an area of about 8,000 square feet. It is difficult to distribute this space with more dexterity, for on this lot the villa has been built with an ample and marbled exterior *escalinata*, garden, small lake, grotto, kiosks, stables, departments for straw, a greenhouse and other accessories, all arranged so that nothing becomes a hindrance—everything is seen and everything is isolated.

In this abode, all the rooms are large, with high ceilings, profusely lighted and ventilated, with great economy of the land. The access to the property is from Claudio Coello Street, by a large and wide entrance between pillars decorated with allegorical details dedicated to the unconquerable city of Bilbao and to its famous siege.

The ground floor has its access at the level of the garden, but the floor is raised more than a meter above this level, profiting advantageously by the slope of the site and freeing the rooms from the humidity of the adjacent plantations; it contains the billiard room, bath room, kitchen, pantries, larders, lavatories and servants' rooms.

The first floor is approached by a commodious staircase, and from the exterior by the wide *escalinata* that we have already mentioned; this floor contains Senor Saracibar's studio, the large drawing room, the dining room, with a charming "rotunda" on the side of the garden, a hall and the beautiful staircase that goes to the second floor; in the latter are the bed and other rooms, all with direct light and with all the best conditions of sanitary and commodious arrangements; rooms for servants and for domestic services are provided in the roof, and a pleasant and isolated study room is at the top of the turret.

We will not fatigue our readers with an exact account of the magnificence and elegance of the ornamentation of these rooms. But we think it is our duty to attest that everything that is seen in this residence, from the ironwork of the doors to the carved furniture, from the curtain to the enormous chimney, the mosaic of the floors and the painted ceilings, everything has been made after the designs and under the direction of the proprietor, and everything shows the seal of the artist.

The pediment is crowned by a colossal head of the "Genius of Art." In the tympanum are sculptured the emblems of architecture, with branches of laurel and oak round them, and the heraldic shield of Senor Saracibar is suspended in a prominent place of the facade.

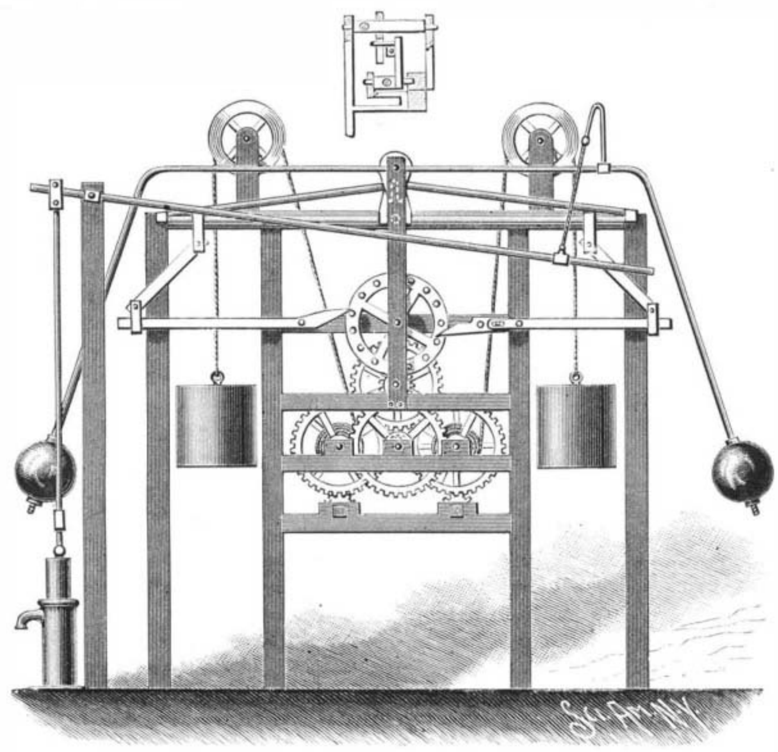
Forming part of this block of the building, follow at its left side and parallel to the public road other two blocks in the center of which is the entrance door, and above, on the same axis, a window; in front of the door there is a small terrace to which leads the broad *escalinata*, of which the balustrade is in the line of the street, adorned with openwork metal and vases in a very good taste.

The other block on the left side is formed by the square tower so characteristic in Spanish construction. There was in it a problem of no easy solution; in its large massiveness there were larger surfaces of the building that had to be decorated with sobriety, but in harmony with the rest of the work. A colossal bust and a statue have been enough to decide the difficulty with dexterity. The first is that of Michael Angelo Buonarotti and the second the Venus of the island of Melos.

