DISTRICT SYSTEM WITH 400 CONSUMERS.

	£.	s.	d.
Seven per cent. interest on cost of fixtures=£41 1s. 11d.	2	17	6½
Two per cent. depreciation and repairs.....	0	16	5¼
Heat bills, for steam supplied.....	9	9	0½
Total.....	13	3	0¼

DISTRICT SYSTEM WITH 1,000 CONSUMERS.

	£.	s.	d.
Seven per cent. interest on cost of fixtures=£200.....	2	17	6½
Two per cent. depreciation and repairs.....	0	16	5¼
Heat bills, for steam supplied.....	8	3	6½
Total.....	11	17	6¼

COMPARISON OF COST.

	£.	s.	d.
Individual furnace system.....	23	7	5½
Individual steam system.....	40	9	7
District system with 400 consumers.....	13	3	0¼
District system with 1,000 consumers.....	11	17	6¼

In a recent report the company state that they have over 200 buildings on their line, including 160 engines for power, and that they supply the steam for running the engines of the *Times*, the *World*, *Commercial Advertiser*, the *Tribune*, and five other newspapers, and a large number of printing offices, the new Produce Exchange with nine elevators and electric lights, etc. etc., and that none of these buildings have boilers on the premises. They go on to say: "To mention one thing in detail, cooking may sound small; it is and will be, in fact, one of the very largest in its consumption of steam. . . . There is one restaurant which has used our steam for eighteen months, Messrs. Smith & McNeil, Greenwich Street, and which buys from this company \$15,000 worth of steam per annum. This is probably the largest restaurant in the world, serving about ten thousand meals per day. Messrs. Nash & Crook, in the *New York Times* building, is the next in size in the city, and one of the best known. The proprietors of both these immense establishments say they would not go back to their former mode of cooking if the coal were furnished to them for nothing." Steam will be supplied to heat buildings, supply power for cooking and laundry work, for baths, and many other purposes requiring water as well as steam, for melting snow in the streets, and for extinguishing fires. Steam will be supplied by meter. The system is expected to spread all over the city, and the company say that, although having been so short a time in operation, they have reached a paying basis. The most recent development in connection with the New York system is that of supplying steam for electric lighting purposes. It was found that there was comparatively very little demand from six o'clock at night until six o'clock in the morning, and there was consequently a waste in blowing it off every evening. To prevent this waste, the company propose to supply steam for running electric light engines during the night, and the cost of lighting should be much reduced in consequence. To prevent misunderstanding, it might be well to mention that there was another company in New York, which laid pipes in the streets, on some other system, for the supply of steam, but this company failed after having repeated accidents and explosions in the streets. The annexed list gives particulars of very nearly all the systems put in, the data in most cases having been kindly furnished by the companies themselves or from published reports. At Springfield, Mass., the gas company there took the matter up in 1878, and have been successful from the start, having utilized waste heat from their retorts, and also coke made on the premises. They put in a very short line to commence with, gradually extending it as consumers increased. Most of the systems are in operation for seven months, and at Denver eight months, out of the twelve. At first the street mains were only laid from 3 ft. to 3 ft. 6 in. under the ground, but it is now thought that this is not deep enough, and double this distance is recommended, so that the frost and snow will not increase the condensation.

In conclusion, it appears as if with the past experience, gained at the expense of several failures, this system of heating will in the future be adopted in many places; the two last systems reporting commercial success after being in operation only one winter.

THE THERMOMICROPHONE.

THE new microtelephonic system of Dr. Ochrowicz is composed of two instruments which, in a paper read during the past month before the Societe Internationale des Electriciens, were thus described: The magnetic receiver differs from all other apparatus of its kind: (1) By the employ of two vibrating plates equally polarized by the same magnet, and embracing the two extremities of the coils; (2) by the mode of attachment of the telephone case, which, instead of being immobile, also vibrates, and is fixed only by means of the second vibrating plate. An examination in detail demonstrates the perfect utilization of the magnetic field and the absolute concordance of the vibrations of every part of the system.

