the previous operation, and the upper horizontal conveyor carries it to the furnace. In this manner it will be seen that the coal is taken, by an entirely automatic process, from the cars to the retorts, or to the magazine, or from the latter to the retorts.

In order to feed the retorts, a coal reservoir is placed above and back of the furnaces, to which the coal comes from the conveyor. The reservoir feeds a number of carriers which roll upon a suspended track for charging the retorts; the carriers are filled by a system of traps at the bottom of the main reservoir, operated by levers. The retorts are arranged in three horizontal rows, and there is one carrier to feed each row; when a carrier has received its contents, it is drawn in front of the retort-mouth and the coal discharged into it by working a hand lever; in this way only one workman is needed to load a battery of forty-five retorts.

Two of the retorts in the model have been made of glass, in order to show the coal in the interior. The retorts are inclined toward the front, the gas being taken from the lower end; the arrangement is known as the Coze system. This inclined arrangement allows the automatic filling and discharging of the retorts to be easily carried out. The arrangement of the furnace is such that the retorts are accessible and may be cleaned without difficulty; besides, the makers claim a complete utilization of the heat produced in the furnace and a great economy of combustible. A very high temperature is obtained in the interior of the furnace by mixing carbon monoxide with the heated air before it is sent into the furnace.

The transportation of the gas-carbon or coke from the retorts is also well provided for. After opening the upper and lower heads of the retorts, the incandescent coke falls into an automatic extinguisher and transporter called Brouwer's chain, placed in front of the furnace. This arrangement will be observed in the front view. The conveying chain moves along in front in a water-canal, and the coke, automatically extinguished, is carried to a conveyor which passes back to the coke-crusher; after being broken in the crusher the coke is raised by an elevator to a shaking-sieve, which distributes it in a series of large reservoirs placed above and back of the furnaces; the reservoirs have a trap below by which the coke is dropped into the cars; if desired, however, the elevator may take it to a horizontal conveyor which runs back to the coke-bins in the rear, and which have about the same size and arrangement as the coal-bins above mentioned; like the latter, they have a car running above them on rails, which receives the coke from the conveyor and discharges it into the bins. From these magazines the coke may be again taken to the loading-reservoir by an arrangement below similar to that used for the coal; it is discharged from the funnels into a wagon which takes it to an elevator, and it is thus lifted to the reservoir. It will be seen that the coke may be thus automatically carried from the furnace to the cars or to the magazine, or from the latter to the cars. For the motive power of the plant any of the well-known types of motors may be used; the model is driven by a small electric motor, and all the conveyors, wagons, etc., are shown in operation.

THE RECONSTRUCTION OF THE KINZUA VIADUCT.

The Kinzua viaduct on the line of the Erie Railroad has long been one of the "show" features of that picturesque route. This bridge serves to carry the railroad across a deep and comparatively narrow valley, which lies high up in the Alleghanies in the State of Pennsylvania, the floor of the bridge being approximately 2,000 feet above the level of the sea. The Kinzua viaduct is claimed to be the fourth highest bridge in the world, the loftiest being the Garabit viaduct over the Truyère, in Southern France, on which the rail level is 401 feet above the river. The new viaduct is 301 feet 6 inches above the normal level of Kinzua Creek, the measurement being taken to the base of the rails. The total length of the viaduct over all is 2,100 feet.

The new structure takes the place of an iron bridge which was erected in 1882 by Clarke, Reeves & Company, now the Phœnix Bridge Company. The old bridge was erected upon skeleton towers, and the superstructure consisted of trusses which were 38 feet 6 inches long over the towers, and 60 feet in length between the towers. The foundations consisted of masonry piers, which in every case were carried down to solid rock foundation. In the old structure were 2,500 tons of iron. Each tower consisted of two bents, the columns of which were given a batter transversely of the bridge of 1 to 6, the columns consisting of sectional, riveted, circular sections, with external longitudinal flanges, a type which has been largely used, particularly in early years, by the Phœnix Bridge Company. The towers were stiffened by means of horizontal, latticed struts, with diagonal tie-rods, and in this respect conformed to the standard practice of that day. The superstructure trusses were riveted, lattice, plate iron structures, built of plates and angle iron.

