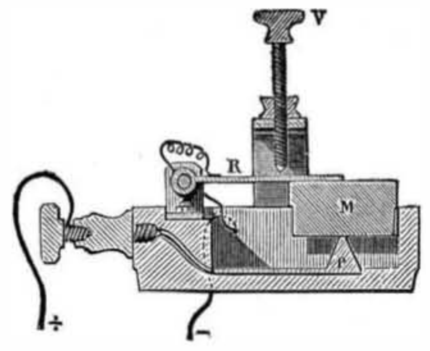
GRAPHIC PHONETICS.

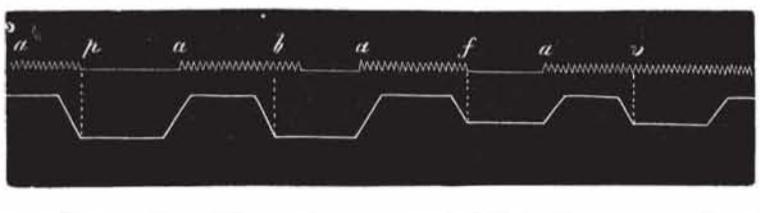
In 1875 the French Linguistic Society called for investigations to determine some method which would furnish an objective trace of the phonetic movements produced by the concurrence of the thorax, larynx, lips, tongue, and palate. The object set forth was not merely to discover the part

Fig. 1.



played by each of these organs in producing sounds, but to find how these different motions combined with and followed each other. The matter was referred to Professor Marey who, in conjunction with Dr. Rosapelly, who had already begun similar studies, and M. Havet, of the Society's Commission, undertook a series of experiments. These have proved of considerable physiological importance, as they may lead to the definition of the laws which govern the evolution of language, the discovery of the transitions through which a letter changes in degree, order and family, and subsequently to the determination of the relative force and the succession of air vibrations and of those of the phonetic organs which are called in play in the production of vocal sounds. Of this, the practical result anticipated is the origination of a more scientific method of education for deaf mutes, by conveying to the mind of the latter the necessary instruction through the medium of graphic traces. By performing the motions of the organs called for by these it would follow that the mute would produce exactly the sounds, etc., indicated.

Fig. 3.



In *La Nature* we find the annexed engravings of the apparatus for the exploration and inscription of the vibrations of the larynx, the movements of the lips, and those of the veil of the palate. In speech the larynx emits the fundamental sound, the timbre of which is determined by the resonators, namely, the pharynx, the nasal fossæ, and buccal cavity. Vibrations, therefore, corresponding to a simple sound are produced, which it has been found possible to register by applying laterally to the larynx the apparatus represented in Figs. 1 and 2. This contrivance is analogous to that devised by Professor Marey for recording indications of very rapid movements, and is based on the inertia of a mass elastically suspended. As this mass is capable of obeying only the rapid movements which are communicated to the parts surrounding it, it constitutes a sort of fixed point against which a series of shocks are produced. M is the mass of copper suspended at the extremity of a spring, R. Below the mass is a platinum point, P, which is exactly in contact with the mass, so as to close an electric circuit which follows the path indicated by the wires marked + and —: in the outer portion of this electrical circuit is placed a battery and a Deprez apparatus for rapid signalling. The mass and the point on which it reposes are inclosed in a small light case formed of wood and hardened caoutchouc, so as to obtain insulation of the two ends of the battery circuit, except at the point of contact of M and P. A regulating screw, V, placed near the spring, in the vicinity of the mass, M, limits the movements of the apparatus around the mass which is placed at the center. It will be seen that each vibration of the larynx, on which the apparatus is applied, will cause the separation of the circuit. The Deprez signal indicates each rupture and each closing of the circuit in which it is placed. Its sensibility is such that a great number of signals may be inscribed in a second, and thus all the vibrations of the larynx causing breaks and establishments of the current are accurately registered. In Fig. 3 are shown the vibrations of the larynx corresponding to the vowel, *a*. These disappear when *p* or *f*, in the syllables *ap* or *af*, is pronounced; and persist, on the other hand, when the *v*, in the syllable *av*, is uttered. The same figure shows, besides, the trace of the larynx vibrations, that of the lip movements registered simultaneously.

