FRENCH PAVEMENTS.

There are few things that more forcibly strike a stranger in Paris than the general excellence of the paving of the roadways. It is a matter of notoriety, and perhaps it is true, that the granite block paving, often called the "Belgian system," was abandoned to a large extent in Paris because the blocks furnished a convenient material for the barricades with which the insurgent population of the city occasionally amuse themselves and bother their rulers. There yet remains a large amount of block pavement, and the macadamized road is still common. So far as these are concerned there is nothing particular to say except that they are kept in excellent condition by repairing whenever a portion begins to grow faulty, and by sweeping regularly every night and watering every day when required, and very often when there seems to be no necessity. The sidewalks are swept very early, and the gutters are all thoroughly washed out and swept clean with brooms every morning.

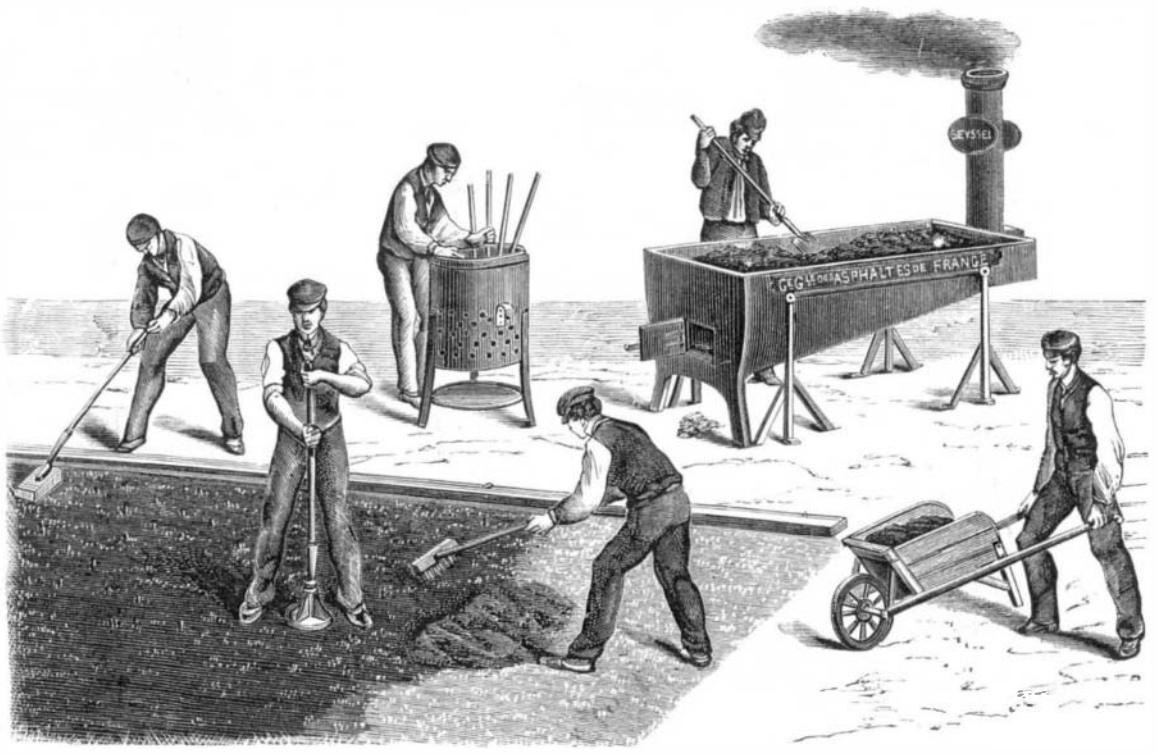

Fig. 1.—SYSTEM OF LAYING DOWN THE ASPHALTE COMPRIMÉ.

These matters cannot be overlooked, but they involve questions of taste, care, and the economic administration of public funds, perhaps a more important question to us than most of the matters which occupy the time of Congress. It is not of them that I propose to write, but of the asphalt pavements which are fast becoming the principal mode of paving in the city. The substitution of asphalt for blocks is going on all the time.

There are several companies of Paris which execute this work by contract, perhaps the largest being the "Compagnie Générale des Asphaltes de France," which claims to have the sole concession for this country of the products of the mines of Seyssel, and of the Val de Travers in Switzerland.

The asphalt paving is of two kinds: the *asphalte comprimé*, that is, beaten and compacted with hot rammers; and the *asphalte coulé*, in which the material is spread with trowels.

