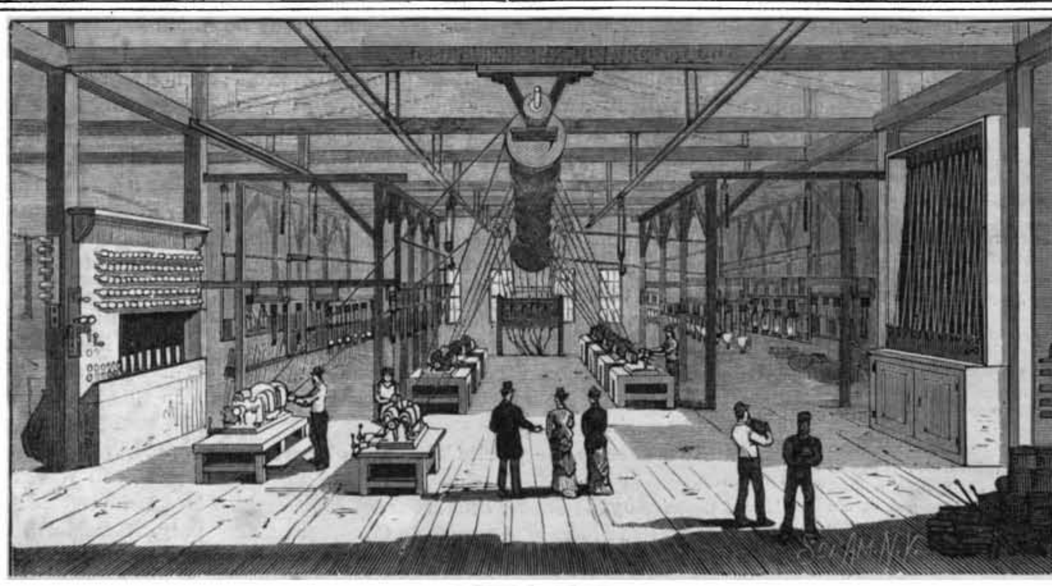
Vol. LIV.--No. 20. [NEW SERIES.] NEW YORK, MAY 15, 1886. [$3.20 per Annum. [POSTAGE PREPAID.]

THE BRUSH ELECTRIC WORKS AT CLEVELAND, OHIO.

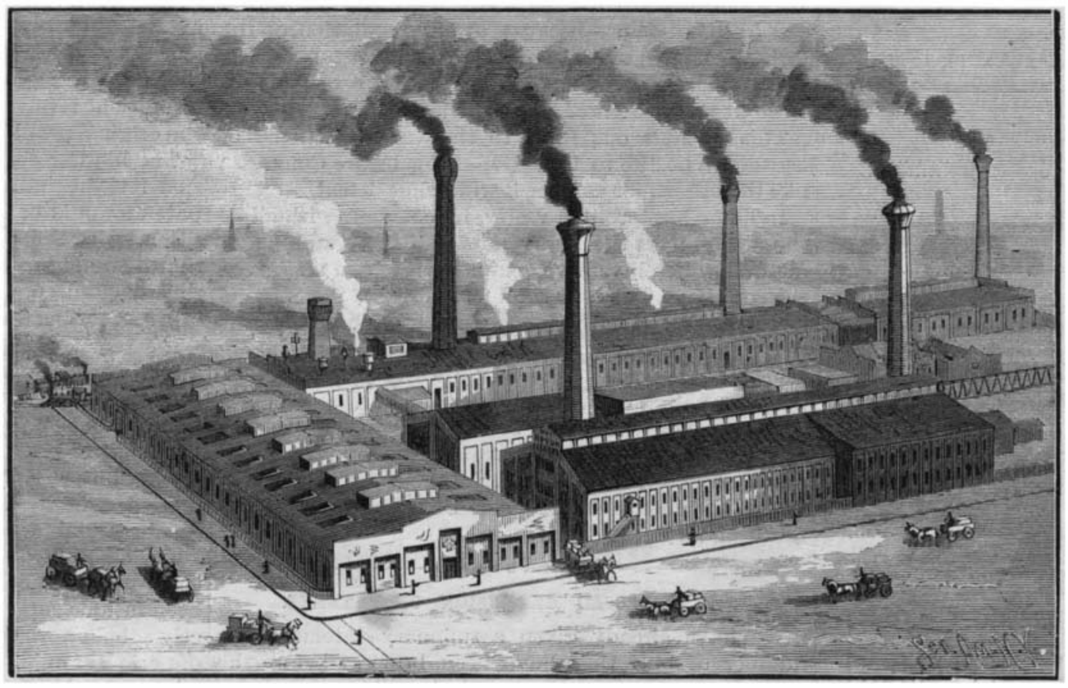
BY H. C. HOVEY.