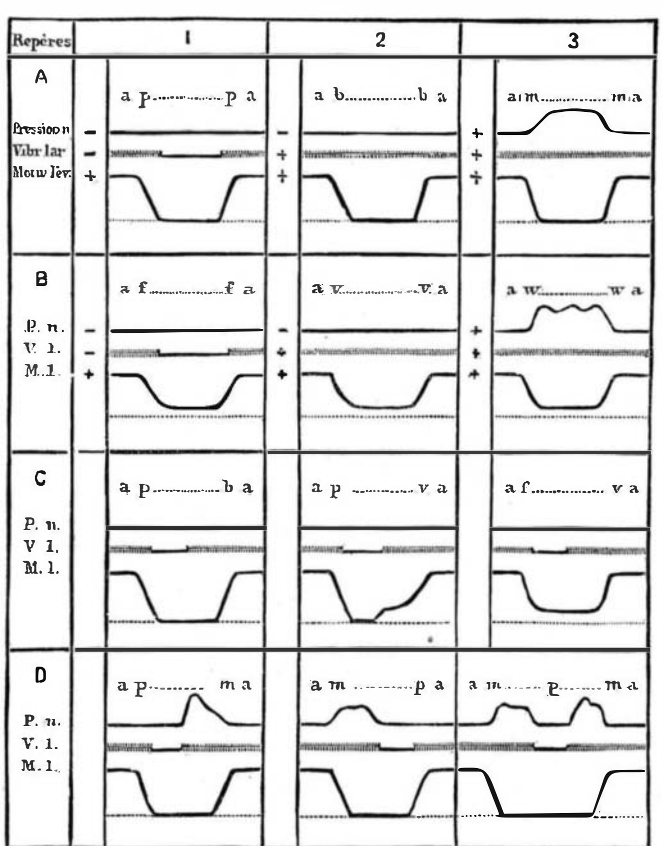
The lips execute vertical movements of raising and lowering and antero-posterior movements in a horizontal plane. During the latter the lips are carried more or less forward. The type of the first kind of movement is observed in the emission of the labial explosive consonants, such as *b* and *p*: of the latter kind, in the emission of the *v*. The apparatus represented in Fig. 4 is designed for the examination of the vertical lip motions. The upper lip is placed in the bent metal arm, *l'*, and the lower lip in the similar piece, *l*. During the elevations of the lower lip the arm which terminates with the portion, *l*, moves about the articulation placed near its middle. It extends the small rubber ring which connects it by opposite end to the upper arm, and so draws toward it the rubber membrane of the drum, T, to which it is connected by a small metal bridge. Air is thus drawn into the drum, T, by the tube, *t*, which also communicates with a drum having an inscribing lever; the pen on which, as the upper lip is raised, makes an ascending line. This will be better understood by examining the broken lower trace in Fig. 3, and in pronouncing the syllable *ab*. The sinuous line expresses the opening of the lips when it occupies the upper horizontal position. It corresponds to their complete closure when it occupies the lower horizontal place. The oblique lines mark the moment of passage from one of these positions to the other.

The movements of the palate, which are of great importance in the articulation of certain syllables, such as *amma*, *ab-ma*, cannot be explored except by introducing in the rear nasal fossæ instruments annoying to the experimenter, and, besides, likely to impair the clearness of the sounds produced. Czermack, however, suggested the idea of registering these movements by holding before the nostrils a cold, highly polished mirror. Whenever the veil of the palate is drawn back a displacement of a small quantity of warm moist air occurs, which dulls the surface of the mirror. In order to obtain an inscription of this feeble air current, a small tube is introduced into the nostril, which leads to a drum having, as before, an inscribing lever. By this means, in conjunction with the other apparatus, it was possible to obtain graphic traces simultaneously of the movement of lips, and palate, and larynx vibrations, and thus to determine the problem of studying the duration and succession of the combined movements.

The diagram, Fig. 5, is an example of the graphic result reached. The column on the left indicates the nature of the lines, namely, nasal pressure, vibrations of the larynx, movement of lips. For each curve the same order is observed. Thus the nasal pressure at the top may be normal when noted during the occlusion of the veil of the palate or elevated by the air pressure when the veil is partly retracted. The middle line corresponding to laryngeal vibrations is straight when that organ is mute, and undulatory during the emission of laryngeal sounds, finally the lower line of each series expresses lip movements as already described.

ACCORDING to recent statistics there are in the United States 227 horses to every 1,000 inhabitants.

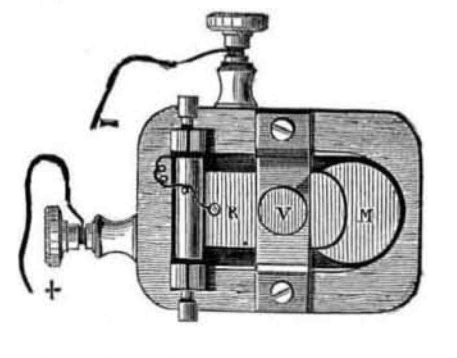
Fig. 5.



