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NOW that we are likely to see in most of our large cities telegraph, telephone and electric-light wires within a few years buried beneath the surface of the ground, it may not be amiss to call attention again to the fact that this change, although in some respects advantageous to the public, will cause a great and permanent increase in the number of those obstructions to street traffic from which we already suffer so much. It is not long since the people, or, let us say, the newspaper reporters of New York, were nearly driven to desperation through the annoyance caused by the operations of a steam-heating company, and the disposition, as well as the capacity, for rendering themselves disagreeable to the public which the officers of any steam-heating company have yet shown would be trifling in comparison with the indifference to other people's rights which we have learned to expect from telegraph and telephone companies. As the streets of at least one city are at this moment being torn up for the placing of electric wires, it is quite time that a determined effort should be made by those who interest themselves in matters of public advantage, if such thoroughfares are to be kept free for their intended purpose, instead of being, even more than now, used by the public only at the pleasure of a dozen corporations, each of which has the chartered right of obstructing them as often and as long as it may wish.

THERE is, of course, only one way, if pipes and wires are to be buried under the streets, of avoiding the necessity for opening the street wherever it is necessary to reach them, and this way is, to make all such communications through a sub-way, or permanent underground passage, large enough to give room for all of them, as well as for the movement of the men employed in laying and repairing the gas, steam, water and sewer pipes, pneumatic tubes, electric wires, and public and private telegraph, telephone, fire-alarm and signal lines which would occupy them. In practice, every one acknowledges this, quoting, rather enviously, the example of Paris, where two lines of water-mains, besides all the gas-pipes and electric wires of the city, are laid, repaired and replaced, in the sewers, without interrupting the traffic, or disturbing the asphalt pavement, of the streets above them from one year's end to the other; but the expense of the Paris sewers, which is always represented as enormous, seems to be regarded as a conclusive argument against the adoption of any similar arrangement in this country. It would not be easy to collect statistics which would show how much money is actually spent every year in tearing up the pavements of the principal streets in such a city as New York, putting up guards, excavating, refilling and restoring the pavement again, but it is certainly a very large sum; and if to the cost of this work is added the expense which will be imposed upon the companies who use electric wires when the regulations requiring them to place their lines underground go into effect, the total would probably represent a large interest upon the cost of constructing sub-ways, at least in the main thoroughfares, which would accommodate all the underground services much more conveniently than the present primitive system, besides putting an end, for all time, to the street blockades which have become, not merely an annoyance, but a source of losses, by delays, vexations, extra wear and tear of vehicles and fatigue of horses, which, though small in each particular instance, being inflicted upon a multitude of persons must amount in the aggregate to a large annual sum.

LA SEMAINE DES CONSTRUCTEURS gives an interesting comparison of the relative distribution of population in Paris in 1876 and 1881, which shows that the movement during the five years covered by the comparison has been from the centre to the outskirts of the city. Two plans are given, one showing the increase or decrease in population, and the other the increase in the number of new houses built, and some singular discrepancies between the two maps are to be observed. Taking up first the map of population, it is found that the business quarter on each side of the "grand Boulevards" has lost considerably, as has also the rather squalid region on the two islands of the Cité, and a small portion of the river bank nearly opposite. The greatest loss, however, has been in the aristocratic and fashionable quarters, the Faubourg Saint Germain and the region about the Champs Elyseés, where the number of inhabitants seems to have diminished very seriously. The districts where the population has increased instead of diminishing seem to be as irregularly distributed as those in which the reverse has taken place. Except a small district about the church of Saint Germain des Prés, the portions of the city which have attracted most of the persons added to the population since 1876 are situated at a distance from the centre, toward the fortifications, and even in the suburbs beyond them. The greatest advance has perhaps been made in Belleville, but the popularity of this quarter extends to the whole region between the Porte Saint Martin and Pére Lachaise. The district next in favor is that situated at the very north of Paris, beyond Batignolles, and thence easterly and southerly to Clignancourt and the hill of Montmartre. The left bank of the Seine is far less popular than the other, but a considerable region of increased population is found about Montparnasse, extending from the Jardin des Plantes westerly to Grenelle, and southerly to the fortifications. Bercy, at the southeastern extremity of the city, has lost population in a greater degree than any othen part of Paris, and a small district called la Santé has also suffered slightly.

THE additions to the house accommodation of the city have followed a distribution so different from that of the increase in population as to suggest very strongly the advantage, to speculative builders, of consulting statistics, to determine the tendency of population, before constructing houses at random to receive tenants who may be suffering in some other quarter for the very habitations which they do not care to seek at a distance from their friends or business. In Paris, for example, one of the principal centres of building between 1876 and 1881 was the region about the Porte de la Muette, fronting on the Bois de Boulogne, and another district, also rapidly built up, was situated in a corresponding position north of the Arc de Triomphe, at Batignolles and Monceaux. Neither of these places, however, found favor in the eyes of the new inhabitants of the city, who, on the contrary, settled most closely, and suffered most from lack of house accommodation, at Epinettes, just between the hill of Montmartre and the Plaine Monceaux, both of which presented rows of houses, and the latter especially, whole streets, ready for occupancy, but tenantless. In another portion of the city, around the two prisons at La Roquette, a dense population has settled, but the number of new buildings has increased very little; while just north, at Belleville, the increase in the number of inhabitants and of houses has been kept nearly together. On the whole, the study of the two plans seems to indicate that building speculation in Paris has followed the usual course of such speculations in other places. A slight tendency of population toward the pleasant northwestern quarter having shown itself, the most desirable land in that part of the city seems to have been bought up in immense tracts, and covered as hastily as possible with houses which the normal movement of population will not bring into the market for many years. Again, as appears from the maps, the common mistake was made of supposing that certain locations of limited extent were so much more fashionable, or otherwise desirable, than the rest of the region about them, that people would pay much more to live in a few particular streets than in others near, but for the moment less reputed. In consequence of this idea, the new houses, even in places where a real and rapid increase of population was assured, are shown to be generally crowded together in a small area, as at Montparnasse and Grenelle, while the people who were expected to live in them occupy the whole region about and between these two places, with little apparent

regard to the superior attractions of one street over another. Hence Grenelle, although rapidly gaining in population, has gained still more in buildings, and houses stand vacant there which would find ready tenants a short distance away. Considered simply as a social phenomenon, the general movement of the city population from the centre to the outskirts is a promising one, indicating not only an improved appreciation on the part of the main body of Parisians of cleanliness and pure air, but also, perhaps, an improved financial condition; since people without money are not often welcomed as tenants of new houses, however patiently they may been dured in the dilapidated quarters for which perhaps no other occupants could be found. Either of these would be a matter of congratulation, and it would be interesting to learn whether statistics would show a similar tendency in other large cities.

A RATHER interesting observation has recently been made upon the methods of stone-cutting employed by the ancient Greeks. Every one knows that the marble blocks of which the Grecian masonry was composed are put together without mortar, and so nicely fitted that in many instances two adjacent stones have, as it were, grown together by the cohesion of their particles, brought into almost absolute contact; a fracture made by a blow upon one passing directly into the other, just as if the two formed a single block. With regard to the fitting of the drums of columns, Mr. Penrose, the most scientific and practical of all investigators of Greek architecture, believes that the desired effect of close fitting was obtained by inserting a wooden pin as a pivot in the drill-holes which are always found in the centres of the drums, and revolving each drum upon the one below it, first placing sand between the stones, until a perfect joint was obtained, in the same manner that glass stoppers are ground into bottles, and pieces of metal work of certain kinds fitted to each other. This explanation, which is probably the true one, solves the problem completely so far as the drums of columns are concerned, but throws no light upon the fitting of the other stones of the Grecian buildings, such as the blocks of the entablature, which are found to have joints as close as those of the columns, the edges of each block, for a certain distance back from the face, being polished, while the rest of the joint is slightly sunk, in order to allow the polished portions to be brought into perfect contact. As no sign of a pivot can be discovered on the stones, even if it were possible to revolve them in contact with each other, it is plain that a different process must have been used for fitting them, and an inscription discovered a few years ago gives us some idea of what the process may have been. This inscription, which seems to have been a sort of official document, answering the purpose which would now be fulfilled by a printed specification, describes the construction of a temple, and stipulates particularly that the joints of every block of marble must be polished with a mixture of oil and vermilion. As vermilion, if the word so translated really refers to the pigment now known under that name, has no polishing quality, it has been suggested that the color was used simply to spread over the joints before trying the stones together. If any inequality existed in the surface of either stone, it would be immediately shown, on separating the stones after a momentary contact, by the transfer of color from one to the other; and the protuberant portion, thus detected, could then be rubbed down by hand to a uniform plane with the rest of the surface. A powder of red chalk is often used by marble cutters for a similar purpose, and it is quite possible that this may have been the only use of the vermilion paint; but there is some difficulty in accounting on this theory for the mixing of oil with the paint, which, if used dry, would be quite as useful for its supposed purpose, and would be much more easily cleaned off the stone. There is no serious improbability in the supposition that the authors of the inscription may have confounded the true vermilion with the red oxide of iron, or crocus, which is a very efficient polishing agent, and if mixed with oil, and applied to the surface of a piece of marble, would serve admirably, both to show where that surface had been brought to coincide with a test plane, and to reduce the inequalities which might on trial be found to exist.

ONE of the most important works of excavation now in progress in Rome is that which has already laid bare a considerable portion of the house in which the vestal virgins lived. The building, or at least the part of it now exposed, contained a large interior court, square in plan, with a basin in the centre, and surrounded by a hundred or more of "cippi," or blocks surmounted with busts, representing the *vestales maximæ*, or high priestesses of Vesta, and inscribed with their names. Many of the cippi are broken, but more than twenty have already been recovered in sufficiently good preservation to make them of value. Some of the priestesses in the latter days of the Empire, desiring to distinguish themselves beyond their predecessors, and lacking the taste which the latter displayed in their choice of a monument, have set up full-length statues of themselves in place of simple stones, and one, apparently relying on the ignorance of her contemporaries, is found to have had the head of an antique statue, probably representing Modesty, or some other personified feminine virtue, cut off, to substitute her own portrait. This curious object is one of the most valuable things found in the excavation, but its value does not reside in the portion which commemorates the features of the ingenious priestess. One cippus was found bearing an inscription, with the date of the year A. D. 364, but with the name of the person to whom it was dedicated cut away with a chisel. It is known that this excision of the name from the statue or memorial of a person of high official rank was a solemn act of condemnation, and as history throws no light on the proceeding, there has been some speculation about the occasion of it. The most probable explanation seems to be that of M. Marucchi, who points out that about the time of the date of the inscription many of the vestals became converted to Christianity, and suggests that the mutilated inscription might have been cut, during her lifetime, in honor of a priestess who became later a Christian, and was then repudiated by her associates, and her name obliterated.

WE imagine that some of our readers will be sorry to learn that a comprehensive plan has been adopted for utilizing the water-power of the River Rhone, at Geneva, by means of a dam, which will regulate the height of the water in the lake, and a series of turbine wheels. A competition, which was recently held to obtain designs for the work, resulted in the definitive adoption of a scheme, which will be carried into effect without unnecessary delay. Fortunately for the nerves of sensitive people, the mills containing the water-wheels will be placed below the little island upon which the market-house stands, so that neither the sight of the building nor the noise of the machinery will interfere with the enjoyment of the view across the upper portion of the river, but the dam for retaining the water of the lake will probably take something from the charm which the rush of the clear green river has always exercised upon tourists. The force of the descending water which can be utilized in this way is estimated at six thousand horse-power, of which forty-two hundred will be in available form for transmission to a distance, by means of belts, by electricity, by compressed air, or by water under pressure, as may be most convenient in each particular case. A part of the force, amounting, it is thought, to about two hundred and sixty horse-power, must be distributed among the owners of existing mills along the bank, whose privileges will be taken from them by the construction of the new works. Another portion will be devoted to pumping water to supply the higher portions of the city, which at present depend upon service by gravitation from a reservoir so little above them that the water flows but feebly, and the rest will be furnished in the form of power to those who wish for it and are willing to pay for it. The water service to the higher streets will be managed on a novel plan, which is worth keeping in mind for possible application to other cases. As there is no hill within a considerable distance of the town lofty enough to enable a reservoir to be built which would supply the houses in the upper streets by gravitation, a substitute is to be provided, in the shape of a group of four enormous iron tanks, each forty feet high, and five feet in diameter, closed on all sides, except for the admission of water under pressure from a powerful pump, and for delivering it into the new mains which will supply the high service. The upper part of the tanks is filled with air, which cannot escape, and therefore acts as an elastic cushion, to transmit to the water in the service mains the force under which the supply is pumped in. As water from these mains is consumed, the pressure in the tanks falls, allowing a valve to open which starts the pumps automatically, so that a tolerably steady pressure is maintained throughout the pipes. It is not very easy to see the superiority of such an arrangement over the ordinary Holly system, in which the water is pumped directly into the mains, and the action of the wrought-iron tanks on the water might be objectionable.