The tower terminates in a belvedere, and in the middle of the cornice is a colossal bust of Apollo, the god who presides over the fine arts.

What is particularly worthy of notice in this house is the economy of the materials of construction and the employment of one very seldom used in Spain. The architect has striven to give the walls the precise thickness that may correspond to the necessary condition of stability and resistance, and where walls are suppressed he replaces them with iron columns or pilasters, properly spaced; this allows him to use thin walls, and to leave others open without complicating the construction; he abandons altogether all vertical wooden beams, and so economizes all the space he can.

The material is the "*sable mortier coloré*," made by M. Charles Stocker, Paris. It is an artificial stone of very good quality, that can be kneaded easily, and is furnished ground or in powder so that it can be moulded, the same as gypsum; it acquires later a great hardness. The walls are dressed with it, and mouldings, statues, adornments, and all sorts of high and low reliefs can also be made with it. Employing this stone mortar, it is unnecessary to paint the walls, and the color it acquires is more uniform than can be secured with any sort of stone. All the walls of the facades and all the work of sculpture of this villa have been made with it.



WHITAKER'S NEW WEIGHT MOTOR.

Artificial Marble.

M. Moreau produces an artificial marble from ordinary limestone in the following way: The stone is first carved into the required shape, and is then immersed in a bath of soap and a kind of varnish, which is floated on water and picked up by the stone. The stone is then immersed alternately in a bath of iron and copper sulphate, which permeates the body of the material, and when the absorption is complete the stone is immersed in hot water, which drives the coloring matter to the very heart of it. After this the stone is placed in a bath of zinc sulphate, and on being removed, after a few hours' immersion, is found to have the consistency and the specific gravity of marble. It is then dried in a warm chamber, after which it is ready for polishing.

WHITAKER'S NEW WEIGHT MOTOR.

The cut illustrates a clock-work mechanism designed to execute the heavier kinds of work, such as working pumps. The power is furnished by the two weights shown, one on each side, ropes from which are carried to and are wound around two drums, which form part of clock-work mechanism, with pallet wheel and escapement. Immediately below the wheels attached to the power drums are pinions with square-headed shafts, on which handles can be placed, and which are used to wind up the weights. The frame which carries the two pawls engaging the 'scape wheel is pivoted directly in a vertical line above the axle of the 'scape wheel, and as tooth after tooth of the wheel passes a pawl the frame rocks like the walking beam of a steam engine. Thus, as long as weights descend, the walking beam keeps up its motion. By an upwardly projecting arm, slotted, and attached to its axle, the motion of the walking beam is imparted to a bent pendulum rod, carrying pendulum bobs at its lower ends. As this rod swings back and forth, it moves, by a working arm, the pump brake, and operates the pump seen on the left side of the cut. Jerks and shocks are provided against by the use of a chain or other flexible connection between pump brake and pendulum rod.

This invention has been patented by Mr. Albert G. Whitaker, of La Porte, Ind.

UNDERGROUND CONDUCTORS FOR ELECTRIC STREET RAILWAYS.

The dangers and disfigurements occasioned by the overhead trolley wires, now so commonly used in this country, are well known. It is claimed by the managers of these railways that the overhead arrangement of the wires is necessary for the successful operation of the roads, and that no economical or practical system of underground conductors has yet been discovered. But this is far from the truth. There is no practical difficulty in placing the conductors underneath the track, where they are entirely out of the way and can do no harm. Roads thus provided can be worked with the same economy as the overhead trolley; the only difference is a somewhat increased first cost in the building of the road. But this is nothing when we consider the better security afforded to the public against loss of life and obstruction of the streets. The ugly telegraph and telephone poles are being removed from the streets in all our principal cities, and the time has now come to include the removal of the overhead trolley wires and their posts. One of the most successful examples of the underground electric system is seen in the operation of the Buda-Pest street railways, which ramify in all directions through that city. These railways have been in operation for several years, and their success, both from an electrical as well as financial point of view, is beyond question. We give an illustration of one of these lines, for which and the following particulars we are indebted to the *Railway World*. Considerable prominence has, perhaps deservedly, been given of late months to the system and details of the electric tramways operating in the capital of Hungary, and this for several reasons. In the first place, the Buda-Pest lines are, in respect of their permanent way design, quite unique, for there seems (at any rate in Europe) to be no other tramway that is operated successfully or practically by means of an underground conduit in which are placed the electric conductor wires. Secondly, the question of telephonic disturbance, due to electric tramways, has come prominently forward, and the Buda-Pest tramways have been cited as an example of the method most likely to give satisfaction to all parties concerned.