The remarkable inventions of Mr. Charles F. Brush have been made available and remunerative by the Brush Electric Company, who are the sole owners of all his patents. This combination of inventive genius and business sagacity has, within the last decade, done much to revolutionize the artificial illumination of the world, and built up a business in whose various branches more than $25,000,000 are now invested. The earlier experiments and achievements of this company have already been described. (SCIENTIFIC AMERICAN, April 2, 1881, Nov. 1, 1884; and SUPPLEMENT, No. 274.) My object now is to lay before the public a full account of the works in their present enlarged and highly improved condition.

The entire area occupied by the buildings is about seven acres. The main machine shop is one story high and 265 feet by 122 feet in its dimensions. The "cathedral," so called on account of its peculiar shape, is two and a half stories high, and measures on the ground plan 200 by 100 feet. The power building is 120 by 110 feet; the carbon house, 600 by 62 feet; the pattern room and carpenter shop, 120 by 70 feet; the lumber room, 80 by 50 feet; the coke house, two stories high, 160 by 60 feet; besides the oil room, tin shop, blacksmith shop, stables, etc. There are five tall chimneys, about 125 feet high, besides several smaller ones. There is an exhibition hall for showing all the styles of lamps, dynamos, electroplating apparatus, electric motors, and other machines constructed here. An incandescence machine in the factory supplies whatever light may be needed, and there is an auxiliary storage battery in the basement, the current for charging which comes from a machine in the factory. This same machine also charges the batteries for several offices in the factory, for the engine room, the armature and magnet department, and the stables.



TESTING ROOM.

