A BOOK ON BUILDING.

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A

BOOK ON BUILDING,

CIVIL AND ECCLESIASTICAL;

WITH

THE THEORY OF DOMES, AND OF THE GREAT PYRAMID;

AND A CATALOGUE OF SIZES OF

CHURCHES AND OTHER LARGE BUILDINGS:

BY

Grimthorpe

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THE GREAT PYRAMID.

SIZES OF GREAT BUILDINGS.

Errata and Note

Page 108, line 5, *after* attended *insert* to

,, 148, ,, 5, *for* 1·474 *read* 1·47 r^2

,, 202, ,, 6 from end, *for* clerestory *read* clearstory

,, 268, ,, 4, *for* clearstory *read* clerestory

,, 299, ,, 7 from end, *insert* half *before* the thickness

,, 306, ,, 1, *for* panels *read* haunches

,, 307, head of table and in second line below table *for* 88 *read* ·88

,, 308, head of table *for* 88 *read* 2

,, 329, line 3, *for* poles *read* holes

,, 338, ,, 12, *for* York *read* Lincoln

,, 348, *St. Albans.* Now that the Lady Chapel is restored to the church, the area should stand as 36,720. The length 532 includes the porch, which has as much right to be included as the Galilee of Ely, and more, because it projects into the nave below the west window. The external length however is 8 ft. less than the 556 of Winchester. The nave proper, from the west door to the inside west face of the transept, is 280, and to St. Cuthbert's screen, across the tenth bay, 203; making the available nave for service 15,225 sq. ft., its width being 75, or rather less than the average width of the choir. The nave of Winchester, similarly reckoned to the inner face of the transept pillars or clearstory (as it has two aisles), must be 275, and of Ely about 260, and York 230. The smaller lengths in the list are up to the transept aisles only, which most people would call the nave, but it is not a fair comparison with the churches which have no such aisles, and where the length of the nave is reckoned up to the tower.

A BOOK ON BUILDING.

CHAPTER I.

AGREEMENTS WITH ARCHITECTS AND BUILDERS.

Reasons for writing—Architectural competitions—Fallacies of drawings—Suggested conditions—New Government conditions with architects—R.I.B.A. alleged customs disallowed by law—Quantities—Tenders and estimates—Contracts—Proper form of provision for alterations and defective work.

CONSIDERING the number of persons who at least once in their lives purchase some experience in building, it seems odd that none of them have thought of imparting any of it to their fellow creatures, with the benevolent object of saving them from falling into the same mistakes and meeting with the same disappointments. I do not mean to ignore the existence of several useful books on house-building by professional architects, nor the multitude of treatises both by amateur and professional architects containing theories and histories of architecture, and the writers' views regarding it artistically. Some of these are very good in their way, but it happens not to be the way of giving practical information how to avoid legal or structural mistakes. Nor can professional architects be expected to look at such questions in the same light as those who employ them; for they have in fact opposite interests in some of the questions which arise. And so it has come to pass that men who would not make a contract for buying or leasing a house worth 1000*l.* without legal advice constantly involve themselves in building contracts to an unlimited amount, without any security for getting what they want, or for having the smallest control over the work in either its nature or its cost, or any remedy if it is done as ill as possible. Even if a lawyer is consulted about the contract he is as likely as not to omit the requisite provisions unless he has himself learnt the necessity of them by experience. I have actually known a right form of contract turned back into a wrong one by a solicitor who evidently knew nothing about building and its usual consequences.

And if the requisite information on these matters is to be given by anybody it can only be by some one who has had more than ordinary experience in building, with more than ordinary taste for mechanical details, which are generally less attractive to amateurs than the artistic or theoretical side of architecture. I happen to be in that position; for I can remember no time when I had not a taste for the practical operations of building, long before I had any idea of architecture. Afterwards, from one cause or another, I have been building, either for other people or myself, for about a quarter of a century, and that not merely in the ordinary sense of employing architects and leaving them to do as they like, but designing and looking after the execution of the work and altogether exercising much more control over it than employers generally do.

As I have nothing to gain by advertising myself as an architect I may say in justification for my offering advice on architecture and building, that I have substantially designed sundry churches and other buildings of considerable size, viz.: the two Great Northern Railway churches of St. James Doncaster and the one a mile north of Peterborough, St. Mary's Lichfield, except the tower which had been rebuilt before, St. Chad's Headingley near Leeds, a small church at Cliffe in the East Riding, and Mr. Bass's St. Paul's church at Burton, which is of unusual size for a modern one; also the Grammar School at Doncaster, the extension of Lincoln's Inn Library, the tower top of Worcester Cathedral, which had never been finished in Gothic times, and was formerly of a mean design in brick and plaister; and a house of my own near St. Albans covering 1000 square yards; besides some smaller buildings not worth mentioning. I mean that in all these cases the architects accepted my designs and added little or nothing of their own. I do not include the great parish church of Doncaster, with which I have seen my name more associated than with these others, because that was designed in all its leading features, and especially its dimensions, by the greatest of modern Gothic architects, whom I need not name, though some things in it were modified at my suggestion, and others added or altered since the building. That church was so fully described in my *Lectures on Church building* (2nd edition 1856) that I shall not refer much to it here, except occasionally for illustrating some practical points of construction.

Architectural Competitions.—We had better begin, as a man or a committee having a building to erect must begin, by considering what steps to take in selecting an architect and plans. For this purpose it is generally assumed that there are, not the proverbial three courses, but only two very opposite alternatives: one is to put the work at once into the hands of some architect who is recommended either by general reputation or by a friend, subject to your approval of his plans before you make a contract with a builder: and the other, which is generally adopted by committees, but very seldom indeed by persons who have only themselves to please, is to have an architectural competition, which committees and corporations and Governments flatter themselves or the public will produce the best design that can be got.

The primary object of these architectural competitions is really to select an architect, whose plans may afterwards be modified in any way that is agreed on, just as if he had been selected otherwise; and therefore we ought to consider the merits of that system first. I am afraid it must be ranked among the many things in which all the *à priori* reasons point one way and all experience the other. Those reasons are obvious and plausible enough. One would say that the choice of one out of many anonymous designs must prevent jobbing or selection by favour or influence: that it may obtain from some unknown man of genius a better design than would be got from any well known architect: thus in the famous Foreign Office competition in 1857 the first prize was awarded by the judges appointed by the Government to a pair of almost unknown architects, with what consequences will be seen presently. Then again it is said, employing an eminent architect commits you to his favourite style, whatever it may be, while seeing other designs might convince the judges that it is not the best for the purpose; and you must apparently have a better chance of getting the best plan by seeing many than by having to accept whatever a previously chosen architect may give you.

All this is so plausible that it is no wonder that all sorts of public bodies are in the habit of accepting it as conclusive. But experience tells another tale, and it is not merely singular but significant, as I said just now, that private persons, who have only themselves to please, never act upon it, any more than they select their clerks by competitive examination; and it is notorious that, however badly some people manage their own affairs, they do on the average manage them more carefully and economically than public bodies. Indeed such bodies, and by a strange anomaly, elected ones especially, are proverbially extravagant in great things and stingy in small ones, though here again one would expect just the contrary. The fact is that selection from a number of anonymous designs is generally a mere delusion. The style of all the best architects, and of their drawings, is so well known that they might as well put their names to them. And we may be sure that any architect who has a friend among the judges takes good care that the friend knows which is his design. Although a pair of comparatively unknown architects got the Foreign Office prize in 1857 from a set of inexperienced judges, it soon came to be understood that the prize was all they were to get, and the award was generally considered a mistake. A parliamentary committee sat upon it, and the result was that the work was entrusted to Sir Gilbert Scott by the Government. And then, to complete the story, that Government went out and Lord Palmerston came in, and after promising the House of Commons to do nothing in the matter without their approval, as soon as the session was over he told the architect that he would cancel his appointment if he did not change the style from that of which he was the acknowledged master to another in which he had never built at all, and so that competition went in every way for nothing. And so did another and still greater one, viz.: that for the long-expected Law Courts, which arose from the offer of the Society of Lincoln's Inn to build new Courts of Equity in 1859 for a guarantee of interest on a sum which will probably be exceeded by the salaries of the architect and the clerk of the works before this job is done. There we had all the parade of a great Royal Commission, and the publication of a blue book of elaborate conditions and instructions, and an exhibition of the designs in a building erected for the purpose, and the appointment of a sub-committee to choose the best design, of persons with as much architectual experience as those who awarded the Foreign Office prize, and then a decision of the Crown and its law officers that these great lawyers (as two of the sub-committee were) had exceeded their powers by recommending two architects instead of one, because they preferred the architecture of one and the internal arrangements of the other. And so at last the architect was again appointed by the First Commissioner of Works, and by an odd coincidence, the very same (Lord J. Manners) who had appointed the architect for the Foreign Office ten years before, as if there had been no competition.

It is also to be remarked that the commission had intimated early in the business that satisfactory internal arrangements would be more regarded than external appearance: so that in this respect the selection was a breach of promise to the competitors. I say this without the slightest preference for the design of the one who was aggrieved in this way, but merely as an illustration of the unsatisfactory working of competitions. Nor is the case improved by the fact that even the revised plans of the successful competitor were received generally by public critics with such a chorus of disapproval as no other selected design for a new building ever was before. Barry's—or rather Pugin's—design for the Houses of Parliament was received with almost universal approval, though the internal arrangements and the extravagant cost—about six times the estimate—afterwards produced the anti-Gothic reaction which lost us Sir G. Scott's fine Gothic design for the Foreign Office, as just now mentioned.

Though theoretically a competition is expected to give a choice between great and small architects, the practical effect of it is often exactly the contrary, and in the worst possible way: viz. to exclude the great ones altogether, except from very great works; and after these experiences they are justly growing shy even of them, and will not incur the trouble and expense of preparing a vast quantity of drawings for the small chance of being employed, even if they get the first prize. Nor will they work down to the kind of taste which they know they have to expect in municipal committees and bodies of that kind, who are the fondest of architectural competitions. I can only account for the badness of all the Law Courts designs by supposing that the excitement of a competition throws even the best architects off their balance. Those for the Albert Memorial were equally bad, or worse. In a discussion on the 'Hope of Architecture' at the Royal Institute of Architects in December 1874 I said that any architect would make me a very different design if I employed him directly from what he would send in for any competition. The President Sir Gilbert Scott most significantly interjected, 'We are obliged.'

Even if the taste of committees were better than it generally is, there is another difficulty which very few people are aware of, and that is their inability to judge without experience how large the building and its parts will look; that is, with reference to the human body, which is the ultimate scale by which it will be tested. Indeed architects sometimes deceive themselves in that way. I asked one who sent me some plans for a church which I had to judge of, containing pillars divided into as many sections vertical and horizontal as would have done for a cathedral, if he had any idea how high they would be in reality, and he was evidently *bonâ fide* surprised when I showed him that the capitals would just reach his shoulder. Not long ago I had a design for a wooden screen for an internal porch sent me, which looked well enough on paper, and had been approved by other people, who had never thought of trying the actual dimensions of the parts. The result was that I knocked out exactly half the divisions, or reduced the parts to half their number. The mistake in this case was the more inexcusable, because the architect was proposing to add this thing in the modern babyhouse style to which he was accustomed, to a church of mine in which everything is larger than usual in churches of that size.

Fallacies of Drawings.—But though these mistakes are often made from mere ignorance, the getting up of competition drawings with an appearance of imposing size is by no means the result of ignorance. It is managed by various pictorial devices. One of the commonest is displaying in the foreground a number of fine ladies and gentlemen on horse and on foot, looking very small compared with the building. Steeples are always surrounded by a flight of crows, which are evidently designed by their number in the flight and its apparent size, to contribute to the grandeur of the building, and because rooks notoriously despise all but very high trees. If my friend with the many-shafted and banded pillars had drawn a congregation in his church, we may be sure he would have kept their heads far below the caps of those pillars which would really have been hidden by their shoulders, and I am equally sure that it would not have been found out by one judge in a thousand. It is no wonder that ordinary people should be ignorant of all this when so many architects have yet to learn that cutting up a building into little bits, which are perceived to be insignificant as soon as you come near them, immediately gives the impression of what I called the babyhouse style to the whole, instead of deceiving the eye into the belief that it is large because of the multitude of parts, as it does in a drawing. Not that I defend the opposite error of making the parts gigantic and too few, and so diminishing their due effect, of which St. Peter's at Rome and the Victoria tower of the Houses of Parliament are notorious examples; though it is true that that error has a kind of grandeur in it, while the other is a miserable attempt at imposition which invariably fails in stone though it too often succeeds on paper.

Depth of Shadows.—Another, and in fact the commonest of all the fallacies of architectural competition pictures is that of showing a false depth of shadows in all the recesses in the walls, and so giving an appearance of thickness and massiveness to the whole, which those who make the pictures thereby show that they know the building ought to have, though they must know equally well that it has not, according to the working drawings, of which again ordinary judges are no judges, and naturally assume the pictorial view to be a true one. But I do not impute intentional deceit to all who thus exhibit inconsistent pictorial and working drawings; for it is evident that, notwithstanding all that has been written about the importance of depth of all the shadow-casting parts of buildings, not merely in the Gothic styles but in every other, the majority of architects still wilfully ignore it; and perhaps it is not wonderful that they refuse to be taught by writing what they apparently cannot see with their eyes in all those old buildings which they profess to imitate. I will not repeat what I said on this subject in my former book on *Church Building*, beyond this one fact, that I persuaded the architect to double the external depths which he had at first designed in all the Doncaster church windows, by showing him from his own books that they would then be no deeper than the windows in old churches of the same style. I will however refer to what was said, not by an amateur but by a professional architect, in a very able book a good while ago now, viz. Garbett s *Rudimentary Treatise on the Principles of Design in Architecture*, one of Weale's Series—now belonging to the publishers of this. He says at p. 103, as an illustration of this special fallacy of preliminary drawings, that 'the difference between the actual depth of the windows in the river front alone of the Houses of Parliament and the depth shown in the original picture amounts to not less than 112,000 cubic feet of wall; which (he adds) would be enough to make all the difference between a sublime building and a mean one.' Other writers have spoken to the same effect; but nevertheless the architects go on in their stereotyped way of putting Gothic windows twice as near the outside of their walls as the inside, while the walls themselves are often only half the thickness that they would have been in the time and style which they profess to follow.

Window Mullions too thin.—Another cognate trick is that of showing massive mullions and window tracery in the pictorial designs, while the working drawings have them mean and thin, sometimes containing not half, or even a third of the stone which would be guessed at from the pictures. I believe I may say that the two Doncaster churches, which were finished together in 1858, were the first modern ones in which something like the old proportions of thickness and depth were adopted, on my convincing the architect from the measures of some similar old churches that they ought to be. I remember the contractor for one of them saying that the east window, for which I gave a new design, contained twice as much stone as he had guessed at from his experience of what a modern window of that size generally would contain.

Fallacious Tenders.—But you may ask, is there no remedy for all these difficulties and fallacies of competition? For some of them I do not see that there is, especially for the unwillingness of good architects to contend for prizes awarded by judges whom they know to be generally unqualified and incapable of judging how their designs will look when translated from paper into stone, and who generally select the most pretentious of all the plans sent in, and the least likely to be well built for the estimate. I say *well* built, because the maker of the worst possible plan in this respect can always fortify himself with a contractor ready to undertake it, and who will doubtless build it somehow, relying either upon swelling his bill with 'extras' ordered by the architect, and probably necessary to be ordered because they had been omitted in the plans and specification, of which the judges understand nothing; or else upon being allowed to scamp the work. Hence we read of cheap churches falling down before or soon after they are finished, and we learnt from a bishop's sermon* for rebuilding one of them that that style of work is called 'jerry building.' Many contracts are taken solely in reliance on these two modes of converting a losing contract into a paying one.

Fixing Price beforehand.—One of the commonest evils of these competitions is that the cost of the building is fixed beforehand by persons who know nothing more of the matter than that they have been told that a building of the same kind somewhere else cost, or was contracted for to cost some given sum, perhaps not half enough to build it properly; and often they proceed to fix the price without even that amount of information. A man may invite plans for a house to cost anything he likes, for the architect can adapt the size to the price; but public buildings generally have not only the price but the required size specified. And then what are competing architects to do? If the committee sent for a single architect and gave him those conditions, he would soon tell them whether it was possible or not to erect such a building properly for such a sum of money. But competing architects have no opportunity of doing so: at least any one who does knows it is equivalent to losing the job. Consequently there are always some

* Bishop of Manchester, in September 1874.

ready to undertake it, and to back up their estimate if required by a contractor with a tender; of which the result will be what I described just now. Sometimes by way of variety of result, the contractor becomes a bankrupt before the work is half done, and leaves the committee to finish it as they can. That happened at two churches which I have been concerned in building, where there were fortunately sureties to a sufficient amount, and also at a certain large town hall which an architect and a contractor professed to build for 42,000*l.*, and which I said would cost twice as much as soon as I saw the plans, and which did cost even more than that. The corporation who employed them had only got securities for 2000*l.*, and so the loss fell upon the town. That had been a case of architectural competition, which the two churches were not.

Notwithstanding all these drawbacks I know that architectural competitions will go on, simply because the kind of bodies who adopt them can see all the plausible or theoretical advantages, and know nothing of the practical disadvantages. I wish I could say that even employing a non-competing architect to judge or help them is at all certain to produce satisfactory results; though it is doubtless better than having no such assistance. The decision of the non-professional majority of judges in the Foreign Office competition was against that of the professional minority of 'assessors,' and was found to be indefensible, as I said. No decently competent and independent architect would be taken in by those pictorial devices which inexperienced committee-men or town-councillors have no chance of seeing through; nor, one would think, by such estimates as that for the town hall above mentioned. But it so happens that in that case a very eminent one was consulted, though not expressly on the estimates, and yet he held his tongue about the insufficiency of the price, though it was transparent to my comparatively small experience. If the corporation had been duly warned about it they would hardly have been so stupid as to be content with security for less than 5 per cent. instead of the usual 33. In consequence of what happened in another place as well as there, it is prudent to stipulate with the independent architect so consulted that he is to be paid a fixed sum for all the advice that he may give, as to alterations and everything, and to resolve that he is on no account to be employed as architect himself; for I have known even that happen after another had been chosen, judiciously or not, upon the competition.

Conditions for a Competition.—It may be of some use to suggest the best conditions that occur to me for a competition, though I by no means pretend that they will obviate all the difficulties I have pointed out.

1. Architects willing to compete may send in plans and specifications before —— to ——, from whom any further information may be obtained.

2. All except the working drawings of details on a larger scale are to be on the scale of $\frac{1}{8}$ in. to a foot, and the longest vertical lines in the perspective drawings are to be on that scale also. Those drawings are to be made from as distant a point of view as possible (which distorts them less), and there are to be no figures or other imaginary objects in the foreground; and they are either all to be or all not be coloured. (If some are coloured and others not, it is impossible to judge fairly, and the colouring is generally deceptive.) All depths of windows, and other shadow-

casting parts and all thicknesses are to be accurately represented in the perspective drawings, and figured legibly on the plans and sections, and all inscriptions on the drawings are to be written in plain letters without lines. (There is a class of architects who expect to get credit for mediæval taste by the wretched affectation of writing everything on their drawings illegibly, and crossed over with lines. It is no excuse to say that their clerks do it.)