The Technical Uses of Cobalt.

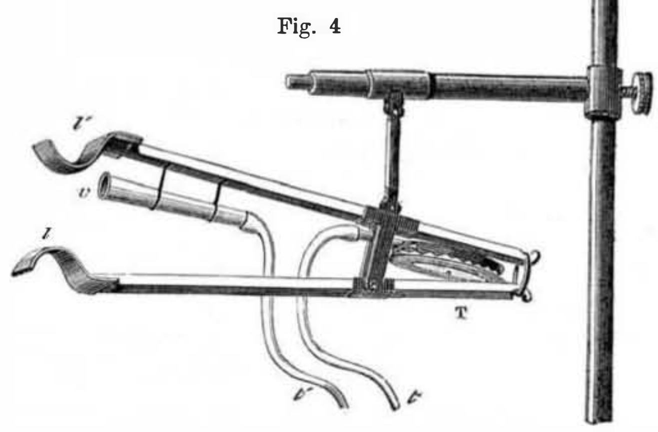
The application of ores of cobalt for blue coloring of glass appears to have been known and practised by the ancient Greeks and Romans, since the presence of this metal has been occasionally detected in ancient glass and porcelain. The general use of cobalt ores for the manufacture of

Fig. 2.



smalt did not occur until about the middle of the sixteenth century, about which time the art was practised in Saxony. The metal cobalt was first isolated and described as a new element by the Swedish chemist Brandt, in 1733. It is closely allied to nickel in many of its properties, and its ores generally occur associated with those of the latter metal. Its chief ores are smaltine, an arsenide of cobalt, iron nickel, some speci-

Fig. 4



mens of which often contain as much as 26 per cent of cobalt, cobaltine, or cobalt-glance, a sulph-arsenide of cobalt and iron, and cobalt bloom, a hydrated arsenate of cobalt. The preparation of pure metallic cobalt is one of the most tedious and difficult of chemical processes, and as our purpose here is simply to call attention to the practical uses of the compounds of the metal, its metallurgy need not concern us. The metal has a reddish gray color, and is susceptible of taking a superb polish. It is less infusible than iron, but more so than gold. Like iron and nickel it is magnetic, but does not lose its magnetism by heat. Its specific gravity is about 8·5. In conducting qualities for sound, heat, and electricity it is about the same as iron. It is somewhat malleable at a red heat, when free from manganese or arsenic. It is quite unaffected by air or water at ordinary temperatures, but when intensely heated it burns with a reddish flame. It is only slowly dissolved by hydrochloric acid, but nitric acid or aqua regia dissolves it readily. The solutions of cobalt salts have a fine rosy tint, easily recognizable when once seen. Cobalt has been found to make a very handsome plating upon copper, brass, and iron, rivaling or even surpassing nickel in beauty. Its expense, however, precludes the possibility, at least at the present time, of competing with nickel for this purpose.

Compounds of cobalt possess the property of imparting a beautiful blue color to glassy substances at a red heat. The important blue color known as smalt is made by fusing cobaltous oxide with siliceous sand and potassic carbonate in crucibles, and pulverizing the resulting blue glass. This substance was formerly extensively employed for the blue coloration of paper, linen, etc., but its use is now mainly limited to enameling and glazing. A very impure cobaltous oxide is made by roasting smaltine or cobaltine, mixed with siliceous sand, and comes into the market under the name of zaffre. It is also employed for the blue coloration of glass and pottery. Thénard's blue is prepared by mixing alum with a cobaltous salt, and precipitating the mixture with sodic carbonate; or by decomposing the aluminate of soda by means of cobaltous chloride. The precipitate is an intimate mixture of hydrate of alumina and hydrated oxide of cobalt. After being well washed, dried, and heated, the resultant blue pigment bears a close resemblance in color to ultramarine. It is indifferent to acids, alkalies or heat, and is used for staining glass or porcelain, and for oil and water colors.

