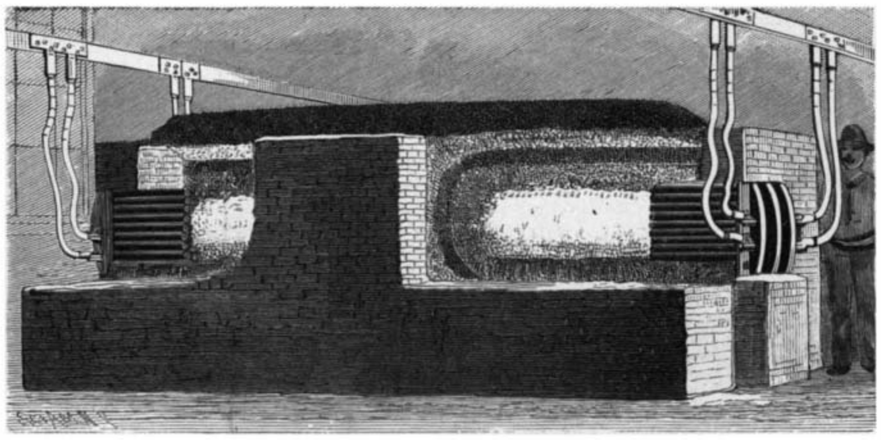
MANUFACTURE OF CARBORUNDUM AT NIAGARA FALLS.

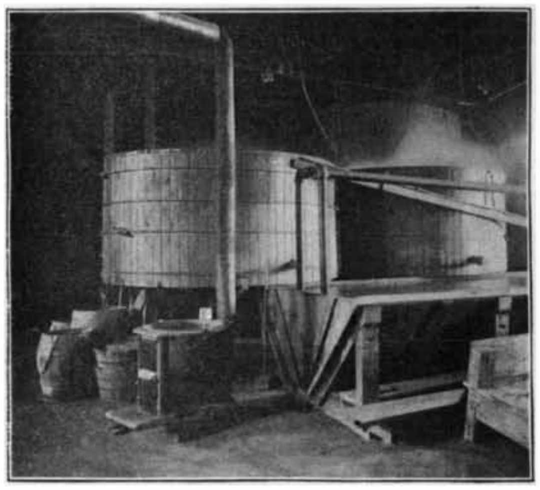
The method of making carborundum was discovered after careful research and a long series of experiments, in which the inventor, E. G. Acheson, found that carbon and silicon could be made to combine to form the remarkable abradant which during the last ten years has entered so largely into the industrial arts. The earliest experiments consisted in forming a mixture of carbon and clay and subjecting it to a high temperature produced by the electric current. An examination of the mass after it had cooled disclosed some minute crystals of a dark blue color, and of extreme hardness, and in a test of these particles it was found that their abrading action was very marked. Early in the investigation it was found that the silicon of the clay was the important factor in the formation of the crystals, and subsequent investigations led to the development of the process of manufacture which forms the subject of the present article.

As to the efficiency of carborundum compared with other abradants, it has been difficult to carry out exhaustive comparative tests; but it is stated by the manufacturers that it possesses eight times the efficiency of emery, weight for weight. That is to say, that one pound of carborundum will polish eight times as much surface as the same weight of emery, and will do it in about half the time. The diamond is the only material which exceeds it in hardness. Its specific gravity is 3·12.

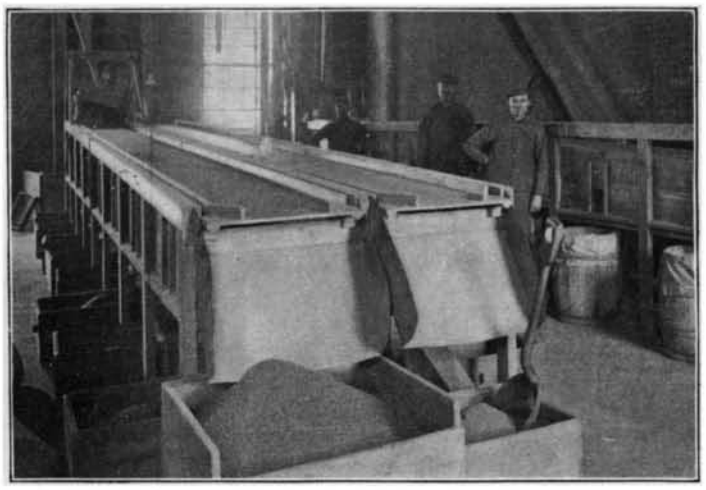


Part Sectional View of Carborundum Furnace.