3. No part of the work that can be defined by drawings or specification is to be provided for by a sum of money named in the specification. (This is a fruitful source of extras, for the sum named is nearly always insufficient for the design which the architect proposes when the time comes; so you are left to choose between a mean looking thing or having to exceed the contract. I have known that happen to such a large amount in an estimate for carving that the committee were obliged to abandon a great deal of it altogether; and even then there was an 'extra' for substituting masonry. I once made an architect to his great disgust leave a conspicuous piece of work of the mean design which the sum he had fixed would only pay for, as a lesson to him; and there it stood for years, until somebody took pity on it and gave a new one. It may be allowed in small articles of ironmongery and the like, which are not worth specially designing, but no further. Things not to be found or made by the contractor should not be in the contract at all, such as handsome chimney-pieces and other fancy articles which the employer means to choose for himself. But that will hardly occur in competition designs for committees.)

4. The plans and specification are to include (according to local circumstances) all necessary drainage,

heating chamber (there are generally separate tenders for the heating apparatus), bells (not church bells), grates, chimney-pieces (except as above), closets and shelves, provision for gas pipes according to circumstances, boundary walls and pavement, and everything, except furniture, that will be requisite to fit the building for its purpose.

5. The estimate for the whole is not to exceed ——, but any architect who considers this insufficient for the proper execution of the work required may say so and send in his own estimate either before or with his plans. (I am aware that this is in some respects a dangerous power to give; but considering how incompetent most committees are to fix prices beforehand, it is a less evil than making it impossible to get the work well done.)

6. The committee will not be bound to accept any plan, nor to proceed with any one which they do accept unless they find that a contractor with sureties in one third of the amount of the estimate to be approved by them will undertake it for that sum. If no such contract can be made to their satisfaction, the whole proceeding is to be void and the architect to have no claim upon them. (The conditions of payment, either for drawings or employment, may of course be anything they please to announce, subject to the reminder that architects will also please themselves whether they will compete on those terms, and that the worse they are for them the worse the competitors probably will be. But I shall have more to say on that point independently of competition.)

Responsibility and Powers of Architects.—It is commonly assumed that the only alternative besides a competition is to engage an architect from reputation or recommendation; tell him what you want and are prepared to spend; and then, as people are in the habit of saying, 'throw all the responsibility on him.' Whenever I hear that proposed I ask the proposer to explain what he thinks he means by it, and what is the mode of making an architect responsible for a bad design. The only real meaning of 'throwing all the responsibility on the architect' is that you are to give no more attention to the plans of the house you are to live in and pay for than if you had nothing to do with it, or else to sit still and see any number of blunders committed, which you will either have to submit to for ever, or else to pay some other architect for pulling the house to pieces after it is done, to try and cure them.

It is impossible however to lay down any rule for the amount of interference which is expedient or likely to be beneficial to the employer: no rule could be adapted to the infinite varieties of knowledge and ignorance. But the expediency of interfering more or less is one thing, and the right of a man not to be made to pay for doing things for him on his own ground contrary to his expressed wishes, is another. Very few people are aware that every building contract prepared by an architect negatives this right altogether, and that architects distinctly deny it. The legal effect of the common form of contract is neither more nor less than this:—The contractor shall build, whatever it is, according to the plans for so much money; but the architect may order any addition or alteration that he pleases, either before or after any of the work is done, without consulting the employer and even though he may object; and the employer shall pay for it at a valuation, and shall also pay the architect a further percentage for designing it, and a further one besides for valuing it, unless some other valuer is employed and paid, which is as bad. It was in that way that the Houses of Parliament were made to cost six times the original estimate, notwithstanding all the work was done by contract. And in that way many a country gentleman has laid the foundation of his ruin with the foundation of his house.

This doctrine of unlimited submission of the employer to his architect is avowed without disguise in the latest architectural books. The author of the 'Choice of a Dwelling' doubtless knew that he expressed the opinion of his fraternity in saying:—'After the plans are settled and the work commenced it must be distinctly understood that the "client" yields himself absolutely to his professional adviser.' If architects imagine that by calling their employers 'clients' (as some tradesmen now call their customers when speaking of them, though they take good care to call them 'patrons' when asking for their patronage) they are *ipso facto* demonstrating the duty of 'yielding absolutely to their professional adviser,' they are very much mistaken. A client can stop his lawyer from proceeding a day longer than he likes, or from taking any step that he objects to, or discharge him in a moment. And it was decided in a famous case that even when the counsel in Court sees that the case is going against his client he may not save him by a compromise against his will. The analogy fails in other ways besides, as analogies generally do, except in the hands of a few great masters of the art of reasoning, such as Bishop Butler and Archbishop Whately.

The same doctrine of submission was moreover laid down with peculiar emphasis from the chair of the Royal Institute of British Architects at their annual meeting in 1871, when the president of the year said that although he, like nearly everybody else, was far from approving the published design for the Law Courts, yet he considered it the duty of the nation to yield itself absolutely to Mr. Street now that he had been entrusted with the work. On which it is at least amusing to remark, that the nation, through its official representative the First Commissioner of Works, had just then compelled Mr. Street and all the other architects employed by the Government to submit to terms of exactly the contrary kind, which I will give presently: for which Mr. Ayrton certainly deserved the gratitude of the public, not merely as to the public works, but because the doctrine of the supremacy of the architect to his employer is now exploded, by the acquiescence of all the leaders of the profession in Mr. Ayrton's terms.

I am glad to see that the president of the rival 'Architectural Association' preached a more sensible doctrine than that which seems to prevail at the R.I.B.A., in his address in November 1875. For he is reported to have said:—'No architect has any right to insist on his client adopting his theories in matters of taste; and if it is found impossible for them to agree, it would be far more discreet, and show a nobler spirit, for the architect to comply with the wishes of his client than to force upon him a work which will always be a source of vexation and annoyance. This is a hard doctrine . . . but I commend the practice to all who wish to maintain the standard of the profession.'

It must not however be supposed that the R.I.B.A. doctrine of the supremacy of the architect will vanish unless employers guard themselves against it, as the Government has done at last. If you ask an architect in the usual careless unconditional way to make plans for you according to such description as you give him of your wants, it is by no means certain that you can reject them merely because you are not satisfied with them, provided he has followed your instructions in his own way. Any prudent man will stipulate in his first letter to the architect to the same effect as in Article 6 of the competition terms at p. 16. On the other hand, if you decline to go on after approving the plans, or make merely frivolous or evasive objections to them, the architect has a right, both morally and legally, to be paid for them, either at the usual rate of $2\frac{1}{2}$ per cent. on his estimate, or whatever fixed sum may have been agreed on beforehand for plans alone, if he is employed to do no more.

That is the first stage of the business. The more serious one comes afterwards; for the form of contract with the builder, as it is invariably drawn by architects, enables them to override the very plans you have approved, to omit the things you most particularly insisted on, and to insert things you particularly objected to, and in short to treat your suggestions as if you were a stranger offering an amateur opinion. I do not mean to say that this kind of proceeding is in one sense common; but I have too frequently heard complaints of it; and I myself heard an architect tell a committee, who found out when it was too late, as they had all been absent for three months, that he had *unordered* something which he had inserted in the specification with a sketch of it by their particular desire, that 'he had never intended it to be done.' I have the satisfaction of adding that it closed his connexion with that public body, which has been building ever since. And though that case was probably unique in the coolness of the avowal it was not unique in other respects; and at any rate it shows what may be done under the common form of contract with the builder. I shall give the proper form to prevent it when we come to that afterwards.

Any architect who does not choose to be employed except on the terms of being absolute as to alterations has only to say so, and if the employer chooses to consent he will have no right to complain afterwards. Architects themselves have very different theories on the point; varying in all degrees, from complete indifference about enforcing their own taste, so long as the employer does not require what is impossible or unsafe to build, as ignorant ones will do sometimes, up to the theory of 'absolute submission to the professional adviser.' Some very properly make it a rule never to order alterations without consulting their employer. One who has done a good deal of church building once said to me, 'I have nothing to do with high church or low church: my business is to design what people want, as far as I can; if they will not take my advice that is their business.' Others not only treat suggestions with contempt but think they are to dictate on ecclesiology as well as architecture. Indeed it has answered admirably to some of them to get the character of having 'sound (which means high) church views': people have taken for granted that such professors of orthodoxy must understand church building better than those who only profess architecture, though I cannot say that the results support the theory.

I conclude this part of the subject with a story which was told me by one of the actors in it. An architect who wanted to alter a bishop's Palace according to his own taste rather than the owner's convenience said to him, 'You know the maxim, Cuilibet in arte suâ credendum.' 'Yes,' answered the bishop, 'and my art is living in this house and knowing what I want.' On the same saying being used to Lord Chancellor Westbury, he answered in his bland way, 'No, that is not the true reading: it is, Cuilibet in arte suâ *perito* credendum.'

Agreements with Architects.—Until a few years ago there was no need to make any preliminary arrangement with an architect as to the sum he was to be paid, because there was one universally understood rule, that it was to be 5 per cent. on the cost of the works executed from his design and under his superintendence, besides his actual travelling expenses, and 2½ per cent. for plans and specification if the work was not executed under his superintendence. It is true that the percentage system is a very bad one in a variety of ways, sometimes unjust to one side and sometimes to the other, and producing different results according to mere local accidents, and giving constant support to the common charge against architects of exceeding their estimates for the sake of the extra percentage, which is frequently unjust; though there is no doubt that they often do omit many things in the plans which they know will be wanted, while the employer for want of experience does not. Neither is there any necessary relation between the trouble which a building takes to design and its cost, as is evident on the least consideration. But for a long time architects preferred to 'take the rough with the smooth,' and the advantage of its simplicity and being universally understood was considered sufficient to maintain the rule.

At last however they became dissatisfied, and claimed to vary it, in their own favour, in a variety of cases; and in 1862 the R.I.B.A., which is the oldest of several voluntary associations of architects, printed a paper called

Professional Practice and Charges of Architects, containing two folio pages of suggestions for increased charges, all on the percentage system, with an intimation that the 5 per cent. might be reduced in the single case of a number of houses from the same design. In 1872 they issued a revised edition of it, after some disputes with the Government and a trial at law, about the right to payment without giving up the plans, the architect pleading that by the custom of the profession the employer had no right to them. The decision of the Court of Exchequer throws some light on the right of a professional association to invent new rules and set them up as an established custom binding on everybody else. The judges said that such an attempt to supersede the common law, by what the *Times* called 'the private code of a highly respectable trades union,' was 'contrary to reason, good sense, and justice, impossible, suicidal, cutting its own throat by its absurdity as soon as it was produced.' * Notwithstanding this tolerably clear language the R.I.B.A. actually say in their revised edition of 1872 that 'no authoritative decision on the point (of the ownership of drawings paid for) has yet been given.' What they mean, I confess I don't know,

* *Eddy* v. *McGowan*, reported in the newspapers of 17 November, 1870, but not in the *Law Reports*, I suppose because the point was too clear among lawyers to be worth reporting. Though it is necessary, for the practical objects of this book, to criticise the official acts of the R.I.B.A., and to speak of them according to law, I desire to acknowledge the courtesy I have always received from them, in being invited to special discussions, and to read papers on subjects to which I was known to have paid some attention. I doubt however whether they did wisely in converting it some years ago into a strictly professional association, from the more general one which it once was. It seems that the Council, or a Committee, actually proposed lately to give it a still more commercial character, by making it a combination of architects and builders.

and I doubt if they do; but they prudently add, for the information of their brethren, that 'it is desirable to have a distinct understanding with the employer,' as no doubt it is if they wish to override the law and keep the drawings they are paid for.

It is no business of mine to reprint this 'private code' for them; nor am I disposed to give it even that amount of recognition; nor to criticise any of the twenty-three rules contained in it, however tempting it may be. But when architects and other writers of books under the patronage of the R.I.B.A. tell us that it is calculated to prevent disputes, and that people may learn what they are to pay their architects in every possible contingency by buying it for 3*d.* at their house in Conduit Street, I feel bound to answer as a lawyer that it is nothing of the kind, but the direct contrary; and to warn employers that all that can be deduced from it is that '5 per cent. on the cost of the work executed from the architect's design' is the very least that they will have to pay, in the absence of some special agreement, and that the maximum may be 10 per cent., and sometimes more. I have known that and more charged, and sometimes paid with grumbling, and sometimes properly refused because no notice had been given of the intention to charge more than the long established 5 per cent., which architects have over and over again sworn to be the rule when somebody has objected to it.

Since this was in type I am glad to see that Mr. Burges, an eminent member of the R.I.B.A. Council, says, in an Address to the Architectural Association, that the R.I.B.A. rules have been misunderstood, and only meant that 5 per cent. was the established charge where no other special bargain had been made, and that they had not the least intention of acting as a Trades Union to interfere with the discretion of architects in making any bargain they pleased, according to the nature of the work to be done. That is so far satisfactory; but it is obvious that if that was all they meant at first, they would never have issued such a paper; and further, that the sooner they burn all the copies of it the better, instead of going on revising and selling it for 3*d*., and writing in various books that it informs employers what they will have to pay architects under all circumstances; which it actually does in none, either with or without Mr. Burges's explanation.

The case therefore now stands thus: every employer who has not already had a dispute believes that 5 per cent. on the cost of the building (and actual travelling expenses) is all that he will have to pay his architect; but every architect believes, because he is told by this 'highly respectable trades union,' that he has a right to throw that rule over if he chooses, and to charge a great deal more in a variety of contingencies, some of which are almost sure to occur in every building above the commonest kind, and that, without having given any notice of his intention so to do. This is quite enough by itself to prove the expediency of having a definite agreement at first. It is easy to talk about bargaining for terms beforehand being disagreeable. Disputing afterwards is ten times more so; and it is quite clear now that you have no security against disputes unless you do agree beforehand. Moreover the architects themselves have at last given up the point. That new arrangement with the Commissioners of Works which I spoke of, expressly repudiates this R.I.B.A. code or any other which they may set up, and the percentage principle altogether, and states that 'the architect's remuneration shall be *a fixed sum to be agreed on beforehand.*' The architect himself must be the best judge of the amount of trouble the work will involve, which has no sort of constant relation to the cost, as their own code admitted; and it certainly can be no hardship on him to invite him to name his charge beforehand according to his own estimate of the quantity and value of his time, and then the employer may agree to it or not as he pleases. Architects are particularly fond of calling themselves Artists, and artists name their charges beforehand for pictures and statues made to order. The leaders of the profession having now adopted that arrangement with their largest employer, the public, any others are, and I know consider themselves, as Mr. Burges says, at liberty to do the same, and agree to any terms they like. The Government arrangement may be improved in some minor points, but it is generally so good that I give the substance of it here.

I will put A. for architect and C. for commissioners, or a committee, and omit superfluous words.

1. The A. will prepare sketch-plans, elevations, and sections of the intended building, having regard to the proposed cost, so that a contract might be made for it including fixtures and fittings, warming, ventilating, lighting, boundary fences, lodges, and every other work necessary to render the building fit for occupation, except furniture, for the proposed amount.

2. If the C. abandon the intention of executing the building the A. shall be entitled to a *sum to be fixed beforehand*, and to the return of his sketches (but see 6 and 12).

3. If the sketches are approved, with or without modifications, and the C. desire to proceed, the A.

shall by a day to be named prepare working drawings and specifications for competition by builders.

4. The drawings and specifications shall be full and complete so as to enable the C. to enter into a contract with a responsible builder.

5. If the most approved tender exceeds the amount proposed the A. shall, if required by the C., revise his plans so as to bring the expenditure within the prescribed limit.

6. The plans and the documents relating to the works shall be the property of the C. (*i.e.* at once, not merely after the work is done) and the A. shall make at his own expense all copies of them necessary for the conduct of the works.

7 and 8 are merely formal as to certificates and clerk of the works.

9. The A. will be at liberty to vary architectural details, *provided such variations do not involve extra cost*, but shall on no account incur any increased expenditure without sanction of the C. in writing. (See notes on this afterwards; it is defective as it stands.)

10. If any additional or substituted works become necessary during the execution the A. shall furnish the plans &c. as soon as possible.

11. The A.'s remuneration shall be *a fixed sum to be agreed on beforehand*; and one third of it shall be paid to him on the execution of the contract; another third when half the contract price has been paid to the builder, and the rest when the last payment has been made to the builder.

12. If after working drawings have been made the C. do not proceed, the A. shall be entitled to a fixed sum to be agreed beforehand, and the plans &c. shall

belong to the C. Or if they proceed only with a part of the works the A. shall be entitled to a proportionate part of the remuneration mentioned in (11) in addition to a proportionate part of the sum mentioned in this article in respect to the works abandoned.

13. The A. shall be entitled to nothing more excep· for alterations and additions made by the written authority of the C.

14. In that case he shall be entitled to such increased remuneration as may be agreed on, or determined by arbitration. (The latter mode will probably cost more than the sum in dispute and is a very bad one, even with 16, which is inapplicable generally.)

15. If the A. becomes incapacitated or dies he or his representatives shall hand over to the C. all plans and papers relating to the works, and shall be entitled to such equitable proportion of the unpaid part of the said remuneration as may be agreed on.

16. Disputes to be settled by an arbitrator *appointed by the Treasury.*

17. No rules of the R.I.B.A. or any other society to be held binding on the C. (This is 'ex abundanti,' since the whole agreement is opposed to the whole principle of those rules.)

Travelling Expenses.—After this complete abandonment of their own code it is out of the question for architects to profess to be bound by professional etiquette or otherwise to follow it; and at any rate I advise every employer to reject it utterly as a mere foundation for disputes and lawsuits, if it is sent to him. Some of the clauses in the Government form are however not the best, and it is in some respects imperfect, though the basis of it is right. It contains no provision about travelling expenses, which are not an unfrequent subject of dispute with some architects. Of course actual travelling expenses should be paid, and it would be very unwise to deter the architect from coming often enough by not agreeing to pay them. On the other hand I have the highest authority among architects for saying that no more than the actual expenses should be charged; first because it is unwise for the architects themselves to weight the difference of distance with more than is absolutely necessary, and secondly because they are not paid by time but by percentage, or by a fixed sum, in which they can take the distance into account if they like. Yet I have known a charge amounting to nearly 1 per cent. more than the 5 attempted on a large job, under the pretence of payment for time in addition to the cost of the journeys. I advise everybody therefore to have a distinct agreement that the payment for superintendence, whatever it may be, is to include everything except actual travelling expenses.

Alterations.—Another frequent subject of dispute is alterations, for which all sorts of charges are sometimes made. This also should be guarded against beforehand; and inasmuch as alterations always mean additions in some form or other, it is unreasonable to charge, as they sometimes do, first for the things omitted and afterwards for those substituted, especially as the architect need not undertake any large alteration without stipulating for a further payment, according to §§ 13, 14 of the Government form, though (as I said) I warn everybody against arbitrations, and there is no occasion for it there. I myself see no harm in agreeing to pay 5 per cent. on the amount paid to the contractor beyond the contract sum for any further works designed and superintended by the architect, at the request of the employer, and in accordance with the provision of the builder's contract for alterations which I shall give afterwards. On the other hand it is true that in every large work there are sure to be alterations, and they ought to be reckoned on as almost certain incidents from the first, and whatever sum is agreed on beforehand ought to carry them, unless they reach an unusual magnitude, and then the architect has only to require a special agreement for them; so that there need be no injustice or disappointment to either side.