ON THE COLOR OF VENETIAN MONUMENTS.[1] — I.

IT is now three hundred years since architecture began to dispense with the use of color. In the sixteenth century a puritanical Reformation taught us to renounce the pomps of the world and the joy of the senses; and we put on the sombre garb that seemed to befit a penitent generation. At the same time the Classicists discovered that white was the color most acceptable to the gods, and the temples, stripped of the glowing hues lent them by the fervid imagination of their builders and the mellowing tones of time, assumed a spectral grandeur more suited to the immaterialized worship for which they served, and the inextinguishable love of color, no longer free to lavish its crimson and azure on the monuments of our piety, nor to imitate in our garments the gay variety of nature, found a morbid gratification in the rags of a beggar or the squalor of decay.

But the healthy instinct of humanity is indestructible. The long repressed craving again stirs within us. We seek out and dwell on the half-obliterated tints of our faded monuments, and feel how the sacred duty of preserving the accumulated beauty of ages, and of transmitting it to our descendants, has been sinned against. And patient Nature still covers the traces of past and present vandalism with her mantle of beauty, to admonish us of all the loveliness that has been allowed to perish, and to teach us how the glow of life may be recalled to these arid ruins. Spurred by all these appeals to a degenerate sense of color, we sometimes dare to tint our modern wastes of plaster a jaundiced yellow, or even venture on a languid pink. But our feeble essays are not happy. We have no longer the sentiment to feel, nor the temperament to follow her bold yet subtile guidance, and we must humbly set ourselves to con the rudiments of the lost art.

Nature and the antique monuments are still the standards of color, and it is in these latter that we find at once the evidences of the recognition and enjoyment of color by our forefathers, and of their tasteful ingenuity in applying it to their constructions. Sometimes the color was inherent in the material itself, — in the infinite variety of marbles so richly veined and tinted by Nature, or the homely brick, whose rough, martial red she clothes so gently with her delicate mosses and tones with the sober gray of time, varied besides by the diversity of gay and genial color given by fire to the various earths. Sometimes the vulgar plaster, the refuge of such a poverty of spirit in our day, was made to serve as a vehicle, never in pretentious imitation of some nobler substance, but to receive the pure red of the old Venetians, or to furnish a ground for the pencil of a Giotto. Alas! these fresco surfaces, the crowning glory of color decoration in architecture, are from the nature of their material the most perishable. In art, as in nature, the most splendid flower is the first to wither.

The intuitive love of color is as old as humanity itself, and as it is implanted by Nature, so its frankest and fullest manifestations are found in those races and ages that border most closely on a natural state. It is the delight of the savage on his tawny skin and his rude dwelling; it yields him a joy that our chastened taste knows not of, and, as he emerges from his primitive condition, it serves still to heighten the splendid creations of his barbaric imagination. Still later, when graver needs have gathered man into ordered society, and growing civilization brings more refined art, he still calls on color to lend a glow to his aspirations and his memories, to adorn the temple and the tomb. The tower of the Chaldean astronomer rises to the stars in the banded hues of its successive stories; the gigantic works of the Pharaohs make resplendent with color the banks of the Nile; and even the stern art of warlike defense looks less defiant in the painted walls of Ecbatana.

The first mode of using color in the decoration of buildings was by mixing with it the constructive forms and masses, and this primeval phase of color decoration was also the first to disappear. Its origin, like that of the art of construction itself, is lost in the mists of antiquity, and we can hardly separate the idea of the primitive building from its color decoration. Historical record points to Thebes and Babylon as the centres from which radiate two main branches of architecture, and we find color an inseparable element of the art at its commencement. The Egyptians raised walls and erected pillars, surmounted these pillars with entablatures, and then roofed in the edifice with slabs: thus the whole construction was of stone. This stone, when possessed of a color of its own, was left unchanged; if naturally white, it was necessary to color it artificially, partly in order to make more prominent and effective the bas-reliefs and hieroglyphics, but above all that it should not be left colorless, surrounded as it was by the azure of the Egyptian sky, the verdure of the palm, the yellow of the lotus, and the red of the syenitic rocks.

The Chaldeans and their imitators, the Assyrians, whose work we know through the excavations at Ninevah, did not use stone, but composed their enormous walls of bricks made of clay mixed with chopped straw and dried in the sun. Owing partly to the nature of this building material, architecture assumed among the Chaldeans a different form from that of the Egyptians; the column was excluded, the ceilings were vaulted and perhaps domed. The necessity of protecting from the weather the surfaces of these walls and vaultings early polychromatic decoration, we naturally turn first to the Palace made of sun-dried bricks, suggested the idea of facing them with alabaster, plaster, or enamelled bricks baked in a furnace; each of these facings exhibited various polychromatic decorations. The grand walls of Sennacherib and Sargon were tapestried to a certain height with colored bas-reliefs of alabaster, whilst above these rose a surface of painted plaster. In other cases the surface of the wall was composed of enamelled bricks in varied designs of blue, red and yellow, resisting so admirably the destroying influence of time that they retain their original brilliancy to this day. Diodorus says of the figures of men and animals displayed upon the walls of the palace of Semiramis at Babylon, that "they were painted upon the bricks before they were sent to the furnace;" he refers here to the same kind of enamelled bricks as those found in Ninevah.

Greece also decorated her monuments with color and with gold. This fact, however, is no indication that the Greeks did not fully appreciate the purity of the Parian marble, for they did not lavish their golden decorations everywhere upon its surface. Lucian, in speaking of the Greek decorations in gold, compares the result of their mode of employing it to "a delicate lace about the neck of a beautiful and discreet woman."

In the remains of Etruscan art still preserved to us in the sepulchres of Volterra we find sometimes that the faces of the reclining figures of marble and tufa sculptured upon the sarcophagi are painted, and that the diadems, bracelets and ear-rings, as well as the cups held in the hand are gilded; gold was also used in the various members of architecture, together with the three primary colors.

The Romans were, in their color decoration, disciples of the Etruscans and the Greeks, whose architecture belonged to the Egyptian branch of which we have spoken. If the Roman architecture showed a divergence from that of the Egyptians, it was in their use of the arch and vault, which constitute the glory of Roman art. It is almost a certainty that the Romans derived the knowledge of them from ancient Asia, for the arch and vault ante-date the foundation of Rome by more than a thousand years. The resemblance existing between these forms of architecture in different countries and at different epochs, finds a parallel in the similarity of their ornamentation. We find the Romans decorating their vaults and arches somewhat after the manner in use among the Assyrians long before. The checkered patterns on the ceilings of the Baths of Caracalla are not unlike the designs of gold and azure on the enamelled bricks that embellished the vaults of Sargon seven hundred years before Christ. When Constantine transferred his seat of goverment from Rome to Byzantium, the already decaying Græco-Roman art was more strongly than ever influenced in its color by its contiguity to the Orient; what it had lost in grace was now gained in splendor.

The Arabs, the most fantastic in their imagination of the Oriental people, after having extended their dominion throughout the Levant, spread over the Mediterranean coast of Africa and invaded Spain and the south of Italy. Wherever they went they carried with them their native love of color; wherever they established themselves they raised monuments, mosques and castles, brilliant in hue and snarkling with gold. To the navigators of the Occidental republics, who trafficked with Tripoli, Alexandria, Damascus, Palermo and Amalfi, and to the Saxon and Norman crusaders, who had been accustomed to buildings of wood and sandstone, when they first set foot in an Arab city, the gorgeous revelation must have seemed like a realization of the poetic fiction of the Thousand and One Nights, the influence of whose magic not one of them would ever be able to forget.

The Pisans, who carried on an extensive commerce with the Arabs, give evidence of the influence produced upon them by Arab art, by their adoption of the pointed arch in their duomo in 1063, and also by the use of alternate white and bluish bands of marble, teaching that lines should not be considered simply as lines but as separations of color. The Venetians, divided between their transactions with the Arabs and their attachment to Constantinople, felt a double influence, the most remarkable demonstration of which, as an amalgamation of Arabic with Byzantine art, is to be found in the basilica of St. Mark's. In this structure every expedient has been adopted to make of it a treasure of lovely and precious color: porphyries, serpentines, pavonazzetti, cipollini, verd-antique, Greek marbles richly veined, and mosaics of colored enamel, all are here brought into artistic combination, and even many of the stones themselves of the building proper were originally colored and gilded — everywhere color: above, when we raise our eyes to the ceiling; around us as we gaze at the walls; beneath our feet, in the pavements upon which we tread.

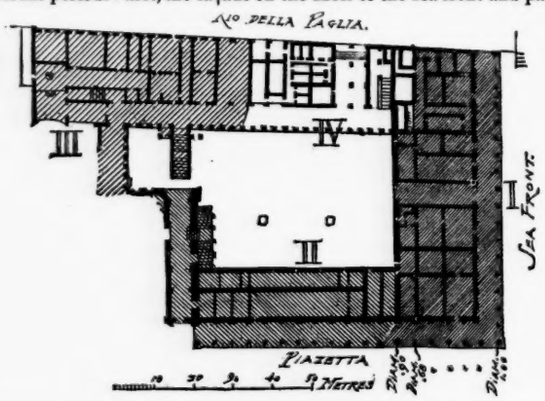
Unfortunately, in our day, few are capable of deriving the intense enjoyment from this beautiful color which it afforded to those who created it, for, as Mr. Ruskin says: "The perception of color is a gift, . . . and the very first requisite for the true judgment of St. Mark's is the perfection of that color faculty which few people ever set themselves seriously to find out whether they possess or not. For it is on its value as a piece of perfect and unchangeable coloring that the claims of this edifice to our respect are finally rested. . . . It possesses the charm of color in common with the greater part of the architecture, as well as of the manufactures of the East; but the Venetians deserve especial note as the only European people who appear to have sympathized with the great instinct of the Eastern races. . . . While the burgers and barons of the North were building their dark streets and grisly castles of oak and sandstone, the merchants of Venice were covering their palaces with porphyry and gold."

In searching among our Venetian monuments for the relics of an

[1] A paper by Signor G. Boni, for several years employed on the restoration of the Ducal Palace, Venice.

of the Doges, which, being the most important monument of the Republic, summed up in itself all the partial applications of color so far attempted in other Venetian palaces, and thus became a prototype of such polychromatic decorations and furnished suggestions for much of the color ornamentation which came after.

In order to understand this more fully, let us consider the four great divisions of the palace which were constructed at as many different periods: first, the façade on the Molo or the sea-front and part



THE DUCAL PALACE, VENICE, IN 1580.

I. (— 1340.) Mainly devoted to prisons. Filippo Calendario, architect.
II. (1424 —.) Architects, two Florentines and a certain Bon.
III. (1484–1500.) Rizzo, a Lombard, architect.
IV. (1516–1550.) Antonio Scarpagnino, architect.

of that facing the Piazzetta, which were built in the first half of the fourteenth century; secondly, the remaining portion of the façade, on the Piazzetta, which, with the Porta della Carta, was erected nearly one hundred years later; thirdly, the Renaissance façade on the interior court, part of which, with the Giant's Staircase, belongs to the end of the fifteenth century, whilst the remaining portion was not built until about 1550.

As all the architecture of the Ducal Palace is either Gothic or Renaissance, it might at first glance appear that only two forms of architecture require consideration, but as this Gothic and this Renaissance each belonged to two different periods, corresponding to the climax and decadence in Venice of the art of the Middle Ages and of the Renaissance, it will really be found necessary to consider four different epochs. In the first, that of the fourteenth century, we observe how color was employed with all the splendor of the preceding ages, and how, through the subsequent ones, by distinct gradations, this lavish use of color was more and more discontinued, until in the latest period it was totally abandoned.

The *loggie* of the façade on the Molo, the first portion erected, are built of Istrian stone, which, when first placed in position, although highly polished, did not in itself possess the beauty of color; we shall see a little later how this want was provided for. Above the *loggie* rose the grand wall of brick, presenting in itself a contrast of color which was deemed sufficient for the side facing the court, whilst the sea-front was further enriched by a facing of alternated white and red marble. This method furnishes the most natural and permanent kind of chromatic decoration, and it was not only applied to the main walls, but also to the spandrels of the lower story covering portions of the previously-mentioned colorless Istrian stone.

Two of these spandrels facing the Molo are adorned with a mosaic of colored marble, and traces of the same are found on another looking towards the Piazzetta. The first two, which are complete, exhibit a circle fringed with dentils and another concentric surrounded by diamond-shaped points known as "dog-teeth." The field of the spandrel is covered with red marble, interrupted by three pieces of white marble of triangular form, which connect the circles with the contour of the spandrels; the space between the two circles io inlaid with bluish-gray and purple-veined marble. In one spandrel these marbles are arranged in rays, and in the other in small arches. The interior of the inner circle in both cases is filled with a disc of verd-antique, fastened in the centre with an octagonal bolt of gilded copper.