Yet another reason for the display of public interest in these lines may be given. As already noted in these pages, a prize of no small value has been offered by tramway authorities in the United States to the inventor or engineer who shall devise the best and most

THE BUDA-PEST ELECTRIC STREET RAILWAY.

practicable substitute for the overhead conductor wire or "trolley" system of electric traction for street purposes. It is thereby doubtless thonght that an efficient plan will be developed for the use of underground conductors in a condnit; at any rate, the Buda-Pest lines are instanced in this connection as proving suitable for all practical reqnirements. What may in some respects be considered good proof of the latter statement is given by the fact that quite lately it has been decided to adapt all the remaining tramway lines in Buda-Pest for electric traction upon a system similar to that which is herein described.

The electric lines in Buda-Pest have been built and equipped by Messrs. Siemens & Halske during the past five years, along four of the principal tramway routes of the city. So far as the street surface is concerned, they do not show any striking difference from ordinary street tramways operated by horses. There are no poles, or span wires across the streets, from which the electric conductors are hung in the "trolley" system; nor is there a third rail, or a third grooved slot. There are simply two rails for each track, upon which run the car wheels as on ordinary lines, and these are not employed in any way as part of the electric circuit for conveying current. The latter travels to and from the motor cars along conductors in an underground conduit or channel made of concrete, and carried underneath the whole length of one rail of the track.

The interior of the conduit or channel is egg-shaped, 13 inches high and 11 inches wide in the clear; at distances of 1·2 meters apart (say 3 feet 10 inches), cast iron frames, of square shape, are embedded crossways in the concrete. These frames have ribs or flanges 7 inches broad, of a profile similar to the concrete channel, and they serve not only to strengthen the latter, but also as supports for the rails. Moreover, the conductors along which passes the current for the cars are fastened to these flanges through the medium of suitable insulators. The bottom of the interior channel is about 22½ inches below the level of the rails. The latter are from the well known Haarmann Works, and in section resemble two ordinary I or girder rails, with the inner flanges removed. They are secured to the iron cross frames of the conduit by means of wrought iron angles, the two rails being placed side by side along each edge of the slot or gap in the conduit. The width of slot, or distance thus left between the rails—for access to the conduit channel and conductors—measures 1$\frac{5}{16}$ inches. This width has been chosen so as to allow the flanges of the wheels to pass easily around curves, and is the same as that used in ordinary rails. If the electrical connection only had to be considered, this width could have been materially reduced.

The current conductors of angle iron are led along the sides of the conduit channel, being fastened as already stated, to hollow insulators; one conductor serves as the lead, the other as the return. They both lie directly underneath the rails, and therefore cannot be seen or touched from above; and they are fixed sufficiently high above the channel bed to prevent contact with any water that may drain through, or lie in the channel. Sumps are provided at intervals to collect and retain such water and mud as may find access to the conduit, the overflow passing into the street sewers. There is no difficulty about this, nor any danger of water backing up from the sewers, as the base of the channel foundation does not exceed at any point a total depth of about 2 feet 4 inches from rail and street level. The second rail of each track might of course be of any desired section, since there is no conductor or conduit underneath. For instance, a flat rail could be used, and in such a case each track would have but one groove in the street surface—an undoubted advantage.

The cars do not outwardly present any different aspect to that of any ordinary street railway car; they have no drawbar arrangement at the ends, but on the top of each underframe sill is a buffer, which also serves to carry a coupling to allow of a trail car being attached. The car motor is placed in a closed casing between the two car axles; a system of double chain gear is employed to reduce the speed ratio, driving on to one of the car axles from the motor spindle. Quite lately, however, some of the cars have been equipped with single reduction gear, working direct from the motor spindle to one of the car axles. Under the end platforms of each car are placed four groups of resistances; by throwing these in or out any desired variation in the speed may be obtained. In practice, however, it is found quite sufficient to use two groups only. Regulation in this way is effected simply by means of turning a handle at either end of the car, according to the direction in which the latter moves; and the same handle, for that matter, serves to regulate the current through the motor, and change its direction of movement, thereby altering also that of the car.