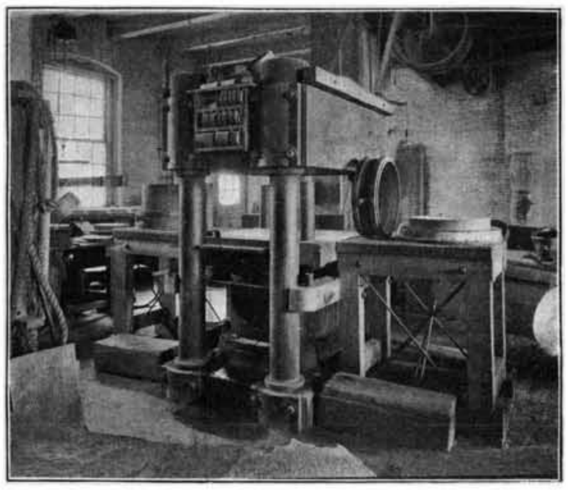
It is not fusible at the highest attainable heat, and it is insoluble in any of the ordinary solvents. It is composed of carbon and silicon in equal atomic proportions, and by weight thirty parts carbon to seventy parts silicon. Pure carbon is white in color, although in the commercial manufacture the crystals are produced in many shades and colors, the prevailing colors being green, black, and blue. Crude carborundum, as taken from the electric furnace, usually consists of large masses or aggregations of crystals. Grain carborundum is pro-



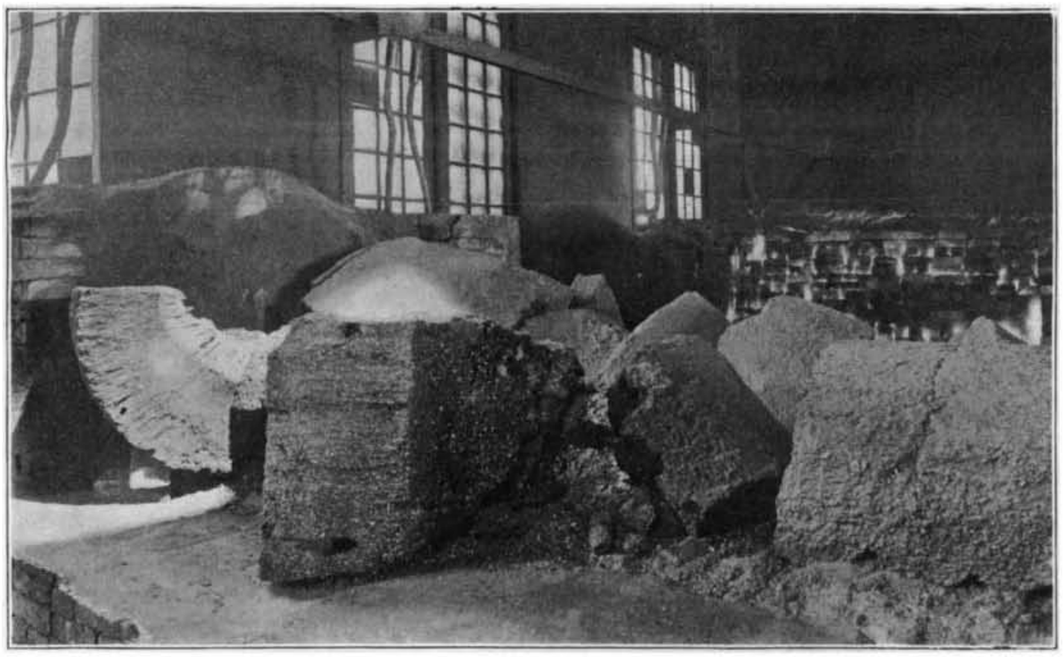
Sulphuric Acid and Settling Tanks.