We find only these two spandrels so treated, but it is certain that the others were intended to be similarly decorated, because there are indentations prepared to receive such marbles, and also the surface of the spandrels does not come quite to the front, thus leaving space for the intended facing. It appears quite certain, however, that this intention was never carried out, for the traces left on the spandrel towards the Piazzetta show two incised circles for the reception of the fringe of dentils and that of the dog-teeth corresponding to those on the completed spandrels, whilst on all the others appear no such incisions, so that in these latter the facings could never have been applied.

Of the façade on the interior court built at this same period, two spandrels of the massive pointed arches in the upper *loggia* are embellished with the discs of verd-antique, fringed with dentils in one case, and with the dog-teeth in the other; the field of both is of gray marble inlaid with white leaves. In the other spandrels of the same *loggia*, on the court, appear the indentations giving evidence of the same intention of covering them with colored marbles as on the molo or sea-front.

Though less important, it may here be mentioned that on each of the cusps of the quatrifoiled tracery towards the Molo light is gradated on a ball of red Verona marble. While colored marbles were used in the above manner in decorating in places this portion of the Palace built about 1340, the large surfaces of Istrian stone which remained, though sculptured, must have, when first placed in position, seemed monotonously white. True, we do not feel now any lack of color, since the sunshine and dew of five centuries have given the stone its present marvellous hues; but when new and still unacted upon by the artistic hand of Nature, the then colorless surface would not satisfy the eye of a Venetian of the fourteenth century; living in the midst of color, revelling in it on every side, he found it necessary to add color to the stone.

The shafts of the columns, however, from their cylindrical form possessing the property of exhibiting all the beauty of gradation of light and shade, from the culmination in the narrow band of high light on the one side to the deep shadow receiving reflections on the other, gratified the eye so fully with this peculiar quality that it was not, in this instance, deemed necessary to add variety of color, with the exception, perhaps, of gilding a light band of minute foliage around the upper portion of the shaft. In other members of the architecture of the Ducal Palace, stone appears to have been cut on purpose to exhibit various surfaces for the reception of different colors.

It is not certain to what extent gold and color were employed upon the battlements, as the present ones seem to be a restoration after the fire of 1577; but when the large windows which perforate the wall-veil covered with white and red marbles are examined, traces can be seen of former decoration, composed of golden leaves on an azure background; the capitals of the windows were originally gilded, the dentils were gilded and colored alternately azure and crimson, as were other embellishments of the façade, such as the fringes in the two spandrels before mentioned; the *nimbi*, swords, and other emblems of the statues; a diadem and buckle adorning the head and breast of the "Venetia" were gilded, and there were gilded and jewelled rings on the fingers of the "Eve."

Confining our consideration to what we know about the original work, the grand wall-veil of the sea-front variegated like an Arab tissue, with its great windows resplendent with gold and purest color, set like gems into its surface, was an example of Oriental splendor of which the Venice of Victor Pisani might well be proud. Though dimmed, the glory of that Venice has not wholly departed, though the azure and gold and crimson have yielded to the influence of time, the stone yet remains, and Nature has substituted other hues for those which she has destroyed. Every original touch of the chisel upon this façade of the palace remains to this day fresh and beautiful as when it came from the hand of the artist five centuries ago.

Though not entitled to an equal pride in this glorious monument with the age which produced it, sentiments of wonder and reverence fill the mind of him to whom it confides its present beauty, "so precious indeed and so full of majesty that sometimes when walking at evening on the Lido, whence the great chain of the Alps, crested with silver clouds, might be seen rising above the front of the Ducal Palace, I used to feel as much awe in gazing on the building as on the hills, and could believe that God had done a greater work in breathing into the narrowness of dust the mighty spirit by whom its haughty walls had been raised and its burning legends written, than in lifting the rocks of granite higher than the clouds of heaven, and veiling them with their various mantle of purple flowers and shadowy pine." (Ruskin: *Stones of Venice.*)

To discover the reasons for the particular manner in which gold and color were employed by its designers in the decoration of this building, it would be well to examine a little closely some of its details, where the traces of gold and color still remain; for instance, the capitals and jambs of the great windows of the sea-front. The traces of gold now found upon the capitals indicate that the foliage upon them was entirely covered with gilding, because of its sculptured form, and the same may be said of the front of the dentil fringe on account of its interrupted surface; but the mouldings required some other means of varying their wide plain surfaces, and here blue was alternated with the gold, and arranged in beautiful forms varied for each moulding; the cylindrical ones resemble strings of pearls, on the convex surfaces a succession of leaves climb one above the other, and the hollow recesses exhibit undulating lines bordered with shell-like corrugations; the convexities formed on each side by this undulation alternately presented the gaiety of the gold contrasted with the severity of the azure. Of all this, some slight traces of gold are left on the sheltered parts of the leaves, a little azure remains on the surface of the mouldings and some golden films on the ornaments painted upon them. In many cases an outline of the ornament may still be seen, and also the violet tint left by the mordant used to fix the gold; not only here, but in other parts of the palace, this violet tint is found under the gilding, and, as if the stone were imbued with it, remains even when the last sparkle of the gold has disappeared. Thus we find that the manner of using the gold and color was determined by the character of the surface they were intended to decorate.

To turn away for a moment from the Palace, we shall find the original color still better preserved on other monuments of the same epoch. In the chapter-house of the cloister of the Frari is the canopy of the tomb of the Doge Francesco Dandolo, a work of the year 1340, and thus contemporary with the early part of the Ducal Palace. The dentils on the canopy still retain the gilding on their fronts, while the side surfaces are colored one blue and the other red; the foliage

of the archivolt is gilded, with a red background; the figures in the bas-reliefs of the sarcophagus, now at the Seminary, show traces of gilding, especially on the robes; on the background are found remains of a blue which was applied thickly, so that what is left of it would easily scale off at a touch. It has now the tone of cobalt, but it may have been ultramarine, which was held in the highest esteem by the artists of that time. "Ultramarine," wrote Cennino Cennini, about the year 1400, "is a color noble, beautiful, most perfect above other colors, than which one can neither make nor imagine anything finer, and with this color, together with gold (which makes all the works of our art to blossom) whether on wall or on panel everything is resplendent."

The inscription which, before the parts of the tomb were separated, was below the sarcophagus, and is now, in its new location, let into the wall above it, has a border of dentils slightly in relief, which was formerly made more conspicuous by gilding and azure, and gold was also applied to the Gothic letters in relief upon the stone.

Another example of the original coloring nearly contemporary appears in the arch in the wall of the atrium of the Carità, containing a long inscription in the old Venetian dialect, describing the earthquake and the plague of 1347. The letters here are gilt, and here again are seen the dentils of gold, blue and vermillion; further to be noted in this arch are the angels bearing the emblem of the brotherhood to which the school belonged; the *nimbi*, wings and dresses were covered with gold, the faces were flesh-color and the hair brown. The emblem (See initial cut) is composed of two circles and a cross, "*ex cruce constat aurea, duos concentricos circulos pariter aureos alterni nexibus implicata.*" The segments formed by the intersection of the cross with the two circles were colored alternately green and azure; "*those who first instituted this emblem,*" says an old chronicle, "*had the intention of showing the union that Charity should have with Faith and Hope.*" The symbol of Faith being the cross, the circles have been supposed to typify the other virtues, but it seems more probable that the symbolism relating to these was intended to be expressed by the colors, green representing Hope, and red Charity.

On many other Venetian monuments, churches, palaces and tombs of this epoch, traces remain of the color that originally embellished them, and not only on the principal architectural works, but in every small street of Venice there were touches of gold and color: on the shields that designated the private dwellings, and on the Madonnas and bas-reliefs at the corners, before which at night hung the lamps, serving the double purpose of lighting the *calle* and the shrine. There was color in the pavement of red brick, color on the façades and on the tiled roofs, and color on the ornamented chimneys.

At the present day, unused as we are, after three centuries of privation, to this profuse employment of color, and deprived of the circumstances which made it so enjoyable, perhaps it is not to be desired that exactly the original color should be restored, especially as the hand of Nature has replaced it with hues far more beautiful and harmonious, and more precious to the artist than any that could be placed there by man. These results produced by time are also very valuable from an archæological point of view, because they are comparatively permanent indications of the age of the monument, whilst the original decoration, from its perishable nature, could only be temporary.

On the Gothic tombs in S. Anastasia at Verona, attempts were made to restore the original color in accordance with the ancient traces, thus destroying these traces, so that no means are left to assure posterity that the restorations were really a reproduction of the original, or that the same material was employed. Further, the restored gold and color does not find itself in harmony with the color on the marbles produced by time. If this kind of restoration of monuments is deplorable, still more so is the condition in which some of them — such, for instance, as the Fondaco dei Turchi — were left, after being scraped and scoured with pumice-stone. Strange that the thought did not occur to the so-called restorers that this structure could never have been so cruelly white. Why did they not either leave the marbles their venerable clothing of centuries, or, when once profaned by the scraper, why, consistently with their own theory of restoration, did they not restore them to their original condition by carefully polishing the marbles, that their beautiful veinings might be exhibited, and why did they omit to replace the original polychromatic decorations, not that this latter course would have repaired the damage done by scraping, but at least it would have spared future generations the infliction of being compelled to look upon the work with disgust.

Having studied the color decoration of Gothic art at the time of its most beautiful development, let us now proceed to examine the period of its decadence, and for this purpose we will return to the Ducal Palace and stop before that portion of the façade towards the Piazzetta, which, with the Porta della Carta, was erected between 1424–1443. The second rebuilding of the Palace had proceeded as far as the completion of the façade on the Molo and the first seven arches on the Piazzetta, when, about 1342, the work was suspended; after a lapse of eighty years the Doge Tomaso Morenigo proposed to demolish the remaining portion, facing the Piazzetta, of the old palace built by Ziani, in order to complete the building in accordance with that portion already reconstructed, which was accordingly done, The decree declared that it should be rebuilt "*in forma ut respondeat solemnissimo principio palatii nostri novi.*" In pursuance of this decree the work was resumed in 1424, and the Piazzetta façade was continued from the seventh arch as far as the Porta della Carta, in continuation of the portion already rebuilt. The work had only to be prosecuted according to methods already initiated, repeating the ancient forms, but the changes which had taken place in art during the lapse of almost a century could not fail to exert an influence which, though not so evident in the direct copyings, is clearly seen in those portions of the work where the artists of the time found themselves at liberty to do something of their own in the way of sculptured decoration, although circumscribed by an architectural ensemble from which they could not depart.

The subject, however, more particularly under our present consideration is that of decoration in color. The influence of the first half of the fifteenth century upon polychromatic decoration first evinces itself when Gothic art begins to lose its original sentiment and assumes those graces of form which distinguish the art of the cinquecento. In order to conform in color with that portion of the Ducal Palace already rebuilt, it was necessary to cover the main wall towards the Piazzetta with white and red marbles. The windows which opened in that latter direction were also at that time ornamented with traceries, but no indications remain of their having been gilded or colored in any way. The spandrels of the lower arcade were intended to be faced with colored marbles, for we find the same indentations in the stone, to retain the facings in position, as in the older portion of the palace, without, however, in this case, giving evidence of the subsequent application of the facings. It is to be noted, farther, that the wall-structure of the spandrels on the sea-front, and of the contemporary ones on the Piazzetta is composed of layers of Istrian stone, equal in thickness, with symmetrical divisions, apparently arranged in this manner so as not to be disagreeable to the eye, should the subsequent intended experiment of surface decoration prove unsuccessful. The two spandrels on which was made this experiment of placing the colored marbles have already been spoken of. Perhaps, finding that this mode of decoration diminished the massive appearance of the arcade, it was judged better to leave the other spandrels in their austere simplicity, but on the façade towards the Piazzetta, of a later date, the wall of the spandrels is composed of large blocks of tufa, without reference to the dimensions of the stones laid in the older spandrels; they are built, also, without reference to each other, and in the arrangement of the blocks do not even possess a symmetry of their own. As the indentations show plainly the intention of covering them with colored marbles, and as the exposed surface of the masonry is in such rude condition, there would seem to be no reason in this instance for the marble not being placed there, except that of neglect or change of mind.

On the corresponding façade on the court the indentations are repeated, and we miss them only in the two arches that were rebuilt when the Scala Foscara was demolished, in 1600.

IMPREGNATION (FIRE-PROOFING) OF WOOD AND SCENERY IN THEATRES.