The line potential is maintained at a pressure of 300 volts, and contact is made with the angle iron conductors in the underground channel by means of a travelling contact piece attached to each car. This is, of course, made of two metallic parts, one insulated from the other, and rubbing against the positive and negative conductors respectively.

There are employed 63 motor cars, 8 trail cars, and 9 large cars for the Friedhof steam line. The maximum speed is 9½ miles an hour; but a little more than this, about 11 miles, is reached in the suburban districts. On the narrower streets near the center of the city it is reduced to 6 miles; and at the crossings of important thoroughfares not more than 4 miles an hour is allowed. In consequence of the greater speeds thus attainable on the electric lines, as compared with horse cars, a very much larger daily car mileage can be kept up, with of course corresponding profits. Each car averages a run of from 75 to 100 miles per day of 16 hours.

Frozen Bottoms.

The *Agriculturist*, Summerside, Prince Edward Island, says: The dredging at Queen's Wharf here has disclosed a curious circumstance. Much of the bottom, where the dredging is being carried on, is frozen, there being about four inches of frost in some places 20 feet west of the wharf, and from 9 to 14 feet under the surface of the water. This has attracted the attention of a great many people, who are astonished to see great flakes of the frozen bottom brought up by the dredge. Different theories are advanced to account for this apparent impossibility, but the most plausible is that the frost follows down the timbering of the wharf until it strikes that part of the bottom adjoining the timbering, thence following the surface out quite a distance from the wharf. If any one doubts the truth of the above—which to some might seem like a particularly large sized fish story—he has only to visit the place when dredging is in progress, and obtain "ocular demonstration" of the fact set forth above.

[The dredging appears to have been in operation about the 1st of March or the latter part of the winter season, when the ocean water, circulating through the Northumberland Strait, may have been near its freezing temperature of 28° F. The current would carry this temperature by its change of 7 to 8 feet tidal height to a considerable depth—or to sweep along the mud bottom near the shore of Summerside. It is well known that fresh water in the land bordering on the sea shore moves toward the sea and permeates the soil beneath the salt water. In many places it appears as springs beneath the sea. The location of mud flats along a shore with fresh water percolating beneath would naturally saturate the mud with fresh water, which, by contact with the cold salt water during the winter season, would naturally become frozen to a small depth and remain frozen until the temperature of the salt water should rise above 32°. The phenomenon is probably not a local one, and may be found along the mud shores of any cold sea. The dredge only brought the fact to light in this case.—ED. S. A.]

The Synthesis of Sugar.

The attention of the French chemical and industrial world is at present attracted to a synthetical process of manufacturing sugar patented June 17, 1893, by Mr. Pellegrini, and the text of whose patent is published in the *Sucrerie Indigene et Coloniale* of February 6, 1894.

Chemists have been endeavoring for a long time to produce sugar directly, through synthesis, that is to say, by the combination of its simple elements. The Messrs. Thenard, father and son, were the first to make tentatives in this direction, but without success.

Mr. Maumene, upon submitting three gases—carbonic acid, ethylene and aqueous vapor—to the action of the convective electric discharge, obtained some substances of the sugar group, but the product contained no trace of ordinary sugar, or saccharose, the chemical formula of which is $C^{12}H^{22}O^{11}$. It was a mixture of various glucoses, which differ from saccharose in an additional molecule of water, and the formula of which is consequently $C^{12}H^{24}O^{12}$.

Mr. Fischer, a well known chemist, recently undertook some remarkable experiments upon the synthesis of sugars. Upon causing acrylic aldehyde, or acroleine, to undergo numerous substitutions and transformations, he obtained some glucoses, and, particularly, levulose having absolutely the properties of the levulose extracted from fruits or inverted sugar. But he was unable to succeed in ascending from levulose to the sugar of the cane or beet, since it was impossible for him to rid the levulose of the molecule of water, the elimination of which would have given common sugar as a result.