The thermomicrophone is, it is averred, the most powerful of all the telephonic transmitters. It reproduces sound in a loud tone, even when the speaker is to some degree distant from the instrument, while music and song can be so transmitted as to be heard by a large assemblage of people. The microphones with which we are acquainted may be classified as follows: (1) The Edison, which embraces all the transmitters acting by pressure; (2) and the Hughes, comprising all those which act by means of vibrations, and which have always a certain number of carbons, variously disposed. The thermomicrophone occupies an intermediate place, being acted upon partly by vibrations and partly by pressure. The principal feature of the system, however, is the introduction of heat. Generally speaking, all microphones are more or less heated during action, and the thermal effect increases their sensibility; but there is one great disadvantage attending it—the heat renders the apparatus irregular. The difficulty has

been to regulate the instrument so as to allow for the generation of heat and guard against its disturbing influence. The action of the microphone is, as has been said, irregular; its resistance is then almost nothing, but from the moment that a current of 18 to 20 milliamperes passes through it, it becomes heated, its resistance augmented (to about a mean of 200 ohms), and the apparatus will be found regulated for transmission.

Under these circumstances, it is evident that the exterior temperature will assist or impede the effective working of the transmitter; but by the application of a layer of insulating material in the interior of the microphone itself, Dr. Ochrowicz has been able to maintain a temperature of from 13° to 39°, which is sufficient for all practical purposes. At the conclusion of the paper the thermomicrophone, actuated by five Leclanche cells, was placed in a room on the third floor of the building, and the receiver upon a table in the conference room some 50 meters distant. The result seems to have given great satisfaction, the articulation of the instrument being so distinct that the three hundred members of the society were enabled to hear it with perfect ease.—*Electrician*.

ILLUMINATION OF FOUNTAINS BY THE ELECTRIC LIGHT.

THE arrangements by which the central fountains at the recent Health Exhibition were illuminated from below will be understood by referring to the accompanying figure, from *Engineering*, which is rather an illustrative diagram of the method of illuminating the central fountain than a sketch of the actual apparatus employed. Immediately below the nozzle, J, of the central jet is fixed a circular plate of glass, G G, which forms a water-tight window in the roof, R R, of the chamber under the island, and below this, and co-axial with the jet, is fixed a sixth order cata-dioptric holophote, H, about 23 in. in diameter, built up of six reflecting zones and a central Fresnel lens constructed of a middle lens surrounded by two refracting rings. The focal length of this holophote is 150 millimeters, and it condenses all

the upper rays emanating from a source of light at its focus (which lies in the plane of its outer zone) into a vertical cylindrical beam of the same diameter as the outer reflecting belt. Near the focus of this holophote is placed a simple arc lamp, L, carrying a pair of carbon rods which are regulated by hand by a simple rack and pinion adjustment; the lower pencil is one of Siemens' 18 millimeter cored carbons, having a hard shell and soft core, and the upper pencil is hard carbon 16 millimeters in diameter. In this case the lower and cored carbon is the negative, in order to get the light-giving crater at the bottom. The lamp is, for this reason, set at an angle with the horizon (but not so great as that shown in the diagram) and is attached by a bracket to a sliding block of wood, while its focal adjustments can be made. The four corner jets are illuminated in a precisely similar way, except that in the place of a holophote a horizontal Fresnel lens of 20 in. in diameter is employed, the lamp and other arrangements being exactly the same as for the central fountain.

In each of the two water-towers and fitted with suitable optical apparatus are three Siemens focus-keeping lamps, each placed in such a position as to throw a concentrated beam of light through the axis of a horizontal glass tube which projects over the ornamental basin and through which a stream of water will be allowed to pass; the effect of this will be that six luminous streams of water will flow from the top of the towers into the lake below. All the lamps, both in the island and in the towers (that is to say, eleven lamps), are worked in parallel circuit from a new form of Siemens direct current machine, to which we shall refer later on, and the resistances of the lamp circuits are so balanced by means of wire and ribbon resistances (fixed in a small hut in the grounds), that the six Siemens lamps, each taking 20 amperes of current, and the five hand lamps, each taking 60 amperes, receive neither more nor less than their proper working current.

The electric light apparatus within the clock-tower consists (1) of a hand-adjustment lamp, fixed in a military holophotal projector, which is capable of being directed in different directions both in altitude and azimuth, and deriving its current from a Crompton-Burgin machine; this apparatus is fixed just above the clock face, and projects its beam through a window on to the fountains. (2) A second military projector fixed above the clock room and at the foot of Edmund's mast light. In this is a Siemens focus-keeping lamp deriving its current from a Siemens alternate current machine. (3) Two Brush focus-keeping lamps, one on each side of the clock-face, and each in the focus of a silvered parabolic reflector which can be directed to

different angles of altitude and azimuth. All these lamps, as well as those on the island and in the towers, are fitted with suitable switches by which they may be thrown in or out of the circuit at any moment. Various colors and combinations of colors are given to the beams by sheets of colored glass or gelatine plates interposed in the beam in front of lenses, and the rapidly changing effects of color are produced by a set of differently colored gelatine plates drawn in succession through the path of the beam.