§ 15 of the Government form is insufficient, and I recommend a more definite stipulation such as this:—'If the architect dies or becomes incapacitated or ceases to be employed, he shall be entitled to whatever sum has been agreed on for the working drawings in case the work had been abandoned, and also to $2\frac{1}{2}$ per cent. on the value of the work executed under his superintendence, and certified by him.' I have myself made an agreement in that way. Even then you would probably find it difficult to get the work carried on by a new architect for the difference between the total sum originally agreed on and what would thus have to be paid to the outgoing architect or his executors; but that is a fatality which cannot be prevented. I have seen a contract with the builder prepared by one of the most popular ecclesiastical architects, I suppose in his usual form, which actually made it impossible to get rid of him by anything short of that fatality which no man can resist. For the contractor was to do, and the employer was to pay for, everything the architect might order on that work *during his life.* And this, involving thousands of pounds, had been signed by a clergyman who would not have signed a lease of a house without legal advice, on the authority of the architect himself.

As a final proof of the necessity for a distinct agreement with the architect (besides a proper one with the contractor) I have known one case myself and have been told of others, where architects charged their percentage not only on the cost of the work designed and superintended by them, but on a quantity of other things of the nature of furniture which they had nothing to do with. It is true that in the case I know of myself the charge was not paid, but in others I believe it has been from unwillingness to engage in lawsuits. Not that such attempts are common: but it is evidently prudent to make them impossible.

Quantities.—Before we consider the tenders and the contract there is another intermediate element or document, which in modern times has assumed great importance, though the employer generally knows nothing of it, nor (be it remembered) is it any part of the contract legally, and nothing but confusion arises from recognising it as such, though it may sometimes be referred to for information. That is the bill of quantities, of every kind of work throughout the building. Formerly contractors used to tender from such rough estimates as their own experience enabled them to make: and I don't know that they were wider apart than they sometimes are now with the quantities found for them. The vagueness of the old contracts which have been preserved, for King's College Chapel for instance and some others, would alarm an architect or a contractor now. And yet we see how their work was done. But now, under the keenness of competition, they have every inch of section of mouldings measured from the plans: the contractor wants to know exactly how many bricks will be required, even when they are reckoned by millions; and an eighth of an inch thickness in a board is claimed as an extra if it has not been specified; and the architect or his quantity-taker will be blamed, and somehow or other an attempt will be made to get it out of the employer if the contractor finds he has had too little quantities given him for anything, even though he may have had too much for others. That is no imaginary case, for I once had a dispute of that kind referred to me. The architect satisfied me that the contractor's claim was unfounded. For that reason I advise employers not to let the quantities be taken by anyone who can be made out to be their agent, nor to recognise them in any way, except as after-mentioned with reference to a schedule of prices for extras. In some cases quantities are given avowedly excessive, to enable the architect to make additions: which is wrong.

The usual practice is for the quantities to be taken either by the architect himself, if he is not above it, or one of his clerks acting independently, or by some still more independent measurer agreed on by the builders who wish to contract; and the one whose tender is accepted pays him, all of them of course having added the charge to their tenders, which is usually 1½ per cent. on the lowest tender; but each man must treat it as ·01½ on his own as he does not know the others. I believe architects generally take care not to guarantee the accuracy of their quantities. The first edition of the R.I.B.A code in 1862 actually prohibited them from taking out quantities, but they were obliged to give that up, especially in the country: and the later one of 1872 expressly sanctioned it, but with the very objectionable addition of bringing in the responsibility of the employer, by suggesting that he should pay the architect directly for it, instead of paying through the contractor indirectly as above. It should be understood also, that, unless there is some agreement to the contrary, the employer is liable to pay the quantity-taker if he does not proceed with the work after the tenders have been got.

In that case, by the bye, of tenders being sent in, the revised code of the R.I.B.A. told the architects they may charge another half per cent. in addition to the established 2½; *i.e.* a further 100*l.* on a 20,000*l.* building for receiving half a dozen tenders by the post. What do they think the Court of Exchequer would say to their attempt to set up such a 'custom' as that, by private agreement, not with their employers but among themselves?

A little legal light was thrown on the quantity question in an action brought by a taker-out of quantities in a case where no tender had been accepted, as reported in the *Times* of 8 February 1875. He claimed 2½ per cent. on the lowest tender, and alleged that to be the customary charge. But Mr. Justice Quain pronounced such a custom unreasonable, and the builder who was employed gave evidence that 1½ per cent. was the real custom of the trade, and that was all the plaintiff got: another judicial condemnation of these attempts to make new customs, which architects seem unable to perceive is an *ipso facto* contradiction in terms.

Schedules of Prices.—Contracts are sometimes taken upon what is called a schedule of prices, which means a contract to do whatever quantity of every specified kind of work is prescribed by the architect—or the employer, if he is allowed a voice in his own affairs—at such and such prices. No sensible man however will let the contract be solely on that footing, as it gives him no idea of even the least that he may have to pay. The contract ought to be, as usual, for a certain sum for the work indicated in the plans and specification; but it is useful and may prevent disputes, to have a schedule of prices for extras, which should be the prices which the contractor has put upon the respective kinds of work in the plans for his own calculation of the total amount. In that case you pay for the extras as you would have done if they had been originally in the plans, which of course is fair to both sides. But care should be taken that omissions are not calculated without builder's profit and additions with it, as I am sure they very often are if you do not make a bargain for them when they are ordered. I have often said that whether you turn a window into blank wall or a wall into a window it is certain to be claimed for as an extra, if you leave it to be settled afterwards.

Tenders. — These are sometimes loosely called 'estimates,' which are, properly speaking, only the architect's or builder's opinion of what the lowest tender will be. The real causes of the proverbial excess of cost over estimates are, first, that the plans and specification seldom comprise all that they ought to do; and secondly, because alterations are required either to cure mistakes and omissions which become evident as the work goes on, or to meet the wishes of the employer, and very often to please the taste of the architect only. I confess myself unable to let any building of considerable size go on without seeing things that I wish to add or to improve, though I always avoid pulling to pieces work already done, unless it is absolutely necessary. Architects are therefore often blamed unjustly for their estimates being exceeded, though very often justly. It all depends on whether the alterations have been caused by themselves, including the correction of their own mistakes, or by their employers wanting something more than they originally intended.

Tenders proper are the offers of the builders to do the work for a certain sum. And care should be taken never to accept them absolutely, but only conditionally on the builder being ready to sign a contract in the form prescribed, and also to find sureties to be approved by the employer (if it is thought necessary) for an amount equal to one third of the tender, or something less in very large works. With great contractors of established reputation sureties are seldom insisted on: but with others I can say from experience that it is most essential. The contractors for two of the churches I have mentioned became bankrupt before the work was half done, besides several others that I know of, and the work was finished by the sureties. I have already mentioned what happened with a large town hall for want of sufficient sureties, not to mention smaller works. Somehow it seems impossible to get a half-finished job taken up by fresh contractors without loss; and it is worse still to finish it without a contract, which I have seen done more than once at an enormous cost. In another case of my own the lowest tenderer was unable to find sureties, for which he had various excuses, and was evidently without the capital necessary for such a job. Unless a contractor can afford to allow the usual 20 per cent. on the value of the work done from time to time to be kept back till the end, he is unfit to be trusted with it, subject to the qualification I shall state afterwards as to large contracts. And even that is not sufficient to dispense with security, except for builders of established position.

I have often been surprised to find that contractors will not take the trouble to read the form of contract if there is one left for them to read with the specification. They are firmly imbued with the idea that all contracts are and must be what I said at p. 17 that those drawn by architects always are. And when they find on coming to sign that it is not, they immediately take alarm and fancy that there is some trick in it and sometimes coolly write to desire you to alter it to the usual form, even after their tender has been conditionally accepted. At the same time, when they have taken the trouble to understand the form that I shall give presently, with the help of their own lawyers, they have always seen that it is fair, and only designed to protect the employer from being overridden by the architect and to secure proper execution of the work which he himself wants. I have never known a contractor whose tender was conditionally accepted throw up the job rather than take it on these terms, when he took the trouble to understand them. All I am saying for the present is, that if you accept any tender unconditionally you will probably find that you have thereby made a very bad kind of contract without knowing it. Also in advertising or sending for tenders it is usual and prudent to say that you do not pledge yourself to accept the lowest, or any tender. There may be very good reasons for accepting one not quite the lowest. Generally large builders of reputation are preferable to small ones, especially for large jobs.

In private contracts only a moderate number of builders selected by the architect are generally invited to tender, but in public ones they are generally unlimited and merely invited by advertisement. The latter plan evidently needs still more caution in accepting the lowest tender and requiring sureties, for the great builders are hardly ever in such cases the lowest.

On the other hand, if the number invited is very small there is a risk of their finding out who they are and combining. It is evident that architects' clerks are not impenetrable, for the tenders even for private houses get somehow into the architectural newspapers, sometimes to the surprise of the architects themselves.

The Contract.—The following is the form of contract which has been used, with small variations, in all the buildings which I have had to do with, including the recent ones at Lincoln's Inn. I give it in the form for a building firm and a committee; for a single builder or employer it will be rather simpler.

6*d.* Stamp.

This agreement made the —— day of —— between *X* and *Y* of —— builders hereinafter called the contractors of one part and *A* *B* and *C* hereinafter called the committee of the other part Witnesseth that for the consideration hereinafter stated the said *X* and *Y* for themselves and each of their executors and administrators covenant and agree with the committee their executors and administrators as follows:

1. The contractors will build and complete within —— months from the time when they are put in possession of the ground for the sum of £ —— a [church] at *K* in the county of *M* according to the plans and specification and directions from time to time of *P* the architect or such other architect as may from time to time be employed by the committee including all things which in the opinion of the architect may fairly be inferred from such plans and specification to be intended without being actually specified.

2. The contractors shall also execute all such alterations and additional works as shall be ordered

by the architect with the consent of the committee or by the committee. But if the contractors shall be of opinion that any such alteration or addition will cause additional expense they shall not be bound to execute the same without an order in writing from the committee stating the price which is either agreed on or certified by the architect as the proper sum to be allowed for the same after giving credit for the value of any omissions which have been ordered and such order shall state also the extension of time (if any) which is to be granted by reason thereof. And neither the contractors nor any sub-contractor under them shall be entitled to recover from the committee or any member thereof any more than the said sum of £ —— together with the amount of the sums contained in all such orders as last aforesaid nor shall this clause be held to have been waived in consequence of anything to be done by the committee or any member thereof except an express waiver in writing and then only as to the particular things included therein. The contractors shall if required for the valuation of extras produce the bill of quantities with the prices attached thereto on which their tender was based, see p. 34.

3. The contractors shall follow the directions of the architect in all respects and of the clerk of the works in his absence subject to the last preceding clause but neither of them shall be considered for any purpose the agent of the committee nor have any power to act contrary to their directions. And the whole of the work shall be done to the satisfaction of the architect. But the passing or certifying of any work by the clerk of the works or by the architect himself shall not exempt the contractors from liability to replace the same if it be afterwards discovered to have been done ill or not

according to the plans and specification either in execution or materials.

4. If anything shall be discovered to have been done in an inferior way or contrary to the specification or plans and especially (but without prejudice to any other questions) if any masonry or wood-work shrinks cracks or opens in the joints either before the work is certified to be complete or within a year afterwards the contractors shall make good the same not by patching but by substituting new work which shall be subject to the same condition; and if any payments are still due to the contractors they shall be suspended until such defective work has been made good to the satisfaction of the architect and subject to this same condition.

5. Payment shall be made to the contractors at the rate of 300*l.* for every 400*l.* worth of work certified by the architect to have been done or of materials delivered on the ground and all materials shall become the property of the committee as soon as they are delivered subject to the right of the contractors to remove all surplus materials when the work is finished. (In small works the payments may be smaller, and *vice versâ.*)

6. When the amount so kept back (in a larger work) has reached one tenth of the whole amount of the contract the contractors shall be paid 90 per cent. on each further sum certified by the architect to be due. And all such payments of instalments shall be made within three weeks after the architect's certificate has been received unless the committee dispute the propriety thereof. And half the balance remaining due shall be paid in three months after the architect's final certificate that the work has been completed according to the contract has been delivered to the committee and the other half in six months unless some defect

has been meanwhile discovered as aforesaid or the committee *bonâ fide* dispute their liability to pay on some other ground.

7. The balance due to the contractors shall be diminished by £ —— for every day that the work is not completed after the time hereinbefore fixed for the completion thereof. But the architect shall have power to extend the time for any good cause such as strikes of workmen or bad weather or additions or alterations ordered by the committee such extension to be certified by him to the committee at the time when such cause arises or as soon as it has ceased.

8. If the contractors or either of them become bankrupt or assign their or his property for the benefit of creditors or become otherwise unable themselves to carry on the work or neglect to do so at any time for a fortnight in the manner required by the architect or refuse to follow his directions as to the mode of doing the work the committee may at once terminate the contract and thereupon all claim of the contractors or contractor so acting his executors administrators and assigns shall cease and the committee may employ other persons to complete the work as they think fit. And in that case no scaffolding or fixed tackle of any kind belonging to such contractor shall be removed so long as the same is wanted for the work. But if any balance on the amount of this contract remains after completion in respect of work done during the time of the defaulting contractors or contractor the same shall belong to the persons legally representing them or him but the committee shall not be liable or accountable to them in any way for the manner in which they may have got the work completed.

9. All notices or orders from the committee or the

architect may be either given or sent to or left for the contractors or either of them by post at the works or at their usual place of residence or business. And every person employed on the work by the contractors whether by a subcontract or otherwise shall be considered their agent or servant. And any order or notice signed by the secretary or otherperson on behalf of the committee shall be treated by the contractors as the order or notice of the committee until the same is revoked or corrected. And all certificates and other things which have to be sent to the committee may be sent or delivered to the secretary or chairman or other person appointed by them for that purpose.

10. It is to be understood that the contractors and workmen are only admitted to the ground for the purpose of building and have no tenancy thereof and any workmen misconducting themselves or found to be doing their work improperly there may be discharged and removed if necessary by the committee or the architect or clerk of the works.

11. The contractors shall be answerable for all damage to the building during construction and until the same has been certified by the architect as complete and shall keep it insured to an amount equal to the value of the work done from time to time [and, in the case of additions to an old building, shall also be answerable for all injury to the existing building from any cause which might have been prevented by them or their workmen or anyone employed by them] and shall deliver up the building to the committee in perfect repair clean and in good condition when complete.

In witness whereof the parties hereto have hereunto set their hands and seals this —— day of ——.

The 'condition' of the bond to be executed by the sureties will be as follows. Printed bonds are sold containing the legal forms, with only the amount of the 'penalty' and the 'condition' to be filled in. The sureties should be bound jointly and severally.

Whereas *X* and *Y* have contracted with *A B* and *C* to build a [church at *K*] for the sum of £ —— by a contract dated the —— day of ——. Now the condition of this obligation is that if the said *X* and *Y* shall duly perform the said contract this obligation shall be void but otherwise the same shall be and remain of full force and effect.

Extras.—I add a few words of explanation of some of the clauses in the contract, and especially the second, the most important of all, relating to what are called 'extras,' which is different from the common architect's form on the same subject.

The common form is that the contractor shall execute any additions or alterations ordered by the architect and that they shall be valued at the end, either by the architect or a 'surveyor.' As I have observed already, the legal effect of this is to enable the architect to order anything he likes, and actually strike out things which he had inserted in the specification by desire of the committee. It is therefore necessary to prohibit alterations without the consent of the employer, although in most small matters his consent would be granted as a matter of course. But it is highly expedient to let it be known that he may refuse it.

Those extreme and comparatively rare cases of architects wilfully overriding their employers are by no means the only ones which make the common form of contract objectionable. At first sight nothing seems more reasonable than that anything ordered by the employer should be valued at the end of the work and paid for accordingly. But by some mysterious process of calculation things valued afterwards in that way always cost a vast deal more than if they were contracted for beforehand. While Doncaster church was building I asked the contractor for how much he would put in the diaper work which may now be seen inside the tower: in a day he answered 300*l.* I replied that I would not have it at that price; and in another day or two he offered to do it for 120*l.*, which I accepted. In another case the architect advised some friends of mine to let the contractor for a church build a churchyard wall at a price which I advised them not to accept, but to throw it open to competition, and the result was that it was done for two-thirds of that amount.

Another advantage of this alteration clause is that it tends to make architects careful, while their common form tempts them to be careless. Under this clause they will have to come to the employer to allow them to supply all their omissions and to correct their mistakes; and though he will probably consent rather than have his house built wrongly, yet every such application will be a confession of carelessness which they will not like to make. But under the common contract carelessness not only does them no harm but tends to their advantage (under the percentage system at least) by swelling the amount of 'extras.' Besides that, there is such a thing as starving the plans in order to get tenders within the prescribed or promised amount, knowing that the omissions will have to be supplied as the work proceeds, and that the employer will know nothing about it till the end; when he will probably have to pay twice as much as if they had been in the contract. But under this clause every such alteration and its cost will have to be brought before the employer as the work goes on, and that will be a great check on either careless or intentional omissions.

I have already given several instances, and I could give more, which prove the importance of the words prohibiting alterations *without the consent of the employer*. Without them you may actually have to pay for things as extras which were inserted in the plans by your own direction; for the architect may direct them to be omitted, or done differently, though at no more cost, and it may cost a great deal more afterwards and involve no end of pulling to pieces to have them reinstated, as in the case mentioned at p. 20. Or again, without these words, the architect may introduce something you particularly dislike instead of what you had approved, provided it will cost no more. No man knowing what he is about would allow such things to be done, and these words are necessary to prevent them.

It is true that the strictness of this clause is often waived in special cases. I have frequently done so myself, and have always paid for alterations valued afterwards by the architect when I have known that it was fair. At the same time it is very desirable to be able to set your back against the law in resisting a claim which you know to be unfair; as when you have been told that an alteration will cost little or nothing and have ordered it on that understanding and then a monstrous 'extra' is claimed for it; or when the contractor has obstinately disregarded your warnings (as they often will) that you will not pay for alterations ordered without your leave.

If it is attempted to get rid of those words by asking how the contractor is to know whether the employer objects to any small alteration, the answer is, that if the alteration is of such a kind or magnitude that the contractor has any doubt about it, he has only to decline to make it until the consent is given. He cannot possibly suffer from that, nor from any part of this clause about alterations, as he is not bound to spend a penny beyond what he has engaged to do without a written order from the employer agreeing to pay for it according to the architect's valuation as usual: the only difference being that the employer is to have the valuation beforehand instead of afterwards, when it is too late for him to consider whether he thinks the alteration worth the cost. When this has been explained I have never known a contractor refuse a contract on account of this clause. And that Judges will hold it to be effective (whatever arbitrators may do, who decide without reasons and very often without law) is proved by the cases of *Franklin* v. *Darke* (3 Foster and Finlason 65), *Russell* v. *Bandeira* (32 L. J., N. S.: C. P. 68) as to a ship, and *Myers* v. *Sarl* (3 Ellis and Ellis 306); in all of which it was held that on a contract providing that extras should not be charged for without a written order, nothing but a written order would support the claim; and quite rightly both in law and common sense; for the contractor knows, while the employer may not know, whether any proposed alteration causes greater expense or not: if the contractor gives no notice that he means to claim for it it is quite right that he should be estopped from setting up the claim afterwards.