We may consider them in this order. This company has laid their *asphalte comprimé* in 158 of the streets and places of Paris, between 1855 and 1877. This shows the period within which the great change in the system of paving has been effected. Beginning under the Second Empire, it is still in progress.

The *asphalte comprimé* is especially employed around the churches, schools, theaters, concert halls, banks, and public buildings, on account of its freedom from noise; and generally for the additional reasons of cleanliness and salubrity in the places mentioned and also in the main streets of the city. In the fashionable drives macadam is preferred on account of its freedom from slipperiness, and on the quays and warehousing quarters of the city the block system yet remains a favorite.

In the preparation of a good concrete foundation for asphalt pavement, as practiced in Paris—and the lesson cannot be as well learned elsewhere—four things are necessary:

1. Materials of good quality. 2. Used in proper quantity. 3. Mixed energetically; and 4. Allowed proper time to consolidate.

Not one of these is to be dispensed with; the second and fourth may not be inflexible, as a difference in the quality of articles procurable in different countries or cities may require special treatment in the working of it.

A general idea of the method adopted in Paris may be gained from an observation of the process as pursued in the Rue Scribe, where I observed them to be taking up one half of the granite block pavement, from the middle of the street to the gutter stones, preparatory to laying down asphalt. The reason for taking up half at a time is manifest, as the street is a busy one and could not be entirely spared even for a while.

The bed of gravel found beneath the stone paving was considered sufficient and was not disturbed, the first operation to be described consisting merely of placing a layer of concrete upon it to form a bed for the asphalt. There are but three materials used and but three tools. The materials are: Gravel screenings or sand; a silicious gravel in pieces, say, from ½ inch to 3 inches in diameter; a gray hydraulic lime, usually Portland cement. The tools are: Pointed shovels; two rakes with long bent prongs; two flat beaters, about 18 inches square and with handles set in obliquely. To this may be added six wheelbarrows, holding about a bushel each, and 18 water buckets, of 2½ gallons each.

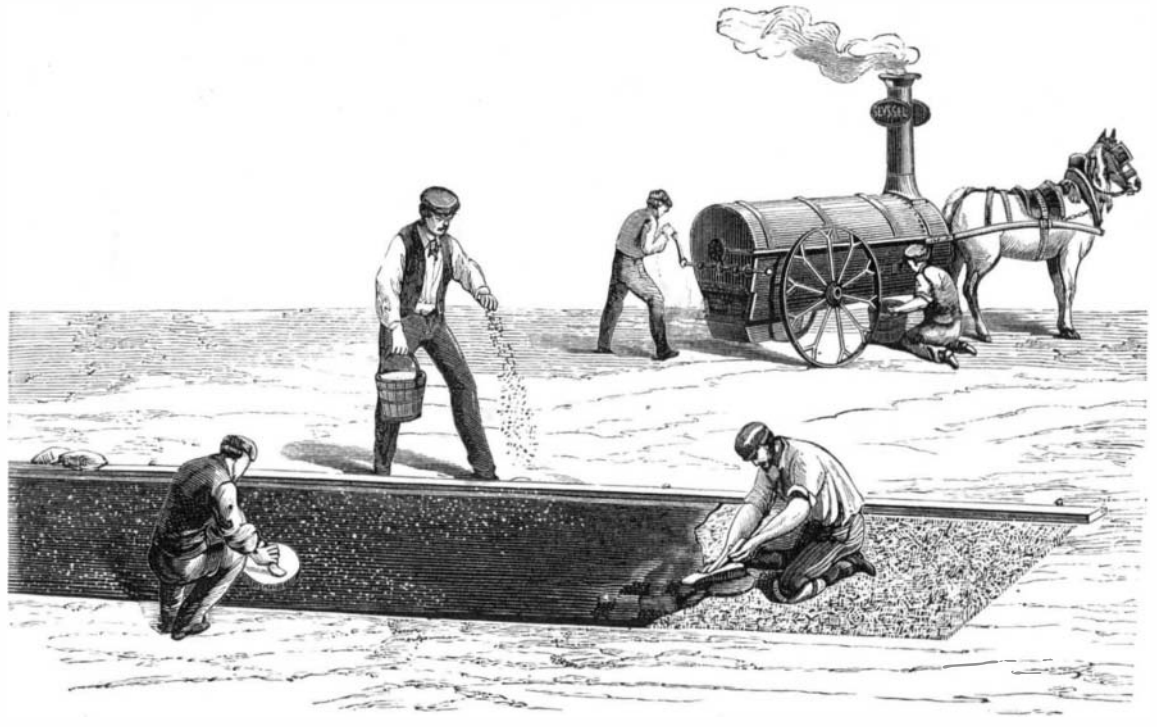

Fig. 3.—LAYING DOWN THE ASPHALTE COULÉ.

