they are located, and also by private individuals. They are for the most part under the control of the State board of agriculture, the Governor, and other State officers; but the president of the institution and the faculty practically have all the liberty they demand in carrying out the work according to well-defined policies. Some of these State agricultural colleges are remarkably well equipped and endowed for the work they have in hand. Thus the Iowa State College has fifteen buildings, which have been erected by the State at a total cost of half a million dollars. There are nearly a thousand acres of land attached to the institution. A corps of 55 professors and nearly 600 students is engaged in study and work. All kinds of crops raised in the State of Iowa are planted and cultivated on the farm, and cattle, horses, and poultry are kept by the students. Experiments are constantly being carried on by the professors and students in agriculture, horticulture, chemistry, and general farming; and the results of these experiments are published in bulletins and papers for the benefit of the world.

The Pennsylvania State College, or "The Agricultural College of Pennsylvania," is even broader in its educational aims than the Iowa State College of Agriculture. Almost all studies from agriculture, chemistry, physics, engineering, mining, and mathematics up to philosophy, general literature, and languages are taught there. In recent years this college has steadily broadened toward a high-grade technical, scientific, and classical institution. Nevertheless, agriculture, in all its wide fields of application, is one of the chief studies emphasized at the college. A correspondence course has in late years been organized for the purpose of instructing students on farms who cannot attend the college, but who wish to avail themselves of the researches and facts obtained at it. Forestry is one of the most useful branches of work carried on at this college; and it not only trains young men to appreciate the value of cultivating orchards and woods, but also turns out practical foresters, capable of taking charge of large forests and converting them into profitable possessions, without destroying and denuding them of trees.

The Michigan State Agricultural College is another similar institution which, for more than forty years, has endeavored to help the farmers in their struggle to wrest from the soil a fair compensation for their labors. The original idea of this college was to perfect in their studies all graduates of the common school who wished to possess a complete practical and theoretic knowledge of the arts and sciences which bore directly upon agricultural and kindred pursuits. Economic zoology, meteorology, physics, veterinary science, entomology, bacteriology, chemistry, geology, and agriculture and horticulture are a few of the studies pursued. Post-graduates can pursue advanced studies in the sciences, and in the library of 20,000 volumes they can find nearly all the literature of value pertaining to their particular studies. There are some 676 acres of land attached to the college, 230 acres of which are devoted to field crops, 45 to woodland, 114 to orchards and garden, 47 to experimental fields, and 240 to forest. There is a fine arboretum, a fine botanic garden, a grass garden, and a weed garden, where a hundred or more noxious weeds are grown to show their destructive possibilities to the students. There are some 450 students at the college, and more than half of them take the full agricultural course.

The South has a good institution of this class in the Mississippi Agricultural and Mechanical College, with a faculty of some two dozen members, and a student membership of nearly 400. The college is under the management of a board of trustees, with the Governor of the State an *ex-officio* member. The students who attend this college are paid eight cents per hour for their work in the fields or orchards, which enables them to pay for a part of their living while studying.

The Kansas State College, with its 300 acres of land, buildings valued at $350,000, and a faculty of 45 professors and assistants, has become an important factor in the middle West in developing the agricultural possibilities. Agriculture, engineering, and general and household economics are taught to the students. There is a dairy, blacksmith shop, foundry, machine shop, printing office, and woodwork and painting shop connected with the college, where practical work can be followed by the students.

With agriculture as our leading industry, many of the large universities have in recent years established an agricultural course and experimental farms as a part of the regular college course. When this subject is mentioned, one turns instinctively toward Cornell University, with its admirable agricultural and forestry departments; toward the Ohio State University, with its buildings and equipments aggregating nearly $3,000,000 and with an income of $350,000; or toward the University of Wisconsin or of California. These typical universities, which have given agriculture and horticulture a prominent place in their curriculums, have sent forth annually hundreds of students to teach practical farming to new communities, which may still labor under the disadvantage of old methods and ideas of agricultural production. The Ohio State University at Columbus, Ohio, has over a thousand students, and a corps of 78 professors and assistants; but it aims to give a scientific and classical education to both young men and women. It is divided into six colleges, with one devoted to agriculture and domestic science, and another to veterinary science. Students pursuing other studies can take courses in these departments, and there are also opportunities for graduate studies in the science of agriculture. There is a well-stocked farm of 200 acres connected with the university, a fine dairy department, a large laboratory for student work in soils and crops, and a fine veterinary laboratory and operating building.