The reconstruction of the viaduct is due, not to any defects or decay in the old structure, but to the great increase which has taken place of late years in the weight of engines and rolling stock. The greater strength of the new viaduct results from the greater weight of the material used, 3,500 tons as against 2,500, from the improved materials of construction (mild steel taking the place of iron), and from the more scientific distribution of the material. The only portion of the old structure that remains is the foundations, which proved sufficient to carry the greater load imposed by the new bridge.

The principal dimensions of the old and new bridges are practically identical. The viaduct is carried upon twenty towers, each tower consisting of a pair of two-column bents. Each column consists of two built-up channel beams, the webs of which are $\frac{7}{16}$ of an inch thick and 2 feet and ½ inch in width. The channel beams are spaced 3 feet apart, and they are connected by stout latticework of steel plates and angles. Each bent is stiffened laterally by means of deep latticed struts, and the columns are further stiffened at the point of their connection to the struts by means of massive, plate-steel knee-braces, one of which is shown in the accompanying view of one of the footings of the towers. The towers are braced longitudinally by means of latticed struts and ties. All the connections are riveted, an arrangement which, as compared with the pin-and-link connection of the old structure, insures much greater rigidity. The transverse batter of 1 to 6 gives to the towers at the center of the bridge, where it is loftiest, a maximum spread of 102 feet 10¾ inches, measured from center to center at the piers. The superstructure consists of two lines of plate-girder spans, which are spaced 9 feet apart between the centers. The bents in the towers are spaced 38 feet 6 inches apart, and the spans between the twenty towers are 60 feet in length. Provision is made for expansion due to changes of temperature by interposing between one column of each bent and the foundations expansion rollers, there being a nest of these rollers, which are 3 inches in diameter and 43 inches long beneath each bent.

From a popular point of view, the most interesting feature in connection with the reconstruction of the bridge is the method adopted in removing the old bridge and building up the new structure in its place. For this purpose two "travelers," each consisting of a complete Howe truss timber bridge, 180 feet in length, were constructed and run out over the old bridge. They were built long enough to reach over three towers, say from tower one to tower three. The method of operating them was as follows: The traveler was run out over the particular tower which was to be removed, and the three spans, that is, those between the three towers and over the tower itself, were removed, and then the material of the tower was cut loose, section by section, drawn up by hoisting cables to the traveler, and run out on to the permanent structure and removed to either shore. After the old tower had been taken away, the material for the new tower was run out over the bridge to the traveler, lowered into place and riveted up. The two travelers worked from opposite ends of the bridge, and finally met in the center, as shown in one of our illustrations. The new bridge has been constructed by the Elmira Bridge Company, from plans made by Chief Engineer Buckholz, of the Erie Railroad Company. Traffic over the bridge was suspended on May 14 last. The work of reconstruction commenced May 20, and this important work has been successfully carried out in the interim by a force of from 140 to 150 men employed by the contractors, Messrs. Grattan & Jennings, of Buffalo.

Compounds of Osmium.

In a communication recently made to the Académie des Sciences, M. L. Wintrebert describes a series of experiments in which he has produced several new compounds of the metal osmium. The metal here plays the part of an acid, in combination with oxalic acid forming a series of salts, which the experimenter calls osmyloxalates; he has succeeded in producing several of these salts. The first experiment in this direction was made last year by M. Vèzes, who found that by adding an excess of oxalic acid to a potassic solution of peroxide of osmium, OsO_4, fine needle-like crystals were obtained, of a brown color, acting strongly upon polarized light. M. Wintrebert, in taking up the experiment, formed the same salt in a different manner, using the osmiate of potassium, K_2OsO_4, as a starting point. Oxalic acid is added to an alkaline and concentrated solution of the osmiate until an acid reaction is obtained and the liquid is slowly heated; it passes from a dark red to a light yellow-brown, and after cooling deposits the brown needle-like crystals previously mentioned. The conditions of the experiment indicated that the osmium is at the same degree of oxidation as in the osmiate, which is derived from the trioxide, Os_2O_3; this was confirmed by direct analysis of the compound, which gave the formula $OsO_2(C_2O_4)_2K_2,2H_2O$, it being thus an osmyloxalate of potassium hydrate.