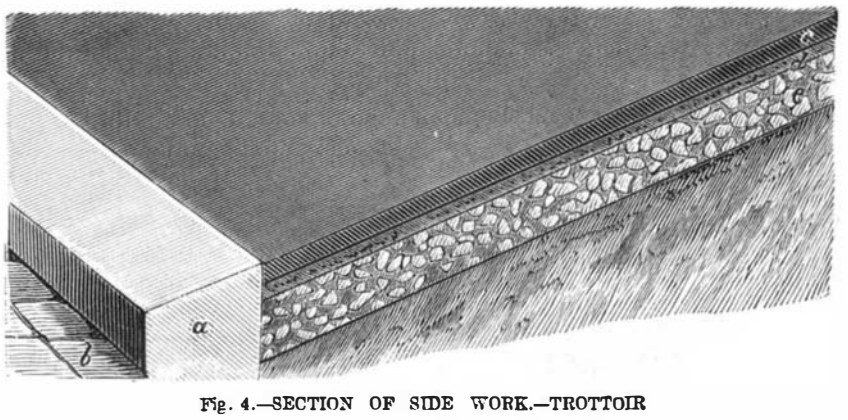

Fig. 4.—SECTION OF SIDE WORK.—TROTTOIR

a, curb; *b*, street; *c*, asphalt; *d*, mortar; *e*, béton.

Twenty men formed the gang under a foreman, who worked diligently in giving the final shape to the surface of the concrete, preserving the proper camber of the street, gauge pegs being driven into the gravel foundation to work by, their tops representing the future surface of the asphalt. The illustration shows a smaller gang of men, but I give the actual number observed, as the proportion is a part of the accuracy of description.

Carts brought the various materials from the river and dumped them alongside where they were needed, on the pavement of the undisturbed half of the street. The water was obtained by turning on a hydrant and damming, flooding the gutter on the side of the street just mentioned.

The work now proceeds as follows: A man dumps a wheelbarrow load of sand and another spreads it out to 4 feet diameter. A bag of 3 pecks of lime is emptied on to it and spread evenly. On this 3 barrow loads of silicious gravel are emptied, and the heap is trued up into conical form by shoveling from the foot of the heap and throwing it on to the apex. The materials (in the case observed) are damp, and the lime clings to the gravel where it touches. The heap is torn down and built up in a spot alongside, the effect being to mix the materials of three different finenesses. The heap is presently flattened out to 6 feet diameter and a bucket of water distributed over it. As the middle is the wettest a cone is made at the center, so that a second bucket of water reaches the outside ring of the material. The conical heap is again constructed, and about a quarter of a bucket of water splashed by the hand upon the outside—the outlying portions of the spread mass as it lay previously upon the ground.

It rests thus a certain time, but a few minutes, and then is torn down, beginning at one side and throwing it, shovelful by shovelful, into a new location, a man with the three pronged rake, like a manure hook, working it energetically and unceasingly as each new shovelful arrives at the heap. This mixing is a very important matter, as it insures that every particle of silicious rock shall be covered with the lime, and the heap now is, instead of the yellow of the flint gravel, a uniform gray. The water is only sufficient to cause the parts to adhere, and some little (without attempting to trace the chemical reactions) lost as such in the attack of the lime on the silex and in slaking.

The heap is ready in a few minutes to be removed in barrows and dumped on the line of working, where it is spread with shovels and with a second one of the three tined rakes. Here the eye of the master is called for, and he gives it the final shape, so far as the shovels are concerned, due regard being paid to the gauge pegs.

A man with the flat beater compacts and levels the surface by his blows, and the concrete is then surfaced with an inch thick coat of hydraulic lime mortar laid on with a trowel, and on this a coat of loose sand, which roughens it and forms a bond for the asphalt, which is afterward laid hot upon it, rolled and beaten. Of this presently. The sand appears to become partially imbedded in the yet soft mortar, and is in turn grasped by the asphalt. If the final asphalt were laid upon too smooth

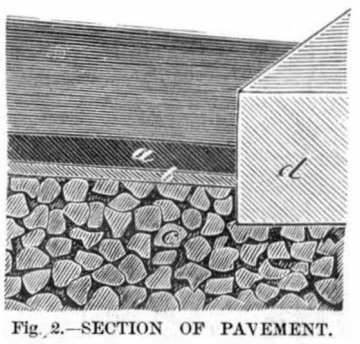

Fig. 2.—SECTION OF PAVEMENT.

a, asphalt; *b*, mortar; *c*, béton of Portland cement and gravel; *d*, curbstone.

a surface it would be apt to fail in adherence and to flake off. Its mere adhesive quality is aided by a mechanical bind to the particles of sand which are, so to speak, riveted in the mortar, and it in the concrete.