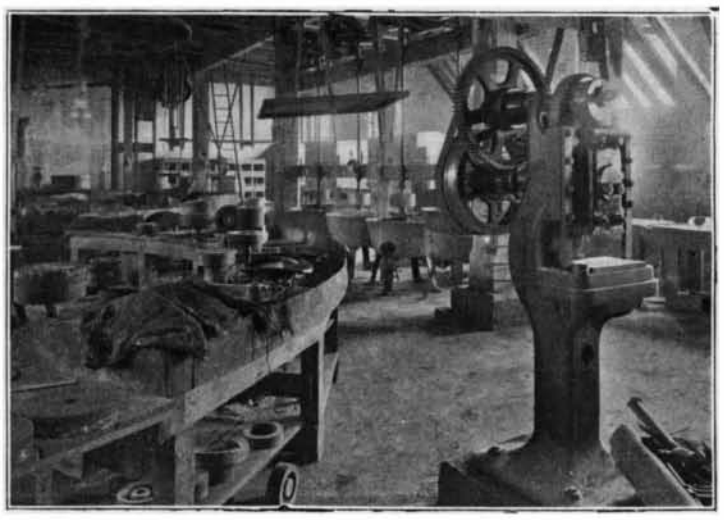
Shaking Screens on Which the Carborundum is Graded.



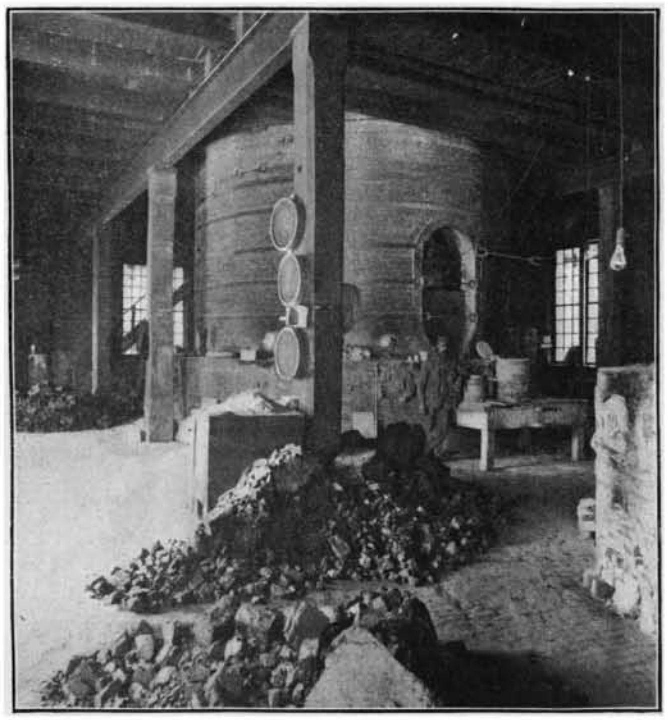
1,500-Ton Hydraulic Press for Forming the Large Wheels.