AFTER a conflagration of a theatre the cry, by both laymen and chemists, is raised: "Have all scenery impregnated;" the general public being convinced that means are at hand to make a piece of canvas or gauze "fire-proof." Chemists propose processes which they have perhaps never tried, or when tried have seldom taken into consideration that there is a vast difference in the results they have arrived at in their laboratory, by carefully impregnating their canvas, carefully drying it, and — I might say — carefully igniting it, and the results obtained from a piece of impregnated scenery, which is painted upon, tossed about, folded up and exposed to all sorts of maltreatment imaginable. It is on this account that the impregnation of wood and scenery has been more of a theoretical plaything than of much practical value.

Several preparations exist which render wood impervious to heat, and also increase its durability. Some of these solutions have been tested on a large scale, and have proved a success. Although these measures are cheap and their success demonstrated, they have, with few exceptions — as for example, at Frankfort-on-the-Main, the Hof-theatre, at Berlin — not been employed. Perhaps constructors of theatres will, in view of these frequently-occurring catastrophies, at last comprehend that even the incombustibility of the wood-work would be of inestimable value in securing immunity from fire in theatres, and that the spreading of flames would be greatly retarded when instead of burning rapidly, as dry wood will, it slowly, without flames, chars into coal. The nature of wood makes it an easy matter to change it into what an exultant chemist has called a "fire-proof" substance. On account of its porosity a solution applied to its surface sinks deeply into its pores, thereby attaining a firm hold, and on account of its rigidity exposes the covering to abrasion only. Care should be taken, where such solutions have been used, to replenish them from time to time, so as to keep the wood entirely covered. It

may be well to state here what is meant by "fire-proof." As this term is usually used it signifies the property of remaining intact in high temperatures such as are produced by the conflagration of buildings; but this is not the state impregnated wood or scenery is in. These are destroyed when in contact with a flame; not, however, by burning, but by charring. If we hold a piece of impregnated scenery in the flame of a Bunsen burner we will find that the part which was in contact with the flame has been destroyed, that is, it has been charred without producing flames or injuring the parts not in direct contact with the gas flame.

In experimenting on the impregnation of wood, canvas and gauzes, I was particularly careful to use only chemicals as they appear in commerce, and undistilled water. In my opinion one of the chief causes of failure in methods in practice, which were successful in experiment, is that the chemicals employed in experimenting were the pure reagents of the analytical chemist, while those used in practice contain many impurities which must necessarily alter the results arrived at by purer supplies.

One of the oldest and best known processes is the coating of woodwork by water-glass (sodium tetra-silicate), which for a short time gives good results, but soon the covering drops off. The reason for this is that a covering of water-glass is as brittle as ordinary glass, and is readily cracked and broken; and secondly, as it dries very rapidly, it does not enter any distance into the pores of the wood, but rests on the surface. Any jar or abrasive action will, therefore, cause the water-glass to drop off in small chips. Another objection to this substance is its solubility. It cannot be employed in places exposed to the action of water.

Another process is to paint wood with a solution of three parts of alum and one part of sulphate of iron; after the wood has received two or three coats of this solution it is thoroughly dried; then a solution of potters' clay and sulphate of iron, having the consistency of paint, is daubed on the prepared wood until all pores are filled, and a thin layer remains on the surface. It is claimed that in this process the alum and sulphate of iron enter deeply into the fibres of the wood, and form indestructible compounds with the chemical elements of the fibres which cling tightly to them and cannot, as in the case of water-glass, be readily washed out. The covering of clay greatly protects the wood from moisture, so that the first solution cannot be washed out, or thrown out by the action of frost. This sounds well, but in practice would be too complicated.

Another objection which makes it valueless for theatres is that the clay on the surface comes off very readily in the form of dust, and, therefore, must frequently be renewed; it is also an unclean process; an actor unconsciously leaning against a piece of wood thus prepared would afterward appear before the audience with a stripe of clay-dust on his back.

The following is also a complicated process: The wood is painted with hot glue-water until all pores are filled, the number of coats depending on the porosity of the wood used. Then applying to the surface, before the glue dries, a powder consisting of one part of sulphur, one of ochre (or clay), and six parts of sulphate of iron. Care should be taken to powder and mix these substances well before applying them. This process labors under the same difficulty as the preceding one described.

A clean and excellent coating for wood is asbestos paint, or better still, the thicker asbestos concrete. These substances act like true paint, adhere tightly to the wood, give good protection against high temperatures, and do not readily rub or chip off. It has but one objection: that is, its solubility in water; it cannot be used in places exposed to the action of water, but for interior theatre purposes this is no material objection. Great care must be taken in purchasing this article, and should always be tested before being used, as much of the so-called "asbestos paint" which is sold is entirely worthless. — *C. John Hexamer in the Spectator.*

THE ILLUSTRATIONS.

APARTMENT-HOUSE FOR JOHN WHARTON, ESQ., NEWARK, N. J. PAUL G. BOTTICHER, ARCHITECT, NEWARK, N. J.

THIS building, recently completed, was the first of its kind erected in Newark. It is 70′ x 76′. The front is of Trenton pressed brick, with Belleville brownstone finish. The feature of the recessed bay was adopted to afford an oblique view without encroaching on the street. The building contains three stores, and twelve suites of apartments of seven rooms each, besides bath-rooms. The attic story contains drying-rooms, play-room for children and the janitor's quarters. The means for escape in case of fire are ample, there being six stairways, besides iron fire-escapes on the rear. The building is heated by steam, and the total cost was about $53,000.

"SHADOW FARM," NARRAGANSETT PIER, R. I. MR. DOUGLAS SMYTH, ARCHITECT, NEW YORK, N. Y.

THIS house, built for S. A. Strong, Esq., cost about $16,000.

HOUSE AND BARN FOR FRANCIS H. SLADE, ESQ., LAWRENCE, L. I. MR. H. M. CONGDON, ARCHITECT, NEW YORK, N. Y.

OLD BRICK CHURCH, SMITHFIELD, VA.

THIS building, situated five miles south of Smithfield, Isle of Wight County, Va., was built in 1632 by the English settlers, the brick used being, of course, imported. An attempt is now making to procure money to restore the building, and the rector of the parish will undoubtedly welcome any contributions that may be offered for the preservation of one of the oldest structures in the country.

SANITARY PLUMBING.[1] — XX.

CAPILLARY ATTRACTION.[2]

BESIDES the well-known enemies of the water-seal of traps already described, another exists, less generally understood, which, is, however, more insidious and no less fatal in its action. It works like the vampire, silently and stealthily drawing the life from the trap without warning of any kind, and often leaves open the gates of the sewers without detection. Where the trap is constructed entirely of opaque material the absence of the water-seal cannot be seen, and the source of the leakage of sewer-gas into the house is attributed to some other cause.

Capillary attraction is the subtle thief which does this mischief. Hairs, lint, bits of twine, paper, sponge, or matted filth are the tools it operates with. A small quantity of any of these substances forming a continuous mass or chain from the water in the trap to and over into the outflow will, under certain conditions, soak up and slowly drain off the water from the trap until the seal is destroyed. Let us examine the conditions favorable to this action, and ascertain by what means, if any, it may be prevented.

In books on the subject of capillarity we find the theory explained with scientific accuracy. The precise amount of elevation of liquids in tubes of very fine bore, nominally of the diameter of a hair (*capilla*), is calculated in these treatises to a nicety, and we are in most of them referred, for complete satisfaction and elucidation, particularly to the gigantic work of La Place on Celestial Mechanics (Tenth Book, Supplement). Knowing from the study of this interesting work that the tension of the surface of contact of two liquids or bodies is represented by the equation:

$$T_{1,2} = \int_0^{\epsilon_1} \left(x_1 - x_{01}\right) \rho_1 + \int_0^{\epsilon_2} \left(x_2 - x_{02}\right) \rho_2{}^d v_2.$$

What more need the practical plumber ask to cause the whole subject of the capillary effect of sediment in traps and the best methods of dealing with it to burst upon his delighted understanding in a flood of light? All he requires is a knowledge of the higher mathematics and some skill and ingenuity in arranging his data for calculation. He knows from the treatises that the finer the bore of the tube the higher the liquid will rise in it, provided the surfaces are of a kind that the liquid can wet them; that plane surfaces which can be wetted by a liquid will exert a similar attraction on liquids, provided they are put near enough together, not exceeding one-tenth of an inch apart, and that the attractive power is in proportion to the proximity of the surfaces, and independent of the thickness of the bodies underlying them. But he will not find in the treatises what the exact effect will be on liquids of the juxtaposition of numerous plane and rounded surfaces such as are presented by the sediment found in traps, under the peculiar conditions of surroundings, temperature and moisture met with in plumbing. Inasmuch as these peculiar conditions would render his calculations somewhat more complicated and difficult, and as the books have not investigated the subject sufficiently, a study of this particular branch of the subject from a practical rather than a theoretical standpoint seems needed.

What is the capillary effect of large and small quantities of the sediment found in traps, and how can the loss of water by this agency be prevented?

It is evident:

First, that the substances exerting the capillary attraction can conduct the water only to a certain limited distance beyond and above its surface, and that the rapidity of the removal of the water in a closed vessel will be in proportion to the shortness of the distance required to be raised.

Second, that capillary attraction in an open vessel greatly increases the loss by evaporation, and that the rapidity of the removal of the water in vessels of similar form, but exposed to different degrees of change of air will be in proportion to the velocity and hygrometric condition of the air current.

Hence if we so construct our trap that the distance from the surface of the water to the mouth of the outflow shall be sufficiently great, and do not allow the air above the trap to be changed in such a manner as to cause evaporation, the trap will be secure against this danger.

(1.) *Limit of Distance above Water-Surface.*

To ascertain the distance which water will travel above the seal of

[1] Continued from page 179, No. 433.

[2] It should be here noted that most of the experiments on siphonage, evaporation, capillary attraction, etc., recorded in these articles have been made with great care and accuracy by an assistant, Mr. Ernest H. Farrar. As they were made under the writer's immediate direction and supervision, he is able to vouch for their accuracy.

a trap under the influence of capillary attraction, a number of experiments were made with various materials such as are liable to collect in traps in practical use, including among them those which are found to have the maximum of effect in conducting the water by capillary attraction. The experiments were made both in ordinary open glasses and in different kinds of traps, both open and closed. The first tests were to ascertain the *perpendicular* distance. Figures 120, 121 and 122 show the manner in which the tests were made with ordinary drinking-glasses. A number of goblets were supported on blocks and filled with water. Over their edges were hung the different substances to be tested, one end extending below the bottom of the water in the goblet, and the other to the top of a tumbler placed below it, as shown in the figures, to receive the water drawn from the goblets. The substances tested were matted hair-felt, lamp-wicking,

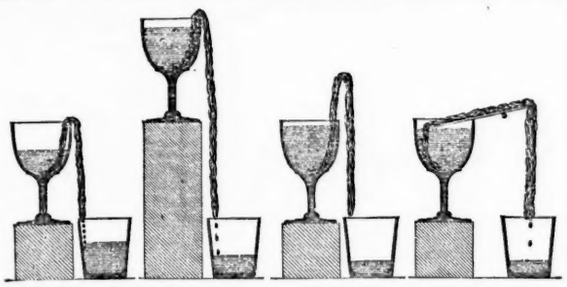


Fig. 120. Fig. 121. Fig. 122. Fig. 123.

Capillary Attraction in Open Vessels.

both with and without its covering, jute, hemp-cord unravelled and separated into fine fibres, hemp-cord in its natural braid, and pieces of string. Of all the substances tested, jute, such as is used by plumbers in caulking joints, proved to be the most effective in removing the water by capillary attraction. Different amounts of each substance were used in making the experiments. In each case experiments were made both with a small quantity of each material and with a mass large enough to completely fill the waste-pipe. As might be expected, the water was most quickly removed when the quantity of the substance tested was large enough to completely fill the pipe. These experiments showed the limit of the carrying power in an upward direction with these materials under capillary attraction to be 4½″. The water was rarely lifted more than 3″ or 3¾″. The majority of the water carried into the lower glass was moved during the first ten or twelve minutes, the rapidity of the action gradually decreasing as the water descended, becoming extremely slow when the level was reduced about 2″, and generally ceasing altogether, and the fibres becoming entirely dry at the top when the water in the upper vessel was reduced about 3½″ or 4″.

In emptying a vessel of water by means of a bent tube forming a siphon, the excess of length of the outer over the inner limb of the siphon governs the rapidity of the flow. With capillary attraction, however, though the outer limb must always be longer than the inner, yet beyond a certain fixed point the excess appears to have no marked influence. A small predominance of the outer limb, as shown in Figure 120, or just enough to overbalance the column of water in the inner limb, carries off the water as rapidly as the long limb shown in Figure 121.