The electric signaling apparatus consists of a key-board of thirty-six pushes fixed in the clock-room, from whence the orders are given, and these are connected by wires with the indicating apparatus in the island and on the water-towers. This latter apparatus consists of two electric bell indicators, one for giving instructions respecting the valves, and the other for controlling the lights. The eight tablets in the "water indicator" are labeled respectively "Steady," "Red," "Green," "Blue," "White," "Black," "Center," and "Yellow," and refer to the valves which regulate the different systems of fountains, and which, as we have described, are painted with the above colors in order to readily distinguish them and to facilitate the signaling. The "Light indicator" has six tablets, labeled respectively "Center lamp," "4 Side lamps," "Blue," "Yellow," "Red," and "Green." There are besides several electric bells, one large bell labeled "On," and a smaller bell "Off," indicating that the water or the lights are to be turned on or off, the signals on the indicators showing to which it refers; and, in addition to these, there are bells of different tones for calling attention or for answering an order. The pushes on the key-board correspond of course with the tablets on the indicators, but an almost infinite number of orders can be conveyed by combining two or more signals together, and Sir Francis Bolton employs this means to indicate to the assistants in charge of the valves and lights any one of the multitudinous effects which he may at any moment desire to produce.

CONCRETE AS A BUILDING MATERIAL.*

By THOMAS POTTER.

THE reintroduction, about twenty years since, of concrete as a material for building walls received at that time considerable impetus from two causes: 1. The invention of appliances or moulds for forming the structural portions of buildings of a monolithic character. 2. The superior properties possessed by Portland cement as a matrix in place of ordinary lime. And as an important addition to our stock of building materials, concrete would undoubtedly have received more public attention, and become more generally adopted, if it had not been subjected to the fate of most inventions; for, as usual, we were told that concrete was to be the savior for every sore in building operations; there were to be no more damp walls or tumble-down walls, for it was impervious to moisture, and I don't know how many times as strong as any brickwork. Mechanics would be no longer needed, for the appliances could be fixed and the work executed by any ordinary laborers; while its cost was less than one-half that of the commonest specimen of brick walling.

Many other improbable statements of a similar character were made public, one enthusiastic concrete builder offering in a trade journal to prove, or otherwise to forfeit a considerable sum of money, that concrete was ten times stronger than any other building material; while, on the other hand, a concrete building in course of erection by the same individual soon after collapsed without any apparent cause whatever. But the remedy for all this clap-trap was simply a question of time, and, as a matter of course, we do not now hear such extraordinary statements as these put forth. Concrete is now simply recognized as an important addition to our building materials, and a valuable factor in construction under certain conditions, and its employment for many purposes in connection with building is perhaps more extensive and more varied than many are aware of. Its introduction as a wall-building material served a good purpose in certain ways.

For example, previous to then, little care or trouble was taken in many instances about the concrete used in foundations, the fact being that no means existed to test its quality or strength after it was buried in the trenches dug for its reception. The usual formula of a certain proportion of Dorking lime and Thames ballast, to be well mixed and thrown in trenches from a certain height, was the sum and substance of many specifications for ordinary buildings, and in some instances is so even now. But the quality of the concrete used in foundations is equally as important a matter as if the walls themselves were to be constructed of the same materials, especially with buildings of considerable altitude, or where the ground is of a treacherous character. The knowledge gained from experience of the immense strength possessed by good concrete has engendered various considerations in connection with the ordinary system of executing foundations and footings of walls; for instance, assuming that the concrete in foundations is of first-class character, it is submitted whether brickwork footings which are intended to distribute the weight of the walls over a greater superficial area, and which are not calculated to be of any practical use in strengthening them laterally, are of any service whatever when the sustaining medium (the concrete) is incapable of yielding from the superincumbent load it has to bear.

And, again, whether it would not be practicable in many cases, as, for instance in clay soil, to excavate the ground of a wedge-shape section, the large end downward, reducing the thickness of the concrete at top to that of the wall itself, or somewhat more, and increasing it at bottom so as to give the foundations themselves a broader base, and thereby more correctly define, without any increase of materials, the principle of correct distribution of strength. Practically the foundations of walls should not be dependent upon the ground for lateral support; they should be strong enough to permit the soil on either side to be excavated to the bottom of foundations, if needed, after the building has been erected, and without a possibility of danger. But how many new buildings would be safe under this ordeal? The cost between good and bad concrete is so little that there is no excuse for an inferior material for foundations in any building with a claim to substantiality.