In the University of Wisconsin, with its membership rapidly approaching 2,000, and a corps of over 130 professors and assistants, there is a college of agriculture, which gives excellent courses in dairying, veterinary science, experimental farm work, entomology, scientific plant investigation, and general horticulture and agriculture. There are cheese factories, creameries, and dairies on the farm, with large green-houses for raising plants, extensive barns for cattle, and bacteriological laboratories. The college co-operates with the sixty-odd State institutes of the farmers, both in supplying literature and lecturers; and thus becomes a real and essential part of the State's chief industry.

Like the two former, the agricultural college of Cornell University, in New York, has become one of the greatest factors in stimulating and broadening the farming interests of the State and, indirectly, of the whole country, while it has contributed largely to the establishment of agriculture on a firmer and higher scientific basis than ever before in its history.

ACTION OF GELATINE UPON GLASS.

In a paper read before the Académie des Sciences M. Cailletet describes the action of gelatine upon glass and other surfaces. When a glass object is covered with a thick layer of strong glue, the latter adheres strongly when wet, but upon drying it may be detached and carries with it glass scales of different thicknesses which have been lifted from the surface. The glass which is thus treated presents a surface whose designs resemble those of frost on a window-pane, and have a decorative effect.

M. Cailletet made experiments with gelatine upon different substances, and found that tempered glass was easily attacked, as well as Iceland spar, polished marble, fluorspar and other bodies. A sample of quartz cut parallel to the axis of the crystal was covered with two layers of fish-glue; after drying it was found that the surface was attacked and showed a series of striæ which were parallel, rectilinear and ran close together, while in the case of glass the striæ were curved. When certain salts were dissolved in the gelatine, namely, those which were easily crystallized and had no action, there was produced on the glass a series of engraved designs which had a crystalline appearance. Thus a solution of strong glue containing 6 per cent of alum gave very fine designs somewhat resembling moss in appearance; other salts such as hyposulphite of soda, nitrate and chlorate of potash, will produce analogous forms.

M. Cailletet told of the strong mechanical action exerted by a layer of gelatine when drying. If a sheet of cardboard, lead or even wire-gauze is covered with a gelatine solution the surfaces are seen to curve into the form of a cylinder as the gelatine contracts. Upon thin glass the effect is striking; when a layer of strong glue is spread upon a cylindrical vessel of thin glass the effort which it exerts when drying is sufficient to break the vessel with explosion. When a plate of thick glass covered with gelatine is examined by polarized light a powerful mechanical strain is observed in the glass, and the value of this effect could no doubt be measured.

NEW ELECTROMAGNET FOR MAGNETO-OPTIC WORK.