Arbitration Clause wrong.—Some contractors stand out for a clause which is no less objectionable than the common architect's clause respecting extras. I have seen it attempted in various forms, but in all of them the substance is that they may have an independent arbitration on every question of valuation, not by the architect, who is the natural standing arbitrator and knows all about the matter, but by somebody else; which reduced to plain English means that they may insist on a lawsuit, and the worst kind of lawsuit, which may last any time, and cost any money, on every question between them and the employer, though the architect could settle it in an hour without a farthing of expense. They may have got this clause assented to by persons who do not understand it, or by public officers, or by committees who are not spending their own money, but by no one who both knew and cared what he was doing. Not only is the notorious expensiveness of arbitrations a fatal objection to it, but the notorious disposition of the kind of arbitrators who generally try such cases to favour the contractors is equally fatal. Of course the contractors know all this very well, and know that the employer will be advised in nine cases out of ten that he had better pay anything that is demanded than fight such a battle. I don't know what the architects themselves think of it; but it is totally at variance with their proper position; and whether they care for that or not, I advise employers on no account to accept it.

The third clause, providing that neither architect nor clerk of the works shall be considered the agent of the employer, is at least prudent, because it is sometimes contended that they were, and in one case with some special circumstances (not in the 'Law Reports') the contention succeeded. It is true that it was before a Judge whose judgments were oftener reversed than affirmed on appeal, and contrary to the decision in *Coker* v. *Young* (2 Foster and Finlason 981), that a contractor cannot claim for any excess on the quantities (which was the point in the other case) but only for the amount of his contract. Still it is prudent to make it clear beyond dispute that you are not to lose the benefit of your contract through something done or omitted by the architect or clerk of the works converted by legal construction into your agent.

Clerk of the Works.—This is a convenient place to say a few words about that important functionary of modern times, who is a kind of representative of the architect in his absence, to see that the work is properly done throughout, and to give directions which cannot wait; for the occasional visits of a distant architect would not detect many defects and much 'scamping,' if the contractor is inclined to it. And now that every workman is the slave of the Union, which discourages excellence and does all it can to bring down good workmen to the level of bad ones, continual inspection by somebody is absolutely necessary. At the same time it is a great reflection on the building trade that so many people should have to be employed to look after each other, at a cost which might be much better spent in paying workmen to do more or better work. The salary of a clerk of the works is a serious addition to the other charges on a building of moderate cost, though it is less in proportion for a large one built pretty quickly, as it is a weekly salary and not a percentage, and therefore it is sometimes dispensed with, though at some risk. He ought never to be necessary when the architect lives near enough to see the work frequently, or when you know by experience that the builder is a good one. He is almost always selected by the architect, though it should be borne in mind that he is subject to approval and dismissal by the employer, who pays him independently. I would never keep one in whom I had lost confidence, whatever the architect might say to it; and it is quite understood that he may not take a second job at the same time without your consent: sometimes it is convenient to let him do so, when they are near together, and neither of them so large as to require all his time. It is almost unnecessary to say that he should thoroughly and practically understand building, and a mere architect's clerk is not fit to be a clerk of the works, unless he has somehow or other learnt both masonry and carpentry practically, which it would be far better if they all did as part of their education. One who is found either by the architect or the employer to allow any bad work ought to be at once dismissed, for he does not do it for nothing, and will not do it only once. Some of them are very able men and take great interest in their work, and I have had valuable suggestions from them, and occasionally good designs too, for things wanted or improvements in the course of the work. Others are simply very bad both intellectually and morally.

Bad Work afterwards discovered.—Returning to the contract; the fourth clause may be either in the specification or the contract, but in one or other it is as essential as it is unusual. Every architect who attends to details and cares about the condition of his work after he has done it, must be aware of the constantly increasing difficulty of getting it well done, and woodwork above all things. And yet they are content to go on specifying that 'everything shall be done in the best manner, and with the best materials of the kind'; and then in a year after they have certified that everything has been done in the best manner, every joint of every floor is gaping as if it were left open for the dust to be swept down, as in Exhibition buildings; windows and doors shake and rattle, skirting boards leave all connection with their floors, because both they and the joists below have shrunk, once solid-looking communion tables and pew ends split into several pieces, pannels crack, and a house or a church only a year old looks infinitely worse than those of 50 or 100 years ago, because then woodwork was done well. For that reason I always regret the destruction of the often ugly but always excellent and sound oak pews of the last century in church restorations. I once had the satisfaction of making a builder take off every bit of the oak boarding of a new chancel roof because it had shrunk so much as actually to draw the tongues out of the grooves, luckily before the work was certified to have been completed to the architect's satisfaction, as it probably would have been very soon.

The only provision generally made for this specific defect is that 'the wood shall be well seasoned'; and that is supposed to be complied with by stacking a pile of boards out in the day to the heat and in the night to the damp for some months, and then, perhaps after weeks of wet weather, working them up as fast as possible and laying them down in floors and roofs, &c. Even the oldest wood will shrink from being merely cut and planed. I once had a table made of planks cut out of oak beams at Cambridge 400 years old, and every joint split because it was framed too soon after being cut.

It is fair to say, however, that people have often only their own impatience to blame for their woodwork failing. They will insist on having their houses finished in a year; and the consequence is that the woodwork has to be put in before the plaister is dry, and the plaister before the walls are dry. I have seen them plaistering rooms in a great house after all the woodwork was in. However dry it may be it necessarily swells with the damp, and as soon as it dries again it shrinks and shows the defects above described. I do not see how it is possible for a house to be properly built, woodwork and all, within a year, unless indeed some kind of fast-drying cement is used instead of plaister, which otherwise requires a summer to dry in.

But this fourth clause of the contract does not apply to woodwork only: it attempts at any rate to provide for the discovery of all concealed defects which the architect has not seen in his flying visits, and the clerk of the works has shut his eyes to. It is impossible to specify them all, and it is not worth while to mention only specimens at random. No one who does not defend cheating as a divine right of trade, (as a celebrated commercial politician did adulteration, which is one of the worst forms of cheating) can maintain that building frauds in particular ought to pass with impunity, merely because two persons who are specially paid for looking after them neglect their duty. And yet without this clause the architect's certificate is a final bar to all redress against a builder for the most fraudulent bad work, especially with the universal jury determination to find verdicts for a brother tradesman if they can. At the same time architects may as well remember that they may find themselves in a very serious scrape for certifying that work has been done according to the contract when it has not. Any employer who has a good case of that kind would be a public benefactor by enforcing it.

Divided Contracts.—It is sometimes expedient to modify the contract so as to divide a large work into stages or sections, at which the committee may stop if funds are not provided for going on; and they are more likely to get the funds in that way than when the public know that they have made themselves liable to complete it. In that case it is fair to the contractor that they should be bound to say within some reasonable time after the first section is completed whether they require him to go on: which again gives them the advantage of being able to tell the public that the contract will be lost if the funds are not speedily subscribed.

A large work may also be divided among several contractors, or at any rate two, for the masonry and the woodwork. But it is seldom expedient, as one always complains of the other, and it generally causes delay. Most builders prefer contracting for the whole. When a contract is so divided each of them (or the specifications) should provide that each contractor is to give all necessary assistance to the other, but that the failure to do so shall be no exemption from liability to complete within the time fixed, leaving each to enforce the liability on the other. The specification, even for one contractor, is always divided into 'Trades,' headed 'Mason, Carpenter, Plumber,' and so on. But specifications are seldom read by employers and would be intelligible to very few. It would be useless to give any model one here, and in fact they must vary for every building. A good number of specifications, including that for Doncaster church, are printed in Mr. Donaldson's two volumes of them. I shall only suggest some things which are often omitted, in the chapters on details of building. My object is not to encourage people to dispense with architects, but to give their employers the benefit of some experience. The rest of the contract above given requires no explanation and is much the same as the architects' usual form.

CHAPTER II.

PRINCIPLES OF CONSTRUCTION.

Styles—No new style possible—'The Hope of Architecture'—Architects and workmen—Gothic, Classical, and other styles—Symmetry belongs to all — Plaister and painting—Cornices and mouldings—The 'vigorous' and 'streaky bacon' styles — Length *v.* height—Monotony and variety.

Though plans and specifications must be made before contracts, it was desirable to include everything relating to preliminary and legal arrangements in one chapter, postponing all questions of construction (of buildings not agreements) to another. And the first question of construction that has to be faced for every new building of any architectual pretension is the much vexed one, of what Style it is to follow. I need hardly say that this word is a technical one, and also that it is used in different senses, sometimes embracing under the single name of Gothic all the mediæval styles with their well-known distinctive names, down to and including Elizabethan, and at other times indicating each of them by itself, as the Early English style, or the Perpendicular; and similarly embracing sometimes all the forms of the old Classical or modern Renaissance styles, and at other times distinguishing them according to their minor differences. All these distinctions have been explained and discussed so often that I shall say nothing of them here, and I shall take for granted that they are known, and that the only question is which of these old or existing styles we are to use for any particular building.

Some readers will be exclaiming already, as I have heard and read till I am sick of it, 'Why are we to copy any of them? Are we never again to have a new and original style, a Victorian as well as an Elizabethan or a Queen Anne style? Are not the architectural critics continually telling us that we can never have any good architecture except in some style which is "genuine," "original," or "true," and not merely copied or imitated?' To all which the simple answer is, that no builder in any period of the world ever did more than imitate or follow some existing style, though in old times they were clever enough to make small modifications which were seen to be improvements and so came to be generally accepted, and thus one style gradually changed into another. At least that took place until all the Gothic styles had successively gone out of fashion, and then the seventeenth century architects thought they would begin again and take up and copy the old Roman architecture, from which the Norman style had sprung (which was actually sometimes called Roman to distinguish it from pointed Gothic), and thence all the later developments of Gothic. Therefore the modern Italian style is otherwise called the Renaissance, or the Palladian, introduced in England first by Inigo Jones, who stuck a horrible Corinthian portico on the west front of old St. Paul's. The only difference is that from that time down to the present nobody has been able to invent any modifications which have come to be generally accepted as improvements, and so no new style has been developed as the old ones were. Modifications enough have been indeed displayed, but it is difficult to believe that even their inventors thought them beautiful, or aimed at more than appearing to be 'original,' and they die off as mere abortive offshoots of the old style on which they were engrafted, whatever that may be. The same has to be said of the attempts to make new styles by compounding old ones. Not that there is any demonstrable *à priori* objection to what is called eclecticism: it is only a question of experience whether it is successful or not. The objections that are sometimes made by small critics who have got up their Rickman well, to the mixing of any two successive Gothic styles, are mere prudery and nonsense; for every two successive styles were mixed at their own period of transition, and there is hardly a cathedral in England which does not exhibit styles, several generations apart historically, close together, and they are certainly not incongruous. I do not say the same of Gothic and Italian, of which it is equally certain that no successful mixture has been made yet.

Those who may decline to accept this account of the development of new styles in old times on my authority will perhaps accept it on that of Mr. Street, who says in an essay on his favourite foreign Gothic in a certain ritualistic book called the *Church and the World*, 'It is idle to talk in the glib way so common in the professional papers of the day about the invention offhand of a new style. Such deliberate invention in art is impossible, unless the whole history of art is wrong.' And again, 'The history of the art of northern nations is almost entirely the story of a gradual changing, and generally *Deterioration* of detail'—after it had passed its climax, I suppose he means, for otherwise the latter part of this statement is manifestly incorrect, and indeed suicidal. Mr. Street is at any rate a good authority on the history of Gothic architecture, though I decline to follow him into the mystical regions of what he dexterously christened the 'vigorous' style, a word which may mean anything that anybody pleases. Certainly no plain man would guess that a square abacus is 'vigorous' and the almost invariably round English ones 'weak.' If we may prefer real meanings to mystical ones, and if vigour means strength, a round abacus has more vigour than a square one in proportion to its mass. If Mr. Street and his school prefer square abaci to round ones as a matter of taste by all means let them say so: one opinion is as good as another on such a point. But these pretences of reasons for things which admit of no demonstration are nothing but artistic clap-trap.

There is moreover another real reason, as I said above twenty years ago when this outcry for a new style began, why no such thing is to be expected. The varieties of geometrical forms suitable for building are manifestly not unlimited. It is true that we cannot prove that the limits have been reached, just as no mechanical invention which is not mathematically impossible (like perpetual motion for instance) can be pronounced either possible or impossible until it is made: and then we want no discussion as to its possibility. But the openings in walls must have either flat or arched tops, and the flat were used up in Egyptian and Greek architecture. Arches can have no shapes that have not been tried over and over again in every possible variety. The admissible shapes of pillars and their capitals are as few. Door and window jambs can have no kinds of shapes that have not been used already. Window tracery was exhausted in the three Gothic styles which are distinguished by the only three possible forms, geometrical, flowing, and perpendicular, unless you add monstrosities. Nobody can imagine that there is anything fresh to be done in the shapes of roofs. If throwing the different parts of buildings together without any plan at all is to be called a style, even that has been quite sufficiently exhibited within the last few years, and I shall have more to say of that presently. If any man believes that other modes of building are still open, let him produce them; at any rate he has no right to call upon us to accept his creed until he does.

What then is the real difference between the present state of architecture in this respect and its old condition, before all the 'original styles,' as Mr. Fergusson calls them, had each had their day and gone out for the time? It is only this. In those days there was never more than one style in fashion at once, and now there are several or many. Builders then understood only one mode of building, and even rebuilt or continued in their own style anything which had been done before wholly or partially in another. But an architect was no more original who designed a window of geometrical or flowing or perpendicular tracery in the days when no one thought of using any other, than he is now when people use any style they like. Plenty of large modern Gothic windows, whether bad or good in taste or execution, are as original in design as those in York or Exeter cathedrals. And on the other hand the practicable patterns of windows of few lights are so limited in number that they were necessarily used over and over again in the most genuine Gothic times.

One of the greatest fallacies put forth by the demanders of a new style is that of denouncing modern Gothic as the copying of an old style, and setting up Renaissance or Italian as a new one, when their very names condemn them in that respect at any rate. It is odd that critics of the Evelyn school, when that style was reviving, more correctly in point of history, however ignorantly otherwise, denounced the Gothic style as 'modern' and set up the other as the 'truly antient.'

All this outcry for a new style is of the nature of 'crying for the moon,' and is mere cant, repeated by one person after another without any one of them reflecting what it means. What we want is not a new style but the genius or taste to build decently in any style. If a new one were invented to-morrow, it would very soon be old, and would be only one more than we have already to choose out of and copy. If the old Gothic builders could make the variety they did with only one style lasting for a century, surely our architects might manage it with half a dozen; and if they cannot build well with half a dozen styles they would do no better with a dozen. Only two things are wanted to produce good architecture; taste, or the power of designing what is pleasing; and practical or scientific knowledge, which is only to be acquired as it is in engineering; which differs from architecture in requiring no taste. One can be taught, but unfortunately the other cannot, though it may be cultivated and improved.

Architects and Master-builders.—It has been alleged with some truth, though with some exaggeration, that one great cause of the difference between antient and modern architecture is that in old times the builders designed for themselves; and not merely the master-builders, whom we should now call the contractors, but the workmen by a sort of joint-stock or co-operative genius or instinct. For the latter proposition as a matter of history I say at once that not one scrap of evidence has been produced, and I shall have more to say of it as a theory presently. For the former one, as to the master-builders, which has been denied by some architects, there is sufficient proof, though both parties have failed equally in proving either the universality of that practice, or, on the other hand, the universal employment of mere designers such as architects now are. Monks and bishops frequently designed their own buildings, which however is far more like a gentleman now designing his own house than the employment of a stranger called an architect. And perhaps in a few cases special designers or architects were called in for that purpose only; but I cannot say that all the research of the authors of several papers on this subject at the R.I.B.A. in the winter of 1874-5 succeeded in producing many unquestionable proofs of that, though I am not at all anxious to deny it. The general result of the evidence produced is that the great majority of old buildings were designed either by the ecclesiastics on the spot or by what we should call the contractors. The looseness of some of the old contracts which have been preserved shows that a vast deal more was left to the discretion of the contractor or master-builder than ever is now.

But (as I said at the R.I.B.A. on that occasion), what then? There is no magic in a building being designed by one man rather than another, provided he is competent and master of his work in a larger sense than being the mere hirer of workmen. No builder of any large work has time to work at it with his own hands, and what better would it be if he did? There is an old saying, that 'the eye of a master is worth more than both his hands.' It does of course make an infinite difference whether the designer or director of a work thoroughly understands it and looks after it, or not.

But so long as he does, it does not signify the least how he has learnt his business, whether by working or by looking on. And as to the taste which is necessary to design good architecture, it signifies still less, if possible, whether the designer is a workman besides. People may talk and write fine language about the philosophy of art and theories of architecture, and may call it 'the expression of a people's wants' and many other things which sound well and mean anything or nothing; but the long and short of the matter is (as I said just now) that architecture or architects want only two things, expressible in two short words, taste and knowledge. Taste can no more be defined than taught, and the only test of it is that things in good taste are admired in the long run permanently, and that those who have seen them once desire to see them again. Moreover it is odd that taste does not follow education, but sometimes the reverse; for there seems no doubt that people far below us in civilisation and knowledge, working entirely by themselves, display an instinctive taste which they actually lose on becoming more civilised. But the other essential quality of an architect, practical and scientific knowledge of building and all that belongs to it, can be taught and ought to be possessed more completely now than ever, as there never were such facilities for acquiring it.

Now one of the points in the *Quarterly Review* of October 1874, on 'the Hope of Architecture,' which gave rise to that discussion at the R.I.B.A., was that the superintendence by the designer is very far short of what it used to be in old times, when the designer was on the work continually and seeing the effect of everything as it went on, besides seeing that the work was done properly. And I must say that does not seem to me very easy to answer, beyond saying that architects in great practice have too much to do to be able to superintend their work properly, and that clerks of the works are substituted for them, or rather added to them, and paid by the employer in addition to the 2½ per cent. paid to the architect expressly for superintendence. But though that is true as a fact, I was glad to hear it admitted there that it is not satisfactory. It is indeed no answer at all to the charge that this is one cause of the great quantity of bad building that we suffer from, and I must add bad designing too; because I am sure no man can design details satisfactorily without trying them as the work goes on, in the only way in which they can be tried, viz. by models. I never saw any details so tried without some improvement being suggested; and I see Mr. Burges lately said the same to the Architectural Association.

It is amusing to see the different views taken by architectural theorists of the value of an architect being also an artist. Mr. Ruskin asserted long ago in effect that that was the cause of the great architectural success of Giotto and Michael Angelo; and I answered at the beginning of my book on *Church Building* that we had a painter architect named Kent in England in the last century; and I think he was a musician into the bargain. But though he was very much in fashion for the time he is now chiefly remembered by one of Hogarth's caricatures. But we have now had another answer, from the anonymous critic who has written a series of architectural articles in the *Quarterly Review* in a tone no less dogmatical than even Mr. Ruskin himself. He tells us that Michael Angelo and Giotto failed utterly when they set up for architects, and Mr. Fergusson agrees with him in calling Mr. Ruskin's praise of Giotto's tower at Florence very much exaggerated. I am not concerned to express an opinion one way or other about that just now; but I am satisfied there is no foundation whatever in history or experience for the proposition that a designer of buildings is a bit the better for being an artist of any kind, *i.e.* for being able to work with his hands at any art whatever. And I am sure that architecture has not been and will not be advanced one bit by all the writing and talking about the philosophy of it, of which we seem only to have the more the worse it becomes. In the days when there was real architecture there was no architectural philosophy. Men designed and built well simply because they understood it and had naturally good taste, and were not always striving to appear original, or to do something striking, or to be just ahead of the fashion and yet in it, as fine ladies like to be, and they had no vulgar tastes to play up to in competitions or for ostentatious private employers.