* A paper read before the Society of Architects, March 17, 1885.

There are many opinions and many delusions in connection with the apparently simple subject of "concrete"; for instance, with regard to the size of the aggregate, it is usual to specify that it shall not exceed certain dimensions, usually that each portion shall pass through a 2 in. or sometimes $1\frac{1}{2}$ in. ring, and even 1 in. ring or screen is not an uncommon stipulation, whereas, in point of fact, the larger a certain portion of the aggregate may be the better the concrete, simply because the larger the particles composing the aggregate, the less superficial area to be cemented by the matrix. In other specifications it is stated that the aggregate shall be of a certain uniform size, with a fixed proportion of sharp clean sand mixed therewith. This, especially if cement is to be used as a matrix, is entirely wrong; and another plan is to instruct water to be added to a measured quantity of aggregate, and the amount of the former needed to fill up the crevices of the latter is supposed to represent the proportion of sand necessary to add to the bulk. This is a fallacious system, because the sand could not by any means occupy the minute crevices available for water.

Practically, what is required for an aggregate in good concrete, as far as size is concerned, depends upon the thickness of the foundations, or walls, or floors, or whatever purpose it is required for, and no hard and fast line can be drawn for these relative dimensions; but whatever the size of the largest, the smallest should never be finer than Thames sand. The thicker the wall or foundation, the larger a portion of the aggregate may be, because homogeneity is then rendered more easily attainable, the only limit to size being that homogeneity must be the first consideration. Approximately, it might be safe to specify for work up to 9 in. thick all that would pass through a $2\frac{1}{2}$ in. ring, and above that thickness through a $3\frac{1}{2}$ in. ring, conditionally that the intermediate quantities were so varied both in size and shape that, without any undue proportion of the coarse sandy element, the whole should, when subjected to gentle impingement, be rendered perfectly homogeneous. I admit that in the absence of considerable practice, it requires some judgment to fix upon this condition of materials; but approximate results could be obtained by making up samples of concrete in boxes, each holding a cubic foot, varying the proportions, and when consolidated removing the wood cases, and breaking the cubes of concrete to pieces.

The sample that was perfectly homogeneous, and which contained the least proportion of fine with the greatest proportion of coarse materials, would represent the best consistency of aggregate for insuring the largest amount of strength. And it must be self-evident that the nearer each unit of the aggregate approached in shape to an irregular polygon, the better the particles would interlock with each other, and for this reason sea beach and river shingle never make the best aggregates; and breaking by percussion, such as by hard hammers, produces aggregates too uniform in size, and which require the fine and intermediate portions to be obtained by some other means and added thereto. Probably the best way of obtaining an aggregate suitable in size and shape, and, as a rule, possessing somewhere about the relative sizes and proportions, is to use a Blake's stone crusher. Where this is done it will be found, however, that the harder the aggregate material to be crushed, the less the proportion of fine and intermediate sizes produced, and due allowance must be made in such cases by abstracting a portion of the finer quality, or adding some obtained from other sources, as circumstances may require; usually, however, the latter is unnecessary.

Although it is customary in the neighborhood of London to employ Thames ballast for concrete, it is far from being the best material for the purpose; the harder variety of stones, hard brickbats, brick clinkers, coke, and slag, are all more suitable than flint or flinty gravel. In point of fact, old building materials are often carted away as rubbish or for road foundations which would make most excellent concrete if broken up, and Thames ballast is as often brought miles for an aggregate for the formation of concrete for new buildings to be erected on the same site. If a mass of ballast or flint concrete is broken with a sledge-hammer after complete solidification has ensued, it will be found that some portion of the gravel will show clean surfaces from want of perfect adhesion; with any of the other materials named, this is absolutely impossible if the concrete is executed under proper conditions. One of the most important factors in connection with a good aggregate is that it should be clean, and I can safely affirm that the more experience one has in the use of concrete, the greater will be the care taken to thoroughly wash the aggregate.