Cœruleum, another blue color, is a mixture of cobaltous stannate with stannic acid and gypsum. It is also unaffected by heat or by acids and alkalies. Riemann's green is a compound of cobalt and zinc, made by precipitating with sodic carbonate a mixed solution of white vitriol (zinc sulphate) and a cobaltous salt. Cobalt yellow is a mixture of nitrite of cobalt and potassium, made by passing nitrous vapor through a solution of cobaltous nitrate to which potassic hydrate has been added. A remarkable series of compounds of cobalt with ammonia have been observed and studied by Genth, Gibbs, Frémy and others. The employment of cobalt salts in a laboratory for the detection of manganese, alumina, zinc, etc., by means of the blowpipe, is very important to the analyst. The sensitiveness of cobalt salts to heat and moisture has been utilized in the production of sympathetic inks, which are invisible at ordinary temperatures, but are rendered visible and legible on heating. For this purpose the chloride of cobalt, mixed with a small quantity of gum or sugar, is very well adopted. This "magic ink," as it is called, is rendered visible by holding against a heated surface. It has lately been recommended as very suitable for postal card messages, which would thus be exempt from curious inspection. The sensitiveness of cobalt salt to moisture, which is indicated by a change from blue to a pinkish tinge, has been suggested and employed in the construction of a hygrometer or measure of moisture. In Paris, a late scientific toy is a flower barometer, which is simply an artificial flower of white paper which has been treated with a solution of cobaltous chloride. These flowers when exposed to the sun and dry air become deep blue, but when the air is saturated with moisture they turn of a pinkish hue, thus affording an approximate estimate of the condition of the atmosphere. Landscapes have similarly been painted with cobalt and nickel salts, which on heating develop the characteristic shades of sky and grass. The above facts contain in briefly condensed form the chief features of importance presented by the metal cobalt from a technical standpoint.—*Journal of Applied Science.*

Communications.

Coal Dust as Fuel.

To the Editor of the Scientific American :

Thinking it might interest the readers of your valuable paper, and also call out the experience of some others, I send you the following items of the difference in cost between coal and coal dust as fuel for steam boilers, it being my habit of always keeping a record of the amount of fuel used, kind, cost of same, also number of hours run. This account only includes the actual time run; besides which I have always kept up steam to 40 lbs., all and every night except Sunday.

Boiler is horizontal, 3 feet diameter, 15 feet long, with 24 3 inch tubes running the full length of boiler, grate surface 16 square feet. It supplies steam to the engine, cylinder 9 x 18 inches, steam cut-off at three quarter stroke. It drives an elevator, hoist 40 feet, capable of carrying a safe load of 4 tons, 1 pair of heavy rolls, 1 large skiving machine, 1 McKay sewing machine, 1 No. 2 Sturtevant blower, 1 sand-paper machine, and 30 Howe and Wheeler & Wilson manufacturing sewing machines. It also supplies steam to heat the factory, which is a three story and basement, with 128 large windows, 5 outside doors, and 8 scuttles in the upper story. It furnishes steam to an office heater also. The comparison of coal is as follows.

Amount of coal burned........	94½ tons.
Cost of coal burned...........	$567.00.
Number of hours run..........	2,698.
Average cost per hour........	21c. and a trifle over.

Amount of dust burned	133¼ tons.
Bost of dust burned...........	$203.37.
Number of hours run..........	3,088.
Average cost per hour	6½ c.

The coal was used during the first 18 months the boiler was ever used, consequently everything was in the most favorable condition, while at the time I commenced to burn the dust, scale had accumulated to the thickness of at least 1-16 inch.

Another thing, I was allowed much more time to clean the boiler when burning coal, as the business was quite slack, as compared with it since using dust. I find that it takes no more time to fire with dust than with coal, if as much; but it is very dusty work and trying to the eyesight, while the heating surface of boiler requires double the care to keep it free from ashes and soot. The expense incurred in making the change did not exceed $200.

Milford, Conn. WALTER F. SAGE, Eng.

Canceling Inks and Pads.

To the Editor of the Scientific American :

Noticing in the SCIENTIFIC AMERICAN of October 13 a receipt for marking ink for Post Office use, I give those used in my office for the last two years. I have tried printer's and a great variety of other inks, and find this the best. To one ounce of good sweet oil add, for black, an equal volume of lampblack, and mix thoroughly in a mortar. For blue, use Prussian blue in same proportions. For red, use 6 grains aniline red, dissolve in a small quantity of alcohol, say 1 drachm fluid measure, then add 1 ounce glycerin. To make a pad, take a piece of inch board, previously planed smooth, 5 inches square, cut pieces of any heavy cashmere goods the same size, and place them in layers, say an inch deep, on the block, and smear the ink on alternate layers of the cloth, then sew over all a piece of the same cloth, tacking around the edges of the block to hold the outside cloth firm. Postmasters will find the above excellent for postmarking letters. J. M. H.