Architects are particularly fond of telling us that they are to be regarded as 'artists.' Why they should want to be considered anything else than what they are I cannot understand, except that, for one reason or another, nearly everybody does now-a-days. But generally the title coveted is something distinctly superior to what we have. An artist is one who executes his designs, and the carvers employed by an architect are artists when left to carve from nature or out of their own head, as they are in all good work, especially Gothic. Singers, dancers, hairdressers, dressmakers, cooks, no less than the greatest painters and sculptors, all manage to get called artists, and I suppose rightly, so far as they execute their own designs, or exercise any discretion as to their mode of execution. Architects are artists, if they think it worth their while to say so, in respect of the drawings and pictures which they make, but no farther; and experience has proved abundantly that there is no connection between the power of drawing pretty architectural pictures and designing fine buildings. Few, or more probably none, of the old Gothic builders could have drawn a picture of their own buildings which would have had the least chance of a prize either in an architectural or pictorial competition now; and on the other hand some who practise architecture now are really good artists in the proper (pictorial) sense, but never designed a decent building yet and probably never will; and though they can copy old ones well enough for pictures on paper they seem quite unable to get them copied in stone, or even to see where the copies fail. And again, some of the very best architectural artists have never attempted to design, *i.e.* do not profess to be architects.

Another fact which I would rather introduce on the authority of an architect than my own, was dwelt on by Mr. Boult of Liverpool in a lecture to the Architectural Society there on the same subject, reported in the *Builder* of 5 December 1874: 'Who will say that any of the distinguished men who designed the monuments of the Renaissance period was a trained architect? Neither Leonardo da Vinci nor Michael Angelo, nor Wren, nor Inigo Jones can be included in that category. Later still, turn to Dance of the Mansion House, Chambers of Somerset House, or Fowke of Kensington (and the Albert Hall, a really grand building), and where are the credentials which authorised them to practise as architects?' It was in answer to some complaint of the London architects about that very Captain Fowke, of the Royal Engineers, being employed on the Great Exhibition buildings of 1862, that they were entirely non-plussed by being asked to define, 'What is an architect?' I know of no more correct definition than that he is a man whose designs for building other people are willing to adopt. It would hardly do to say that any man who designs buildings is an architect, for that would include every one who chooses to spend his money in building for himself what everybody else thinks ridiculous and abominable. It is true that these epithets may very fairly be applied to the works of some architects whose designs other people do accept; but a definition of an architect is one thing, and of a good architect another, and not so easy to give. I suppose the nearest approach to it would be that he is a man who designs buildings which answer their purpose and continue to be generally admired; and in that case it must include those who so build for themselves, even if they never gave a design to anybody else; and it certainly would exclude an amazing number of those who are now called architects.

But whatever definition of the term we may adopt, no greater absurdity in connection with this subject has been propounded than the idea that architecture is to be revived or improved by getting rid of architects and setting up builders in their stead. Every now and then a particular builder, like a particular architect, may have natural good taste, and I have met with one or two who had, and with clerks of the works (who have generally been builders' foremen) who sometimes suggested real improvements in the work they were executing. But if architects' architecture is very often unsatisfactory, common builders' architecture is proverbial for ugliness, meanness, and vulgarity. It is true that a few *paradoxers* (to use De Morgan's convenient expression) have taken upon them to propound the theory that builders' designs constitute the real hope of architecture, and these not master-builders or contractors, such as undoubtedly did design more or less in old times, but those whom we commonly call workmen. The latest asserter of that paradox is that same *Quarterly Reviewer* of October 1874; and he fortunately gave to those who take the trouble to use it the means of verifying his theory by ocular demonstration. For he found something of the nature of a public building designed by working men on the co-operative plan, *i.e.* I suppose by some committee of taste, for all the members of the club could not have had a finger in the pie. It is called the Portcullis club (or Temperance Hall) in Regent Street, out of Victoria Street, Westminster, and may be known by a sculptured, *i.e.* stucco representation of that article of fortification, of which the idea was perhaps taken from the portcullis ornaments in King's Chapel. Our critic pronounces it as having 'a much more respectable and satisfactory *front* (even he judiciously avoids turning the corner) than the Charing Cross Hotel or the National Gallery.'

Declining the collateral issue about the merits of these two buildings, which I never heard selected before as eminent specimens of architectural ability, I only regret that the reviewer did not give his readers a pictorial demonstration of his theory without sending them down into the back regions of Westminster to find it; for a description can only do imperfect justice. It is a narrow-fronted building of the usual form of a small 'meeting-house' with the front stuccoed, and a gable so much higher than the real roof that it looks as if the front had been bought secondhand from a taller meeting-house and stuck on there. If an architect had done it the reviewer would have said he had the base design of making the building pretend to be larger than it is. The stucco is divided into very large sham stones, with the little portcullis encircled by a kind of frill under the gable, and PORTCULLIS HALL inscribed under it. There is a large door with a heavy pediment over it, evidently copied from some much larger building, and two long round-headed windows by the side of it, each with a pair of flat pilasters and Corinthian capitals forming the jambs and carrying a small architrave round the arch, and two of the orthodox teetotums of that style (perhaps intended for tea-urns appropriate to 'Temperance') at each corner of the gable. In short it is just the kind of building which the reviewer himself, if he had not been in the secret and wanting to praise it for the purpose of his argument, would have guessed to be the work of some small architect's clerk working up a few Renaissance patterns which he found in the office, a door and pediment from one place, a pair of windows from another, their jambs and architrave from another, the teetotums from somewhere else, and so on: or to speak more plainly, it is exactly the kind of building that any person of experience would expect from one or more workmen setting up for architects.

But according to the reviewer's own story, this magnificent effort was not a result of 'harmonious co-operation' or joint-stock genius after all; for 'the beautiful drawings and elevations,' 'which he has had the advantage of seeing,' were made by *one* of the workmen. I should like to know what difference that made to all the others, who had no more to do with the design than if it had been made by an architect. So we have still to wait for the evidence to support this pretty theory of instinctive co-operation, like that of a hive of bees, to produce a beautiful result; as we have to wait for the evidence to support another modern theory of spontaneous production, without a designer, not of buildings, but of something infinitely more complicated and wonderful, viz. ourselves.

I thought too that this 'beautiful drawing of plans and elevations' was one of the differences between our system which is wrong and the old one which was right. No one will deny that our architects can draw much better than the old designers. The fact is that our critic, in his enthusiastic exaltation of the artistic workman, forgot that the logic of his case required him to depreciate the importance and perfectness of the drawings. He ought to have been able to say, 'Here is an admirable, genuine, truthful building, with all its details invented and not copied, of far more satisfactory design and proportions than any architect's, built by a set of workmen from a simple sketch or plan arranged by themselves, cutting and fixing the stones in some instinctively harmonious way, each by a separate man, yet in perfect and spontaneous concert with a general design,' as he divines was the case with the Baptistery of Pisa, though he cannot possibly know anything about it, as he 'was not there to see,' nor cites anybody who was. It is a capital way of proving any proposition about art, or anything else of bygone times, to assume and assert that everything good was done in the way you think it should have been and everything bad some other way, and leave other people to disprove it if they can.

London House-building.—We need not go far to find a proof how little theories are worth on subjects of this kind; for we have one in the fact that both the best houses in London and the worst are designed by the builders. The worst speak for themselves. If it be said that the best builders' houses in respect of solidity and comfort, whether of the last century or this, make little architectural pretension, I answer that they are infinitely better even in that than the vulgar monstrosities of indescribable character, and nothing but pretension, both in brick and stone, which architects are planting over the estates of some of the great metropolitan landlords, to whom, as to Sir Balaam in the poem, 'some demon whispered, "Have a taste,"' in an unlucky hour for their lessees and for the public—except of course the architects and builders. They had better look after the doings of some of their agents a little more, and attend less to architectural cant about 'monotony and ornamentation,' and encourage substantial building, and healthy, by giving proper area for houses to stand on, and to get air and light from, instead of building mere towers with only one side really open, having only a deep and dark cell behind. Yet we have what are called Building Acts periodically revised into more and more blunders.

Superintendence, Antient and Modern.—Was there then no essential difference between the mode of building in old times and now, beyond the mere difference in genius or taste? Yes, there was undoubtedly. We know as a fact, from some few specimens of drawings and contracts which remain, that the architect or first designer, whatever he was, did not design beforehand in anything like the minute detail that architects do now. Of course somebody must have designed at each successive stage what others were to execute, as nobody could do it all himself: at least we may venture to say so until we have some better evidence than the divination of a reviewer of that 'instinctively harmonious working of separate workmen in perfect and spontaneous concert with a general design' spoken of just now. But it is evident that much more was left to the taste of the workmen, from the highest downwards to the mere cutter of mouldings, than is ever done now. Carving undoubtedly was left to the carvers, who are in fact sculptors, and therefore 'artists'; and so it is now in all the best work, at least of the Gothic kind. Whether it is in those things like black puddings coated with leaves, which adorn Renaissance architecture, I really do not know. The capitals of the columns of that style too are so purely conventional and have so little variety that there is hardly anything for a carver's taste to expatiate in. But except the carving, nothing now-a-days is left to anybody below the architect. The contractor expects to have every detail sent down to him from the architect's office and calculated to measure in the 'quantities' beforehand. So that the master workman and his men have sunk into mere machines for executing the design. Consequently there is no designer living on the work and seeing it from day to day and observing how things look as soon as they are begun, or trying them by models: nobody finds out until too late whether details look too big or too little, or suitable to others in the same building. The consequences of this have been pointed out over and over again, in the universal disproportion which prevails in many of our buildings, and in the details often looking as if they were not designed at all, but copied at random from some stereotyped forms of the office, which had themselves been copied, perhaps incorrectly, at some time from genuine ones, and sent down with no regard to scale or appropriateness of any kind. I have one memorable case of this sort, where I found a church door jamb building in what looked to me an extraordinary shape. The architect—a most eminent one—assured me that it must be right, as it was copied from St. Mary's Abbey at York. I replied that I did not believe it. It turned out that we were both right; for St. Mary's door jamb had been copied, *i.e.* a published drawing of it, but the paper and the splay had been turned the wrong way, through 90°, and nobody in the office or on the ground had found it out.

Models v. Drawings.—It may be said that the architects see their work after it is done, and can avoid repeating faults which they have made once. But the question is not whether they can but whether they do. If they did complaints of the badness of our architecture would not be so universal as they are. The fact is that faults are not perceived in that way, by a cursory *ex post facto* inspection with no desire to discover them, as they would be if every thing were treated as an experiment at first. There is not the least doubt that in the ages of imperfect drawing they worked far more by trial than we do now. I never had a first model made of anything from which it was not easy to see that it might be improved; and yet every one of them would have been executed from the drawings if I had not had models made. Sections across mouldings, plinths, and other such details, can give nobody any idea, at least none that can be trusted, how they will look. Even a difference of material, between one kind of stone or wood and another, sometimes makes a great difference in the appearance, and in the kind of execution required to produce a good effect. All these things we may be sure were looked after carefully by designers on the spot, who saw and were anxious to see the effect of their work from day to day. In the modern way of building they are, practically speaking, not looked after at all. And that is the real difference between the designing by old Master-workmen and designing by modern Architects; always remembering that builders are not a bit more likely to have good taste than mere designers, and probably much less, though there are occasional exceptions to that rule.

Finish.—At the same time I agree with the critics I have been criticising, that the effect of the present system of reducing everybody below the architect to a mere machine tends to degrade the taste of all of them, and has done more than anything else to give all modern work that mechanical and spiritless appearance which critics have been censuring for years. In other words, 'finish' is the only aim of the modern workman, if he aims at anything beyond the Trades union object of doing as little and as ill as will be tolerated. Notwithstanding all that has been written on this point, and never questioned, so far as I know, I am sorry to say it has been but very feebly and unwillingly (if at all) seconded by architects, however theoretically they may have occasionally assented to it. Those who have occasionally done so, and allowed the common provisions for 'dragging,' pointing, polishing, and general dressing up, to be erased from the specification for some one building, let their clerks go on ordering the very same things ever afterwards.* In vain it is pointed out to them and they admit, that

* I am glad to see an exception made at last, in no longer polishing and waxing oak in some churches; but it went on for some time after I had stopped it at Doncaster Church.

the very works they pretend to imitate were executed in a totally different fashion from theirs; that the old builders cared nothing about precision and finish; nay more, that they knew it makes things look monotonous and spiritless; that though they regarded symmetry of the larger parts of buildings where there was not good reason to neglect it, they knew that details should not be too much alike.

Take for example the common Early English 'tooth moulding.' Did anybody ever see a foot run of it from modern hands that gave the slightest pleasure? Why? because it looks as if it could be turned out by the mile from a steam engine. Whereas in old work you see that it had just the same kind of variety as in leaves of the same tree—all alike but none identical, in the sense of the proverb 'nullum simile est idem.' The modern imitations of Early English conventional carving are still worse, for the same reason; and as for imitating Norman work, it is better at once to give up trying, except where it must be done in restorations; which in that case above all others are mere destruction precipitated instead of stopped, so far as architectural effect is concerned, though they are of course sometimes necessary to prevent ruin. The aim of everybody engaged in a building now, from the architect down to the last workman who 'drags' and points up, is to make the work look smart for the opening day. What becomes of it afterwards, either as to use or appearance, or duration, not one of them seems to care a farthing generally, though I admit there are exceptions, who are really anxious to do their work as well as possible when they find an employer who appreciates that more than the ornamental rubbish which captivates committees and a good many private people too.

As for the practical results of the present mode of getting architecture done, though the *Quarterly Review* statements and theories about art workmen and master-builders are grossly exaggerated, and in some respects refuted by experience, I must say I agree with the criticisms in a former article of April 1872, of most of our grandest recent attempts, which it is not worth while to enumerate again.

Architectural Education.—The most eminent of French architects, Viollet le Duc, expresses quite as unfavourable an opinion of the ordinary architectural education in his country as our most severe critics have of ours; and perhaps his description is not entirely inapplicable here. In his 'architectural novelette' called 'How to build a house' (which had better have been confined to the house-building and condensed into half its bulk), he makes his hero Paul a young architect ask his teacher, 'Did you begin to learn architecture in this way?' *i.e.* by acting as the clerk of the works yourself. The teacher, who I suppose is intended for M. Viollet le Duc himself, answers, 'O by no means. I was articled to an architect for two years, who set me to copy drawings of buildings of which I was not told either the age or the country or the use; then to lay on tints. During this time I took lessons in mathematics, geometry, and drawing from models' (which I suspect would not be applicable to most articled clerks here, and therefore I omit a little more of that stage of the history) . . . 'I was obliged therefore (and by want of employment afterwards) to get into an office, *i.e.* to work for so much an hour at an architect's who was in large practice. There I learnt to trace plans, and nothing else, except now and then to make some detail drawings—Heaven knows how, for I had never seen the smallest part of a building executed. Being so fortunate as to have a few hundred pounds left me I resolved to travel and study architecture in actual buildings, and no longer in those shown to me on paper. I set myself to observe, to compare, to see practical men at work, to examine buildings that were crumbling to pieces &c. . . At the end of ten years one of my patrons' (he does not patronise them by calling them his 'clients' as our architects do) 'introduced me to an agency for Government works, where I saw methods employed which scarcely agreed with the observations I had been able to make during my previous studies.' And so at last he got on by making a plan for a commercial company 'for whom another architect had wanted to build in the plains of the Loire edifices recalling the splendours of ancient Rome,' and the company preferred his.

Nevertheless I must confess to some disappointment at the pictures and the plans of 'the House that Paul built.' Possibly French habits may find it convenient to have the drawing room open with folding doors to the billiard room, though we find it unpleasant to have billiards even in the hall on account of the noise. But it requires something more than a difference of habits to make the south-west a proper aspect for the dining room and kitchen, especially when we are building an imaginary house on paper and so are not restricted by external circumstances; nor should we think the principal staircase a good one if it consisted partly of triangular steps called 'winders,' as confined backstairs sometimes must. And I shall remark afterwards on the mistake of that very high pitched roof of Paul's House, which some modern Gothicists ignorantly think essential to that style.

But for all that, the observations and practical instructions in Viollet le Duc's book are mostly very sensible. We know otherwise that he is distinguished for his proficiency in various branches of knowledge, and he avows the old doctrine that 'an architect should know every thing,' while many of ours seem rather to be proud of declaring that they know nothing of many things which any one would expect them to know, and some others would be more honest if they made the same declaration. Considering their usual mode of education, as just now described, their frequent deficiency in practical knowledge of building is hardly their own fault. An architect's clerk must have a passion for acquiring such knowledge in any way he can, if he is to acquire it at all. Indeed I do not know how they are to acquire any practical knowledge of either masonry or carpentry, and still less of the minor trades employed in building, by merely copying specifications and drawings from the precedents in their master's office. I have seen wonderful things doing by builders who knew that they were wrong, but also knew that they would be told to mind their own business if they told the architect so. But the wonder rather is, considering how architects are educated as to practical knowledge, that some of them know as much as they do; except that clever men with a mechanical instinct (which if not natural is never acquired) and some general education pick up such knowledge quickly when they come to see real work. But others never do, and so they make builders dovetail stones end-ways over a portico, and say it is their fault if it falls and kills people, besides multitudes of less fatal blunders. Yet one cannot read the architectural periodicals even casually, without seeing their jealousy of any assumption of equal knowledge of the most practical matters on the part of builders, and the conviction that they themselves are thoroughly acquainted with them *virtute officii*, which can only mean, 'by virtue of having served their time in an office,' and never handling any tool except a pencil and a pen; not even seeing any work done, except by accident, before they set up for themselves and claim to be able to direct and instruct builders, if anybody will adopt their designs in a competition or from any other motive. I remember a very ordinary clerk indeed leaving his master with a letter saying that he was going to set up for himself, and had already 'acquired a connection,' *i.e.* by going out to tea in the town, and I suppose blowing his own trumpet there, for he had never done a bit of work outside the office.