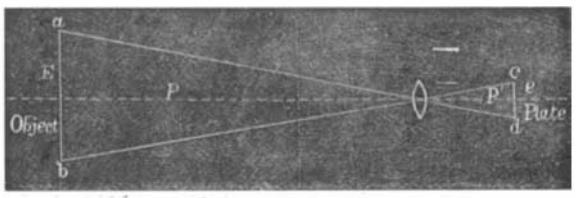
It is evident that the potassium may be replaced by other metals, and a series of salts obtained; two of these salts have been prepared, those of sodium and of mercury. The osmyloxalate of sodium is prepared by heating to the boiling point a solution of peroxide of osmium in caustic soda and adding an excess of crystallized oxalic acid, so that after this is dissolved the solution is quite acid. The boiling solution changes after a time from a dark red-brown to a light yellow-brown; it is then concentrated by evaporation. It deposits first the bin-oxalate of sodium, then the osmyloxalate appears in the form of brown crystals, which are much more soluble cold than those of the potassium salt. These two alkaline salts are but little stable in the presence of water; their solution soon becomes turbid, and a black precipitate of osmic acid is formed; this decomposition may be prevented by adding a small quantity of oxalic acid or alkaline oxalate to the solution. To prepare the silver salt, one of these solutions is poured into a solution of nitrate of silver; the brown liquid changes color, passing to a greenish brown, and deposits small greenish-brown crystals, which appear yellow by transparence, and act upon polarized light. The silver salt is rather unstable; the liquid in which it is formed often becomes turbid, and deposits osmic acid and oxalate of silver. In the crystalline state the salt undergoes a slow decomposition.

PHOTOGRAPHIC METHOD OF DETERMINING SPEED OF AUTOMOBILES.

Owing to the number of arrests which have been recently made in Paris for the fast driving of automobiles, attention has been called to a method which will determine the speed exactly, and not leave this to the judgment of the police officer. Several photographic methods have been proposed, but the only method which is entirely automatic is that proposed by M. Delamarre. The determination of the speed of a moving object depends upon the measure of the space passed over in one second; if V is this speed and E the space passed in T seconds,

$$V = \frac{E}{T}$$

Suppose an apparatus provided with a shutter and an arrangement for obtaining upon the same plate two successive images at the interval of one second, the displacement of the image would permit of measuring the space passed over.



The fundamental formula for lenses would then give, according to the diagram,

$$\frac{E}{e} = \frac{P}{p} = \frac{p-f}{f}$$

where f is the focal length of the lens used; whence

$$E = e\frac{p-f}{f}$$

If E is known, the value of V will be at once obtained. The problem then consists in measuring E. M. Delamarre has already shown that if in operating from the same position two lenses of different focus are used, f and f_1, giving for the measure of E the values e and e_1, then

$$E = (f-f_1)\frac{e\,e_1}{e_1 f = e f_1}$$

This formula being independent of the distance at which the operation is made. It suffices then to construct a hand apparatus of the detective form with coupled shutters, whose two lenses will have different focal lengths. The operator will then make the exposure, and the plate when developed will be measured and the above formula applied, thus indicating at once the speed of the vehicle in question. An apparatus of this kind would fulfill the conditions required; it is necessary, however, before reducing the idea to practice, to overcome a number of difficulties, and the originator of the device is at present working in this direction. The difficulties, which are inherent in any apparatus of the kind, are that it is necessary to operate upon a portion of the path of the automobile which is perpendicular to the axis of the lens, and besides a lens with fixed focus must be used. It is, however, quite possible to construct an instrument of this kind of an entirely practical nature.

Sneeze-Wood.

Among its many peculiarities, South Africa includes the "sneeze-wood" tree, which takes its name from the fact that one cannot cut it with a saw without sneezing, as the fine dust has exactly the effect of snuff. Even in planing the wood it will sometimes cause sneezing. No insect, worm, or barnacle will touch it. It is very bitter to the taste, and its specific gravity is heavier than water. The color is light-brown, the grain very close and hard. It is a nice-looking wood, and takes a good polish. For dock work, piers, or jetties it is a useful timber, lasting a long while under water.—The Building News.