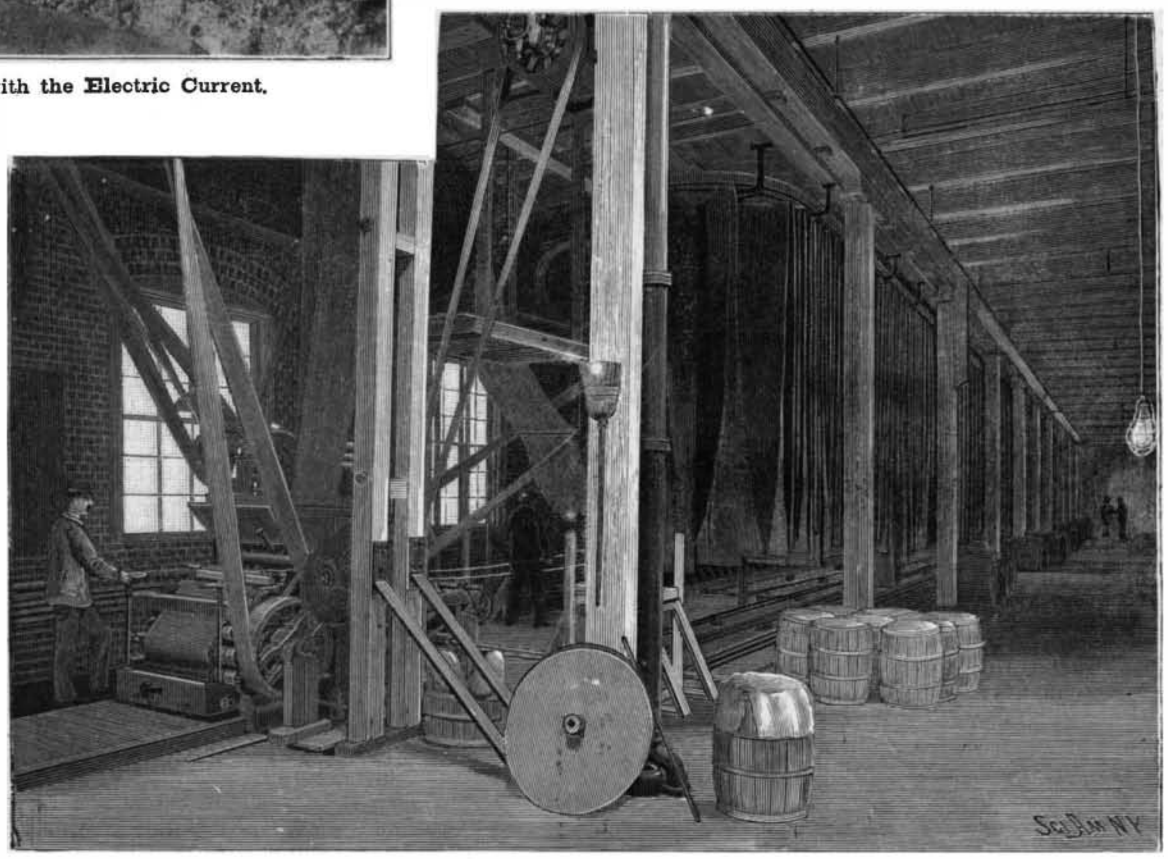
Contents of Furnace Broken up after Treatment with the Electric Current.



Mixing Ground Crystals with Bond and Moulding the Wheels.



Kiln in Which the Wheels are Baked.



Making Carborundum Paper.

MANUFACTURE OF CARBORUNDUM.

duced by crushing and grinding crude carborundum, treating it with acid, and separating it by sieves into grains of various sizes.

The crude materials for the manufacture of carborundum are sand, coke and sawdust. Part of the coke is reduced to kernels of a certain size to be used as the "core" of the electric furnace, while part of it is ground to a fine powder to be used in making the mixture or charge of the furnace. The mixture is made up of 60 per cent of gritty pure sand containing 99 per cent of silica, to 40 per cent of coke. A certain amount of coarse salt is added, and sawdust in sufficient quantity to make the mixture porous as soon as the sawdust shall have burnt out in the operation of the furnace. The furnaces are built of loose brick in the form of an oblong box, measuring 22 feet by 7 feet by 5½ feet. The ends, as shown in the engraving, are built up very solidly with a thickness of about 2 feet, while in the center of each end is a terminal which is built up of twenty-five carbons, measuring 4 inches square in section and 30 inches in length. The outer ends of the carbons are inclosed in a square iron frame, to which is screwed a plate bored with holes, through which are passed short lengths of ⅜-inch copper rods, one of which fits tightly in holes drilled in the ends of the carbon. Each end plate is provided with four laterally projecting copper bars ⅝ of an inch thick by 4 inches wide, to which the cables conveying the current are bolted. The side walls of the furnace are first built up to a height of about 4 feet, and it is then filled with the mixture of coke, sand, salt and sawdust until it is rather more than half full. A semicircular trench with a radius of 10½ inches, reaching from end to end of the furnace, is now hollowed out in the mixture, and in this trench is placed a core of the grains of coke, which measure, by the way, from ¼ to ⅜ of an inch in diameter, the bottom of the core being a little above the level of the bottom row of carbons. A new core requires about 1,100 pounds of coke, and after this amount has been placed in the trench, the top is rounded off so as to give the core a cylindrical shape. When it is finished we have extending from terminal to terminal, through the center of the furnace, a cylinder of coke 21 inches in diameter and 14 feet long. The brick walls are then carried up to their full height of about 5 feet, and the mixture is packed in around the core and heaped up to a height of about 8 feet above the floor of the furnace room.