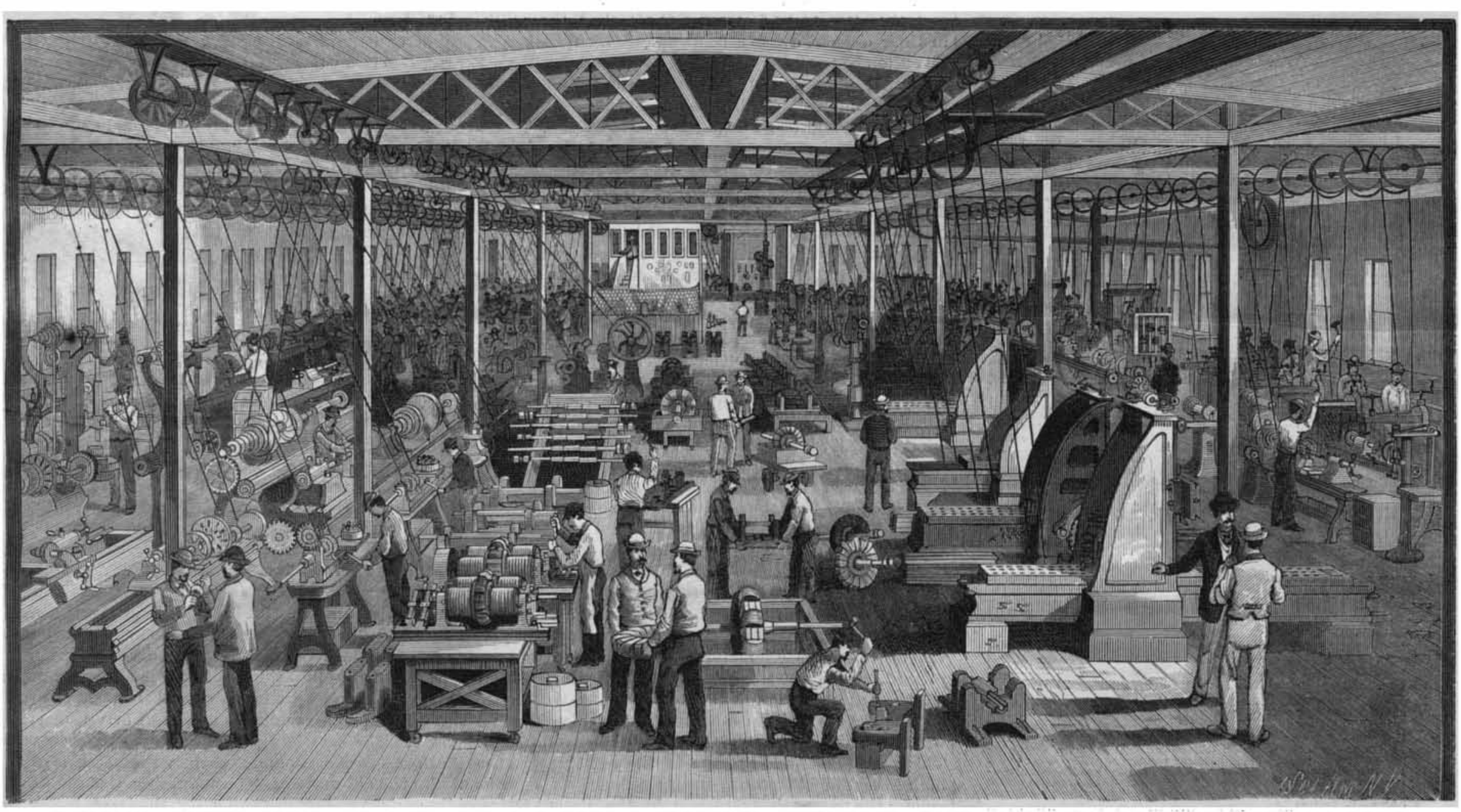


GENERAL VIEW OF MANUFACTORY.

The main shops are entered from Mason Street, where is also the time keeper's office. Happening to be there at the close of the day, I noticed that each of the 400 workmen who filed through the gate dropped a card into a box provided for the purpose. On inquiry I learned that at the beginning of each day's work every workman is provided, as he enters the factory, with a daily time ticket, on which he records during the day the particular kind of work he is doing and the number of hours he has worked. These tickets are all collected at night, and by this simple system the superintendent readily keeps track of the workmen, and ascertains the exact cost of all repairs and all new work.

In the main shop are manufactured the dynamos, arc lamps, and indeed all other

(Continued on page 308.)



GENERAL MANUFACTORY OF THE BRUSH ELECTRIC COMPANY, CLEVELAND, OHIO.—INTERIOR OF MAIN MACHINE ROOM.

THE BRUSH ELECTRIC WORKS AT CLEVELAND, OHIO.

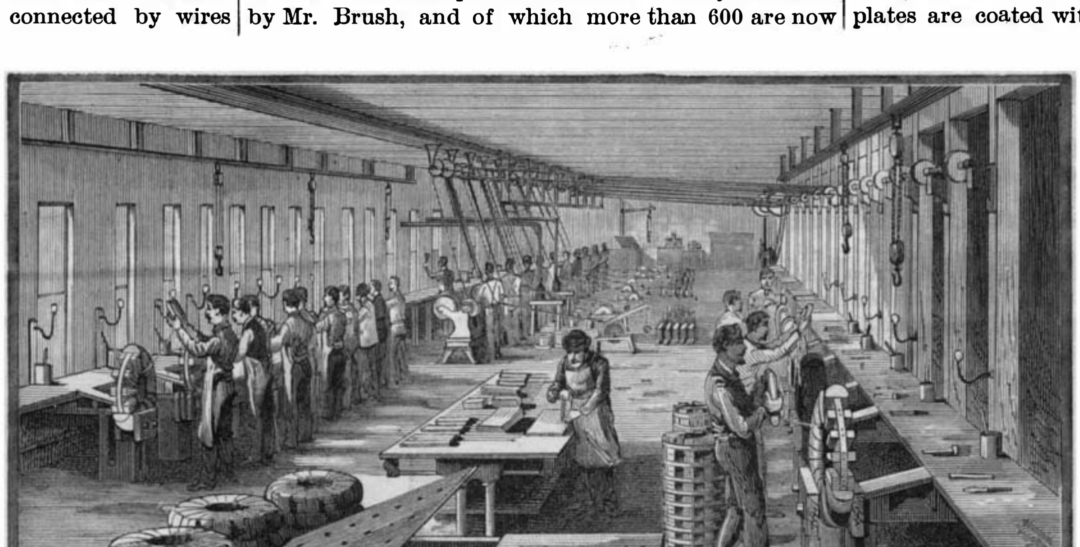
(*Continued from first page.*)