Ordinary sugar is, as we know, the product of the combination of three simple elements, carbon, oxygen and hydrogen, associated in the following proportions: 12 molecules of carbon, 22 of hydrogen and 11 of oxygen, whence its formula $C^{12}H^{22}O^{11}$. It is Mr. Pellegrini's opinion that, before uniting to form saccharose, the carbon, oxygen and hydrogen combine with each other in pairs, constituting carbonic acid (CO^2), ethylene (C^2H^4) and water (H^2O); that these three bodies then unite in the following proportions: 4 molecules of carbonic acid, 3 of ethylene and 3 of water; and that the result of the combination is saccharose. This explanation, it must be admitted, corresponds to the formula of ordinary sugar. We can, in fact, write the following chemical equation, which exactly translates Mr. Pellegrini's theory:

$$\underbrace{4\ CO^2}_{\text{4 carbonic acid.}} + \underbrace{4\ CH^4}_{\text{4 ethylene.}} + \underbrace{3\ H^2O}_{\text{3 aqueous vapor.}} = \underbrace{C^{12}H^{22}O^{11}}_{\text{sugar.}}$$

It will be understood that the three gases, carbonic acid, ethylene and aqueous vapor, are capable of combining in such a way as to produce sugar only under certain peculiar conditions. Mr. Maumene had recourse, unsuccessfully, to convective discharge of electricity; the Italian chemist utilizes the phenomenon of osmosis. Into an iron box divided into two compartments by a partition of pumice stone, boiled in a solution of chloride of platinum to increase its porosity, he introduces on one side a current of carbonic acid, and on the other a current of ethylene, while aqueous vapor is made to circulate in the apparatus intermittingly. The three gases traverse the pumice stone through osmosis and combine therein, and the product of the combination, under osmotic action, is a white sirup that it suffices to concentrate in order to obtain, as Mr. Pellegrini claims, pure sugar. Such, briefly, is the principle of the apparatus, which, according to the inventor, permits of effecting the synthesis of crystallizable sugar in starting from carbonic acid, ethylene and water.

As for the possibility of producing sugar by this process, it appears impracticable to several scientists who are familiar with theoretical speculations, on account of the schematic position attributed to sugar, and which is due to the decompositions that the latter undergoes in the presence of reagents. Chemistry, which, through theoretical considerations, has led to the synthesis of so many substances of an everyday industrial application, such as alizarine, indigo, etc., will certainly, after persevering efforts, succeed in producing sugar also, but whether the problem is practically soluble by the Pellegrini method remains yet to be seen.

Wooden Water Mains.

A recent paper read before the American Society of Civil Engineers by James D. Schuyler, member of the American Society of Civil Engineers, on "The Water works of Denver, Col.," contained some very interesting observations and figures relating to this subject. He states that sixteen miles of thirty inch wooden conduit were constructed in that work, in addition to a considerable length of forty-four inch pipe. The timber used was California redwood, and the thirty inch conduit was constructed to stand under a head of 185 feet. We understand from the paper named that the total average cost of the thirty inch pipe was $1.36 per lineal foot, of which about forty-eight cents constituted the cost of trenching and back filling. A gang of eight to sixteen men laid from 150 to 300 feet of the same size conduit per day. These mains were composed of staves dressed very smooth to cylindrical sides and radial edges, and were held to the cylindrical form by mild steel bands placed at a distance apart depending upon the head, but never exceeding seventeen inches. The pores of the wood are filled with the water under pressure, so that it oozes through to a slight extent, thus realizing the condition for permanent preservation. The pipe is framed in the trench, and all handling in full-sized sections is avoided; at the same time the interior finish is so smooth that the most advantageous conditions of flow are secured. Mr. Schuyler estimates that the use of these wooden conduits effected a saving of over $1,000,000 in this particular work.—*Fire and Water.*

New Atlantic Cable.

A new telegraph cable is now being laid from Waterville, Ireland, to Nova Scotia. The entire cable will be about 2,000 miles long. The Faraday, not being large enough to carry the whole cable, will drop the shore sections, about 500 miles, first, and then lay the deep sea cable, which is smaller than the shore ends. The cable is guaranteed to afford 33⅓ per cent improvement in speed over the other cables in use by the Commercial Company.

This will insure transmission at the rate of thirty words per minute. The cable is much larger than any ocean cable hitherto made. The Nova Scotia end has been provided with additional protecting armor to prevent its being broken by the anchors of fishing vessels.

Test of Projectiles.

At a recent government trial of projectiles at Indian Head, half ton missiles were fired from the 13 inch gun. The target was a 12 inch nickel steel plate, and two shells went entirely through it, one of them breaking to pieces and the other remaining intact after it had cleared the plate. The Carpenter shell was unhurt by the operation of rushing its half ton mass through a foot of solid steel. The 17 inch armor for the battle ships is yet to be tested.