Prof. A. Gray delivered an interesting paper before the Glasgow Section of the Institution of Electrical Engineers on March 11, on magneto-optics. He explained at the outset that the old Ruhmkorff electromagnet, though better than the permanent magnet, was incapable of giving a very intense field, a circumstance which was chiefly due to general ignorance of the theory of the magnetic circuit. Given this, however, the improved knowledge enabled more powerful magnets to be constructed, and several of these were described and illustrated on the screen. Among them was one constructed at the author's instigation for work on the properties of substances in magnetic fields at his laboratory in the University College of North Wales, Bangor. A magnet described by Mr. S. L. James in Nature (June 13, 1901) was also detailed and illustrated. On going to Glasgow, Prof. Gray decided to have a much larger magnet built for a series of researches on magneto-optic effects, somewhat similar in form to his Bangor magnet and that of Mr. James. A different arrangement for carrying the pole-pieces apart was adopted, and the cores of the upper coils were made sufficiently long to allow them to be slipped to the right and left through a distance great enough to give the length of gap required, and at the same time to accommodate the coils. The magnet was constructed by Messrs. Mavor and Coulson, and it was found that with a current of 25 amperes a field of upward of 50,000 C. G. S. units was produced and confirmed by determinations of different observers. The field was determined by putting a ring of wire round it between the faces of the poles, and then suddenly withdrawing it; the deflections produced on a standardized ballistic galvanometer having been observed, it between the faces of the poles, and then suddenly was found to be of ample power for the magneto-optic experiments. Since in the earlier experiments on the magnet it had been found impossible to obtain with pole-pieces with narrow tips so high a field intensity as at first, this raised the interesting question as to whether the poles had lost considerably their capacity for conducting lines of force; but the point was shortly to be put to the test. The author understood that dynamo builders believed that as a machine aged a greater speed was required to give the same E. M. F., and this was possibly due to deterioration of the iron, though he considered that the impaired insulation of the magnet coils was accountable for it. If any deterioration in the iron of a dynamo occurred it was more likely to occur, and that quickly, at the pole tips, and in view of the reluctance of that part of the circuit, a great deal depended for the success of such a magnet on the obtaining of the best possible iron for the conical pole-pieces.

SCIENCE NOTES.

The original map made by George Washington in 1775 of the lands on the Great Kanawha River, West Virginia, granted to him by the British government in 1763 for his services in the Braddock expedition, is now in the possession of the Library of Congress, says The National Geographic Magazine. The map is about two by five feet, and is entirely in the handwriting of Washington. The margin is filled with notes, also in Washington's handwriting, describing the boundary marks set by Washington and different features of the tract.

The coca plant, *Erythroxylon coca*, among others of medicinal value, is being experimentally cultivated in the Victoria botanical garden of the Cameroons. A firm of alkaloid makers in Germany, to whom some of the leaves were sent, found them to contain only 0.28 per cent of total alkaloid. This low yield may be attributable either to improper drying of the leaves or deterioration during the long voyage. It is suggested that it would be advisable to extract the crude alkaloid for export, unless the leaves can be carefully packed in air-tight boxes without unduly increasing their cost.

The British weather service is systematically collecting reports from the North Atlantic and Mediterranean of the temperatures observed by shipping masters. The data thus collected are to be worked up into charts showing the temperatures over marine areas between latitudes 30 deg. and 60 deg. What the practical results of this enterprise will be cannot be foretold. Much light will be thrown upon the Gulf Stream, for it will be possible to ascertain exactly where it extends. Naturally most of the information thus collected will relate to the Atlantic Ocean, for the North Pacific is not traversed so often by shipping.

In the decennial publication of the University of Chicago may be found a suggestion by Professor Michelson of a new method of determining the velocity of light. The Professor reviews previous results, contrasts astronomical, electrical and optical methods and processes. Instead of the revolving toothed wheel of Fizeau, he suggests the use of a stationary grating, and by a double reflection of light from stationary and revolving mirrors, proposes to measure the eclipses the light suffers from the gratings. Figures accompany the original article, which make the author's plan clear. He estimates that the velocity of light can be measured to a probable error of only 5 kilometers.