I have been thus particular in stating the matter in order that persons disposed to try the experiment may have some to data save them time in experimenting.

The result of the carefully executed work would repay any city or corporation which should be in need of smooth, clean, and easily repaired ways.

After a few days, the foundation, having been carefully guarded from disturbance by travel, having become fully set, the asphalt compound is brought hot in carts, and being transferred to wheelbarrows, dumped upon the surface of the foundation concrete and spread by rakes to a thickness of about 4 inches. It is then lightly pounded by a very hot iron rammer with a circular face 10 inches broad. A furnace is kept on the sidewalk for heating the rammer. A second ramming with hard blows of the same rammer then takes place, condensing the asphalt to but little more than one half its thickness apparently, and causing its intricate union with the rough surface of the layer beneath.

The final smoothing is given by a hot iron block, which is pushed and pulled over the surface and burnishes down the elevations and rough marks of the pounders.

The *asphalte coulé* is laid with a trowel upon the concrete basis and is not pounded, as in the case of the *asphalte comprimé*. It is used for sidewalks, platforms, and waiting saloons of railways, prisons, skating rinks, baths, warehouses, breweries, and manufactories of all kinds.

To make a square meter of surface, 15 millimeters thick, it is necessary to use 1½ kilo. of bituminous minerals, 23 to 24 kilos. of Seyssel mastic, and 13 to 15 kilos. of washed, dried, and sifted gravel. 1,200,000 square meters of *asphalte coulé* have been laid down in Paris by this firm.

A large portion of the floor area in the Exhibition building, Champ de Mars, is covered with this material. Many of the covered ways in the buildings, the transverse passages, and the walks under the verandas are floored with this material marked off into squares so as to resemble tiles or marble slabs.

The material is also wrought up into the form of tiles and laid upon a soft and level bed of concrete, melted mastic being poured into the joints and fashioned by the rule and jointing iron. The prices of these tiles are as follows:

Thickness, metric.	Weight per square meter, kilos.	Price per square meter, francs.
0·015	36	2·50
0·020	48	3·35
0·030	72	5·00
0·040	96	6·70
0·045	108	7·50
0·050	120	8·35

The two lighter descriptions are used for walks, stables of the smaller animals, thrashing floors, coach houses. The medium thicknesses for stables and cow houses. The thickest for the driveways of hotels and paving of courts serving for the passage of loaded vehicles.

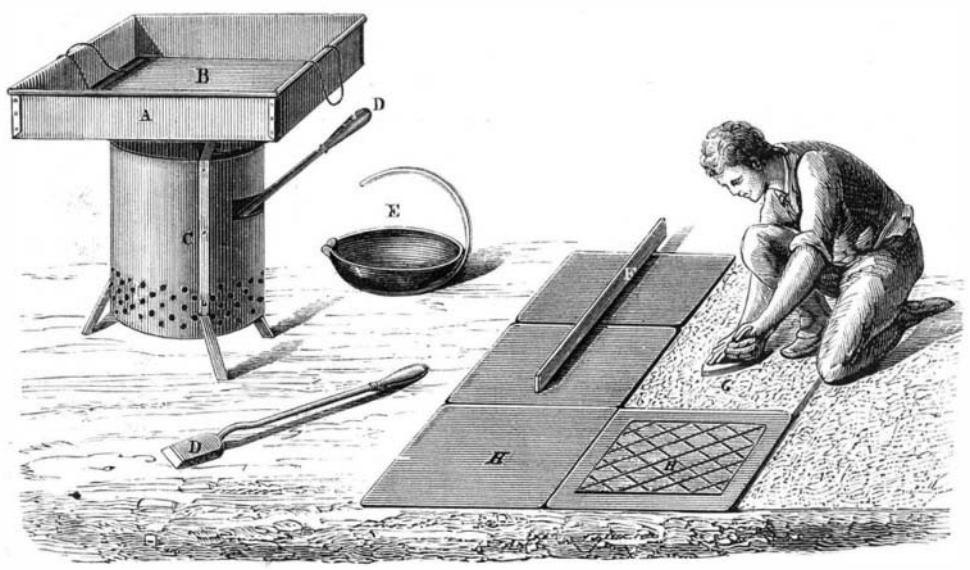

Fig. 5.—IMITATION OF TILE PAVEMENT (*carrelage*) IN ASPHALT.