And this is more essential where Portland cement is used than with lime, for as matrices they essentially differ from each other in their special properties. A small proportion of fine sand may not be highly injurious in the aggregate if lime is the matrix, more especially as the proportion of the latter is usually greater than where cement is used; but with cement the case is different—it has but little affinity for any material as fine as itself, and it also possesses the strongest adhesive and cohesive properties when unmixed with sand. The usually small proportion employed also, 10 to 15 per cent., although ample to secure an excellent concrete produced under the best conditions, is insufficient to allow the presence of a quantity of deleterious foreign matter in the aggregate. If the material for aggregate is absolutely clean previous to being broken, it still requires washing afterward; for the action of percussion, say, if reduced by hand-hammers, or of compression, if reduced by a stone-crusher, produces a quantity of dusty particles. The necessity for cleaning, where no foreign matter existed previous to the reduction of the aggregate, will possibly be disputed; but it can readily be proved by mixing samples of cement with the water in which some clean broken aggregate is washed, and testing the sample in a cement-testing machine. And as the cost of washing would but rarely exceed 6 d. per cubic yard, I submit the concrete is increased much more than that amount in value by the elimination of all the dusty and fine-grained constituents of the aggregate.

With regard to the matrices employed for concrete, there is a unanimity of opinion which admits of no doubt that for strength and other qualities there is nothing to surpass good Portland cement. But poor limes of hydraulic character, such as that made from lias limestone, possess very considerable strength, and are

adapted not only for concrete in foundations, but for walls themselves. It can safely be affirmed that concrete made of a suitable aggregate, and ground blue lias lime, in the proportion of one of the latter to five or six of the former, is as strong as ordinary brickwork, and can be used for walls of any description where brickwork can be employed. But there is this difference in the natures of lime and cement, that whereas with the former a fixed proportion of sand is absolutely necessary for the chemical change which converts the lime into mortar, with cement the case is the reverse; for although the sand is essential to fill up the interstices of the aggregate next above it in size, it has the effect of weakening the adhesive properties of the cement. And here we obtain one of the main contributory causes to both good and bad concrete.

Blue lias lime is supposed to attain its normal strength as a mortar when it is mixed with double its bulk of coarse sharp sand; when, therefore, the aggregate contains either more or less than this proportion of sand to lime, so is the cementitious nature of the matrix reduced, and a lime concrete composed of six parts of an aggregate to one of a matrix should therefore consist of one part of lime, two parts of coarse sand, and four parts of a coarser and irregular sized material. With cement, on the other hand, the aim is, or should be, to do with as little sand as possible, but not to risk that *sine qua non* of good concrete—homogeneity. It is a mistaken notion to suppose that lime used as a matrix will expand or "blow." It will undoubtedly do so if used directly it is ground; but it should be treated in the same way as cement, viz., spread out on a wood floor away from all damp, and not used for two or three weeks at least after having left the millstones, and there will be then no danger whatever from expansion. Nor will this cooling in any way lessen the ultimate strength of the lime, nor will it affect its setting properties so far as to render building operations tedious if employed for wall building; practically it requires about double the time of Portland cement to set or harden.

As blue lias lime is oftentimes procurable in neighborhoods where Portland cement is a costly article, it is somewhat surprising to find it so little used for concrete building; where, however, the cost of cement is not handicapped too severely by the expense of carriage, the gain in cost, all points considered, is but little. It is not an uncommon practice to employ lias lime concrete as an underpinning for walls of old buildings which have given evidence of sinking, using the lime fresh for the ostensible purpose of causing the concrete to expand, and thereby pin or wedge up the building. This I submit is wrong in principle; the lime in no way causes the aggregate in itself to expand, but forces the particles asunder, and instead of forming a dense mass, creates fragmentary blocks, whose effect is entirely at variance with the object of the concrete. If we mould a sample of concrete made with fresh lime in a box or frame, and when hardened take away the wood casing, it will sooner or later crack and split up into small portions.

The practice of "packing" concrete—that is, depositing in layers, or otherwise, bowlders of stone or similar suitable materials in the soft mass—reduces the cost, and is by no means objectionable, provided it is thoroughly incorporated with the concrete itself, and this forming a portion of the aggregate, is simply an illustration of the principle that the larger the portion of the aggregate the better—always on the understanding that perfect homogeneity must not only be aimed at, but obtained. There are some objections to concrete as a wall-building material. For instance, it has an inherent tendency to show cracks on the finished surface, especially if stuccoed to a smooth and even face with cement. All building materials, as is well known, are subject, more or less, to change of form with change of temperature; but in an ordinary way, with ordinary materials, the change is imperceptible when spread equally over the innumerable mortar joints of the materials of construction. But this decided evil in concrete is very much lessened if the cement is not used too fresh, and the work is not hurried. I have found, too, that the time of year during which concrete work is executed has a marked difference in this respect upon the behavior of the walls; if performed during cold weather, there is but little after-evidence of contraction or expansion, while if done in hot weather these cracks seem inevitable and irremediable.