The results of the experiments with ordinary open vessels were as follows: —

(*a*) *Hair-felt.* This is a material which closely resembles the matted deposit of short hairs which form so large a proportion of the deposit in traps and waste-pipes. Strips of this felt ¼″ thick and of various widths and lengths were tested under different conditions. Tested with the glasses arranged as in Figure 120, with a strip ¾″ wide, it lowered the water in the goblet 2″ in the first ten minutes, but required four hours and a half to diminish the level another inch.

After this no more water was carried over into the lower vessel, but the rate of evaporation of the water in the goblet was considerably increased by the hair-felt, which lifted the water to a certain height and distributed it over the fibres of the felt, thereby exposing a very large surface to the action of the air. A piece of felt 2″ wide tested in a similar manner gave similar results. An increase in the width or length of the felt made, in this case, no corresponding increase in the amount of the water transferred from the upper to the lower vessel.

(*b*) *Lamp-wicking.* A material closely resembling the soft, porous lint found in traps and waste-pipes. This was tested both with and without its cylindrical fibrous covering, as it comes prepared in the market for use in lamps. The wicking was cylindrical in form and about ¼″ in diameter. It was first tested without its cover. Placed as shown in Figure 120, the wicking lowered the water in the upper goblet only 1¼″ in seventeen and a half hours, after which no further transfer took place. With wicking placed as in Figure 121, 1¾″ were transferred from the upper to the lower vessel in the same time. Another experiment made under similar conditions transferred only 1½″. With the wicking covering on, only half the amount of water was transferred from glass to glass in the same time.

(*c*) *Jute.* A hempen, unwoven cord, with long, fine fibres, used by plumbers in caulking. This substance produces the strongest capillary attraction, and acts like very fine hair and lint. Arranged as in Figure 120, a piece ¼″ inch in diameter transferred from the upper glass to the lower 1½″ in fifteen minutes and 2½″ in four and three-fourths hours. Another piece of somewhat smaller diameter, but similarly arranged, transferred 1″ in twenty minutes, and a third piece, 1″ in diameter, transferred 2″ in fifteen minutes, and the whole (4″) in four and three-fourths hours. A fourth piece, 1″ in diameter, transferred 1½″ in six minutes, ½″ more in twenty minutes more, and the whole (4″) in four hours. A fifth piece, 1″ in diameter, supported as shown in Figure 122, raised the water 4½″, after which the lower end dried up, and what water was thereafter raised from the goblet was carried off by evaporation, but not transferred to the lower glass.

(*d*) *Hemp-cord*, unravelled and separated into fine fibres, was in no case able to raise the water above 4″ from its surface.

(*e*) *Twisted or braided*, as it comes in cord for the market, it could not transfer more than 2″ from glass to glass.

(*f*) *Pieces of linen twine* (eight pieces) could not transfer more than ¾″.

Beyond these points the various substances invariably dried up at their lower ends, after which, of course, whatever water was taken from the upper vessel was removed by evaporation.

Tests were next made with small quantities of the following substances: eight pieces of black linen thread, eight pieces of blue cotton thread, eight pieces of red cotton thread, eight pieces of No. 36 white cotton thread, one piece of cotton tape ½″ wide, twelve ladies' hairs twisted together, one piece of blue thread, one piece of white thread, a large and a small strip of sponge, a very small strip of jute, and a fine piece of lamp-wicking. The tests on these substances were made both as shown in Figure 120 and enclosed in small ¼″ bent lead tubes to prevent evaporation from effecting the action.

In no case, except with sponges, could the water be raised over 3½″, and rarely over 3″ by these substances. The outer arms dried up before the water in the upper glasses was lowered 3″ or 3½″. Without the lead tubes the outer arms dried up sooner than with them; hence less water was carried over into the lower cups, but more was lost by evaporation. The loss of water was greater without the tubes, but the action was slower, since the drying up of the outer arms prevented the rapid removal by the combined capillary and siphonic action. With larger quantities of the substances, the loss without the lead tubes would be less, since siphonic action would not be prevented, inasmuch as evaporation from the outer parts of the mass would not prevent the siphonic action from working in the centre, thereby producing a double draught on the water.

The following table shows the result of the experiment on the small quantities of substances and on sponges.

TABLE SHOWING EFFECT OF CAPILLARY ATTRACTION PRODUCED BY SMALL QUANTITIES OF SEDIMENT.

(*Exposed to the Air.*)

Kinds of Substances Tested.	Time occupied in hours.											
	½	2	4½	7	20	44	68	92	116	140	188	250
8 Black Threads.....	in. ⅛	in. ¼	in. ⅜	in. ½	in. 1	in. 1½	in. 1¾	in 1¾	in. 1¾ dry	in.	in. ..	in. ..
8 Blue Threads.....	¼	¾	1	1¼	2	2½	2¾	2¾	3	3	3 dry	..
8 Red Thread.....	⅛	1	1¼	1¼+	1⅞	2⅛	2¾	2¾	3	3	3 dry	..
8 White Threads.....	⅛	½	¾	¾+	1⅛	1½	1¾	1⅞	2	2	2⅛	3 dry
Tape...	⅛	⅜	½	½	⅞	1⅛	1¼	1½ dry	..	..	..	..
1 Blue Thread.....	1/32	1/16	⅛	⅛—	⅜	½	⅝ dry	..	..	..	..	..
1 White Thread.....	0	0	0	0	0	0	0	..	..	..	..	..
12 Hairs.....	1/32	⅛	⅛	¼	⅜	½	⅝ dry	..	..	..	..	..
Large Sponge.....	..	..	..	..	..	6	7½	8	8	8 dry	..	..
Small Sponge.....	1	3	3⅛	3¼	4½	5	5½	5⅞	5⅞	6 dry	..	..
Jute 1-16″ diam.....	⅛	⅜	½	⅝	1¼	1⅝	..	6 days 2⅝	..	12 days 3 dry	..	..
Lamp-Wick 1-16″ diam.	⅛	⅜	½	¾	1	1¼	..	2	..	2¼ dry	..	..

(*Enclosed in Lead-Tubes.*)

8 Blue Threads.....	½	⅞	1⅛	1½	2⅝	3	3½	3¼	3 dry	..	..	..
8 Red Threads.....	¼	⅝	¾	⅞	1½	1¾	1⅝	2	2¼ dry	..	..	..
8 White Threads.....	⅛	¼	⅜	½	⅝ *	¾	¾	⅞	1 dry	..	..	..
Tape.....	1	1¼	1¼	1½	1⅝	2⅛	2¼	2½	2¾	2⅞	2¾ dry	..

From the experiments recorded in the above table, and from numerous other tests made in the same manner, we learn that the extreme limit of the lifting power of very small quantities of the long and fibrous substances which might lodge in traps so as to exert a capillary

action is within three inches. Sponge is the only substance known to the writer as likely to be found in waste-pipes which has a lifting power exceeding this. The limit of sponge, even in large masses, appears, from the tests made at the same time with the others, to be 8″; but as the general shape of a sponge is spherical and never filiform, and as no sponge large or long enough to extend upwards this distance or anything approximating it, and then down again the same distance into the waste-pipe, could possibly be squeezed into a trap without stopping up the water-way altogether, the consideration of this material and all others of similar form need not enter into our calculation.

Tests for Carrying Distance in Horizontal and Inclined Directions.

Figure 123 shows the manner in which the tests for the limit of horizontal and inclined distances were made. The same substances were used which were already tested for vertical distance. A large mass of jute about an inch in diameter, arranged at an angle of 10°, was found to carry a few drops of water 14″. Raised to an angle of 35° it carried the water 7″, the elevation raised being 4″. With small masses horizontal extension produces a greater effect in preventing loss by capillary attraction. In general it appears, however, that the advantage of an increase of horizontal extension is due chiefly to the drying of the fibres of the substances tested, which prevents the water from progressing.

Tests with Traps.

Thus far the experiments have been made in the open air in ordinary open vessels. The tests were made in the shade and in a temperature varying between 60° and 70°F., or the ordinary temperature of house interiors. To render these results of more practical value they should be compared with the tests made on the same materials in the actual positions found in practice, *i. e.*, in the trap itself. The tests were, therefore, made both in detached traps, and in traps fixed in position and properly attached to the drain-pipe.

Tests with Ordinary S-Traps.

A $1\frac{1}{2}$″ S-trap having $1\frac{1}{2}$″ seal was arranged as shown in Figure 124.

(*a*) A string or mass of jute $\frac{1}{4}$″ in diameter was introduced so as to extend from the bottom of the trap over the outlet and down several inches below the bottom. The experiment was repeated five times, the results each time being nearly identical. In the first half minute the water in the trap was lowered $\frac{1}{2}$″. Five minutes sufficed to lower it 1″; twenty minutes lowered it $1\frac{1}{4}$″; a half an hour usually sufficed to break the seal, and about three hours was enough to leave the trap almost dry.

Fig. 124.
S-Trap with Jute $\frac{1}{4}$″ diameter.

(*b*) The quantity of jute was increased to 1″ in diameter, which was the maximum amount possible, inasmuch as it was sufficient to fill the trap. Four tests were made. In every case enough water was drawn out of the trap to break the seal in less than half an hour. In general the loss of water was considerably more rapid than in the tests with a smaller quantity of material. Two minutes sufficed generally to lower the water an inch.

(*c*) A mass of hair felt 1″ wide and $\frac{1}{4}$″ thick was substituted for the jute. Three tests were made, and the traps were emptied in from 9 to 15 minutes.

Tests with Pot-Traps.

A number of pot-traps were then tested. An 8″ pot-trap having $3\frac{1}{8}$″ seal was arranged, as shown in Figure 125, the mass of jute used being 1″ in diameter. It required 24 hours to lower the water in the trap $1\frac{3}{4}$″. Two days lowered it $1\frac{3}{16}$″; three days $1\frac{7}{8}$″; seven days lowered it $1\frac{15}{16}$″. After this no further change took place in the trap. Evaporation was too slow to make any perceptible difference in several days, since the trap was not ventilated.

A vessel of water of about the same size and form with the 8″ pot-trap, but freely open above to the air, so that evaporation could go on, and having a piece of jute $1\frac{1}{2}$″ in diameter hanging over its edge (as in Fig. 120), lost 5″ of water in the same number of days. A portion was carried over as in the 8″ pot-trap into the vessel below, but the rest was removed by evaporation.

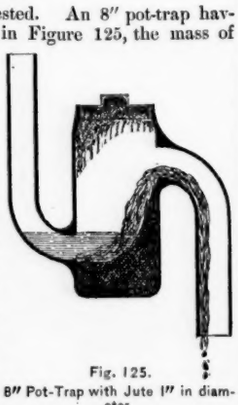


Fig. 125.
8″ Pot-Trap with Jute 1″ in diameter.

A 6″ pot-trap was similarly arranged, and lost $2\frac{1}{8}$″ in one day; $2\frac{5}{16}$″ in two days; $2\frac{3}{8}$″ in three days; $2\frac{7}{16}$″ in five days; after which no apparent further change took place as long as the observations were conducted, which was for several days.

A $3\frac{1}{4}$″ pot-trap lost $\frac{5}{8}$″ of water in one hour; 1″ in six hours; 2″ in fifteen hours; $2\frac{3}{4}$″ in two days; $2\frac{7}{8}$″ in three days; 3″ in six days, after which no apparent further change took place.

Thus we see that the effect of capillary attraction in traps detached from the drains is similar to that in open vessels, with this exception, that in the traps (unventilated) no perceptible loss takes place through evaporation, and that after the limit of perpendicular distance at which the capillary force can act has been attained, no further loss of water is perceptible. In open vessels, on the contrary, the draught on the water goes on indefinitely by rapid evaporation.

Tests of the Effects of Capillary Attraction in Ventilated and Unventilated S-Traps fixed in Position.

To test the loss by capillary attraction on ventilated S-traps as compared with the loss on the same where unventilated, an S-trap having a seal of $4\frac{5}{8}$″ was arranged as before with jute, half filling the trap. With the trap attached to the waste-pipe, and connected with the drain in the ordinary manner, but unventilated, the loss by capillary attraction was as follows: In the first five minutes $\frac{1}{2}$″; in the first forty-five minutes 1″; in twenty-four hours 3″; in three days $3\frac{1}{4}$″; in four days $3\frac{3}{8}$″. Thereafter no further perceptible change took place. It made no perceptible difference whether the basin side of the trap was opened or closed, showing that evaporation in an unventilated trap is practically almost imperceptible.

The experiment was then repeated on the same trap ventilated at the crown, into a cold flue with the following result; in one hour $1\frac{1}{8}$″ had been removed; in five hours $1\frac{3}{8}$″; in twenty-two hours $2\frac{1}{2}$″; in two days $3\frac{1}{4}$″; in three days $3\frac{1}{2}$; in four days $3\frac{3}{4}$″; in five days 4″. Thus the loss continued at the rate of about $\frac{1}{4}$″ a day by evaporation, after the outer end of the jute mass had entirely dried up. This rate of evaporation was nearly double *what it would have been had it not been assisted by the capillary attraction.* From this we see that ventilation greatly increases the danger arising from capillary attraction, often rendering the latter dangerous in cases where, without ventilation, the seal would not have been broken.