A is the pan, B is the woode plate in the hot w ter pan where the tiles are heated; C is the furnace; D is the jointing iron; E is the pan for melting and pouring the mastic for the joints; F is the wooden rule; G, preparing the foundation of beton; H, the tiles, smooth or channeled.

The bridge over the Seine at Elbeuf has 1,200 square meters of *asphalte comprime* surface laid upon concrete above the joists and iron arches. It affords another instance of the mode of application, the joists being supported upon the iron trusses.

The foundation of bitumen or asphalt when properly laid is proof against permeation by water or vermin, and is much used in the manner indicated.

The coating is of mastic mixed with sand and applied hot over a surface of mortar of silicious sand and hydraulic lime.

Cellars and caves (silos are much used in France for storing roots and grain. It is the old Eastern and Southern practice, and seems to have been adopted from abroad. At St. Ouen, near Paris, are immense subterranean storehouses for grain, where it may be kept undamaged for years.

Corn fodder (maize) is put away in large quantities, in silos as much as 60 feet long, being packed in tightly and slightly salted. The circulation of air is prevented, and it affords green forage all winter and early spring.

Roots are kept with less difficulty for animals, and the beet root, which is the principal source of sugar in France, is stored in enormous quantities, so as to spread the process of extraction over a larger period of the year.

The silo shown is especially constructed for the conservation of the pulp of beets.

A layer of asphalt affords a means of excluding the water in wet or damp foundations from the upper part of the structure, as in the case of the stratum, *a*, interposed between two courses of bricks or masonry.

The above will give some idea of the variety and extent of the uses to which asphalt is applied in France, and especially in Paris, and may be useful to some who read your valuable paper.

EDWARD H. KNIGHT.

Paris, June 28, 1878.

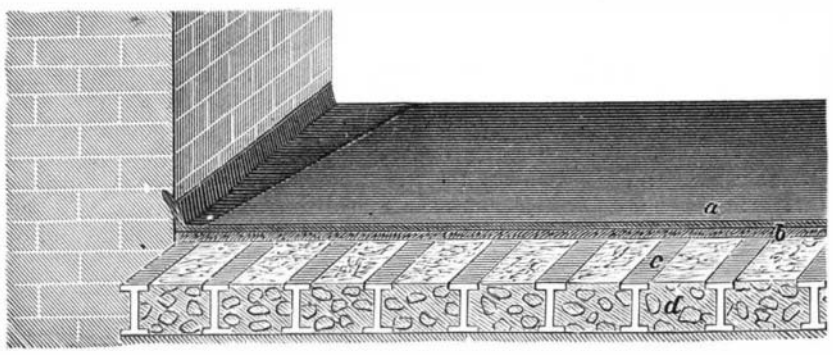

Fig. 6.—TERRACE OF CHATEAU DE CHAMBORD,
a, asphalt; *b*, mortar; *c*, joists; *d*, masonry filling.

Fig. 10.—COVERING FOR CASEMATES.
(Port de Tourneville, Havre.)

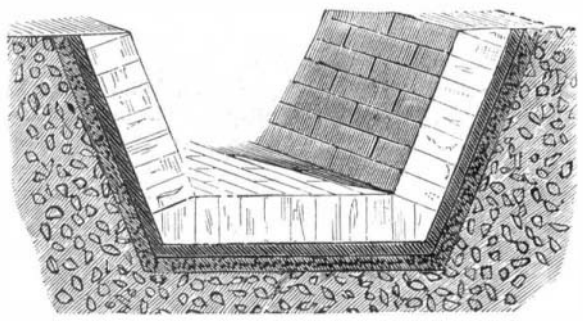

Fig. 11.—SILO FOR BEETS, PULP, OR GRAIN.