apparatus requiring the use of machinery. The castings of all sorts are received at the east end of the shop, the end nearest the general offices, and go through the several departments in order until they reach the west end, near the railroad track, where, in a finished state, they are packed and shipped to all parts of the world. One of the most noticeable features of these shops is the perfection of all the machinery in use. Everything is made of the best material and in the best style of workmanship. The long lines of shafting are bright, clean, and true, suggesting the hand and eye of a master in its erection.

The heavier machines, such as the planers, drill presses, lathes, some of them being very ponderous, are all placed on solid stone foundations. There are cranes, tramways, etc., for handling heavy castings, and transporting machines in the various stages of construction from one part of the shop to another. The motive power that drives the machinery in the main shop consists of one pair of engines, built by William Wright, of Newburg, N. Y., and rated at 300 horse power. The carbon department is run by two "Straight-line" engines of 55 and 65 horse power, the power department is run by a Cummer engine of 450 horse power, and six boilers of 150 horse power each furnish the steam for the above engines.

Beginning at the east end of the shop, let us follow the work through in order. The first thing to be noticed is the manufacture of the armature. This was formerly made of cast iron. But that method was objectionable on account of the cross (Foucault) currents, to avoid which the armature is now made of numerous thin layers of soft hoop iron, the core being laid in a coil, and the other pieces being put on transversely in such a manner as to form openings for the wire bobbins. When the armature has been fitted to its hub, and perfectly balanced, it goes to the winding department, which will be described hereafter. The shafts for the dynamos are all made from open hearth steel (Siemens-Martin) turned and fitted to hardened rings and caliper gauges so exactly as to be interchangeable. As an illustration of this, the company sent a machine to England five years ago, and has just sent to the purchaser a new shaft, which fitted as perfectly as if it had been made for that very machine. The hubs, which are also interchangeable, are usually cast from German silver; though in some recent instances Cowles' aluminum brass has been used with admirable results—a material that has a tensile strength of 95,000 pounds per square inch. The "commutator" is an ingenious device for collecting the currents from the revolving armature. The latter is wound with an even number of coils of wire, the inner end of each being connected by a wire to the inner end of its opposite coil, while the outer ends of all the coils are carried through the hollow shaft of the dynamo and connected with the commutator. The currents thus collected are transmitted by the copper brushes through the field magnets to the binding posts. The commutator, which is attached to and turns with the shaft of the dynamo, is built up from a wooden ring, that is covered with a shell made of the toughest Manila paper wound up with a shellac filling, through which the wire runs to connect with the armature. Outside this paper shell are insulated brass segments, of which there are as many as there are coils on the armature, each set of segments being connected by wires with a corresponding pair of bobbins. Thus each pair has a current passing through it only during three-fourths of a revolution and rests during the remaining quarter, meanwhile keeping its own circuit open by means of its segments. This contrivance greatly increases the efficiency of the dynamo. Copper wearing plates are placed outside the brass segments; and these plates and the brushes are said to be the only parts of the dynamo ever needing repairs. The brushes, as every reader probably knows, are flat strips of elastic copper, two or three inches wide, slit at the ends into eight tongues, which press against the rings of the commutator, one pair above and the other below, and each making contact in such a way that the main circuit is never interrupted.

In the planing department, which is quite extensive, the chairs, magnets, and rails are planed and carefully fitted. They are then tested for softness and quality, and afterward drilled to standard gauges. One end of each magnet is distorted to form a pole piece, and this is grooved to prevent cross currents.



BRUSH ELECTRIC CO.—ARMATURE AND MAGNET DEPARTMENT.

Having again been rigidly inspected, the parts of the machine are then set up on dummy shafts and armatures, and once more tested to see if they are in all respects perfect.