As to another objection applied to concrete, the difficulties of alterations to existing buildings, arising from the tenacious quality of the constituents, I think is evidence in its favor, for probably no owners of property would prefer weak walls to strong ones, or, as a simile, would for such a problematical reason select brick walls built in common lime mortar to those built in cement mortar, assuming they had a choice, and the cost of each were identical. Another objection is the difficulty of suitable means for the fixing of joinery and other fittings. Wood bricks can be built in asin brickwork, but are not advisable. Wright's fixing blocks, however, are available, and superior to wood bricks, without any of their shortcomings, and at but very little cost. When a small plug is likely to be required for a single nail, such, for instance, as for narrow architraves, pieces of bell-wire tube 2 in. in length, filled with sand, can be built in, the sand being afterward withdrawn and a wood plug inserted. I might mention this is an excellent way of providing means for wiring concrete garden walls for fruit and flower trees. Concrete walls convey sound unfortunately only too well, and the better the concrete the better the conductors they become; there appears to be no remedy that I am aware of, except the ordinary and objectionable practice usual with brick walls, such as battening, covering with dry hair-felt, etc. But its greatest defect in the eyes of most people is that it is assumed to be difficult to treat artistically, and no doubt there is much to be said against concrete on this head.

Stucco is, as a rule, inadmissible now, and it is unfortunate that the introduction of concrete was, for some reasons, fifty years too late, for then the cry of sham had not taken so deep a root as now, and in many cases buildings for which it is admirably suited are built with other materials, because of the inevitable stucco. But concrete can be moulded into almost any shape or size, and dyed to any permanent color, and it is difficult to know why it should not be as much recognized as a facing and ornamental material as terracotta, for it has the advantage of the latter inasmuch

that it can be produced with absolute truth of form, which, with terra-cotta, appears to be out of the question. The specimens of concrete work produced by Messrs. Lascelles and others are equal in workmanship and appearance to carved stone or cut brickwork, with the advantage of being undamageable by frost, and more economical in cost. Rough-cast, pebble-dash, and othersurface finishings have been introduced according to individual tastes and fancies, and for buildings in the country are very good methods of finish.

Facing slabs of concrete have also been used. Mr. Marsden, an architect of Liverpool, invented a system by which the inside and outside slabs were tied together by iron ties, and the cavity filled with concrete. Mr. Chas. Drake introduced a similar system, with the addition of dovetailed grooves cut in them to assist in securing them to the core, and I made some for a special purpose some years since, doing away with the iron ties, and using dovetailed lugs of concrete cast on the slabs themselves. This enabled walls to be built of brickwork externally, with a core of concrete, and facing slabs on the inside. Made in different colors for the inside of the walls, instead of plastering, they have been employed by the architect of the Epsom Townhall, Royal Albert Dock Hotel, and other structures, Messrs. Lascelles being the builders. It does not appear to be so easy to get any other stain for concrete except a deep red, and for which mineral oxide is a suitable medium. Stains of an earthy character deteriorate the quality of the cement, otherwise almost any variety of tint or shade is possible. I have used bullock's blood instead of water, and obtained an excellent tint and hardness of finished material; but there are obvious objections to its general use.

The question has often been raised as to the amount of water necessary for the mixing of concrete, and the general view appears to be that great care should be exercised in not applying too much; but probably too much is better than too little. Without sufficient water homogeneity and perfect cohesion are impossible; whereas if too much is used, the cement parts with all or a greater portion not required for setting. In such instances clear water may be found on the surface of the concrete in foundations, and in the case of concrete resting upon boards or centering, the clear water will pass from it through the joints of the boards in considerable quantities. With regard to the assumed expansion of Portland cement concrete, it is doubtful if any takes place; a continuous floor, 130 ft. in length, on iron girders, commenced and finished within a fortnight, never affected the end walls sufficient to disturb their perpendicular position in the smallest degree. The best use for concrete, however, is undoubtedly for floors—best because there is no other material can approach it for facility of execution, strength, and economy.