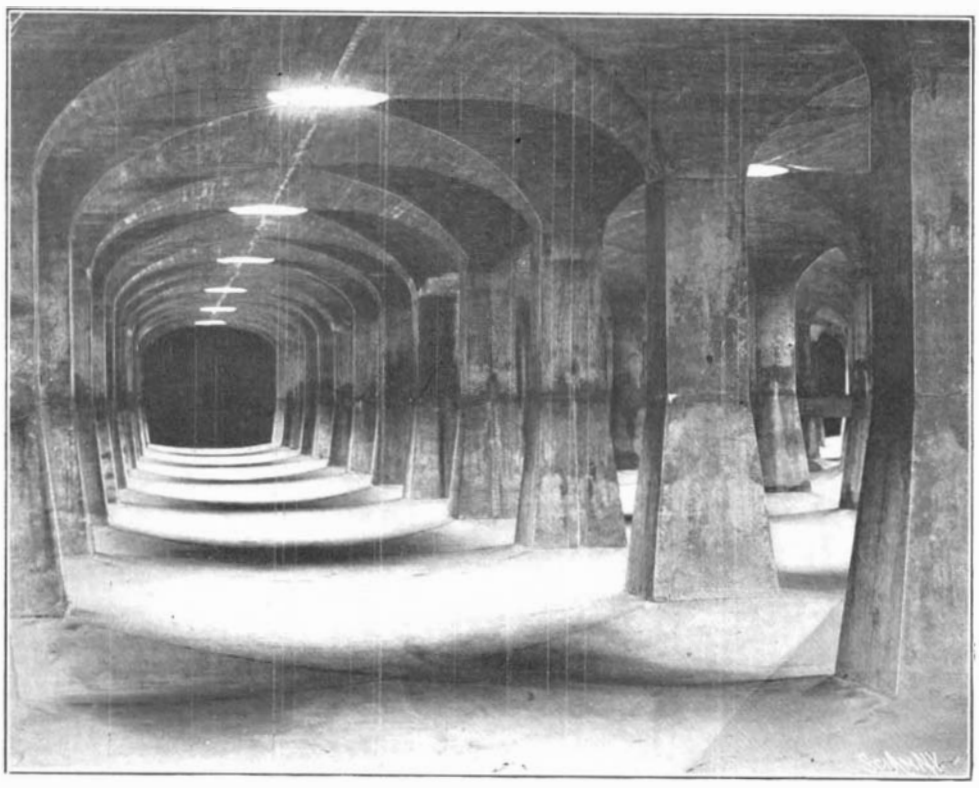
Dr. Ludwig Biro, the eminent Hungarian explorer and scientist, has returned to Europe with a large collection of zoological and ethnological specimens gathered in the Malay Peninsula and New Guinea, during a period of six years. So extensive and varied is his collection, that it will require several years to examine, catalogue, and classify them for the Hungarian National Museum, where they are to be exhibited. He has obtained among his zoological specimens a number of species which have been hitherto unknown to science. Dr. Biro was formerly an assistant master in a college in Hungary, but was so imbued with the desire to prosecute his studies abroad, that he sold his remarkably extensive entomological collection, numbering 60,000 specimens, to the Hungarian National Museum, to defray his Malay expenses.

THE NEW PHILADELPHIA FILTRATION SYSTEM.

BY H. D. JONES.

In the words of Consulting Engineer John W. Hill, who is installing the new filtered water system with which Philadelphia will be provided with pure water in unlimited quantities, the improvement will be the "greatest municipal advance in the history of the world, and comparable only to the renovation of the entire sewerage system of London thirty years ago." To begin with, a conduit is being hewn, cut, drilled, and blasted out of the solid rock a hundred feet beneath the surface of the Delaware River bank, and only a few feet less beneath the surface of the stream, for a distance of more than 14,000 feet. This conduit is only a small part of the general plan, which includes five one-half acre filters at lower Roxborough, eight filters at upper Roxborough, eighteen filters at Belmont, and fifty-five filters at Torresdale. In round numbers the entire system when working will have a capacity of 300,000,000 gallons of filtered water a day, more than the entire consumption of the city. The Lower Roxborough plant is intended to supply the section of the city known by that name and Manayunk; Germantown will depend for its filtered water upon the supply from the filters at Upper Roxborough; West Philadelphia will be supplied from the Belmont plant, and the older parts of the city will be furnished with pure water from the enormous plant at Torresdale.

For an explanation of how the beds are made and how the filtering of the water is done, the Torresdale plant will serve as an illustration, that being the largest plant, and all the others being built practically in the same way. The amount of ground held by the city for the Torresdale plant is 384 acres, of which something in excess of 55 acres is now being built upon, the remainder being held for operations not immediately contemplated, but which will some day be necessary when the question of enlargement is forced upon the engineers.