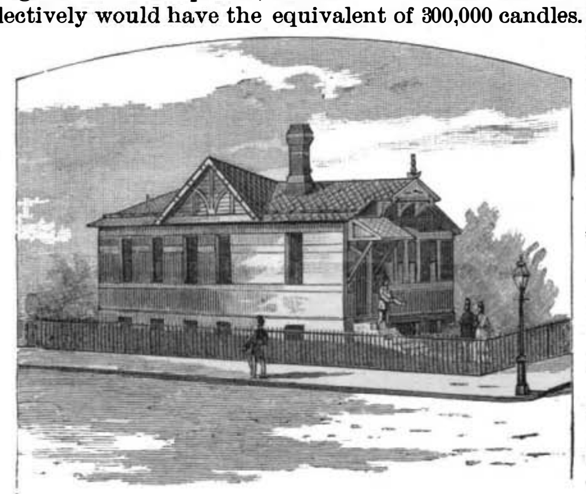
There is a "screw" department, where all sorts of screws for the lamp and dynamo are manufactured by machinery made expressly for this company by Pratt & Whitney.

In the "lamp details" department, all the details of the varieties of lamps made here are manufactured. The parts are made by means of hardened jigs and fitted together with exact nicety. All this

OFFICE.

work undergoes rigid inspection before going to the assembler.

The testing room is provided with a testing rack, switch boards, resistance boards, and other contrivances for testing arc lamps and incandescence lamps. Opposite the main entrance is a brilliant display of arc lights, sometimes as many as one hundred and fifty being tested at once. Each light having 2,000 candle power, it follows that the 150 collectively would have the equivalent of 300,000 candles.



MR. BRUSH'S LABORATORY.

The lamps all swing on a level with the eye, and yet my own experience was that the result of looking steadily at them was not at all painful, as one might suppose would be the case with such a dazzling array. The secret of this is that the pure white light, like daylight, is adapted to the human eye.

In passing among the arc lamps, I noticed groups of incandescence lamps, and learned that these were to test "the multiple series cut-out" lately invented by Mr. Brush, and of which more than 600 are now in successful use. The object of this invention is to enable groups of 4, 7, 14, 28, 32 (or indeed almost any desired number) of small incandescence lamps to be substituted on arc circuits in place of the large single lights with the ordinary 2,000 candle power current. With each group goes a multiple series cut-out box, whose levers may be worked by cords.

The general stock room is centrally located. So also is the superintendent's office, being elevated six feet to enable him to overlook the entire machine shop, and by a system of call bells he can at will summon to him the foreman of any department.

Leaving now the main building, we cross an open passage way and enter a huge structure styled the cathedral. A portion of it is occupied by the factory of the Swan Lamp Manufacturing Company, for making the Swan incandescent lamp.

On entering the long apartment devoted to the winding of armatures and magnets, our attention is first directed to three men whose business it is to wind the wire that is to be used and to examine with the utmost care the insulation. They must see that no splinters occur in the wire, nor breaks in the thread. The consequence of neglect might be that what the workmen call "a nigger" would get into the armature, and burn it so as to destroy its service. The wire, having undergone this inspection, is measured off into suitable lengths for the winding of each bobbin. For some large bobbins, as much as 1,200 feet is required.

The greatest possible care must be taken in winding, to see that the wire is properly put on and that all the bobbins of any given armature are exactly of the same size. All this work has to be done by hand, because it requires such expert manipulation at each step; and for the same reason there are but few men successful in this department, there being only twelve or fifteen in all at the time of my visit. Each armature requires a specific number of convolutions for its successful working; and all calculations as to the length of the wire must be exact to within one one-thousandth of an inch. Too little wire will overheat, and too much will offer too great resistance. In this department the best of materials are used for insulation, consisting of the finer cotton goods, best of canvas, and paper containing the most fiber. Quantities of shellac are spread, as a varnish, on each successive layer of wire. This room also has various ovens for drying the armatures, which must be very thoroughly done. There are, likewise, crimping blocks to form the insulation for the different sizes of armatures. The machinery and tramways for the handling of the heavy parts render the otherwise hard work easy. The dimensions of the armatures vary from nine inches in diameter to twenty-six inches, and very much larger ones are now under contract.