At present it may be said that the construction of concrete floors—by which I mean floors carried by iron girders or other means in contradistinction to concrete laid on the natural ground and designated paving—is almost in the hands of specialists; and although for many reasons better so than if otherwise, it greatly restricts its use for private buildings. The limit of this paper and the importance of this branch of the subject render it impossible to enter upon the question of floor construction; but there are a few general matters in connection therewith worth passing consideration. An American journal lately reported that a high authority in that country had proved that concrete was not a fire-resisting material; but we are not told what the concrete referred to was composed of. In point of fact, if the aggregate was of a flinty character, it would under a moderate test, no doubt, go to pieces; but fire-brick, hard-burnt brick, coke, or slag as aggregate, will stand the effects of a conflagration as well as ordinary brickwork. Mr. Hyatt, of Farrington Street, some years since tested concrete beams in which iron was embedded, and after being some hours in a furnace they were found uninjured; and when tested by means of Holtzapffel's thousandth gauge, it was found that the expansion of both materials was, to all intents and purposes, the same, and that iron and concrete could be used in combination as a fireproof material without danger.

It has been usually assumed that concrete floors will withstand no vibration and sustain no deflection; but Lieut. -Colonel Seddon some years since, while conducting some experiments, proved by actual results that this theory is far from being correct; for a concrete slab under severe trial deflected without breaking to such an extent as to tilt up on the outside edges, and leave a cavity between these edges and the walls it rested upon. A number of men also jumped simultaneously upon the same slab, and although causing perceptible vibration, the slab remained perfectly sound, and a beam weighing 329 lb. dropped endways from a height of $4\frac{1}{2}$ ft. on to the center of the slab had only the same effect, the concrete remaining uninjured. Mr. Hyatt also found that a beam of concrete, free at all points, bent considerably when exposed to a great heat, but returned to its normal shape when allowed to cool. Much antipathy prevails to a finished surface of cement for concrete floors and pavings of dwellings; and even for agricultural laborers' cottages, a strong feeling exists against it. This is accelerated by the cold surface of the cement inducing condensation of watery particles, in damp, changeable weather.

Where the surface can be covered with a carpet or cocoanut matting, this objection is of course removed, although wood is more generally preferred. Where circumstances permit, a perfect floor may be formed by covering with or gluing down linoleum to a smooth surface of cement for the center of rooms, and employing parquetry fastened down with Eberhard's patent glue for the borders. Provision must of course be made for the finished floor surface to be level or flush throughout, and a carpet just to cover the edges of the parquetry all around completes the arrangement. In this case the concrete and cement must be absolutely dry, or the parquetry will burst up, and the linoleum expand or wrinkle, eventually cracking or splitting as the concrete below becomes dry. For cottage and other common floors ordinary deal battens in narrow widths, and half or three-quarters of an inch in thickness, may be nailed securely and permanently to concrete made with soft bricks or coke, the ordinary sheet floor brads being well adapted to fasten the boards down with. This has been used in a number of laborers' cottages, apparently with complete success, and Mr. Hall, of Moorgate Street, treated some floors in a similar way a

year or two since for some model dwellings in the city; and possibly others may have adopted the principle as an economical system of cheap flooring, possessing very many advantages over ordinary floor joists and thick flooring boards. As in the previous case, the concrete should be thoroughly dry.

For pavings of courtyards, basements, and similar places concrete is an excellent material laid monolithically, provided there is no probability of periodical upheavings being required to examine contiguous drains; where such a possibility exists, then the paving should be of ordinary concrete slabs, such as laid down for footways by the Victoria Stone Company. This paving is an example of what can be accomplished with concrete made with the best materials and under the best conditions. Among the multitudinous articles used in buildings or in connection therewith made of concrete, may be mentioned stairs, sinks, troughs, sills, copings, pier caps, ridge tiles, and others of a similar character. For rough lintels over door and window openings it ought to quickly supersede wood; for while it is or may be made as strong as York stone, there is practically no deflection and no decay, as with timber, while in case of fire they would help to support the walls; whereas the destruction of wood lintels is often-

thereto, leave to others an opportunity of suggesting or practicing means to remedy them.

SIXTEENTH CENTURY HELMETS AND ARMOR.

This sheet of elaborate armor of Italian and Persian workmanship includes three very choice specimens of highly-perfected design, carried out with the utmost delicacy of execution, each piece being decorated throughout in minute and appropriate ornamentation. The full suit of plate armor, first worn in Italy, was not known until about the year 1300, and in England, or even France, does not appear before several years later. At first it was, naturally, quite plain, but very soon became the fit subject for much decoration. This gradually developed from the hammered-out flutings, which usually followed the lines of the armor, till, in the reign of Henry VIII., considerable elaboration was freely introduced. The helmet and every other part of the suit was covered with embossed figures or arabesques engraved, chiseled, chased, and damascened with gold and silver; while shields and swords, especially their hilts, were often carved with very complicated subjects, more or less in bass-relief. Italy, closely followed by Germany, continued to produce

[Continued from SUPPLEMENT, No. 486, page 7759.]