To test this point still further, two ordinary drinking glasses were filled with water, and placed side by side. The first was treated as shown in Figure 122, with a mass of jute hung nearly 5″ above the surface of the water, and having one end immersed in it, as shown in the figure, and the other extending below the bottom of the glass. Owing to the height from which the jute was suspended the water did not rise to the point of support; consequently, the outer arm was dry, and whatever loss of water was observed was, therefore, due to evaporation. The glass having the water alone lost by evaporation only $\frac{1}{4}$″ in seven days, while that having the jute above it lost 1″, or four times as much. This was in air almost perfectly motionless. Had the air been in motion as it is in the current over a ventilated trap, it is evident that the difference would be proportionately greater.

SOME NINETEENTH-CENTURY ARCHITECTS.[1]—I.

Finial of a Dormer. Château de Pierrefonds Fragile. Restored by Viollet-le-Duc.

THE title prefixed to this paper is so broad, not to say vague, that it will be desirable at once to state more definitely what is to be attempted. It is simply proposed to give some account of a few of the architects, no longer living, who have been for various reasons prominent during the recollection of the writer of the paper, and with most of whom, though not all, he has in some way come into personal relations. Neither the work nor the life of any living architect will be introduced — a circumstance which will remove any inducement to attempt anything so ambitious as a general outline of English nineteenth-century architects; and in fact, nothing more must be expected than disconnected sketches, fragmentary and slight, but still, it is hoped, capable of interesting you for an hour, and of leaving some impression behind.

Thirty years ago, the leading architects may be said to have been Barry, Cockerell, and Pugin, and each of these, in his way, has left his mark upon the architecture of the century.

Professor Cockerell. — Professor Cockerell was a man who managed to inspire something like enthusiastic admiration by his high character, his fine works, and the lectures he delivered at the Royal Academy. He travelled far as a student, and during a long time, and was the fortunate discoverer of valuable remains of Greek architecture. He was one of the most accomplished draughtsmen and colorists of his day, and a man of fastidious and refined taste; and his finished drawings, especially those which he contributed to the Academy exhibitions, were masterpieces. His studies, researches, and sympathies all ran in the direction of Classic and of Renaissance architecture; and though he took an interest and some share in the archæological pursuits of his time, I am not aware of his ever having designed or erected any building in any of the Pointed styles. He built for the Bank of England several branches, mostly of Greek architecture, in different provincial towns; and erected public buildings in Oxford, Edinburgh, Liverpool, and London, all of them original in their design and refined in the extreme in their details, but all Classic or Renaissance. Among these works the completion of St. George's Hall at

[1] A paper read by Professor T. Roger Smith, at a meeting of the Leeds Society of Architects and published in the *Architect*.

Liverpool was prominent. Elmes, who designed it, died when the shell of the building only was up; and much of the interior, I believe, also the architectural surroundings of that splendid pile of buildings, were designed as well as carried out by Mr. Cockerell. He was the surveyor to the Dean and Chapter of St. Paul's Cathedral, and that post gave him an immense amount of pleasure, for he was an ardent admirer of Wren and his work. As Professor of Architecture at the Royal Academy, he delivered lectures which were listened to with profound attention and genuine admiration. Whatever the subject, we knew that we should have plenty of light cast upon it; but we knew also that from time to time there would be thrown out a short sentence of winged words — a maxim, a precept, or a criticism profound, suggestive, instructive — so tersely and often quaintly put that the words would remain in the memory, and so full of meaning that it would furnish food for reflection and consideration for long after. "Be a gentleman," said he, one day, "among artists, and an artist among gentlemen." These lectures must have had no small influence on many of those who heard them, and the gallant, generous nature of the man, and the enthusiasm for his art which shone through and brightened up the whole of his life, were quite as influential as his words. Those who had the privilege of knowing him to any extent personally can all bear witness to the charm of his manner, due as much to a straightforward simplicity of character, which was apparent in everything that Mr. Cockerell said or did, as to his singular accomplishments, polish, and ability.

In appearance Professor Cockerell, in the last few years of his life, when alone I knew him, was still strikingly handsome. His gray hair was parted in the middle, his fine features were wonderfully mobile and sensitive, and the expression of his face would constantly vary as conversation went on, now lighting up, now quieting down, in harmony with what he was thinking; while, with the most appropriate gestures, he would emphasize the points of anything that he was saying in a manner more like an Italian than an Englishman.

When after being for some years presided over by a nobleman, a friend of art and artists, the Institute of Architects decided that their President should be a professional man, the unanimous choice of the body fell almost by acclamation on Professor Cockerell; and, when the Royal Gold Medal was granted by the Queen, he was the first architect recommended to Her Majesty to receive it. He was esteemed and recognized by foreign academies and learned bodies, as well as in his own country, and he died full of honors, as well as of years.

A. W. Pugin.— A very different kind of man, with very different ways and motives, and exerting a very different influence, comes before us when we turn from Professor Cockerell to Augustus Welby Pugin. Cockerell was to some extent identified with a style which it seems impossible should ever take permanent root in England. I refer to Greek architecture; and when his work was not Greek it was Renaissance, a style which was beginning to lose ground, and which, though it has been continuously practised ever since, has not been always, or even usually, carried out with the skill, care, and knowledge of detail that mark Cockerell's work.

Pugin, on the other hand, came in on the rising tide of a complete change in taste, and had no small share in directing, popularizing, and intensifying that change. His father was of French refugee family, and is best known by the books of Gothic details, and other illustrations of architecture, which he published. His son was his pupil; he was a man of genius and force of character. His knowledge of detail and fertility of invention were immense, but it is doubtful if, with our present experience, we should call him a thoroughly successful architect, as few of his many churches rise to a high standard of excellence. He went over to the Roman Catholic faith, and was chiefly employed on buildings for that form of worship, and his work, though better than that of most men of his day, is often poor and thin, and far from being impressive.

Pugin, however, exerted an immense influence on the art progress of the country by his facility as a designer of ornamental metal-work, wall-papers, glass, and furniture, in all which works he was thoroughly at home, and was constantly fully occupied. He was really the creator of the modern school of art manufacture. He also did much by a series of shrewd, caustic, well-illustrated publications to foster the growing taste for mediæval art and architecture. The "Contrasts" and the "True Principles" are now all but forgotten, but they were as powerful in their day as anything which Ruskin has written has since been.

Pugin was appointed to superintend the details of the wood-carving at the Houses of Parliament, and had also under his charge the metal-work, stained-glass, and encaustic tiles, and here there can be no doubt his services were most valuable. Barry was fully equal to the highest work of the architect of the building, which Pugin, even in works of a far smaller calibre, had been barely able to discharge; but it is no disparagement to Barry to say that Pugin was absolutely unrivalled as a master of detail, and that his ornament added a grace to the work which no one else could have so well imparted. Perhaps having alluded to this association, I ought here refer to the claim, raised long after Pugin's melancholy end and when Barry was no more, that he had been the real designer of the Palace of Westminster. That claim, which it is charitable to consider had its origin in a disordered brain, was finally disposed of by Barry's son; but if any one is inclined to believe that there was something in it, I would suggest his looking carefully over the vast pile at Westminster and noticing well how masterly is the treatment of the whole, and then crossing to Southwark and inspecting Pugin's most important work, the Roman Catholic Cathedral there. He will find the latter with thin, poor, feeble features, its exterior undignified and its interior by no means impressive, and the better judge he is of architecture the more thoroughly convinced will he be that Pugin, who was so unequal to cope with the moderate difficulties of a church of not very unusual size, was not the man to master the infinitely harder task which Westminster presented.

Pugin built several dwelling-houses which were successful, and he built at his own expense a church at Ramsgate, said to be, though small and simple, his best work. His drawings were wonderfully rough, though effective; but they could hardly have been carried out except by artisans whom he had trained and who understood his intentions; and this he generally managed to accomplish. He must have been a man of immense force of character as well as originality, and he probably did more than any other man to promote what has been termed the Gothic movement,

Mr. Hardwick. — Mr. Hardwick, an architect like Tite, better known in London than elsewhere, has a strong claim for mention in any paper by the present writer. He was a man of great personal ability, and highly esteemed as singularly upright and honorable. His skill in planning was great, and he was among the first to inaugurate, at the Euston Terminus, the system of railway hotels which has since become so common. His best work was Goldsmiths' Hall, London, an admirable building for its purpose, whether its skilful planning or the general appropriateness of the dignified architectural treatment be taken into account. He was also the architect of the picturesque hall and library of Lincoln's Inn — an excellent Tudor building — which was, however, to a great extent carried out (in conjunction with him) by his son Mr. P. C. Hardwick.

T. H. Wyatt. — An architect better known in the provinces, and like Hardwick, one of a family of architects, was Thomas Henry Wyatt, a most genial man, and a successful practitioner. His best-known work, perhaps, is the Liverpool Exchange, but he obtained many commissions in various parts of England, and led a life of great activity. He, like Cockerell and Tite, was President of the Institute of Architects, and in that position his devotion to his duties and his kindly cordial manner made him very welcome both to the general body and his colleagues on the council. At the time of his death he was erecting a very interesting work — the Consumption Hospital at Brompton — which has been completed by his son.

Sir Matthew Wyatt. — From Thomas Henry Wyatt we pass naturally to his younger brother, Sir Matthew Digby Wyatt, who was a more brilliant man generally, and perhaps better known, but hardly so successful as an architect. Digby Wyatt was a highly-cultivated man, most industrious, most energetic, and almost universal in his knowledge of the Fine Arts. His studies and his sympathies were, however, turned chiefly in the direction of Renaissance, and especially Italian art. He had a fine critical taste, and his judgment on points connected with pictures, sculpture, enamels, decorations, was rarely at fault. He was a rapid and effective draughtsman, and altogether an accomplished scholar, artist, and man of the world.

As a young man Wyatt worked a good deal on the preparations for the Great Exhibition of 1851, being, I believe, secretary to the Commissioners for part of the time. When it was proposed to establish the Crystal Palace at Sydenham, Digby Wyatt and Owen Jones were sent all over Europe to obtain casts of sculpture and architecture, and collected that superb gallery of specimens which buyers have forgotten at Sydenham, and which unhappily few architectural students ever look at, much less study.

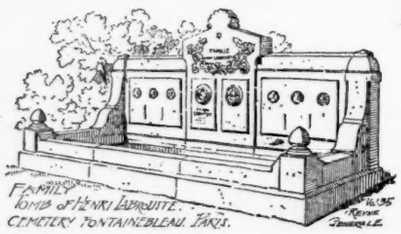
For the Crystal Palace Mr. Wyatt wrote several of those excellent manuals on art which were published by the directors at the opening, and which now few people know of. He also wrote or edited two or three books on art subjects.

He held the appointment of architect to the Indian Government, and in that capacity designed and carried out the very beautiful Renaissance interior of the India Office, which was probably his finest work, though he erected some excellent houses of large size, and some other public buildings.

Wyatt's influence was mainly directed towards keeping up the traditions and knowledge of Italian and other Renaissance work. His sympathies with Gothic were not keen, and his weight, which was not inconsiderable, was thrown into the opposite scale. He was a most energetic worker, and in fact wore himself out, and had to retire from active practice almost in the prime of life, with his health impaired, unfortunately, too seriously for its restoration to be possible. Wyatt was a man of commanding appearance — tall, strong, with a dark beard, and a fine presence, he could not for a moment be overlooked. Speaking several languages, familiar with many countries, on terms of intimacy with all artists and many persons of distinction, he was at home and at ease in any society and under any circumstances. He was a ready public speaker, an excellent man of business, a good writer, and a clever designer, and being so much, we need hardly add that he was one of the men who raise the credit of our profession, and of whom we ought to be proud.

Wyatt was genial among acquaintances, and trustworthy with friends. I was once concerned with him and Owen Jones in affairs of no small importance, of which I had had little previous experience and they much; and the cordial yet delicate way in which they both let me have the free use of the results of their practice is one of the pleasant things which one not only desires never to forget, but which, when an opportunity like the present offers, one is bound to put on record, and to commend to others as an example.

VITAL STEPS IN SANITARY PROGRESS.[1]



Physical purification. — In speaking, a few months ago, on one of the departments of physical purification, I seem to have startled the proprieties of many of the people by the assertion that absolute cleanliness — cleanliness of the body and mind, and all that belongs to them — is the beginning and the end of the sanitary design, and that such perfect cleanliness would wipe off all the diseases which cause at this time the leading mortalities. I do not withdraw from that statement a syllable, and I again place this subject of national purification first on the paper.

Into all the varied studies connected with this argument it were impossible to enter. It will be fittest to take two of the Augean stables which have to be cleansed.