The same care is taken in winding the field magnets as in winding the armatures. The cores are thoroughly insulated by paper and cotton cloth; after which they are swung between centers, and the wire is wound on in layers from a reel that has sufficient tension to make a true job. The crimping machines and drying ovens are here in requisition, as well as in the treatment of the armatures. Some of the machinery used in this room is ponderous, and all must be very exact, and handled with great precision.

The *storage batteries* are also manufactured in the cathedral building. A storage, or secondary, battery makes it possible to have a reservoir of electricity, from which a supply can be obtained when the dynamos are not running. Such a battery can also be located to suit the convenience and economical wishes of the consumer, without reference to the location of the generator.

The battery consists of a number of cells containing lead plates that are cast in a peculiar laminated form, to obtain as much surface as possible. These plates are coated with the peroxide of lead, and immersed in dilute sulphuric acid. The cells may be connected so as to get any desired result as to current or pressure. When the battery is in use, the theory is that, while being charged, the negative side parts with its oxygen, which combines with the positive side; and when the current is discharged this chemical process is reversed.

It is not denied that there is much loss both in charging and discharging; and it is clear that an overcharge would tend to destroy the plates. If carefully and skillfully handled, the storage batteries will do what is promised for them. A large number of them can be placed on one circuit, and charged by dynamos at a time when the latter are not required for running the arc lights. With each battery goes an automatic switch, so arranged that as soon as the former is fully charged it shall be disconnected from the circuit; and when the charge has been drawn down to a given point, the switch brings it into the circuit once more to be recharged. Each battery has a meter that registers the amount of electricity stored. The advantages of the storage batteries are apparent, especially for lighting steamers and railway trains. They are in successful operation on the trains of the Pennsylvania Railroad and elsewhere, but are hardly adapted as yet for general use, for the reason that they require such intelligent care.

The carbon building is of great size. Here the carbons are made from retort coke. One crusher reduces the coke to egg size, another to the size of buckwheat. It then runs through burr mills and bolting machines until the whole is reduced to an impalpable powder. It is next conveyed to mixing tanks, where it is mixed with adhesive material, after which it is tumbled in roller tumblers until it is ready to be moulded for use. The pressure on each mould is 300 tons. After being moulded, the carbons are "burned" in a reverberatory furnace a week or more, to expel all moisture. Having been assorted for straightness, and inspected and tested for their burning qualities, they are plated with copper and boxed for shipment. The company at this time is making 50,000 carbons a day.

The company employs four expert pattern makers, who are most of the time engaged on new schemes devised by Mr. Brush. A word is here in place as to Brush's electric motor. It is designed to distribute *power* as well as *light*, and under conditions practically the same. This will be a boon to hundreds of small factories, etc., where steam is now used at a disadvantage. The consumer is to turn on electrical power, whether for a sewing machine or a printing press, or for more ponderous machinery, by merely turning a switch, just as a key is turned for starting the electric light from the same arc circuit. In this manner, also, power is to be transported to a long distance from the dynamo by which it is generated.

The last building I visited was the "power building." Here are three boilers, of 150 horse power each, and furnishing steam for a large 24 by 48 inch engine. Here is a system of Worthington pumps, Berryman heaters, water tanks, etc. This engine, besides doing other work, drives two great dynamos, the current of which is utilized in the adjacent smelting furnaces of the Cowles Aluminum Company. The smaller one has 600 amperes, and about 50 volts of electromotive force. The larger one is the largest that has thus far been built by the Brush Electric Company. The armature of this great dynamo is 26 inches in diameter, and revolves 907 times a minute, producing a current of 1,575 amperes with an intensity of 46·7 volts. The entire dynamo is 8 feet long and 32 inches wide, weighs about 7,000 pounds, is rated at 125 horse power, and would furnish current for about 1,200 incandescence lamps of 16 c. p. each. Its powerful current is conducted to the furnace room and back by a circuit of thirteen copper wires, each 0·3 inch in diameter, which, as they approach the carbon electrodes, are twisted into a copper cable an inch and a half in diameter. An ampere meter is inserted into this circuit, through whose helix the entire current flows, and on whose dial is indicated the total strength of the current being used at any given moment. A large resistance box also forms part of the circuit, over which passes a heavy copper slide, by means of which the current is readily regulated, enabling the operator to choke off the main flow before breaking it at the switch, thus preventing any serious flashing at the dynamo. Mr. Cowles gave me some astonishing figures as to the practical efficiency of this dynamo in the reduction of refractory ores, and the economical value of the process. The intention is, at an early day, greatly to enlarge their works and remove them to another locality; and in order to accomplish their aims they have contracted with the Brush Electric Company for a new dynamo of immense size, which is now being constructed, and which will be the largest in the world. The machines made on this limited area of seven acres, in the suburbs of Cleveland, have illuminated nearly every city on this continent, and have even been lagely used in other lands than our own. Their brilliant arcs shine in Canada and China, South America and South Africa, Mexico and Madagascar, New Zealand and Australia, India, Egypt, and Japan, and in every kingdom of Europe, and, indeed, have lighted every prominent country of the world.