Science Notes.

According to The Medical Record, a young woman in a town near Philadelphia was recently burned about the head from the combustion of a celluloid comb worn in her hair. Burning joss sticks were stuck in the hair for the purpose of keeping away mosquitoes, and this resulted in the combustion of the comb.

German agriculturists have expressed a desire to have established a meteorological signal service, and the government is inclined to comply. A meeting of the government officials and meteorological and agricultural authorities is soon to take place at Hamburg to discuss the introduction of a telegraphic service for German agriculture.

Prices of fine woods have recently advanced from 15 per cent to 35 per cent. This is caused by an increased demand for veneers for making furniture, piano cases, musical instruments, etc. The new method of decorating walls with veneers instead of tapestry or wall paper and leather has also resulted in a great increase in the demand for fancy woods.

An attempt will soon be made by Californian merchants to put fresh asparagus on the market in London and other places in Great Britain. The California navel oranges are growing in favor in England and are being much appreciated. It is expected that California asparagus will compete with French asparagus, which is sent to England in large quantities. Great Britain is now importing considerable quantities of prunes from California.

Detailed study of the different vowels and consonants and the corresponding currents and counter-currents of air has induced M. Gellé to conclude that the intra-buccal column of air is not inert, and that the buccal cavity does not act as a resonator, as it is usually said to do. It is the air itself, by its alternate condensations and dilatations, which result from the action between the currents, and produce the sub-vowels along with the laryngeal sound.

The Remington Standard typewriter has received a Grand Prix at the Paris Exposition, which is the highest form of award, outranking all medals. The same machine received a gold medal in 1878 and also one in 1889, so this is the third time that they have taken the highest possible form of award at a Paris Exposition. The Bristol Company, of Waterbury, Conn., manufacturers of recording instruments, steel belt lacing, etc., received a silver medal at the Paris Exposition for their recording instruments.

Permits are not now required by the Department of Agriculture for the importation of certain animals. This includes: Mammals—Anteaters, armadillos, bears, chimpanzees, elephants, hippopotamuses, hyenas, jaguars, kangaroos, leopards, lions, lynxes, manatees, monkeys, ocelots, orang-utans, panthers, raccoons, rhinoceroses, sea-lions, seals, sloths, tapirs, tigers or wildcats. Birds—Swans, wild doves, or wild pigeons of any kind. Reptiles—Alligators, lizards, snakes, tortoises, or other reptiles. Canaries, parrots, and domesticated birds, including pigeons, are subject to entry without permits, but with the exception of these species, and those mentioned above, special permits will be required for all live animals and birds imported from abroad.

F. Larroque has recently made some interesting observations of the mechanism of hearing. He studies the action upon the ear of sounds produced by the bowing of a string stretched by a vessel containing water which slowly flows away and thus releases the tension very gradually. He finds that when the sound is conveyed to the two ears through hearing-tubes, two distinct impressions are created, and there is no interference whatever by the phase of the two sound-waves. This shows that the auditory apparatus of any one ear acts independently of the other. The author discovered a peculiar break of continuity in his right ear, amounting to $\frac{2}{15}$ of a semitone between mi_3 and fa_3. He thinks that some of the Corti fibers have been accidentally broken, and looks forward to future microscopic verification of his supposition.

On September 22 last Mr. Zekeley, of Berlin, in company with Dr. Berson, of the Royal Berlin Meteorological Institute at Berlin, Mr. Alexander, of London, Dr. Süring, of the Meteorological Institute at Potsdam, made au ascent in a balloon from the Friedenau Sport Park near Berlin. Their object was to ascertain exactly how long a balloon can remain in the air. The balloon had a capacity of 90,000 cubic feet of gas, and it was inflated under the direction of two officers of the German army assisted by soldiers of the military ballooning section. The balloon rose rapidly, and in about ten minutes had completely disappeared from sight. It was expected that the balloon would remain in the air for several days, and with this end in view the voyagers had observed the precaution of carrying sufficient provisions for several weeks, while they were also supplied with maps in case they landed on some inhospitable island in the north of Europe. Unfortunately, however, the balloon, owing to the lack of wind, descended a few hours after the ascent, having traveled only a few miles.