From this point on the work of turning the mixture into carborundum is performed entirely by the electric current, which is supplied from the Niagara Falls Power Company, and has a pressure of 2,200 volts. This, of course, is too high for the purpose, and the current is first transformed at the carborundum works by a transformer of about 1,100 horse power which brings the current down from 2,200 to 185 volts. By means of a regulator it is possible to vary the pressure of the current as thus transformed between 250 and 100 volts. Current is conveyed to the furnace by two copper conductors having a sectional area of 8 square inches each, while heavy cables connect the main conductors with the plates on the terminals of the furnace. This arrangement is clearly shown in one of the accompanying engravings. For the first half hour no apparent change occurs in the furnace; but when the current has been on for three or four hours, the side walls and top of the furnace are enveloped by burning carbon monoxide gas. At the end of four or five hours the top of the furnace subsides, and fissures form, from which pour out the yellow vapors of sodium. At the end of thirty-six hours the current is cut off and the furnace, whose temperature is supposed to be between 6,000 degrees and 7,000 degrees, is allowed to cool. The side walls are taken down, and the outer mixture, which has not been changed by the fierce heat, is raked off, until the outer crust of amorphous carborundum is reached. This is broken away, exposing an inner crust of amorphous carborundum; and after this has been taken off, the crystalline carborundum is exposed.

The cross section of a carborundum furnace now presents a remarkable appearance. In the center is the core of coke, which has lost its crystalline appearance and is now a pure carbon, the impurities having been all driven off by the fierce heat engendered in the furnace. Around the core is a cylindrical shell 10 or 12 inches in thickness composed of beautifully colored carborundum crystals, the yield from a single furnace being about 4,000 pounds. Outside of this is a comparatively thin shell, 3 inches in thickness, which constitutes the inner crust of amorphous carborundum, and beyond this is an outer crust of amorphous carborundum, which latter ends abruptly in the unchanged mixture. The unit consists of several furnaces, but only one furnace is operated at a time, taking the whole 1,000 horse power of electric current for thirty-six hours.

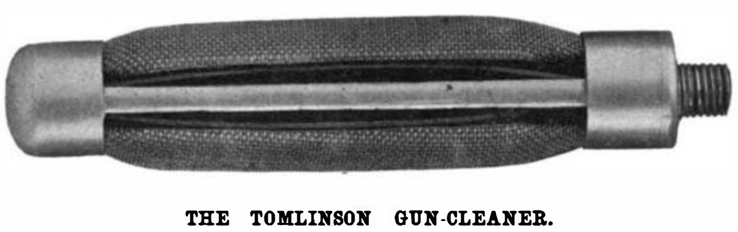
The carborundum crystals are next taken to the crushing mills, after which the material is put into large lead-lined tanks, and treated for three days with diluted sulphuric acid to remove impurities. From the circular tanks it passes to a long trough where it is washed with water to remove the finely powdered carborundum, which is carried by the water down through the settling tanks. Here the fine powders are collected, and from these are made the so-called "flowers" and the hand-washed powders. After the water has been drained off from the sulphuric acid tanks above mentioned, the crystals are shoveled out, dried, and graded on the long, inclined, shaking screens, which are shown in one of our illustrations. There are twenty grades of crystals from No. 8 to No. 220, the numbers indicating the meshes to the linear inch of the screen through which the crystals have passed.

In the greater part of the carborundum goods put on the market the vitrified bond is used. The carborundum is mixed with a certain proportion of kaolin and feldspar, and the mixture is then placed in moulds and subjected to hydraulic pressure. The moulded wheels, disks, stones, etc., are taken from the press and placed on supports known as "bats," which are made of baked clay. The bats are placed in clay "saggars," which are built up in columns within the kiln until they reach its roof. Here they are baked for about six days, during which time the feldspar fuses and serves to bind the carborundum into a solid mass. When wheels are removed from the kiln they are too rough for service, and they have to be placed in lathes, trued up with rotating, chilled-steel disks, and the central hole bushed to the proper size.