Underground purification. — The complete removal from our communities, day by day, of all their organic excreta, is still an unsolved difficulty which, remaining unsolved, is a block to every step of perfect purification.

We are yet distracted with the debate ever going on between the advocates of the combined and the separate system of drainage. Shall our organic excreta go with the storm-water into the river and sea, or shall the water go to the river and sea, the sewage to the land? Unlike our neighbors on the other side of the Channel, we have agreed to give up the cesspool, and to divide on two questions which they have not, seemingly, admitted, and one of which, that of disposal in running streams, they have long legally prohibited. But, in giving up the cesspools, have we greatly advanced, so long as we pollute the running stream and lose the natural fertilizer of the land? Looking back on all the controversy for the last thirty years, and reading back still farther, I feel we have not advanced. I do not think it would be wise to return to the most scientific system of cesspoolage, but I cannot conceive any next worst plan than the plan of passing the sewage with storm-water, even on the most scientific system, into running streams, and of robbing the land of its greatest requirement for its fruitfulness.

I submit, therefore, as a point to be argued out, that this Society can never be soundly assisting sanitation until it assists none other mode for removal of excreta than the separate system.

In saying so much for the separate system I do not, however, wish to contend for the introduction of that system in the hard and unchanging line which some would fight for. I know quite well, from the inspections I have had to make, officially, of different towns and districts, that there are centres of population in which the separate plan, in its rigid application, is not suitable. A town may have no river into which its storm-water can run. A town may have a river, but no land near to it which can be cultivated. These conditions may affect details, while they need not affect the principle. For storm-water for which there is no natural outlet there is always the good resource at hand of storing it for domestic use. For sewage that cannot be utilized on land near to the community which yields it, there is always land not far away which is waiting for it. In these days there need never be necessity for any difficulty in the removal of sewage day by day from the largest centres of population, presuming always that it is not mixed and increased in volume by storm-water. Closed sewage-tanks movable by night train, closed sewage-tanks movable by steam-power on sewage canals and rivers, closed tanks movable by steam-power on the sea, could convey away all this product for fertilization, and deposit it where it could administer its full benefits to the earth. Barren portions of our sea coasts could, by these modifications of the separate system, be made the most fertile and beautiful of all our tracts of vegetation.

To the engineer, when once a system were decided on and declared, these modes of transit, and many improvements on them, would occur. With the engineers it is not our special province to interfere. They exist to carry out what had been determined on, and when they know what the people want, they will do what is wanted, as surely as they will lay down, after the country has said they must, a new railway or a telegraph. We have but to declare the principle, and get it fixed, that every town in England must be cleansed of its organic excreta out and out, day by day, as certainly as it is supplied with the food that is brought into it, and the thing will be done.

Toward such perfection any powerful society, steadily and resolutely devoting itself, would soon be backed up by the common sense of people who require but a competent instructing authority in order to understand the subject accurately. The utter failure of the combined system as a permanent solution of the drainage difficulty, and as a mere transition from the cesspool to the method of removal day by day, combined with immediate and fruitful utilization, is of itself becoming apparent with such swift conviction that it will come whether assisted or not by our will and deed. But it were wise to hasten it, and it is one of those pressing practical things which we could hasten effectively, if, irrespective of all interests but true ones, we laid ourselves out for the duty.

At the instance of Mr. Edwin Chadwick—whose name as a sanitarian is a name of the century — we did, some time ago, commence an inquiry here bearing upon the vital point now under consideration. We opened—or, more correctly speaking, we re-opened — the sewage question, and we discerned all at once, although our inquiries were entirely confined to limited areas of London, so much evil, that we rather abruptly closed the evil up again, as if we were frightened at it. It is all in vain, for sewage, like murder, will out, and we must once more proceed. What we did discover was in truth so serious, that the wonder we labor under is how London can be so healthy as it is. We found that London is still honeycombed with what are in fact, if not in name, cesspools, a fact we all practically recognize by the second-hand measures we take to meet the primary blunder.

From the window at which these remarks are written, I see that one of my neighbors, the owner of a large house in our square, has carried out of his house from the basement, a three inch tube to above the level of the parapet, in order to deliver into the air any gases that may accumulate in main drain of the residence.

It is not good for the air which I and many others have to live upon, that it should receive the foul air which rises from the decomposition of my neighbor's organic excreta; and if everybody's neighbors did it it would be detected in some weathers, so that the process must be stopped, as it was in a former day on a recommendation of the Royal College of Physicians. I do not, however, blame my neighbor for what he has done, because I have done it myself. It is a natural species of self-protection amongst those who know best how to protect themselves. My contention is, that the necessity for any such a method is proof demonstrative of the rottenness of the primary system which causes the necessity, and which keeping us foul beneath our houses, makes the air, at its best, foul also above them. My contention is that the decomposition from accumulations of sewage, which gives origin to the gases that are let out by thousands upon thousands of channels, by tubes from houses, by soil-pipes within houses, by accidental openings and pores in all directions, by gullies in streets, by great outlets of sewers ought never to have been generated at all, but that the sewage, removed clean away, hour by hour, many miles from the community, without having decomposed either above or below the living place, should never infect the place nor have any destination except the land which is calling for it, and which dies if its demands be not naturally supplied.

The moment we can, by the skill of our engineers, get our in and out going drainage system as good as our railway system, as true in its working, as continuous and automatic, the most important of all the basic sanitary reforms will have been introduced. Without any stretch of the imagination, volumes might be written on the affirmative side of this proposition. I must be content to put the negative side. I must declare on all heads of experience and observation, that until the basic reform is carried, there can be no sound sanitation at all. I have asked many times, sought many times, for so much as one instance in which the combined system — apart altogether from its loss and extravagance, which might be tolerated if its results were good— has proved a sanitary success. I cannot find one instance of the kind.

The towns which depend on storm-water to flush and inundate their sewers are like the old mariners who depended on favorable weather for a favorable voyage. The day has passed for that, as it has for a system of sewerage, which at all costs must be swept away.

Overhead purification. — The plan for completest removal of the fluid and solid organic excreta, basic as it is, would not be perfect unless it were attended with the purification of the air above as well as of the earth beneath. Just now the public mind is full of this topic, and Mr. Westgarth's munificent donation to this Society of prizes for plans of reconstruction will rival handsomely the Health Exhibition itself in the interest it will excite. A clear sky in a place like London; clearer and cleaner streets; the emancipation in close places of one person from the empoisoned breath and emanation of another; room to breathe; these are the blessings which the people are looking to their sanitary deliverers to give them.

We shall have in this Society sufficient work for some months to come in adjudging on the schemes proposed for these intents; we shall be overwhelmed with details; we shall have before us every plan and every model which human ingenuity can devise, to compromise interests, and make necessity the mother of invention. I will not presume to anticipate the judicial labors of the Society for the awards that will have to be made, nor suggest for it any new labors at present in this direction in addition to these, which will, probably, be sufficiently onerous.

I may, however, tell the Society that if I were going to be one of the competitors for the purification of London through the reconstruction of it, I should propose such a reconstruction as would be, in an architectural sense, perfectly revolutionary. I should propose to go up stairs to the top of the houses to do it, and should indicate the construction of another London overhead—London-super-Aër.

To convey what I mean, let us move to the best constructed as well as the most beautiful street of this metropolis, if not of the world — Regent Street — in the part called the Quadrant. That is laid out for such a design as if it had been prepared for the experiment. All the houses are of the same height, and the height throughout is just

[1] Portions of a paper by Benjamin Ward Richardson, M. D., F. R. S. read before the Society of Arts, and published in the *Journal* of the Society.

right for a city like ours. It is sufficient to be handsome and commodious without being overwhelming, and without excluding the light from the streets. The roofs of Regent Street, at this part, are flat in comparison with other roofs. They are utilized here and there by photographers' studios, which, although temporary structures, stand firmly and well, in ready communication with the houses on which they are placed. The studio, where it exists, seems naturally to form and become a part of the house. When we glance along the line of roofs, as on a level terrace, the idea of reconstruction of all roofs, and of the re-adaptation of them, becomes most distinct and suggestive. The width of most London houses averages, as near as I can estimate, about twenty-five feet from front to rear. Here, then, is good space for a terrace for foot-passage. Imagine along two lines of long streets a terrace of this kind, with handsome railing on each side, and perfectly level floor-surface of wood; and, at intervals, light bridges spanning from one terrace to another, and you have an upper-day London which might almost relieve all the pressure from foot traffic in the streets below. Each house would have its own exit, or door, at the upper as well as at the lower parts; and, at convenient spaces, each terrace would be accessible from the street as the Holborn-viaduct is at the present time.

It suggests, at first, a revolution of ideas to conceive such a change. It suggests much out of which a humorist can for a moment make capital. I know all this very well. But there is, in point of fact, nothing more in it than the first idea of making a tunnel under the streets or under a river. When the suggestion is looked at bit by bit, without prejudice, it offers more of sanitary advantage for the purification of the atmosphere, the protection of property, the comfort of the people in transit, the lodging of the people, the exercise of the young, and the beautifying of the whole city, than could be entertained on a mere general statement of the proposition.

In the first place, for every house in connection with an upper terrace, there would be the most perfect through-and-through ventilation of air. The staircase would no longer be a closed cupola for holding and storing all the emanations from the basement upwards.

In the second place, the fact of having terraces on the upper surface of London would lead to immediate arrangements for the purification of air from smoke. So soon as the roofage was accessible as a terrace, the plan which Mr. (now Sir) Spencer Wells projected for the removal of smoke from every house, by laying down horizontal conducting tubes with central exits and smoke-consuming furnaces, would be easily practicable, presuming always that some smokeless fire be not invented, or that coal-gas does not become the fuel of the people. These terraces would then be the healthiest parts of London; charged with flowers and trailing evergreens, they would be the empyrean gardens of the great city.

The terraces with their light intercommunicating cross-bridges in the long thoroughfares would be more than pleasant foot-ways and shady lanes for the foot travellers, or travellers in light noiseless vehicles, like tricycles; they would be most useful for other purposes. Along them the electric lines would pass and enter the houses direct; and from them the letter-carriers would most easily deliver their letters.

These terraces, while relieving the traffic in the streets below, would remove all necessity for the fire-engine, and would make London practically safe from fire. From them water would be supplied readily, a trained police for this upper London being ready at every moment to go down and extinguish fire in every domicile, carrying his hose with him, or plying it from above.

I think that no one who reflects will fail to see that all these changes would be advancements of great value for the health of a city like ours. They are, however, not the chiefest advantages. If any one will take the trouble to go observingly through the busy parts of London, where there are long miles of roadway — along Whitechapel and Mile End, for example — he will see the most jagged, hideous lines of roofage. Here a row of houses two stories high; there a row of three or four stories; then a single house five or six stories, and so on, over and over again, like a set of bad teeth. If the plan here suggested were carried out all this would be rectified. A street like Regent Street expanded into a straight line would extend from the Marble Arch to the City, and from the City to the extreme East End. The line of terrace pitched at five stories would necessitate the building up to the same level all the houses in that line, by which at least one-fourth more housage would be supplied, with arrangements for giving comfortable and healthy homes, beyond what now exists, to a fourth of the present population. The suspension cross-bridges would not be without their compound service. They would be bearers of electric lines along their sideways, and would probably soon be utilized as centres from which electric beacons would be suspended to light the streets beneath.

Imagine the metropolis turned into a fairy land by this adventure of science into the domain of art, and art reciprocating the idea with all her rich resources, and we see in our mind's eye what our children, when we are all of us gone, may really see, and, perhaps, thank us for proposing for their benefit.

Objections will be made about mechanical and architectural difficulties. I heard them all made when the Holborn viaduct was projected; I saw them all melt away as Colonel Haywood's practical mind came into work, and his unthanked skill, and industry, and responsibility, and genius carried all before him.

It will be objected that flat-roofed houses are not weather-tight. In the year 1825, the then Parisian Asphalte Company roofed two houses with asphalte in Hinde Street, Manchester Square. I lived in one of those houses for twenty-eight years, and a better roof I never knew; but for the London smoke it would have been made into a garden. Men working upon it, walking over it, communicated no sound whatever into the rooms immediately below.

It will be objected that houses will not bear the weight of superimposed suspended terraces for foot-walks. If they will not they ought. In no direction would the sanitary improvement for the purification of a great city be more useful, as a side improvement, than in so reconstructing defective houses as to make them capable of bearing an equalized weight which, carried by many, would, as we know from the bearing of ice, be comparatively light and practicable.

Of the many plans which have been suggested for giving space to crowded cities, such as terraces in the streets opposite to first floor windows, and tunnels subterranean — none seem to me to be half so practical, half so likely to secure the purification of atmosphere as this, which I have now for the first time, after some years' hesitation, ventured to sketch out, not as expecting ever to see such a project realized in my own time, but foreseeing as even a necessity and practicability in the times to come.