Engineering Notes.

It has been suggested that calcium carbide be used as a deoxidant in foundry practice, the reagent being added to the metal before pouring. It is stated that aluminium bronze can be produced by highly heating a mixture of alumina and copper chloride in contact with the calcium carbide.

The steamer "Paris," which went aground last year, is being rebuilt at Belfast, and will be known as the "Philadelphia." The vessel is receiving an entirely new bottom, and new boilers and engines will be put in. She will have two funnels instead of three, but will otherwise preserve her former appearance.

At the Paris Exposition there is on view a large diving bell, 138 feet in length, 46 feet in width, with a working space height of 8 feet. It is being utilized in connection with the new dry docks at Kiel for the German navy. The fittings of this diving bell comprise a suspension frame supported by two barges, two air chambers for the workmen, one of which is set apart for the concreting, and two fitted with electric lifts for the supply of materials to the workmen. Two large electric cranes serve for the bulk transportation of the materials; while the concrete is prepared by two electric mixers with a capacity of 523 cubic yards per hour. It is expected that the docks will be completed by 1903.

During the early stages of the Boer war, the English War Office was bitterly censured for its backwardness regarding arming the troops, and also in connection with the mounting of the coast defenses with obsolete muzzle-loading guns. The Defense Committee of the Cabinet have recently placed orders to the extent of $29,035,000 for modern guns for coast defenses, thus bringing up the expenditure during the last few months for this purpose alone to $35,000,000. The arsenals at Woolwich and at several other armament factories are working at full capacity for the delivery of government orders. When the war is concluded, there is no doubt that the whole artillery of the British army will be carefully overhauled, and the most powerful guns substituted in the place of those which have become obsolete.

The French government has just mounted a huge Creusot gun at Calais as a set-off to the enormous harbor works that are in progress for the British Admiralty at Dover. It is said that the new gun has a range of twenty miles; and as the Straits of Dover at this point are only eighteen miles in width, the gun will, if it proves satisfactory, be able to drop its projectiles upon British soil. The English government have mounted some exceptionally powerful ordnance at Dover within the last month or two. Several guns that have been placed upon the forts there have a range varying from fifteen miles to eighteen miles, so that Dover practically sweeps the Channel at this point. Great activity is at present being displayed all along the south coast. New, heavier, and modern ordnance is rapidly supplanting the obsolete muzzle-loading weapons, while several new batteries are being constructed.

Lieut.-Colonel Leuchen, of the Swedish army, and director of the shooting school at Rosenberg in Sweden, has invented a new rifle. Its most distinguishing feature is the automatic placing of the cartridge in the firing chamber. The small arm is similar in every respect to the Mauser and carries the same cartridge. The soldier when using the rifle fills the magazine with the cartridges and fires. Directly the rifle has been discharged, instead of the soldier having to withdraw the empty cartridge to place the next cartridge in position by a sudden movement of the breech, it is done automatically. By this means the soldier has nothing to do but to continue discharging his rifle until he has emptied the magazine. The rifle is extremely simple, both in design and operation, and what is more important, the shock of recoil is reduced to a minimum, since this shock is utilized to place the next cartridge in the firing chamber.

Compressed air motors, in lieu of horse traction, are to be employed for the propulsion of the vehicles belonging to the Compagnie Générale des Omnibus of Paris. The station for accommodating the necessary compressing plant is to be erected at Billancourt. The plant will develop from 5 000 to 7,000 horse power, and the air will be stored in the main receivers at a pressure of 1,400 pounds to the square inch. From these receivers the compressed air will be conveyed to the distributing stations in weldless steel pipes from two inches to four inches in diameter, laid along the roadway. In order to reduce the possibility of extensive leakage, through imperfect joints, the pipes have been manufactured in 64-foot lengths. Each car carries eight receivers with a total capacity of 88·27 cubic feet, which is estimated to be sufficient to enable the car to run a journey of 7½ miles without recharging, and they can be recharged in three minutes. Before the air passes into the motor cylinders it is heated by means of a small coke fire. Fifty-two passengers form the complement of two cars, accommodated upon two decks.