THE PRODUCTION OF AMMONIA FROM THE NITROGEN OF MINERALS.*

By Mr. GEORGE BEILEY.

It has been shown, in what has gone before, how comparatively easily the process could be applied to the ordinary process of shale distillation: (1) Because of the small percentage of carbon left in the coke or spent shale; (2) because a current of steam was already in use in oil-making retorts, and had only to be supplemented to a moderate extent for the new process; (3) because the spent shale had at best only a very trifling value as a fuel, and was, therefore, practically a waste material.

On these accounts the extra costs involved by the process were merely nominal, so that the whole of the increased yield of ammonia was clear gain. In seeking to apply the process to new purposes many new factors are introduced. It is evident that if a gas company, turning out a good salable coke, were to proceed to spend money in converting ten shillings' worth of coke into ten shillings' worth of sulphate of ammonia, the operation would not commend itself to business men.

ITALIAN PARADE HELMET
FROM THE ARTILLERY MUSEUM PARIS.

ITALIAN CUIRASS AND HELMET IN
FROM THE COLLECTION

REPOUSSE AND ENGRAVED IRON
OF NAPOLEON III.

times the cause of their collapse; and in addition, the cost of concrete lintels, as far as my experience goes, is always below that of good Baltic fir timber. For water tanks nothing is so suitable as concrete; it is unyielding in character and economical in cost, and many hill farms and outlying cattle sheds have of late years been supplied with excellent water collected from slate or tiled roofs into concrete tanks, and which formerly depended for their supply upon the runnings from roads drained into clay ponds, and oftentimes little better than sewage.

The use of concrete, both at the present time and in the future, involves so many issues, and its application to building purposes is gradually becoming of so varied a character, that I regret limit of time has only permitted me to refer in a very brief manner to some of the more important points in connection with the subject. The various methods of building walls, the appliances in use for the purpose, and the construction of fire-proof and other concrete floors are necessarily left untouched. I have endeavored simply and briefly to call attention to some of the less generally known but most vital points in connection with the production of good concrete, also to several matters of detail, and last, but not least in importance, to its faults. Having enumerated some of its good qualities, it is superfluous to acknowledge not only its shortcomings, but candidly avow them, and by calling attention

the most beautiful armor, and the parade helmet from the Artillery Museum at Paris, which we herewith illustrate, of late 16th century date, is, perhaps, one of the richest examples of repousse work which could be instanced. All the ornament is dexterously beaten out with the hammer in thin sheet metal, so as to express the smallest pattern as well as indicate, as in the bolder figure work, the graceful curves and modeling of the forms introduced as centers for the rest. Towering above the crest a defiant dragon, plume-like, gives a graceful finish, and completes the whole, both in suitable proportion and scale. The Italian cuirass and helmet in repousse and engraved iron, from the collection of Napoleon III., is another instance corresponding with the last, and of the same date.—*Building News*.

A PATENT taken out for a yellow metal, by T. Parker, describes it as of great tensile and compressive strength and hardness, and made by melting copper, 50 parts, spelter dross 25-30, spelter, 12-17, tin $2\frac{1}{2}$ parts, with a flux of the following composition made into a paste: salt cake, 5 parts; coal dust, 5, silica, 15; bone ash, 20 parts. Manganese or copper sulphate, or the chlorides of these metals, and also common salt, may be used in place of the salt cake. This flux is also applicable to the founding of brass and bronze generally,

But if, in addition to the ten shillings' worth of ammonia, a further ten shillings' worth of something else were to be obtained, the whole matter would assume a more practicable aspect.

In connection with this process the something else must be heating gas. I feel some hesitation in venturing to approach so heretical a subject as a double gas supply—for heating and lighting purposes—and have no intention of suggesting such a thing in any but a very limited sense. There is, I believe, a sense in which the realization of a double gas supply is both possible and hopeful.

In a paper read before the Mining Institute of Scotland, in September 1883, among other suggested applications was the following: That gas companies in the immediate vicinity of manufacturing towns might carbonize cheap coals or slack, selecting from the gas the portions of highest illuminating power to be purified and distributed in the ordinary course; the coke from the carbonizing retorts to be dropped into secondary retorts below, and there gasified in excess of steam, producing a large volume of heating gas and ammonia; this heating gas, after separation of the ammonia, to be distributed by large mains to manufacturers in the immediate vicinity of the gas works, to be used by them for firing steam boilers, pottery kilns, glass furnaces,

* Paper read before the Society of Arts on February 12, 1885.