The officers of the Brush Electric Co. are: President, G. W. Stockly (who is also business manager); Vice-President, J. J. Tracy; Secretary, W. F. Swift; Treasurer, J. Potter; Superintendent, N. S. Possons, and Assistant Superintendent, W. J. Possons, besides a board of directors.

A RESIDENT of Minnesota, who has seen several severe tornadoes, says that their most peculiar feature is the singular sucking movement. Buildings are sucked up into the clouds entire, and come down soon in fragments. After the great Rochester tornado, a farmer twelve miles from town found an uninjured marble top table in his field. Another found a very large sheep that had come from no one knew where and had been deposited in his yard unhurt. The Minnesota man further said that he had seen a board into which wheat straws had been driven until they stuck through on the other side.

CENTRIFUGAL SPEED INDICATOR.

Journaled in a transverse partition and the bottom of the case in which all the parts of the indicator are contained is a shaft, the lower projecting end of which is provided with a pulley. This shaft is slotted to receive a pivoted lever, the arms of which upon opposite sides of the shaft are of equal length and are provided with weights. The journal of the shaft in the partition is made hollow, to receive a rod whose lower end is connected by a cord passing under a pulley hung in the slot with the arm of the lever. The upper end of the rod is attached to a slide moving along a guide rod secured in the casing parallel with the shaft. A cord attached to this slide is wound once around and secured to the drum on the spindle of the indicator. A cord from the free end of a flat spring secured to the partition is attached to the smaller part of a snail secured to the spindle, so that as the cord is wound upon the snail it is received on a continually increasing diameter. A spring, projecting from the partition at right angles to the main spring, bears against the side of the latter with sufficient friction to modify its movement and that of the lever, when the indicator is used for indicating low speeds; but the small spring, being of less length than the distance through which the other moves, the two do not touch during the latter part of the outward excursion of the main spring. Upon the

HERDEN'S CENTRIFUGAL SPEED INDICATOR.

outside of the casing is a dial, in front of which the pointer carried upon the end of the spindle moves. The indicator receives its motion through a belt passing from the machinery whose speed is to be indicated around the pulley. As the shaft revolves, the centrifugal action of the weights tends to bring the lever into position at right angles with the shaft. This action of the weights is opposed by the spring through the connections as described. When the speed is increased, the action of the weights tends to put the spring under greater tension, and by unwinding the cord on the drum and winding the cord on the snail, the spring secures a greater advantage over the weights. When low speeds are indicated, the tendency of the lever to vibrate under the light pull of the spring is opposed by the bearing of the small spring against the side of the other.

This invention has been patented by Mr. Henry Herden, of Wellsboro, Tioga Co., Pa.

What Work Is.

I was riding up town in a Third Avenue car the other day when a butcher's boy, a lad some 14 years of age, in a hickory shirt and with a battered Derby hat on the back of his head, stepped airily upon the back platform and hung his basket on the handle of the brake. He had sandy hair cut close to his head. He was very much freckled, his eyes were pale blue, but keen in their expression, and his nose was of the genus pug. He was smoking a cigarette. For some time he shared the privileges of the platform alone with the conductor, who began talking to the boy about the wrongs of the conductors and their right to strike.