Silverton, San Juan county, Col.

The Manufacture of Jewelry.

Fine gold, both on account of its higher value and its ductility, being more difficult to work by modern processes than when alloyed with other metals, has been almost universally succeeded by alloys of a lower grade. For diamond mountings and the better order of jewelry, 18 carat gold has found general acceptance, while for jewelry in general, 14 carat is used. Due to the present depression of business, alloys from 4 carat to 12 carat have been extensively employed for cheap ware. According to the relative proportion of silver and copper added in alloying, the yellow or red color of the gold is regulated. Fine gold being taken as 24 carat, 18 carat red gold consists of fine gold, 18 parts; fine copper, 5½ parts; fine silver, ½ part. Total, 24 parts.

The shade more or less red being regulated by the greater or lesser quantity of silver. For yellow gold, to the 18 parts of fine gold, even quantities of silver and copper are added, and the shade regulated by copper. Green gold is made by adding to the 18 parts of fine gold, silver alone; and blue gold, though very difficult to make, due to iron not making an intimate union with gold, is produced by adding 6 parts of iron to 18 parts fine gold. The alloys are melted in a crucible with the addition of borax as a flux, and cast into ingots—either as bars or plates. These are hammered or laminated according to the purpose for which they are intended. The diamond mounter, or jeweler proper (for the factory workman who works after given rules and patterns, and whose whole duty is to solder together the stamped parts that are given into his hands, scarcely merits the name), receives the crude metal and the design, generally in the form of a drawing, and the execution is left to him. We will select a design and follow him in its development, of two pearls and thirty-one diamonds given him. The main points to be kept in view are to show off the stones to the best advantage, and, if they are perfect, to have no more gold than is absolutely necessary, so that their effects may not be marred. It will first be necessary for him to make the "sittings" for the stones. For this purpose he works out a piece of gold about 3-16 inch high and at the bottom 1-16 inch thick. From this he bends the boxes for the pearl and five upper stones. Of these he makes the settings by scalloping them out, first from the top and then from the bottom, and then solders the small frame under them for a finish. The solder consists of gold of a lower grade, which, melting at a less heat, firmly unites the parts between which it flows. Having done this, he next makes the "cluster." Into a piece of gold about an inch in diameter, and ⅜ inch thick, he makes holes just so much smaller than the stones as to allow setting. Next the outer edge of the "cluster" is finished like a setting, and scalloped "bizzle" and frame soldered under. Now he makes the mounting for the other diamonds. A frame like the contour is made, which is scalloped, and upon which a thick plate is soldered, and into which the diamonds are afterwards carefully mounted. The "knife edge wire" is made from gold bent into the shape of the design and filed sharp at the top. The gold band for the enamel is so arranged that it can be secured after all the rest is finished, in order that the entire work need not go through the enameling fire. The small shot are made by melting particles of gold, which thereby assume a globular form and retain it upon cooling. And now all is ready for construction. This is done by placing the pieces upon a flat charcoal, applying borax and small pieces of finely cut solder to the places where the pieces are to be joined, and heating them by means of a gas jet and blowpipe till the solder "runs." After all the soldering has been completed the work is boiled in dilute sulphuric acid, to clean it of oxide and borax, carefully trued with files, all the file marks removed with a scraper and emery paper, and the task is ready for polishing. This is done first by means of tripoli and oil, and afterwards with rouge and alcohol. By means of gravers, rests for the stones are cut in the settings, and the gold securely pressed over their edges, and the brooch is completed. In the manufacture of the so-called "Etruscan ware," the delicate wire ornamentations are all bent into shape first and then soldered on the jewelry, according to the design. The neat fine gold-like appearance is produced by immersing the jewelry for a few minutes in a boiling solution of muriatic acid three parts, saltpeter two parts, salt one part. This eats out the alloy and brings the fine gold to the surface. Since it attacks copper more readily than silver, a finer effect is produced by alloying the gold with an excess of copper. A very praiseworthy attempt has of late been made to reproduce flowers in their natural colors and details; but, due to the amount of labor necessarily expended upon them, they command higher prices than is generally invested by the majority of purchasers. It is sincerely to be wished that they may gain the approval of the public. By the combination of platinum with red gold for seals, rings, and chains, many novel and very effective designs have been produced. In making plain linked watch chains, the links are wrapped about a mandrel having the exact shape that they are expected to assume. They are then cut apart at one end, hung together, and the joints soldered. Oxidized silver, so much in vogue a few years ago, is made by treating silver with ammonic or potassic sulphide. Enamel is a fusible glass melted into cavities in the gold. Niello, lately fallen almost entirely into disuse, is a black composition of gold, silver, copper, and lead heated together, and melted into a design prepared in the same manner as for enamel. The metal is then scraped and burnished, and produces the effect of a drawing in black upon a gold or silver ground.—*Herman T. Wolf.*

The Purification of Drinking Water.