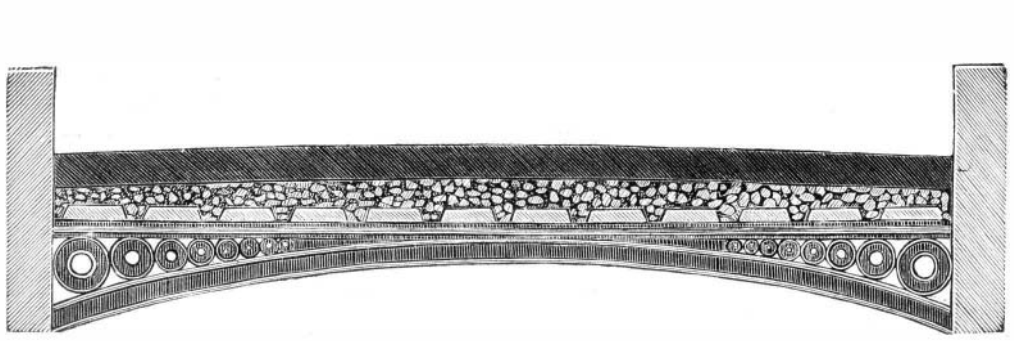

Fig. 7.—BRIDGE OVER THE SEINE AT ELBEUF.

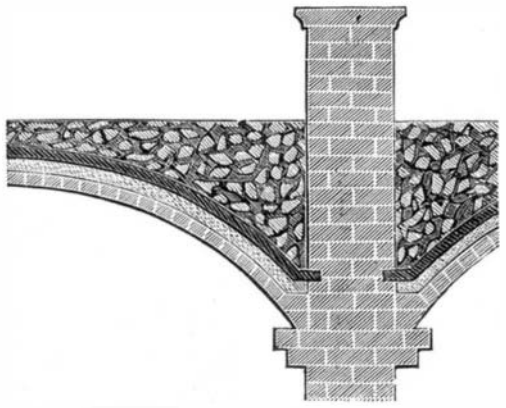

Fig. 9.—WATERPROOF COVERING FOR ARCHES.
(Bridge over the Loire near Tours.)

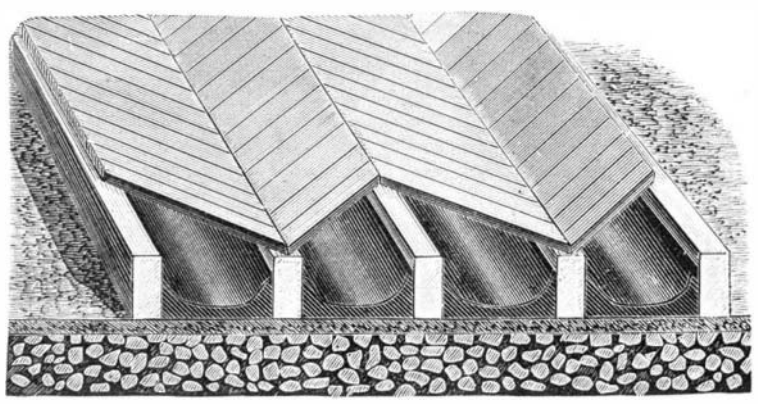

Fig. 8.—JOISTS AND FLOOR UPON A FOUNDATION OF BITUMEN AND CONCRETE.

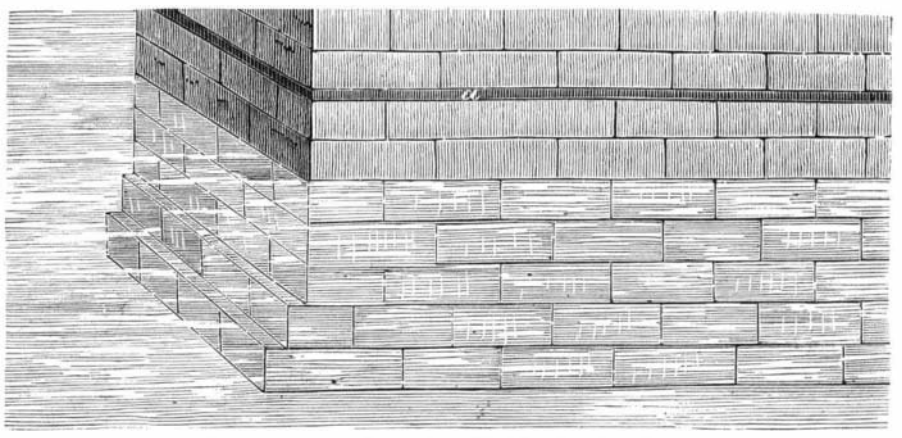

Fig. 12.—WALL CONSTRUCTED IN THE WATER.