Electrical Notes.

The New Haven and Derby Railroad will be equipped with electricity during the coming year, and a start will be made toward building an extensive railroad system connecting New Haven, Derby, and Bridgeport. A 3,000 horse power plant is being erected at New Haven. It is said that this step is being taken with a view to head off the danger of paralleling by an ordinary trolley road.

The Marconi installation between the Mumbles lighthouse, off the coast of Glamorganshire, has just been completed and will soon be in operation. The distance over which the messages will be transmitted is twenty-five miles. The Chilean government have also just placed an order with the Wireless Telegraph and Signal Company for an installation of the Marconi system between Punta Arenas and Ancud or Puerto Montt.

The whole system of modern chemistry is based upon the axiom of the indestructibility of matter, and that indestructibility is proved by the permanence of the weight of a given substance through all the physical or chemical changes it is made to undergo. Any experiments, therefore, which shake our belief in that primary property of matter must have a far-reaching effect. Landolt's classical researches in 1893 embodied the first work done with all the modern instruments of precision. Certain minute changes of weight were then placed in evidence, and these have since been confirmed. A. Heydweiller has endeavored to trace some connection between the change of weight and the changes in other physical properties, such as magnetic permeability, electrolytic dissociation, and material or optical density. He has failed to trace any such connection, though he has distinctly established a diminution of weight of about 1 part in 50 million in a number of reactions, such as the mixture of copper sulphate with water, where a loss of weight of 1 milligramme was observed. Researches such as these take place in the extreme borderland of science, but the logical outcome of the results would be nothing less than the destruction of matter.—A. Heydweiller in the Physikalische Zeitschrift.

The first electric railroad in which the triphase alternating current system has been used in Germany has been recently installed between Oberammergau and the town of Murnau, its total length being about fifteen miles. The road, starting from the latter station, is comparatively level for the first few miles, but further on a three per cent grade is reached, extending over four or five miles. The highest point of the line is between Saulgrub and Altenau, which is 2,500 feet above sea level and 438 above the starting point. The line ends at Oberammergau; the terminal station is not far from the theater in which the Passion Play is represented. Hydraulic power is used to operate the road, a fall in the Ammer River being utilized. The station is located at Kammerl, about 10 miles from Murnau; the fall gives 1,000 to 1,500 horse power. A dam has been constructed across the river, and the water is brought to the station by a canal 1,500 feet long, terminating in sheet iron tubes of large diameter. Three turbines of 500 horse power each are used to operate the alternating current generators. For the road the trolley system is used, with overhead line. The road has been planned so that steam engines may be used; this will be necessary to provide for the great traffic at the time of the Passion Play, which occurs every ten years. During these periods the road will be operated by steam, and connection will be made with the main railroads, so that the international express trains may be run. At ordinary times the road will use the electric system.

An interesting utilization of wireless telegraphy is recorded in connection with the ice-breaking steamer "Ermak" during last winter. The Russian ironclad "Generale Amiral d'Apraxine" ran on the rocks fringing the coast of the island of Hohland, in the Gulf of Finland. It was necessary to save the vessel, and to accomplish this it was desired to establish communication by some means or other with the mainland and with the "Ermak." A high mast supporting a wire was erected upon a high point on the island of Hohland, and the necessary transmitter and coherer installed, while a similar plant was stationed on another island 33 miles away, the instruments in both cases being supplied from the warship, which was equipped with the apparatus. The vertical wires utilized, 157 feet in height, and the sparks from the induction coils were 14 inches long. The installation worked without the slightest hitch over this great distance. On one occasion it was successful in the rescue of 27 fishermen who were carried away on an ice floe. The perilous position of the fishermen was transmitted from one station to the other, thence to the "Ermak," from which vessel a boat put off and so effected the timely rescue of the unfortunate fishermen. The apparatus was in operation for 84 days, and was only suspended on two occasions, owing to severe snow storms. In all, 440 official messages were dispatched between the two stations, with complete success. Curiously enough, the apparatus was found to work better during the prevalence of storms than in calm weather.