Chief Engineer McFadden of the Philadelphia Water Works, in his recently issued annual report, gives the following information relative to the purifying of drinking water:

Water, though theoretically made up of only two elements, without perceptible taste, color, or smell, is never supplied by nature chemically pure. Analysis proves that it always contains, in a greater or less degree, foreign matter gathered from many sources. It is only where these impurities exceed a certain percentage that they become dangerous to the health of a community, and make a purifying process necessary to fit the water for domestic use.

These impurities may be classified under three general heads:

I. Floating *débris.*

II. Mineral sediment.

III. Organic impurities.

Impurities of the first class are confined mainly to the surface, and are made up of floating wood, leaves, etc. A properly arranged system of screens will arrest them and obviate this trouble.

The second class is made up of such mineral sediment as is derived from the abrasion of rock, and the washing of the different soils forming the river basin. Unless present in very large and unusual quantities, these impurities are seldom injurious to health, but society demands clean looking water, and the manufacturer often requires it; therefore it is well to get rid of this sediment whenever possible.

Subsidence or gravitation is the simplest plan to pursue, but requires a storage capacity of at least one week's consumption, to give the particles time to settle.

It is in the third class of impurities—those derived from organic bodies—that we find the elements most dangerous to the community; and while their removal is of vital importance, they present the most formidable obstacles to the engineer.

The principal source of organic impurities is decomposing animal and vegetable matter, sewage, dissolved fertilizers, waste from manufactories, etc. These matters remain in suspension until decomposition has removed so much of their volatile natures that the mineral components can sink, but their really dangerous elements frequently so unite chemically with the water that no artificial system of filtration can separate them, and under the guise of pure limpid water they convey the seeds of disease to the consumer.

Subsidence will only partially remove organic impurities; oxidation, by exposing the water in thin sheets to the action of the air, as in running it over weirs, is beneficial; but even an elaborate and costly system of filter beds will not eliminate all those deleterious particles held *in solution* by the water.

The only true method of furnishing pure water is to maintain the purity of the source of supply, by diverting from it as much as possible, all sewage, manufacturing refuse, etc. Economy and common sense should teach us that it is false in principle, to first pour all manner of filth into our water supply and then attempt to get rid of it by costly and seldom efficient processes. The advice of an eminent hydraulic authority is: "If any water intended for domestic purposes is found to be charged with organic matter *in solution,* the very best plan of treatment is *to let it alone,* and take the required supply from a purer source." The next best plan, when we have no available purer source, is to so perfect the system of sewers—the most fruitful sources of dangerous organic impurities—that they discharge their contents as far as possible from the stream from which we derive our water supply.

A very brief sketch of the methods of artificially purifying water for the use of a community may not be out of place.

Evaporation and the use of chemicals, though really the most effectual, cannot be applied economically to a large public supply. Simpler and cheaper methods must be relied upon.

Carbon, prepared in large plates, and so placed that the water must percolate throught it, especially reacts on all organic matter, but when the demand is heavy this process is very expensive, owing to the large area of filter made necessary by the slow rate of progress of the water through the carbon plates, 3,330 square feet of the *most porous* being required to supply 1,000,000 gallons of filtered water per day.

In England *magnetic carbide,* made by roasting hæmatite iron ore with granulated charcoal, is used in layers of from 2 inch to 12 inch, in a sand filter bed, and is said to give wonderful results in removing organic matter.

Infiltration basins are used in a number of our towns and cities. These are simply galleries excavated in the porous margin of a lake or river, or in water-bearing sand formation, as at Brooklyn. These galleries are sunk below the water level, and are supplied by percolation. They are usually formed of two side walls, say 8 feet apart, arched over, and of a length commensurate with the demand. The amount of water furnished by them depends on the porosity of the sand and gravel beneath and around them, and the head of water under which the filtration is maintained. When the location is favorable, and the volume required not too great, they are simple and effective.

Filter beds purify the water by passing it downwards through intercepting strata of sand and gravel into a clear water basin beneath, from which it is supplied by pumpage to the consumer. They are much used in England and on the Continent, but their first cost and the constant expense of maintenance have discouraged their use in this country.