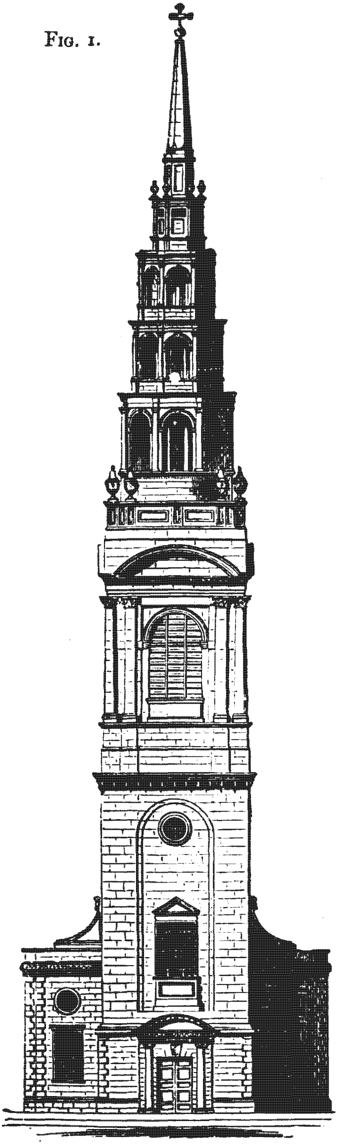
Nevertheless building and architecture will take its course; or rather, architects and builders will. Critics may be right in saying that the modern and increasing severance between working, or even genuine personal superintendence, and designing, tends not to exalt architecture, as its professors pretend it does, but to degrade it more and more into a trade for making money by the help of clerks. But all the criticism in the world will not make one architect refuse a job which he is otherwise disposed to take, and the public must take them as they are, especially that enormous majority of the public who will not take the trouble to understand a little of these subjects for themselves until it is too late. But in spite of all that is said at 'opening' festivities, and other occasions when people meet to glorify each other and 'make things pleasant,' nobody can hear building talked about among friends without seeing that there is a deep and settled conviction that the much talked of 'Hope of Architecture' is little better than despair.

Choice of a Style.—Dismissing then the baseless fabric of a vision of any new style, I also see no use in discussing the abstract beauties or advantages of one of the old styles over another. All the argument in the world will not persuade a man to like what he does not like, or prove what does not admit of proof. When a lecturer on art announces that he 'does not come to tell us his belief or his conjecture, but that he comes to tell us the truth, and asks what we should say if Faraday were to talk of his *belief* that iron has an affinity for oxygen,' and so on, one can only answer that such a lecturer does not know what conjecture and demonstration mean. It is amusing to contrast with that, the language of one of the greatest masters of logic and wit that the world has ever seen, who in lecturing on moral philosophy begged his audience to bear in mind that, 'When I say a thing is so and so, I only mean that I think it is so and so.' Sydney Smith knew, if Mr. Ruskin does not—and too many other people with him—the boundaries between the demonstrable and undemonstrable, or between facts and opinions.

Style for Churches.—In ordinary building then I can only say that people must gratify their own taste, and use whatever style they may prefer, doing the best they can to get the work done really in that style, and not in some modern perversion of it. For Church building however, there has long been such unanimity of opinion that some variety of the Gothic styles is the best, that it is hardly worth while to enforce it. But whenever there is an opportunity of testing any theory by experience, that is infinitely the best way of doing it, and it is certainly a striking fact that though Gothic building was completely out of fashion for two centuries and was pronounced by the then leaders of taste 'barbarous, dark, heavy, melancholy, without any just proportion, use, or beauty'—'mountains of stone not worthy of the name of architecture'—there is not one single church of any architectural celebrity, (though there are other buildings) in the style which then prevailed, except a few which owe their reputation chiefly to their size. And when the younger Wren wrote that nonsense about 'mountains of stone,' and John Evelyn called Gothic churches 'dark, heavy, and melancholy,' they were so grossly ignorant of the subject as not to know that the internal piers, or 'mountains of stone,' which support St. Peter's or St. Paul's Cathedral, occupy nearly twice as much ground as those of Lincoln, which is the nearest to St. Paul's in area; and that St. Paul's is not lighter but much darker than any of our Gothic cathedrals, apart from the effect of painted windows. In fact it is so blocked up with huge piers, both of the dome and the body of the cathedral, that everything outside of them might as well not be in the church for any purpose except passages; whereas in multitudes of Gothic churches the whole area is used. It is remarkable that during the time Gothic architecture was out of fashion even the art of drawing it altogether vanished, and Gothic churches were drawn as if they were Italian, and of course with all kinds of inaccuracy in other respects, as you may see in the prints of the seventeenth and eighteenth centuries. Even after the Gothic fashion had begun to revive many of the pictures are so absurdly inaccurate both in proportions and in details, that it is never safe to trust them.

Nobody has ever succeeded in building a creditable

Fig. 1.



steeple (which old-fashioned word includes both towers and spires) in any form of the style called Classical. Wren's St. Bride's, which is decidedly the best of his spires, is a totally false construction and could not be what it looks, and must contain three or four times the weight of a spire such as Salisbury, which is far more beautiful. The tower below it, and his Westminster and other towers, are little or no better than the 'churchwarden Gothic' of fifty years ago. Domes indeed do belong to that style specially, but domes cannot do the work of towers, nor rise to any great height, except when they are very large; and Ely cathedral shows us that the internal effect of a dome can be got quite as well in the Gothic style. As churches are always expected to have steeples, both for bells and for appearance, that consideration alone is enough to retain the Gothic style for them.

It is also generally the cheapest and the best, in the sense of getting the best appearance and easiest construction, for large halls, schoolrooms, and places of that kind, especially where large windows are required; which are altogether unmanageable in the Italian style. I believe it will be found that, *cæteris paribus*, the Classical style is always more expensive for such purposes; and the construction, especially of the roof, is more necessary to be concealed. Indeed it is self-evident that the Gothic open timbered roof is the most genuine construction for that purpose; just as Gothic windows are the only ones that admit of any great size without iron framework, which is not architecture but engineering, and is not intended to be seen as an architectural feature.

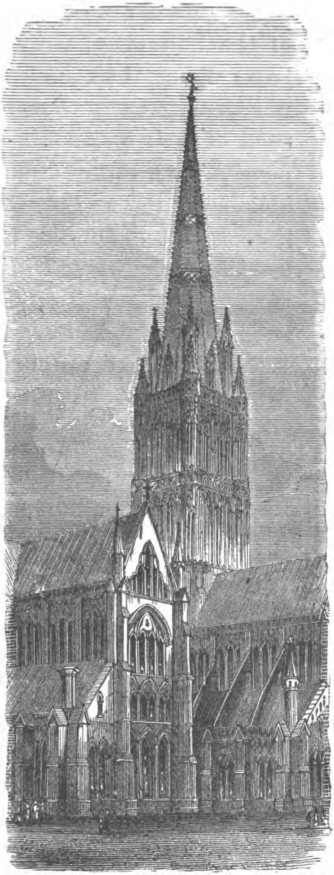


FIG. 2.

But for buildings below these, or not involving these conditions, I cannot see that either style has any constructional advantage over the other. Several independent architects and surveyors with no Gothic prejudices gave evidence before the Parliamentary committee on the Foreign Office plans before spoken of, that there is no necessary difference in either convenience or expense between the

Gothic and Classical styles for buildings of that kind, assuming the same degree of ornamentation in both cases. I am afraid however that I must add that most of the builders of Gothic houses have been for some years doing their best to refute this evidence which was then given in their favour, and to justify the assertions of their opponents that such houses are more expensive both to build and to keep in repair, and more inconvenient than those of any other style, except indeed the Greek temple style of the last century, which is now happily exploded and obsolete, and was simply a mass of absurdity in this climate and for buildings wanting windows in the sides. Subject to that remark, I cannot see that all the arguments or theories and so called principles that have been invented by their various advocates leave it any more than a matter of taste which of the existing old styles is to be used, except for churches and other buildings of that kind.

Styles for Houses.—I suppose however that very few people will deny that the word 'picturesque' is more applicable to Gothic building, when it is done well, in something like the old way; but that is so seldom that this is the last epithet which is generally applicable to modern Gothic houses. As a matter of fact, whether it need be so or not, the most comfortable and substantial looking houses since the real Elizabethan times are generally not Gothic, but probably more in the Dutch or Queen Anne style than any other, or somewhat later. I certainly do not mean that modern version of the so-called Queen Anne style which is just now in fashion with some architects, but something much solider and plainer. Italian ones have the same advantage of being what is popularly called square, and by builders 'self-contained,' or speaking mathematically, parallelopipeds, having no projections or re-entering angles, and therefore containing the maximum of space within a given quantity of outside walls. They also have larger windows free from mullions than you can have in Gothic. But they can be built properly of nothing but stone, and large stones too, and stones of nearly equal size, and worked smooth, or at least 'fair,' all over, and all that is very expensive; while the genuine English styles and the Dutch require only small stones, of almost any sizes, and they are all the better for not being uniform or worked smooth; or they may be built of bricks, provided only they are not white; for I defy all the architects in the world to make a decent looking building out of them in any style of architecture yet invented. There may be in the womb of time, or in the brains of some unborn genius, a style which they will suit, but it has not come out yet. I just mention however that I have observed that very large white bricks of about twice the common size sometimes look tolerably like stones, and they would be more so if several sizes (all large enough) were used together; and this is the more curious because red bricks above the usual size look decidedly worse. But it is a very absurd waste of money to have special bricks made smaller than the usual size, as some architects do. When I speak of houses in the Italian style having these characteristics I do not mean the flimsy looking abominations which they call 'Italian villas,' and which are below the level of what can be called architecture at all; but rather, that which is described as the Florentine style in Mr. Garbett's 'Treatise on Design,' p. 243.

Elizabethan Style—Symmetry.—It is not worth while to consider for any practical purpose a form of the Gothic style of house building which had a short run early in this century, but is properly obsolete, viz. what was called the 'Castellated;' for nothing could be more foolish than to imitate in these days a mode of building which was designed in rude times to fortify houses against violence, not of one or two nocturnal thieves getting in by back windows and picking locks, but of besieging armies. The earliest Gothic or English style which is worth imitating for domestic purposes is the Elizabethan. And with respect to this modern architects have fallen under a most strange delusion, encouraged doubtless by the writings of some fanciful amateurs, which their own experience and observation ought to have taught them to disregard, especially considering how contemptuously they usually write and speak of amateur architects. That delusion is that Elizabethan houses ought not to be symmetrical, or with the parts on each side of some middle line corresponding. We can never do anything now without overdoing it, or running from one extreme to another. Because the architects of the Palladian or Renaissance school had made symmetry a byword for absurdity, building shams or utterly useless parts and long 'wings' to balance each other, making a chapel to correspond with a washhouse and stables to match a servants' hall or a picture gallery, and so on, and because the older Gothic buildings were often unsymmetrical, where symmetry would have been inconvenient or impracticable, therefore up starts a race of generalisers who denounce symmetry as un-Gothic, un-English, contrary to all principles of true art, as a false, base, and altogether un-Christian kind of architecture.

If they had only taken the trouble to look at any book of 'Mansions of England' or any such title, they would have seen that after the days of castellation and of large halls, which must stand alone and unbalanced, great houses always originally aimed at symmetry on at least one face, as churches also did: not symmetry of the smaller details, which may judiciously be varied, as in the western towers of some cathedrals, but general symmetry of outline. I say 'originally' because the absence of symmetry is often due to alterations or additions. Smaller houses were naturally less symmetrical, because they had not rooms enough of equal size to make considerable features on each side of some central part of the building. But the modern notion, that cutting out a lot of rooms in cards and throwing them together anyhow is the way to plan a Gothic house, is at variance with every real style of architecture that ever existed.

Confining ourselves to Gothic, for it is not pretended that any other style preferred lopsidedness to symmetry when there was no reason for it, has not every cathedral a front substantially symmetrical? It is true that a few of the foreign ones have the western towers differing much more than ours—and much worse they look; but still there is a general symmetry between them, except in a very few cases of great difference, and those look worst of all. And why? Because, *cæteris paribus*, symmetry on each side of an axis is pleasing and lopsidedness unpleasing. At the same time the eye does not expect symmetry in both directions. Every building has a front and a back, or by whatever other names you like to distinguish them; and it is not to be expected that they should be alike. In churches the grand entrance is at one end, and the chancel at the other, and you expect some kind of external difference. King's Chapel may be allowed as a single grand exception. In most other public buildings the front is still more distinguished from the back, and external symmetry between them would be felt to be false and at variance with the known internal arrangement. But on each side of the middle of a large front the rooms are not naturally so unlike in either height or size, one way at least, that they may not very conveniently be similar; and so they are generally made in the later Gothic times, after houses began to have a multitude of rooms and of something near the same size, as we have now.

But having so disposed of the main front as substantially symmetrical, it is perfectly legitimate to add a wing, or a tower (if there is any reason or object for one) or any other building on one side only; and the Gothic builders certainly never stuck another on the other side, as the Palladians did, merely for the sake of balancing or symmetry, except the two western towers of cathedrals. The modern fashion of dogmatising about reality, verticality, horizontality, irregularity, and such like qualities, as being the characteristics of one style or another, has done nothing but mischief. As Paley said, 'nothing is easier to invent than a maxim,' and in nine cases out of ten they are invented *ex post facto* to support some foregone conclusion, or are hastily generalised from some two or three instances which the inventor has met with. The old builders would listen with amazement if they heard such rules imputed to them. Considering that we profess to recognise no philosophy but that of induction from the largest experience we can get, it is wonderful how readily mankind accept anything that sounds plausible as an universal maxim or axiom, if it is confidently stated and well repeated until a fashion of repeating it is established; and that in things of far more consequence than architecture.

Fallacy about Orientation.—The first architectural specimen of such maxims that occurs to me is one that has been repeated dozens of times, and will be so again, though every one could refute it very soon by his own observation. Somebody, I daresay, found a church or two pointing not due east, but in the direction of sunrise on the day of the saint after whom the church is named; and he at once jumped to the conclusion that such a charming bit of ecclesiology ought to be universal if it was not. So, without going to look whether the half a dozen churches nearest him conformed to that rule, which he would certainly have found that they do not, he straightway published it as the solution of the problem why so many churches do not stand cardinally; and deduction from general rules is so much less trouble and so much pleasanter to most people than induction from a course of observation, that this piece of nonsense came to be accepted and repeated continually. Any book of churches with the cardinal points indicated will show you in five minutes that there is not the least foundation for it, and that there was never any rule but this, that churches should point to the east unless there was some local reason for deviating not very much, though some of the finest are even beyond N.E. or S.E. St. Peter's at Rome has the chancel actually at the west, which would be a puzzle for sticklers for 'the eastward position' of the minister at the communion. In fact, as Mr. Fergusson says, orientation was never recognised at all in Italy.

Shams, Plaister.—Again, we have the preachers against 'shams,' who profess to have discovered that in all genuine styles of architecture, and especially Gothic, the real materials and constructive forms were never concealed by any others; and they rage against painting deal to look like oak, and go about skinning church interiors of their genuine ancient Gothic plaister, and exposing rough walls, such as you would not leave in the scullery of a cottage, though at other times they will go and daub all this same plaister over with their own vulgar painting, making it a double sham, if plaister is one. And lately, by way of a specimen of consistency, we have had some of this school, headed by a Gothic architect of the straitest sect, wanting to cut off the solid stonework of St. Paul's in order to veneer it with marble. Their excuses for their inconsistencies only make them still more ludicrous. Their most eminent realistic preacher, Mr. Ruskin, was hard put to it to find absolution for his favourite Italian builders having veneered some of their churches with thin marble slabs: not indeed so bad as cutting off solid stonework to stick that on, as it was only veneering bricks instead of plaistering them. And at last he found it in the fact that the fastenings of the marble slabs were not invisible, so that by looking sharp you can see that they are slabs and not solid blocks. At that rate plaister certainly can be no sham, for it is mistakeable for nothing else—unless it is painted into sham stones.

It is satisfactory to find that while some of the inferior but extreme Gothicists go about committing this plaister-skinning iniquity, the most eminent of our architects, whose name will go down in connection with the Gothic restorations of this age fifty times more than theirs, has pronounced strongly against it. I find that he said in a paper read at the Northampton

Architectural Society, quoted in the *Architect* at Christmas 1874:—

'There are some principles common to all kinds of art, which modern architects, in mere caprice or in painful striving after novelty sometimes venture to depart from. Ever since civilisation began it has been the rule to finish the interior of a building with all possible care. Every ancient building, whether of Egyptian, Greek, Roman, or Mediæval times, was carefully faced internally with wrought stone, or plaister, and decorated. . . . We now see churches whose interiors are faced with rough brickwork, relieved perhaps with lines of red and black, and others in which the rudest rubble is pointed with the blackest mortar, ingeniously combining the harshness of barbarism with the disingenuousness of civilisation. It is a duty to protest against making our churches the field for the exhibition of such vagaries. Let those who, satiated with feeble refinement, can find no relief but in still weaker affectation of barbarism, confine their taste to their own drawing rooms, but let our churches be spared. Unfortunately the evil is not confined to new buildings. Numbers of fine old churches have been stripped internally and reduced to a nakedness compared with which Puritan whitewash is decency.'

I know two adjacent ones so scarified by Mr. Street under the name of restoration. If architects think it below their dignity to mind what is said by amateurs, they will hardly venture to say that Sir G. Scott's experience is to be set aside for their theories of what Gothic architecture ought to be. The inconsistency of these destructive and 'vigorous' theorists is made more striking by their additional invention of the phrase 'Conservative Restoration,' of which I shall have more to say in the chapter on church building. At present I only say that the moment a man uses that phrase I suspect him of some deeper scheme of destructiveness or innovation than usual, and I don't know that the plans, or the work, when I came to see them, have ever belied my suspicion.

Sham Stone-painting is another specimen. From the time when some feeling for Gothic architecture and a decent degree of reality began to revive, until lately, the marking out of plaister into apparent stones used to be denounced as the vilest of shams and a distinguishing feature of the style called 'Churchwarden Gothic.' Then it came to be discovered, on the removal of old whitewash, that some of the very early Gothic builders, whose ideas of wall painting were shown by their other works to be ruder than the merest sign-painter would venture to exhibit now, had been unable to think of any better patterns to paint upon their walls than this same sham division into stones. And so straightway our architects threw overboard all their denunciations of it, and began with the usual ardour of perverts to think they cannot give us too much of it. I have challenged the most eminent offenders—and they include the President of the R.I.B.A. himself—to defend it, and never a word more can I get from them than that the old builders did it; which we know just as well as that they did the other daubs just now described, which no architects dare copy now, obviously because they were only just beginning to learn the rudiments of painting and could do no better. It was just the natural thing for a beginner to start with. They thought plaister looked bare, and of course inferior to smooth well-jointed ashlar, and so, like our churchwarden architects of fifty years ago, they said 'let us make it look as like stone as we can,' and painted in the joints accordingly, until later times when they learnt to do something better and left that alone. Our architects have more reasonably tried to imitate that better painting, but unluckily have failed more signally than in anything they have attempted. Why, I do not know; but the fact is certain, and there are cases enough, and will be many more, where people have been as anxious to take the modern painting off their walls as they were to have it put on twenty or thirty years ago.

Before I leave this sham stone-painting I ought to notice an ingenious excuse which some of our architects have invented for it, not feeling quite easy in their minds at having nothing to answer the objection that it is a sham, and contrary to their professed principles. That excuse is nothing less than this: that these parallelogrammic divisions of the shape and size of stones are not to be regarded as an attempt to imitate stones, because the lines are generally red, and occasionally double, which mortar joints would not be, and sometimes they have a kind of twirligig offshoot on each side which would still less exist in real stonework. In other words, the sham is good because it is so bad. But if such excuses are worth answering, do they not see that the lines were coloured simply because white lines on plaister would not have been conspicuous, though white mortar joints are visible enough in stone? Further, it does not follow that imitation of stones was not the primary idea, because they afterwards tried to relieve the monotony of those marks with something else. No man of common sense who sees the original work of this kind in St. Albans for instance could be persuaded by all the members of the R.I.B.A. (if they all agreed, which I am glad to find they don't) that those who did it had any other idea in their heads but that of imitating stones. And I repeat that that is a thoroughly mean and rudimentary idea of decoration, which was abandoned as soon as they learnt to do something better; such as the patterns which began to show themselves through the later whitewash at the east end of Salisbury (over the altar) some years ago, and still better ones on some of the arches at Worcester, and some bits in the later part of St. Albans, very different from the earlier daubs and stone-marks on the square brick Norman piers.