"What are you givin' us?" said the boy; "yer call it hard work to stand out here on the platform and yank a bell? When you ain't doing that, you are inside taking fares, and knockin' 'em down, too. That ain't no work. Jest you begin at 4 o'clock in the morning, like me. Open the shop, sweep it out, clean ice-cold fish out of the refrigerator, and never get no chance to warm yourself; then lug big baskets of meat up to the top of flats all day long, and be cussed by the boss because you don't move round faster. That's work. You fellows have struck it soft, you have. You can't talk to me. I ain't no greenhorn." And he jumped off the car and went down the street whistling "The flowers that bloom in the spring."—*Phil. Record.*

Correspondence.

How to Prevent Anvil Noise.

To the Editor of the Scientific American:

I notice an item in your paper of April 17, on noiseless anvils. It is advised to set in lead or sand. I find by setting the anvil on a piece of plank say two feet square, and hanging that by the corners to the wall above with small ropes, you will get scarcely any noise and no jar, and the anvil is as solid as if placed upon a block. J. L. P.

Owego, N. Y., April 25, 1886.

A Home-made Ash Sifter.

To the Editor of the Scientific American:

I send you this bit of information for the women who, like myself, read the SCIENTIFIC AMERICAN.

To sift cinders, cover your sifter with an old apron or rag. Seize it thus covered, and shake without lifting the edge of the rag.

In case of wind, tread on the edges to keep them down. A few stones applied at the corners will do as well.

I have found the above device a thousand times more practical than any of those cumbersome and dear apparatus which are found in most hardware stores. J. A.

Washington, D. C., May 4, 1886.

A Texan Meteorite.

To the Editor of the Scientific American:

The article on the "New Mass of Meteoric Iron, from Independence County, Arkansas," which appeared some time ago in the SCIENTIFIC AMERICAN, was read with great interest by the officers stationed at this fort.

The appended postscript, requesting readers to communicate through your paper any knowledge they might possess of the existence of masses similar in nature to the one described, and also to report all meteorites that may fall in their vicinity, accompanying their information with specimens, prompted me to send to you a sample of a mass of meteoric iron which I secured while serving in Texas in 1882.

As to the history and manner of discovery of this rare specimen, I will here give it to you as briefly as possible.

On the morning of June 10, 1882, being stationed at Fort Duncan, Maverick County, Texas (a military post situated on the left bank of the Rio Grande), as I was returning to the garrison from a trip in the vicinity, I casually noticed a round bowlder that presented a very metallic appearance. I examined it closely, found it in truth to be a metallic body and a specimen worthy of careful preservation. It being on the land of a Mr. Wieste, I did not remove it at the time I discovered it, but later I persuaded Mr. Wieste to visit with me the place where the mass lay, and inquired if he knew anything concerning it, or of its nature. He stated that "he did not know what it was or where it came from, and if I wanted it, I was welcome to it." It was then that I, for the first time, attempted to lift it, and found it exceedingly heavy for its small bulk. Unlike the plan of the boys who "rigged up a drag of poles and bark" for the removal of the Arkansas 94 pound meteorite, as stated by Mr. Hindman, I had one of the privates (Mr. Brand) of our company carry the mass to our camp. After his task, which was a very tiresome one, was completed, he remarked that "he would not care to carry about with him many such specimens of Texas rocks." I early arrived at the conclusion that the mass was meteoric iron, as it possessed all the characteristics of such bodies.

The photograph which I send to you shows a broad view of the meteorite, and also its resemblance—as expressed here at the camp—to the "shape of a ham."

I have found it to weigh ninety-seven and one-quarter pounds, and to be twelve inches long, ten wide, and six inches thick. Its specific gravity is equal to that of wrought iron, *i. e.*, 7·522. Small pieces cut with a chisel from a pointed and much abraded part of the mass were malleable to a high degree, whether heated or cold.

Like all meteoric irons, this mass is also isometric in crystallization, which is proved by etching a smoothed surface.

Its color when polished is unusually white, more like that of quicksilver; much whiter than is common to meteoric iron.

Owing to the presence of a small percentage of nickel, it has thus far resisted all corrosion or oxidation. A surface of five inches length, which I polished nearly four years ago, remains at this time very free from rust.

The outer surface has the commonly observed black coating, or crust, always found on meteorites.

C. C. CUSICK, U. S. A.

Fort Lyon, Bent County, Colorado.

[We duly received the specimen. It is a very interesting example of meteoric iron.—ED.]