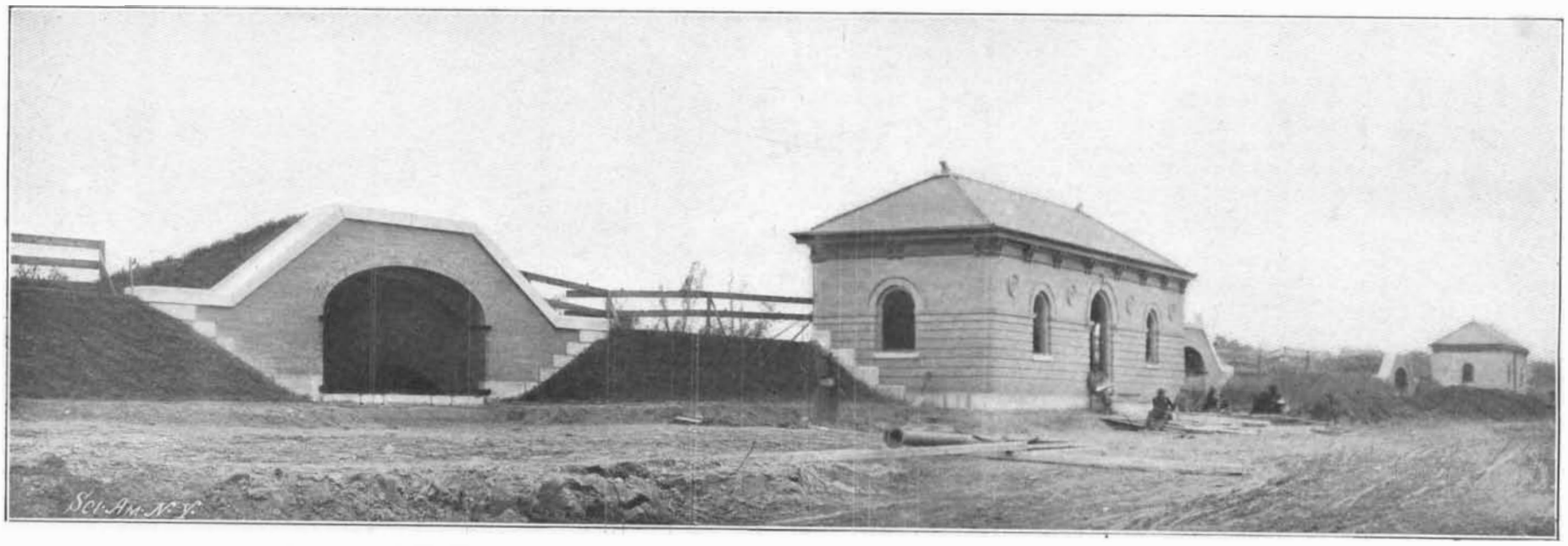


Perspective View of One of the Compartments of Filter Bed.