But I have no hesitation in saying that smooth plaister with its natural face, not that horrible brown paper looking stuff, called 'floated' plaister, with a sandy face, which all the architects prescribed until a few learnt better lately, is infinitely preferable to any such painting as we have got yet, or seem at all likely to get. The difference between the two modes of plaistering is that the rough kind is finished with a wooden trowel which 'floats' over it, and the other with a steel one which makes a smooth face. The rebuilt brick piers of the great tower of St. Albans are done very nicely in the latter way: indeed none of the new plaister there is rough; but the transepts are partially defaced by that abominable sham stone-painting, which I am happy to say is stopped from spreading farther, and will some day be effaced with unanimous condemnation, both there and elsewhere. Thus far it may be said with lamentable truth of every architect who has lifted up the painting brush on either stone or plaister, 'Nihil tetigit quod non fœdavit.' I remember when the painting of the restored figures in Salisbury Chapter House was thought by some people a great success. I heard lately that the tide had turned against it, and that they were contemplating getting rid of it, and perhaps they have done so.

The preachers against shams (as they call many things which are not so) have been sorely puzzled with the west fronts of Salisbury and Lincoln, and the east front too of the aisles of Lincoln, which is ndoubtedly the grandest of our cathedrals externally. Other smaller things of the same kind are equally fatal to their theory, and are further proofs of the folly of artistic maxims, which are made to order as they are wanted. If works of art permanently give pleasure they are good, in spite of all the theories in the world, and the art or genius of a good designer lies in being able to design what will do so in the long run, and not as a mere passing fashion like ladies' dress.

Wide Mouldings.—At the same time I am far from saying that reality should be so much neglected as it often is, and by these very preachers against shams as much as anybody; who will give you, and in buildings which they mean to be handsome, doors with shallow mouldings sprawling an inch and a half or more over the panels, and manifestly tacked on, forgetting that they are or ought to be nothing but the slightly decorated edges of the 'rails and styles' into which the panels should be framed. And the panels themselves are merely thin flat boards, often only half an inch thick, instead of thick ones as they used to be with the edges bevelled, or what are called 'raised panels;' which however should be rather thinner than the styles, or they look too heavy.

Cornices.—Again, you never see now, unless you have insisted on it yourself, anything like a real cornice; and I have actually found architects either ignorant or unwilling to acknowledge that cornices originally were and ought to be or appear to be a real projection of deep stones, or bricks (if necessary) in successive set-offs, carrying a ceiling or a roof. The modern cornice, which has come in since these people began raging against what they call shams, is an indiscriminate heap of two sets of mouldings, one of them sprawling some enormous width over the ceiling and the others for some generally less distance down the wall, with a great hollow between for dirt and spiders: indeed large enough for those spiders who catch birds, and for the birds' nests too, quite unreachable by brooms, at the very place where a real cornice would be thickest. These two figures, in which I have drawn

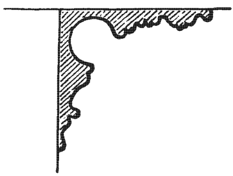


Fig. 3.

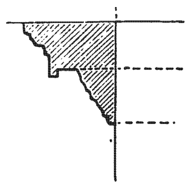


Fig. 4.

the details indistinct in order to confine the attention to the great features, show the characteristic difference between the genuine and false style of cornices. The dotted lines carried into the wall in one of them show what the stones would have been if they were still more genuine cornices of real stone. I have myself had one made of bricks gradually set off and of course plaistered, under a gallery of flags which the architect wanted to carry on iron brackets, which were quite unnecessary. Perhaps they will justify this as they do the painting of the double stonemarks upon plaister, by saying that it is so unlike a real cornice that it is honest, while those of proper shape made of plaister blocked out by framework are a sham because they pretend to be real cornices but are not. If so, I leave them to the enjoyment of their excuse, which is worthy of their work.

I don't know anything that so distinctly marks the decline of architectural taste, and I must add, knowledge of principles of design, as this one matter of cornices. Up to about fifty years ago, they were never absolutely bad and incapable of being what they profess to be, though some of course were handsomer than others. In modern houses it is the rarest thing of all to see one that is not offensive, from being ill-proportioned, sprawling, unmeaning, unsuitable for the work of a cornice, and evidently designed on no principle at all. And no wonder, when architects think they can design an original and handsome thing, of which the section never will be seen, by drawing a section of it on paper, as indeed they do most of their other details; but hardly any others in house building are so large and important as the cornices, or so difficult to judge of without trial in their place, both as to their shape and size.

It is just the same with respect to all other ornamental terminations of edges and corners, which may be classed under the comprehensive name of mouldings. The possible varieties of a small depth of moulding are very few indeed, at least of those that can look well. The common 'ovolo'* (see fig. *c*, p. 95) which you see in nearly every door of the last 150 years until lately, will never be improved on; but our architects think they must try something original, and

* The builders' names for mouldings do not always agree with those in books on architecture, where the builders' 'ogee' is called a *cyma recta*, or *reversa*.

must make something more of it, and so they give us a set of curves in and out running over twice as much width as depth on the door frame; or rather a pretence of it, for ninety-nine out of a hundred of them are only stuck on and not worked in the frame at all. In like manner, pew ends in churches are splayed or bevelled away far beyond 45°, in order to get a wider space for mouldings, which our designers fancy will give a false appearance of thickness, whereas in fact it does the contrary and makes the piece look thinner than if it were left quite square or with a small chamfer or bead.

Many old mouldings and splays, in various styles of architecture, had greater depth than width, even the common door mouldings, but never the contrary, so far as one may safely assert a negative with the possibility of some occasional exception which was not followed because it was perceived to be wrong, or in the expiring efforts of a manifestly decaying style, as in the latest Gothic work, in which false jambs were sometimes made to project beyond the face of the wall with the idea of giving depth greater than the reality. The eye always detects and resents impostures of that kind and takes off more than the proper discount.

Architraves.—Those are different from the Italian, and much older door architraves, which were long flat stones, rather wider than the thickness of the wall, or projecting a little on the face, whereas Gothic jambs were always worked in the stones of the wall. And it is odd that Gothic arches and Italian ones are exactly reversed in that respect; for Gothic arches invariably had an arched extrados, and never the stones stepped into the wall-stones, which Italian arches often have conspicuously, as you may see in many bridges, &c. The common door architrave, or the whole mass of casing round a door in a thick wall, which is now made up of a dozen thin slips of wood nailed to the wall and to each other, is an exact imitation of the stone casing round the doors in the temple of the Sun at Baalbec, probably of the time of Solomon; and there will never be anything so good, except the Gothic ones, which are founded on the opposite principle of cutting ornamental mouldings round a splayed opening in the ordinary wall-stones, sometimes inserting shafts also in the hollows, carrying more decorated arches above.

The Ogee Moulding.—The worst and feeblest looking of all mouldings, except on a very small scale, is that called the ogee, or curve of contrary flexure, or Hogarth's line of beauty, figs. *a*, *b*, which it may be for animal forms, but certainly is not for rigid ones. Mr. Ruskin said long ago, and it is true, that it never occurs even in the boughs of trees; *i.e.* there is always a knot or some irregular projection at the return of the curve. It only came in with the declining Gothic style, and is common enough in the Renaissance, to which it may or may not be appropriate for what I know. But I do know that having had a house full of mouldings chiefly composed of ogees proposed to me in plans, and having soon found the necessity of seeing specimens of all of them, they were all manifestly improved by turning the ogees

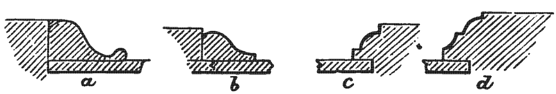


Fig. 5.

a b into two separate curves as at *d*. And it may be as well to mention that I found also that it was better to make the two curves equal, especially in some thick mahogany doors, where the usual single ovolo *c* looked coarse, though it would not do so in deal, taking care also not to let the width of the whole exceed the depth. A specimen of the latter was made for me to look at, which looked very ill and quite unlike the doors of equal thickness in a house of the last century which I had told the men to copy. Then I found that they had taken for granted that the width ought to exceed the depth of the moulding according to the modern fashion, and so the cause of the inferiority was evident.

Some architects are not content with having sham mouldings much wider than their depth nailed on to the panels, instead of moderate ones cut solid on the styles (or thick framing of the door) but they must needs make them project besides above the general face of the door, which is impossible as a genuine construction; for it would imply that all the middle of the styles had been planed off or countersunk to leave these edges sticking out. So that this false pretence of solidity reveals at once that there is no solidity at all, and that these huge mouldings are merely tacked on, besides being very ugly, as impostures and excesses of that kind generally are. I shall have a little more to say of door construction in the fourth chapter, but these matters of principle belong to this.

The Vigorous Style.—Before leaving the question of the styles now in fashion, I must say a word about two more. One is that modification of French or Italian Gothic (for it is sometimes called one and sometimes the other) to which its patrons have dexterously affixed the epithet 'vigorous,' though it would have been just as appropriate to call it 'feeble.' But in fact any such epithet is nonsense, as it expresses nothing really belonging to architecture. I should call it the *Shadowless* style, for that does express its character, and it is as miserable as the man who sold his shadow. The great characteristic of genuine Gothic is the abundance of shadows produced sometimes by quite small cuttings and projections like eyebrows, requiring no such heavy masses and large stones as the Classical projections do This 'vigorous' style displays only the vigour of shaving off all such projections; making the slopes of buttresses without 'nosings' and twice as steep as they ever were in real Gothic, at least in England; window tracery is made as if it were cut out of stone flags; and buildings rise out of the ground without plinths or projecting bases, as if they were mushrooms. It delights especially in that ingenious and refined mode of ornamentation to which some profane undergraduates gave the name of 'streaky bacon style,' and in the raw brick interiors of which I quoted Sir Gilbert Scott's opinion a little while ago; and in woodwork of the most harsh and ugly outlines totally unlike any old examples; and in all sorts of lopsidedness, of which Mr. Street's Law Court tower design is probably the climax. For some reason or other this style is peculiarly affected by gentlemen of the ritualistic persuasion, but whether for any other reason than its novelty, which it has already lost, I do not know.

In London house-building it is already superseded by something which they call the Queen Anne style, though very different from the much quieter style which used to be so called some years ago. That has plain tall windows with slightly arched tops just enough to make them real arches, and sash windows, which in old times had very thick bars, and small panes, not more than a foot wide, but now may have large ones. And that, I am quite satisfied, is the most convenient and pleasant as to light of all modes of house-building.

The new Queen Anne style is a very different thing, being a mere jumble of Italian and Gothic features with most of the disadvantages of both. The name is of very little consequence in either case, but one of the things is good and the other bad. Both the so-called Queen Anne styles have however the merit of requiring no stone except in the window sills, which is an advantage in London and smoky towns, where stone or at any rate carved stone is little more than wasted. The money wasted in carving stone for such places benefits nobody after a few years except the architects and builders who were paid for doing it, for all the carving gets choked up with dirt and becomes invisible for any ornamental purpose. The workmen might far better have been employed in doing something else, as they would have been.

Proportions.—Modern architects, and amateur no less than professional ones, seem to have run wild on the fundamental question of proportions, and chiefly the proportion between the height and length of all buildings, especially in the Gothic styles; though latterly the mania for height has extended to the other styles as well, and nobody will even have an 'Italian villa' now without a tower, which I believe is generally devoted to the combustion of tobacco. Whether that is the destination of that strange-looking tower which Sir Gilbert Scott thought fit to stick at the corner of the Foreign Office which Lord Palmerston made him spoil, I do not know. I disclaim the idea of laying down rules or propounding any theory for determining proportions. Various theories have been invented by ingenious men, only to be forgotten as soon as they are read. It is however a fact, easily verified by observation, that here in England, in the times of all the genuine styles, length was treated as the main characteristic of grand buildings, while in foreign Gothic height was much more cultivated. It is also a fact, which people are constantly finding out too late in modern buildings, that all the other dimensions may be dwarfed, and the whole proportions made to look wrong, by height which is seen to be excessive as soon as it is done, though there is a constant tendency to increase it beforehand. Our town houses have become towers, and our towers chimneys. But no building is ever overpowered by its length. I do not mean that such a thing is impossible, but that they will bear any length which can be given to them within any practicable limits of extension. Even smallish houses, such as moderate parsonages, are generally made to look smaller than they are and insignificant by having no conspicuous dimension except their height, aggravated in the hands of modern Gothicists by roofs of absurdly high pitch, fit only for cathedrals which have wall enough not to be overpowered by the roof.

The modern requirement of higher rooms makes it difficult to build a small house so as to look large enough for its height, even with a roof of reasonable pitch, especially with due regard to economy which becomes more pressing yearly for houses of that class of ordinary parsonages. A few years ago I had to design a vicarage for St. James's, Doncaster, and partly for the above reason and partly for convenience in other respects I added to it what may be called a curate's house, putting the vicar's door in front and the curate's at the end; so that it has the architectural effect of a single house quite long enough for its height, and not of a semi-detached pair. At the same time I must observe that much more is generally wasted in 're-entering' angles, and therefore superfluous external walling, and fancy gables and inequalities in roofs than would serve to make a plain small house of sufficient length to look respectable.

But in large buildings, either public or private, except where every inch of ground has to be considered, there is no excuse for the excessive height which it is the fashion to aim at now; and so far from making buildings look grander it makes them look smaller. I have often found people incredulous that the new parish church of Doncaster is sixteen feet, which is equivalent to a whole bay, longer than the old one, which they say looked not shorter but longer than this. The reason is that the roof, and consequently the tower, are each about twenty-three feet higher than the old ones, which is a much greater proportionate addition than the increase of the length by about a ninth. Consequently every limb of the church is too short. I tried in vain to get it lengthened before a bit of wall was built, but people naturally trusted to the architect and the fact that the length was already increased sixteen feet. The tower has since been much improved by rebuilding the pinnacles four feet lower than before, after they had got loose from bad building, the clerk of the works having got too fat to superintend the work at that height properly. If I had to do it again I would reduce the height of the whole building, besides making the nave of six bays of the same width as the old ones instead of five of the larger size which they are now.

In the next best work of the same architect, Exeter College chapel, the same defect is still more conspicuous; but that was not so much his fault, because there was no room for greater length; but it ought therefore not to have been so high and never would have been in old times. Buildings which are full of other faults are not worth noticing for this in particular, or I might cite them by dozens; so I mention one that is better than usual. The group forming Lincoln's Inn Hall and Library is generally considered one of the best modern ones of its kind. The proportions of the Hall pretty well fixed themselves by precedents: but as soon as he got free from them, the architect, Mr. Hardwick, committed the usual blunder of making the Library much too short for its height and width; and the Middle Temple one is worse. In 1872, as may be seen in Mr. Spilsbury's 'Guide to Lincoln's Inn,' our Library was lengthened on a plan of mine for adding three bays to the original five, with some new rooms below, and the S.W. staircase turret. Though some persons were afraid of it at first it is now universally admitted to be the handsomest room of the kind in London, and not even surpassed by any College Library except Wren's internally beautiful one at Trinity, which however is ugly enough outside, as nearly all his churches are except St. Paul's, though some of them are fine inside, even the ugliest of all, St. James's, Piccadilly.

I have known churches improved acoustically as well as architecturally by being lengthened. When I am told that a church wants enlarging I always enquire first whether it can be lengthened. Length was the special characteristic of our great English churches, which are admitted to look larger for their size than foreign ones, however much some people admire the greater height of those. Old St. Paul's was the longest church in the world, as you may see by the catalogue of large buildings at the end of the book.

It is also of some consequence that increase of height gives no available increase of capacity, unless it is enough to add another story to a house; and therefore it is the most unprofitable redundancy of dimensions. A spare space of floor capacity adds greatly to the internal effect of any large building. Of course they should be high *enough*; but what is high enough in any given case is just one of the things which an eye for proportions will ascertain better without rules than with them. Unfortunately such eyes are very rare indeed; and some people almost seem to think that care about proportions is an obsolete mistake, that the business of an architect is to design in whatever happens to be the fashionable way in any shape he likes, and that all the beauty of architecture depends on sticking on plenty of ornamentation, and spending plenty of money. I have often said from observation that the worst way to get a handsome building is to tell an architect that 'expense is no object'; while if you tell him that it is, and that he must trust to his proportions for effect, you may have a chance of getting good ones, unless of course he is incapable of producing them, and you are also. For that incapacity there is no remedy, though gross mistakes might be avoided oftener than they are by merely attending to the proportions usually followed in old buildings of the same kind.

I say nothing particular about width as well as length, because in the case of single apartments under one roof, such as churches, halls and libraries, the width generally settles itself, as we may say, by various practical considerations: except that wideness together with great height of course aggravates the usual deficiency in length. For that reason York Minster looks too low inside, though none is higher, and none except

Westminster comes near it. On the other hand, too great narrowness prevents your seeing the length, like looking down a gun barrel. The aisles of cathedrals do not look so long as the nave which is generally twice as wide. Here again it is impossible to lay down rules, for some of our cathedral naves are eight or nine times as long as their width, and yet do not look narrow, but then their width is absolutely and manifestly great compared with ordinary churches.

Monotony and variety.—Another common modern fault, of the same family as the two last, is a morbid dread of what is called 'monotony.' That is not quite the same as symmetry, which only involves a middle and some corresponding flanks, nor the same as length, because there may be no successive bits of the whole length alike. The avoidance of 'monotony of sky line' was the ground on which Barry advised the Leeds Corporation to add that frightful tower to their otherwise handsome Town Hall; not that he was responsible for the design. In the same neighbourhood I found them a few years ago adding a complicated arrangement of transepts to a church where there were none before. I asked what that was for, and I was told that it was thought so many windows of an ordinary nave and aisles, which would have been five or six, would look 'monotonous.' I wondered if the architect knew the number of similar bays in most of the cathedral and monastic naves, sometimes twelve and thirteen: and also what he would have said to the great town hall of Ypres, with its tower in the middle and twenty-four two-light windows on each side of it, making a total length of 440 ft. (See Fergusson's Handbook.)

It happened that soon afterwards I had to design a new church, St. Chad's, Headingley, within a mile of that same place; and so, partly for the purpose of illustrating this monotony doctrine, and also because I thought it would look well, I made the clearstory with thirty-four equal lancet windows, viz.: twelve on each side and ten round the five-sided apse. When they were up just high enough to show, I was told that some people asked if I was crazy to build such a church. But I have since seen it almost copied in that respect and others; as another of my churches has been still more literally; and though I do not pretend to think it perfect, or to say that I should always build in that way, it is certainly in some cases particularly effective and pleasing. The repetition of members too numerous for the eye to count at a glance always gives an impression of considerable length, unless they are perceived to be individually small and insignificant; in which case the eye at once resents the imposture and sinks the whole thing into what I called a baby house. For that reason six bays in a nave are much more effective than five, for the eye counts five at a glance, by the middle one and two on each side of it, but does not count six so easily. The finest specimen of this abhorrence of monotony is the third edition of the design of the Law Courts, of December 1871, which in a length equal to York Minster has not fifty feet anywhere of continuously uniform design, except the two corners of the central gable and grand entrance, if that can be called central which is twice as near one end as the other. But I do not defend the monotony of a vast number of similar windows all over a church, as at Salisbury; it is exactly the reverse of the proper arrangement, where the details are all slightly varied, as in Decorated buildings.