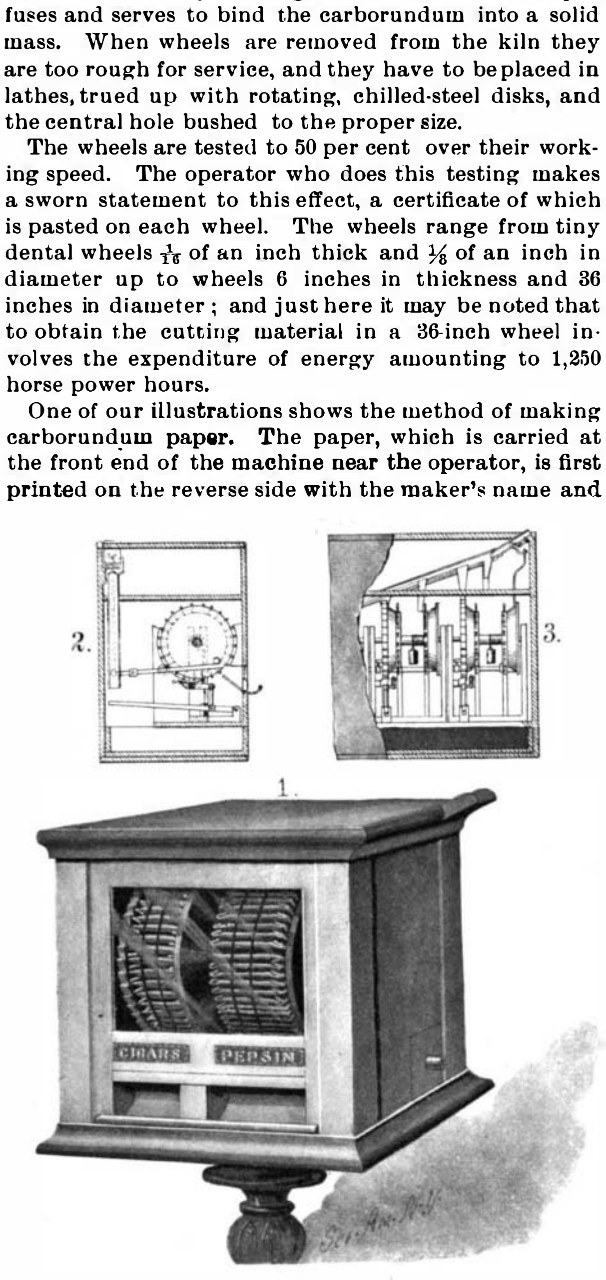
The wheels are tested to 50 per cent over their working speed. The operator who does this testing makes a sworn statement to this effect, a certificate of which is pasted on each wheel. The wheels range from tiny dental wheels 1/16 of an inch thick and ⅙ of an inch in diameter up to wheels 6 inches in thickness and 36 inches in diameter; and just here it may be noted that to obtain the cutting material in a 36-inch wheel involves the expenditure of energy amounting to 1,250 horse power hours.

One of our illustrations shows the method of making carborundum paper. The paper, which is carried at the front end of the machine near the operator, is first printed on the reverse side with the maker's name and other data. From the printing roll it passes to a bath of liquid glue, and then beneath a V-shaped hopper, from the bottom of which a fine stream of powdered carborundum falls upon the glued surface. It is then looped up onto a series of racks where it is hung to dry. When the drying is complete, it is wound into rolls or cut up into sheets ready for the market.

The uses of carborundum are as numerous as the industries which call for the use of powerful abradants. Watchmakers have found that it may be used in place of diamond, as it performs equally good work at less cost. Mounted on cloth or paper it is used in finishing the soles of shoes. It is used in the plate glass industry and in the manufacture of pottery and porcelain, while in the heavier work of roll and car-wheel grinding it has proved that the greater cost of the material as compared with emery is more than offset by its superior abrading qualities.



THE TOMLINSON GUN-CLEANER.