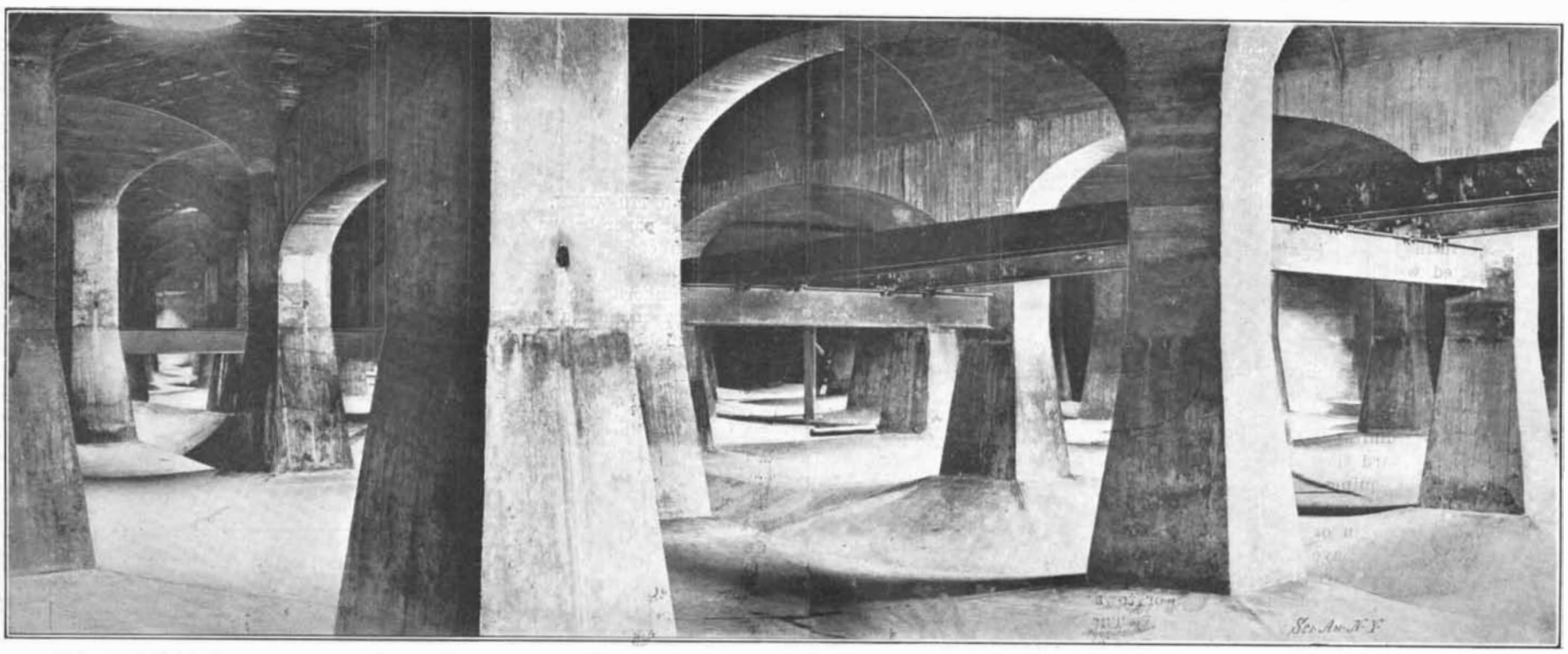
In this plant alone there are 4,450 feet of main sewers, from three and a half to eight and a half feet in diameter. These of course are for drainage, and not for the handling of sewage. There are two miles of 20, 24, and 30-inch terra-cotta pipe; 8,000 tons of cast-iron pipe from 16 to 60 inches; a million yards of excavation; 4,000 lineal feet of concrete conduit from 7½ to 10 feet in diameter; 170,000 cubic yards of concrete work; 118,000 yards of clay puddle work. Everything used in the construction except the piping is made on the spot, as is all of the temporary material, such as the wooden forms in and around which the concrete work is molded, and this in itself necessitates a manufactory that is by no means a small affair.

Each filter bed covers an area of three-quarters of an acre, net, that is exclusive of the walls and the pillars inside which hold up the roof. There are fifty-five of these filter beds at Torresdale, which, as before stated, make the plant the largest in the world. Each bed has a capacity of four and a half million gallons in a day of twenty-four hours under a "six million rate." The six million rate is the amount of water that will run through an acre of sand in twenty-four hours.

The process of filtration is of course exactly the same. Each basin is covered with a roof, the filtering material being placed in the bottom of the basin. The roof of the filter bed is 12 feet 9 inches in the clear above the floor and is supported by concrete walls which are three feet wide at the bottom and taper to 22 inches, and by piers, also of concrete, with bases 22 inches square placed at regular intervals, so that their centers are 15 feet 10 inches apart. The roof supported by these piers consists of a series of arches. The floor of the bed is made by putting down 12 inches of puddle (clay mixed with gravel in



Entrance to Filter Bed. House in which Ingoing and Outgoing Flow is Regulated.



Interior of One of the Filter Beds.—Parallel Lines Running Through Compartments on Right are the Tracks of Railroad Used to Transport Sand into the Filter Bed.

THE NEW PHILADELPHIA FILTRATION SYSTEM.