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Sanitary administration. — To direct the public in matters relating to sanitary administration is a function of this Society of the most explicit character, and one on which its powers can scarcely be too rapidly or too earnestly expended. At this moment every part of sanitary administrations, local and central, is chaotic. For nearly a quarter of a century the medical officers of health have been furnishing their reports. These reports are State papers in the true historical sense. The reports of Dr. Armstrong, of Newcastle; Dr. Dudfield, of Kensington; Mr. Wynter Clyth, of Marylebone, and many others which I could name, are local histories from which the writers of another age will collect the choicest and most reliable information respecting the present time. So valuable are these reports that I would venture to beg every officer to send two copies of each of his reports regularly to Dr. Bond, the chief librarian of the British Museum, so that in the National Library they may be all classified according to time and locality, and be kept there as important parts of the literary treasures of this century.

When, however, we read these reports we read the chaos which exists in administration in all its fullness. It looks as if all the labor were lost in the helpless confusion that prevails. No man seems to be speaking the other man's sanitary language in regard to administrative recommendations, or to know what the other man thinks, or what the central authorities think, on any matter that is administrative. Some things appear to be wanted which cannot be carried out; other things appear possible which are not wanted at all. One thing most wanted always seems wanting, power for instant action when there is most emergency.

In the next few years, when English statesmen can find time and temper to look at England, these faults must be remedied, and an Act passed which shall comprehensively unite existing local administrations into one great, and consistent, and workable system.

In helping forward this progress, we here shall have to consider, chiefly, the mode of combining effectively the local and central sanitary authorities, and of getting unification in the functions of both. Let me touch for a few moments on one or two subjects bearing first on the local and then on the central reformations, and so conclude.

Constitution of local authorities. — I think it good practice, in the selection of representatives of local boards to select from all classes of the community who are eligible for election. I began life with the notion that none but the best informed and most fortunate should rule in sanitary affairs. I have lived to see that if we do not take all classes into our councils we can do nothing well; and that if we take in all representatives of respectable men we can do anything that can be done, as they learn their duties and feel their responsibilities, both of which are acquired with remarkable facility. I would go so far as to let women become eligible for seats on local sanitary boards; for women are by nature sanitarians; they see the lights of health, and the shadow of disease much more acutely and keenly than men do. They are quick at suggesting sound and wholesome reforms, and they know infinitely more about the domestic life and the home than men know. When they are well informed and interested in sanitation they are allies of the first order; while, when they are not informed, and are not interested in reforms, they are opponents which no man and no board can withstand.

Some general system requires to be introduced for regulating the numbers that shall constitute a local sanitary council in each locality. At present, the system, if that may be called a system which has nothing systematic in it, is altogether irregular. In some places there are too many, in other places there are too few local health legislators. In the largest places there ought to be one local representative of health to three thousand of the population, as a minimum of representation.

Again, in respect to the selection of sanitary boards, more care than now exists should be taken to select members to serve in answer to local demands within the district itself. I mean by this that each person selected should have under his particular knowledge and interest his or her particular district, the requirements of which should be at all times before the mind. The district would in this manner be under the most perfect observation, and the medical officer of health would at all times have the most valuable help at his command.

The medical officer of health. — In every local district the medical officer of health should have the true place that belongs to him in all that relates to official action bearing upon health. He should hold to the sanitary department just the same position as the recorder does to the legal. He ought not merely to be the adviser to his board, he ought, by virtue of his office, to be the chief and chairman of the sanitary department. He ought to be elected for a definite period; he ought to be upheld in every useful health reform he brings forward; he ought to be encouraged to inaugurate reforms; he ought to be placed in such an independent position that he can inaugurate any reform, and correct any evil without being subjected to the risk and personal anxiety of dismissal for good service. He ought, in a word, to be able to put down disease of which he is the medical judge as freely, as unsparingly, as fearlessly as the legal judge or magistrate puts down crime. Until this is the rule, medical officers of health will remain as mere clerks and chroniclers of disease; suggesters of placebos in sanitation; scapegoats of sanitary blunderers; gentlemen of education engaged by money for incomplete service.

Nor would it, I think—in parenthesis — be quite out of place to go a step farther in recognition of national sanitary labors, and to crown those who all their lives have labored for sanitation, with the same honors as are rendered to the representatives of the ruder and more savage arts. Scientific labors are their own reward, some say. To greatest minds they are. But as Burke so well expressed in his great speech on economical reform, "ordinary service must be secured by the motives to ordinary integrity. I do not hesitate to say that that State which lays its foundation on rare and heroic virtues will be sure to have its superstructure in the basest profligacy and corruption."

Central guiding authority. — A larger share of sanitary work, committed to a larger community, should be accompanied by more certain rules of practice emanating from the central governmental and guiding authority. Such a central authority it is the business of a Society like ours to help to promote and consolidate; and if a committee of the Council were inaugurated to take the initiative in devising the best plan of reconstruction as a suggestion for the nation, it would be doing one of the most useful of national undertakings.

That which is required is a Board or Ministry of Health, distinctive in character and comprehensively simple in constitution. To such a Board should be referred all matters that relate to the health of the people. To it should be entrusted everything that relates to the registration of disease, mortality, vitality, marriage, birth. To this centre should pass for analysis and report all the meteorological records; to it should go for classification and report all the coroners' returns; under its direction the whole subject of adulteration of foods and drinks should be supervised. The inspection of factories should be brought under its control. To it should be transferred whatever is now done by the Veterinary Department of the Privy Council; to it also should be committed the inspection of prisons and police establishments, in so far as health and regimen are concerned. To it, lastly, should be entrusted the supervision of public works in relation to their sanitary requirements.

You will say that to a central Board as here projected there would be relegated some portion of the duties of many departments of the State, of the Privy Council, the Home Department, and the Local Government Board, not to go farther. That is so, and so much the better. It is because there is so great a dispersion of supervising powers that so little is done for the community.

A ministry of health would bring all work relating to health into a focus. It would insure capable heads for each department, and it would give to the Government, from time to time, the appointment of a supreme head, or minister of health, to whom, not England alone, but our colonies and all the civilized world, would look up with respect; whose judgments would become precedents, and whose annual reports—if they were, as they should be, divested of all political vagaries — would represent the very heart and soul, the potential energy of the nation.

NOTES AND CLIPPINGS.

Iron and Steel in Ancient Egypt.— In the sculptures at Thebes butchers are represented sharpening their knives on a round bar of metal, which is suspended from their girdles, and which is evidently of steel. It was for a long time supposed that steel or iron was unknown to the Egyptians, but this has been disproved by paintings, and later discoveries, as some of the sickles are represented blue and others red, indicating the knowledge of both bronze and steel.

Strength of Portland Cement. — The Portland cement, as it comes from the factory, is composed of an almost impalpable powder. mixed with coarser grains which have but little adhesive quality. Mann's experiments have shown that in a trial of seven days the portions which pass through a No. 176 sieve (31,000 meshes per square inch) exhibit five times the adhesive strength of those which pass through a No. 103 sieve (10,600 meshes per square inch). The necessity of fine grinding is therefore obvious. In ordinary cement 45·6 per cent is stopped by the No. 176 sieve, which is the finest that is made. The force of cohesion is much greater than that of adhesion, varying from threefold to tenfold. The adhesive force upon different substances, such as stone, brick, slate, marble, glass, etc., varies greatly. The degree of surface polish has less effect than one would think. According to these experiments, the best test of Portland cement is its adhesive power. The No. 176 sieve ought not to stop more than 45 per cent of the cement; the part which traverses the sieve should have an adhesive force of 95 pounds, and the unsifted cement of 75 pounds per square inch. — *Chronique Industrielle.*

The Oldest Town in the United States. — Ysleta, a Texan town on the Rio Grande, is now said to be the oldest town in the United States. It is a well-established historical fact that a Spanish military explorer, named Corando, visited the town in 1540, and found it then a popular and prosperous civilized Indian community. He was immediately followed by the Franciscian Friars, who erected a church and established schools. The same race of people exist in the town to-day that existed 350 years ago, and they are engaged in the same agricultural and mechanical pursuits as their forefathers at that period and for ages preceding. — *Exchange.*

Tripolith. — A substance has been manufactured in Heidelberg, for two years, which is called *tripolith*, and which is prepared as follows: three parts of an argillaceous gypsum are mixed with one part of silicious clay, and nine parts of this mixture are added to one part of coke. The entire mass is placed in a caldron, without water, and is heated, with continual stirring, until it reaches the temperatue of 120° (248°F.), in order that the water of crystallization may be expelled from the gypsum. The whole is then heated to 260° (500°F.), and subsequently pulverized and sifted. The tripolith is harder, tougher and lighter than gypsum, and is better adapted to the maufacture of stuccos and the decoration of columns, etc. — *Gaceta Industrial.*

The Architect of the Albany Cathedral. — We would really like to know the name of the pitiful protectionist who writes as follows in the New York *Times:* "It is not a cheering report that comes concerning the proposed Episcopal Cathedral in Albany. An Englishman without proofs of genius as an architect is named as the designer. Were an artist chosen whose completed work testified to his ability, it would still be an open question whether Episcopalians would be right in selecting a foreigner. Only if there were no American architects of the highest grades would such a step be warranted. There are such architects, however, and one fails to see the justice of giving an Englishman the commission. Surely the modern churches and public buildings of England are not such as to raise one's expectations of the most famous living English architects very high! The tendencies in the Episcopal church of America are toward the outer observances of the Church of England, from which the former sprang, and its edifices are full of ridiculous wood-work and bad stained glass, imported at great expense from England. A curious parallel might be drawn between the practice of Episcopalians in favoring bad English art and that of Romanists in encouraging weak and gaudy Italian and French art in their churches. If these denominations wish to keep the people with them let them show more patriotism. Foreigners can no more express the national shades of thought and feeling in religious art than they can in historical, or *genre*, or decorative."

Remarkable Artesian Well.— Cutlar Salmon lives near French Camp, a small settlement not far from Stockton, Cal. Others had been boring artesian wells, and he determined to try his luck. He sunk a well with a seven-inch tube to a depth of about 840 feet, and struck a copious stream of excellent water. Desiring to learn whether he could increase the flow by going deeper, and fearing that, should he continue the well the same size, he might injure the quality of the upper strata of water, Mr. Salmon hit on the plan of sinking a four-inch tube inside the seven-inch one, and then making what might be called the experimental well, four inches in diameter. This inner one he bored to a depth of 1,250 feet, and then came to water again. This lower stream came to the surface, and, indeed, rose in a tube twenty-two feet above the ground. This last water found was unfit for drinking, and but for an accidental discovery of its wonderful properties might have been considered a nuisance, as are many things the uses of which we do not know. It was found that there was a large amount of gas in this water from the lower depth. This came bubbling to the surface, making one think of a gigantic soda-fountain. Some one suggested the idea of seeing if the gas would burn. A coal-oil can was put over the top of the tubing, and having a few holes punched in it, an improvised gas-fixture was at hand. Only a match was required to complete the preparations. The match was lighted and applied to a hole in the can, and a flame shot up three or four feet into the air and burned steadily. The gas would burn. Mr. Salmon had fire and water coming out of the same hole in the ground. The tube of the outer well, that which was only 840 feet deep and furnished the good water, was tapped, and sufficient water for all domestic uses, and for the stock, etc., was led off in pipes to the house and other localities. A curbing was built around the twin wells in such a way that it formed a reservoir for the water from the 1,250-foot level, and that portion from above which was not conveyed away in the pipes. All through this water in the reservoir came bubbling up the gas, generated somehow, somewhere down below. When Mr. Salmon next went to Stockton he had a gasometer made with a stop-cock in the top, and this he took home and fastened over his wells. The bottom was beneath the surface of the water in the reservoir, and gas speedily filled the bell-shaped receiver. The next thing was to attach a gas-pipe, and connect his home-made gas-machine with the house. He put a pipe perforated with small holes across his large open-fireplace, turned on the gas, applied a match, and the problem of cheap fuel was instantly solved. After that, gas-pipe was put into the fire-box of the kitchen stove, and now the meals are prepared with the new fuel. Mr. Salmon has also used this gas for illuminating, but it does not seem to entirely fill the bill, although it is a great improvement on a tallow dip. It has been suggested that, as this gas seems to be almost pure hydrogen, it might be carburreted, and its illuminating qualities improved. But poor light or good, Mr. Salmon is certainly a lucky man, in that he gets his fuel so easily. The gas throws off a great amount of heat, and without doubt, such a well would supply a large number of families with the means of warming their houses, and preparing their food. Colonel Orr states that he has examined this well carefully, and thinks there is gas enough issuing from it to run a twenty horse-power engine. — *San Francisco Bulletin.*