A VENDING-MACHINE OF NOVEL CONSTRUCTION.

EFFICIENT SHOT-GUN CLEANER.

The accompanying illustration represents a simple and effective shot-gun cleaner made by the G. T. Tomlinson Company, Syracuse, N. Y.

The Tomlinson cleaner is composed essentially of a nickeled-brass frame carrying two nickeled-brass caps, one of which is soldered rigidly in place, and the other of which screws on a threaded stud. Between the caps, pads are held, which are pressed outwardly by flat springs. The pads are composed of wood covered with brass-wire gauze. So soft is the brass wire that the finest polish cannot be injured. The cleaner can be applied to any standard rod. It is so designed as to fit the entire length of the shot-gun barrel, notwithstanding the various chokes adopted by different makers. The cleaner will, therefore, remove all lead, rust, and foreign matter from breech to muzzle.

The bearing surface on the inside of the barrel is four square inches. Old pads can be readily renewed by unscrewing the end cap, removing the worn pads, inserting new ones, and replacing the cap.

THE English Patent Office has just issued its report for 1899, and it appears that there has been a falling off during the past twelve months, as there is a diminution of about 1,000 in the number of the year's complete specifications. The outbreak of the war occasioned the invention of several shields and cuirasses for soldiers; the abnormal heat during the summer resulted in many applications for patents for headgear for horses; and the passing of the "Shop Assistants' Seats Act," by which every employer must provide his assistants with seats during their work, resulted in the granting of patents for over fifty various kinds of seats. The largest number of applications in one day was 127, and the smallest 50. Women were responsible for 574 specifications, 149 of which were in connection with articles of dress, and 42 related to cycling. The general diminution is attributed to the great decline of invention in connection with the cycling industry.

IMPROVED VENDING-MACHINE.

Letters patent have been granted to James E. Martin, of Braddock, N. D., for an invention which provides a coin-controlled machine for dispensing cigars and other articles. The machine is so constructed that articles of various prices can be sold, the coins of different value finding their way to compartments especially designed to receive them.

The cigars and other articles to be sold are carried on revolving drums comprising each an inner circular section provided with pins, an intermediate conical section, and an outer circular section provided with teeth. The drums are driven by weights. A trip-lever, as shown in Fig. 2, extends below the coin-conductor of each drum compartment, beneath the toothed portion of the drum, and actuates a pawl which controls the movement of the drum. In order that the cigars may not drop out of the drum, a guard is provided which partially surrounds the drum.

The coins which drop on the trip-levers are conducted by a chute of novel construction. The chute is provided with a series of openings of varying size to receive coins of different denominations (Fig. 3). The upper openings receive the smaller coins and the lower openings those of larger size. Conductors extend downwardly from these openings to the several trip-levers which actuate the various drums. Before each opening a somewhat smaller orifice is located, which is designed to receive a coin of smaller size, so that the mechanism cannot be fraudulently actuated.

When a drum has been emptied, a pin on the toothed face engages a lever (Fig. 2), which, through the medium of a rearwardly-extending arm, actuates a rod provided at its upper end with a fork which operates a non-magnetic retarding device in the coin-chute. The retarding device is hooked, to engage washers which may be inserted in the chute. A magnet is likewise provided, which will retain the iron disks and plugged coins that pass the retarding device. When a coin slides down the chute, it completes an electric circuit, which rings a bell, but the time of its travel is so short that the circuit is completed for an instant only.

A good coin dropped in the chute finds its proper opening, falls upon the proper trip-lever, releases the pawl and causes the corresponding drums to be driven by the weight. When one-half of the drum is empty, the other half will rotate the shaft by gravity, rendering the weight for the time being unnecessary. The drum is allowed to turn by the pawl only for a certain interval. The cigars are discharged on the usual tray. When a drum is entirely empty, the pin on the outer, toothed face engages its lever, so as to operate the retarding device, complete the electric circuit and ring a bell. Washers, pieces of metal and steel disks which cannot pass down the chute likewise complete the circuit and sound the alarm. Perhaps the most attractive feature of the invention is the precaution which has been taken to prevent the operation of the mechanism by none but good coins.