Another form of the same disease is putting church towers in odd places, central in no direction; which first makes the church shorter by the whole width of the tower, and secondly makes it appear to stand nowhere, as we may say, from nearly every point of view. Occasionally I know that it was done in old times, but so rarely that it was evidently an exception for some special local reasons, perhaps not discoverable now. So also the modern Gothic practice of breaking up the roofs even of small houses, and *a fortiori* of large ones, into as many bits and gables of unequal heights and widths as possible, though the architects know very well that that increases the expense both of building and of keeping in repair, and so will augment the pleasures of the new Ecclesiastical Dilapidations Act, which the clergy have begun to discover was passed much more for the benefit of architects and 'surveyors' (which are the same thing) than for theirs.

The Dilapidations Act.—The two excuses for it were, first, that clergymen sometimes die insolvent, with their houses in bad repair; which the Act will not prevent: and secondly, that new incumbents did not always spend their dilapidation money in repairs; which could have been easily provided for by an Act of two or three clauses, without a quantity of machinery which means fees to surveyors and officials at every turn, and an obligation on new incumbents to spend whatever the diocesan 'dilapidator' (as they call him) orders, whether they receive anything or not from the predecessor's estate, and may leave all but five years' dilapidations unprovided for, and allows nobody to settle their own affairs with their predecessor or his executors, on the modern principle that nobody can do their own business as well as some kind of 'governing body' can do it for them. According to a statement at the Church Congress in 1875, more money has already been paid by the clergy in fees than would have built some hundreds of parsonages. The Act was got up by a few bishops who did not see the consequences, and a few astute and experienced surveyors who did.

Mass.—I spoke in the first chapter of the insufficiency of mass, which we may call flimsiness, as a general defect of modern building. Where expense has to be considered at every point, on account of the enormously greater proportion of money which goes for beer and laziness than at any former period, one cannot blame people who must have houses for getting them built as they can. But this excuse will not serve for the general scantiness of materials which we constantly see combined with the most extravagant ornamentation. The commonest form of it is building walls too thin. Large mansions, as auctioneers call them, are sometimes built no thicker than a decent cottage should be, of 14 in. walls; and sometimes when a story is wanted to be added, even to a house of moderate height, it has to be of wood, because the walls would not otherwise carry it safely. Such houses too are hot in summer and cold in winter, and very likely to be damp besides. But I shall have more to say on the proper construction of walls in the next chapter.

Oddities.—I just notice one more peculiarity of modern Gothic architecture; and that is the disposition of some architects to invent apparent difficulties to show how cleverly they can get out of them; which always ends in the thing looking like a blunder discovered too late; and indeed they sometimes are, though the architect will not confess it. All these qualities together, abhorrence of symmetry and of uniformity, which they call monotony, striving after height, carelessness or ignorance about proportions, not only of the whole mass, but of the details in relation to the whole and to each other, extravagance of decoration with poverty of materials, insufficient depth of shadows and wilful destruction of them, and the mistaking of mere queerness of construction for originality and genius, are the chief causes of the continually increasing absence from modern architecture of that essential quality called Repose, which is an undefinable and yet as manifest as the quality of being a gentleman. In fact it may be also said that our architecture is continually becoming more vulgar, *i.e.* more pretentious and good for nothing, and more unlike all old architecture in general character, whether it professes to imitate any old style or not. There is a constant increase in 'fussiness' and what Mr. Fergusson somewhere calls 'flutter' about our buildings, and a disposition to overdo everything, as if the architect had never felt sure of his design, but was constantly adding something or other to make a show of variety or originality. I know that employers and amateurs are equally to blame for some of this, and are much too fond of wanting to introduce into their own building every 'nice thing' that they have seen somewhere else. But that is no excuse for architects committing these abominations when they are left to their own devices, as they are nine times out of ten, not merely by the legal effect of their common form of contract, which I remarked on at p. 17, but because very few employers really want to interfere against their architect, whom they are generally too ready to think infallible until they find out their mistake too late.

CHAPTER III.

HOUSE-BUILDING.—MASONRY.

Position—Trees and Ivy—Aspect—General Plans—Hall with Lantern—Basements—Two and Three Stories—Principal Rooms—Specimen of a Plan—Carriage Portico—Stairs—Chimneys—Sizes of Rooms—Windows—Bays or Oriels—Flat Arches—Concrete under Floors—Hollow Walls—Stone and Bricks—Finish—Mortar and Concrete.

I PROPOSE now to offer some suggestions on various practical points in housebuilding (including some that are common to houses and other buildings) which are too often neglected. It would be a waste of time to repeat those which are generally attended and inserted in specifications, and on which I have nothing special to remark. And first, on one which is and has been in all ages astonishingly overlooked, in old times from ignorance of science and the laws of nature, and in modern times from carelessness.

Position of Houses.—It is a common and too true remark that the great majority of large houses are wrongly placed, either in position or in posture (to use a distinction of modern ecclesiastical law) or in both. In many cases it is impossible to guess what caused them to be placed as they are, when a few hundred yards, or a twist of the plan, would have given them a fine view, or a better aspect, or a high and dry site instead of a low and damp one. There is a story that one of the grandest houses in Shropshire was left to the architect to plant as well as to build, who put it, as they often do, to be looked at rather than looked from—looking north along a sunless valley in a large park with plenty of fine sites and large views; and that the owner came to see it once after it had advanced too far to stop it, and was so disgusted that he never came again. Many others are made to look up hill instead of down; or upon woods so near that the house seems fenced in; or with inconvenient approaches when easy ones might have been got; and in short as if nobody had condescended to spend five minutes in seriously considering where people are to spend their lives and a vast sum of money for the purpose.

In old times the monks were under the impression that low places were warm and sheltered; whereas they are in fact the coldest and the hottest and the dampest, and the air in them the most stagnant and unhealthy even when there are no visible signs of damp. Flowers are earlier cut off by frost in valleys than in the hills, and the thermometer often falls much lower. I have just by accident read in 'White's Selborne,' that in December 1784 the thermometer fell to zero there in the valley, and that he sent up the hill expecting to hear that it was lower still, and was surprised to find it 17°, and from 10° to 18° higher generally through the frost. I remember hearing of the same difference between very high hills and a valley in Yorkshire at Christmas 1860, when the thermometer was at zero in the valleys. The closeness and dampness and stagnation of the air in valleys speak for themselves. You often walk down a hill into a mist in summer evenings almost as sensibly as if it were a pond. Rooms upstairs are notoriously drier and warmer at nights than ground-floor rooms, and you can keep the windows open hours later in the evening. Great plains are sometimes healthy, but the bottom of a valley is nearly always the worst place to build in, though it is true that from difference of soil or other circumstances some valleys are healthier than some higher grounds.

Wind.—Another mistake by no means yet exploded is that the north east is the direction in which houses want most protecting from wind. East winds are undoubtedly odious—though valuable for a certain time; but they are the least violent of all, and their qualities not such as are affected by mere screening, at least with reference to the side of a house, though it is different for a garden, which certainly should not slope to the north east. The highest winds and the wettest are the south west, and the south west side of a house is the most liable to damp from the wind blowing the rain against it. Accordingly that is the side on which protection by trees, not too near, is most important. I remember visiting a house so protected, after the greatest storm of wind I ever knew, and being told that they had hardly felt it. Even a low wall with a sloping top is said to throw the wind upwards so much as to protect gardens and other things behind it; and a very open screen will break the force of the wind.

Ivy and Trees.—Some years ago archdeacons used to go about the world charging against ivy, as making churches and parsonages damp. I believe they have since learnt better: at any rate it is now well known that nothing tends so much to keep walls dry as ivy, especially west ones against which the rain beats hardest. I have heard of west rooms which never could be kept dry until they were covered with ivy. It is also cool in summer and warm in winter; for trees, like animals, have a constant vital heat of their own, which is put in some scientific books at 55°, and everybody knows that they are sometimes killed by extreme cold like animals. But you must take care that ivy does not get into holes or cracks in your walls or it will split them to pieces in time.

It is remarkable that trees near a house produce just the contrary effect to ivy on it, and equally remarkable how stupid the owners of houses are upon this point, especially when they do not live there; refusing to let trees be cut which only injure the house and its inhabitants by keeping it continually damp, sometimes dripping on the roof, and always keeping off the sun and air, besides exhaling damp in all damp weather. I see this also was noticed so long ago as in 'White's Selborne,' and the proper explanation of it given, *viz.* that trees condense or turn into water the moisture of the air which is otherwise insensible. He also says that they 'perspire largely' (which is not quite so clear) and check evaporation, which is certain, so that the ground under woods is nearly always moist: 'no wonder therefore that they contribute so much to pools and streams;' and he might have added, that small streams and even rivers are gradually drying up all over this country and many others from the continual destruction of trees.

But even this very mild piece of natural science is beyond the comprehension of no small number of owners of country houses to which the trees have become an absolute and dangerous nuisance, however ornamental they may be from a distance, if houses were made to look at, not to live in. Non-resident owners seem to have a kind of idiotic notion that it is making too great a concession to their tenants to let them give light and air and dryness to the house by cutting down a tree. People of that kind are beyond argument, if they cannot see for themselves that they are injuring their own property under the fancy that they are preserving it, or keeping it picturesque, or secluded, or something or other which is of no value to them, who don't live there, and a nuisance to those who do. I remember a vicarage being built pleasantly near to a fine tree, as it was thought; and then the owner found his study and the bedroom over it incurably damp and cold. I told him that he always would until he cut down the tree which ought to have been kept farther off; at last he gave in and cut it down, and then his rooms became comfortable. I staid several summers in another house where the library, which ought to be the warmest from its position, always wants a fire three or four weeks earlier than the corresponding east room, and papers in the library become damp and soft after a very little rain, from the very same cause of having been built too near some large trees on the south west. It is difficult to give any rule for distance, because it depends on the size of the trees, but no man can have any difficulty in finding out whether the house he lives in is affected by their proximity or not. In planting a house near trees, or trees near a house, too many people forget that the trees will grow, unless they are already dying, and that a large tree casts a very long shadow, and that a number of them shed a damp influence still farther. The owners of country houses with lodges generally condemn their lodgekeepers to live in houses steeped in damp and often cut off from the sun by large trees overhanging them.

Fogs.—Another curious common delusion on the part of the dwellers in houses in low and obviously damp situations is, that by some peculiar idiosyncracy of the air or providential interference, the fog never reaches them, but always stops at some convenient boundary which they point out to you. But if they will go and stand just beyond that boundary in a fog, they will discover the equally curious fact that their house is then just within the fog: the explanation of which is that you can see a certain distance through an ordinary damp fog much as if there were none, but no farther.

Aspect.—It is perfectly well known that an aspect mainly south is the best for the principal rooms, and indeed for all rooms which are to be constantly inhabited. It is not the south aspect but the west that is the hottest at the only time of year when heat is ever disagreeable in this country. Hot weather does not last the greatest part of the year in England, as the builders of houses at watering places and many others seem to think, with their cold-admitting French windows down to the ground and over-windowing everywhere. When the sun is highest, as it is in the south and in summer, it does not reach nearly so far into a room as it does when lower in the west, or in winter; and of course in the east too; only the afternoon sun is much hotter and the heat more oppressive than in the morning. And therefore living rooms may look somewhat east of south. S.S.E. is quite enough; or you may say, where the south end of a compass needle points, by reason of the 'variation' which is now about 19° east of south and decreases $8'$ a year at present in England. If the best rooms look further east than that the bedrooms over them will have the sun blazing into them in the morning in a rather unpleasant way. For that reason a directly south aspect is the best for bedrooms. A north one gets no sun at all, except a little very late and early in summer. East is too hot in the morning and west in the evening, besides being cheerless in the morning. People are too apt when they go to choose a site to think of nothing but prospect, and of course a good one is important; but in the long run aspect is of more consequence both to health and comfort, and we may add, economy of coals. The fireplace in south bedrooms should be so placed that the bed may be at the east side of the room to escape the morning sun. I have twice built north attics looking inwards into the well between roofs, instead of in the natural way outwards, in order to give them a south aspect, which is of more consequence than the view from bedroom windows, at any rate for attics.

It is singular how few houses in London have an open south aspect, especially so as to see the sun in winter. First of all, the great majority of the *residential* streets run north and south, and therefore the windows look east and west; and even if a street runs east and west, the lower rooms of the houses on the north side of it never see the sun in winter by reason of the houses opposite. In fact, few houses except on the north sides of Squares and Parks, have a genuine south aspect. In considering when the sun will enter and leave any room you must take into the account, what is often forgotten, the thickness of the walls and the width of the windows. Suppose, for simplicity, that the thickness at the shutters = half the distance from the outside of one window jamb to the inside of the other; that is equivalent to no less than 30° of the sun's azimuth or horizontal distance from the meridian. The sun will not enter such a window facing south till 9½ A.M. at midsummer in this latitude, and leaves it at 2½ P.M. At the equinoxes the sun will enter at 8.24 and leave at 3·36. For he not only goes farther north, but is much farther north at any given time of morning or evening in summer than in winter, and is only due E. and W. at 6 at the equinoxes. At midsummer here he is east at 7.20 A.M., and in the latitude of Rome at 8.* At 8 in London at the equinoxes he is not 30° but only 24° 20′ S. of E. For the same reason, of the thickness of the walls, the sun leaves an east room long before noon, especially in the winter half of the year, *viz.* as early as 10.20 at the equinox if the window has the above proportions, and a little before 10 at Christmas: so that east and west windows really admit very little sun in winter, and none of the best, losing 4 hours of the midday sun. So we may say that a south window in a wall of good thickness admits twice as many hours of sun as an east or a west one at the equinoxes, and three times as much in winter, when it admits all the sun there is from sunrise to sunset. That proportion of the depth of the wall and shutter-cases being = half the width of the window is rather above the average in modern houses, but that makes no great difference in these results.

Then as to the aspect for particular rooms, assuming the main front to be S.S.E., that is also decidedly the best aspect for the dining room, and west is the worst. Even N.E. will do for it if the house must stand diagonally to the cardinal points. East is by no means a bad aspect for the dining room, as you come down to a sunny room to breakfast, and it wants no sun after that, unless the dining room is used also for a sitting room, at least in the morning. And it is convenient to have one east room to take refuge in in very hot weather: it is better than a

* See *Astronomy without Mathematics*, S.P.C.K., p. 136, 5th ed.

north one, for that gets N.W. sun in the afternoon. A library is no worse for having one west window, either in a bow or in one side, provided it has also a south one. Smaller rooms, if there are any, can hardly be allowed to affect the plan of the house, and may have any aspect, though they also can have none better than S.S.E., especially if they are to be used as constant sitting rooms, as a study or a lady's morning room. Some architects appear not to have discovered yet that west is a totally unfit aspect for a kitchen. Cooks sometimes cannot, or what is the same thing, will not stay in them, and I cannot say I am surprised at it. The kitchen should certainly be N. or E., or at any rate something on the north side of N.W. and S.E.

General Plans.—It would be idle to suggest any particular kind of plan as the best for houses of any given size, considering the variety of circumstances which affect them. A good many will be found in Professor Kerr's book, from the largest mansions down to moderate parsonages. I shall only make a few remarks on certain kinds of plans. Many old houses, and some new ones, are built in the form of an E, with or without the small projection in the middle, which is generally a porch where it exists, and is in itself harmless and often picturesque in old Elizabethan and Jacobean houses. Sometimes it is carried up into a tower, which also used to be picturesque, but now-a-days is very seldom so.

Advanced wings however are by no means harmless, but have nearly every possible fault. First, those parts of the house are at a most inconvenient distance from each other if they both contain rooms generally or indeed ever used, for they can only communicate through the middle and best part of the house. A friend of mine, whose architect thought fit to alter an old house for him by adding such wings, cannot get a cup of tea into, or a pail of slops out of the rooms in one of his new wings from or to the offices in the other without carrying it through the principal hall and also (downstairs) through the billiard room. So far as that goes it is the same whether the wings are advanced at right angles or extended in a line with the main house; but advanced ones have these further disadvantages, that they enclose a sunless and therefore damp space or court if the opening is anyway but mainly south; and they add nothing to the apparent size and grandeur of the house, compared with the effect of an equally extended front, while they have none of the advantage of compactness which you may get from a house with rooms all round a hall lighted by a lantern at the top.

Hall with Lantern.—It is true that such a lantern requires consideration and care in construction, to prevent it being cold and hot, and noisy under rain, and to keep it watertight, and it appears to waste some space in the upper floor, which a hall of one story does not. But all those difficulties can be met. There must be some opening windows for ventilation, and they should be in the upright sides of the lantern, which however are better if not quite upright, but rather leaning inwards. When that is done the lantern ventilates the whole house better than anything, and a fire in the hall warms the whole house as much as is desirable. Those windows should turn on pivots near the top, and the simplest mode of working them is the best, *viz.* by a short lever and a string. They will shut and keep close by their own weight, not being quite vertical. The top of the lantern should be of thick rough glass from $\frac{1}{4}''$ to $\frac{3}{8}''$ thick * as it does not let the sun blaze in like smooth glass and does not sound so much under rain as thin glass, and is warmer and cooler. If the sides are high the top may be leaded, but if they are not high a lead top makes the lantern too dark for the hall to be pleasant, and in any case the light is best from the top. If there are no side windows of glass, the hall will be darkened in every snow, as it will lie on the top of the lantern till it is thawed off.

But if lanterns are not carefully constructed they are liable to droop and then the rain settles in them and they fall into decay. The best way of carrying a long lantern over a hall is to put several beams boldly across, like the tiebeams of an open church roof of the tiebeam construction, which also has the advantage of holding the walls together instead of trying to push them out. House walls are seldom thick enough to carry a lantern on large brackets or hammer beams like church roofs. The only other strong construction is to carry long beams right through from the ceiling of the rooms on each side of the hall, strong enough to carry the lantern. But the other is the stronger way. Attempts

* It is usual in plans and specifications to denote feet by ′ and inches by ″ for shortness, as there is no danger of their being confounded with minutes and seconds of a degree, and I shall often follow that course, though not always. They have another much less reasonable habit which is calculated to puzzle anyone reading a specification: thus, if you read—'Provide no. 3 grates for attics,' or 'no. 6 pegs in a closet,' these are not a peculiar kind of grates and pegs, so known to the trade, but it merely means 3 grates and 6 pegs. In like manner 'commercial gents' will not write a number in a letter without giving it you both in words and figures, and sometimes thus—'twenty-nine, say 29,' as if you could say anything else.

to do it by mere framing always end in drooping and failure, unless the lantern comes very close to the walls, as if it were an independent roof; and even then it requires some contrivance to carry the pressure vertically down to the walls without objectionable leverage, which is sure to tell in time.

Then as to wasting room in the upper floor, it must be remembered that the only wasted space is the area of the 'well' contained within the stairs and gallery, since there must be passages of some kind to the rooms, and the gallery may save a second wall to form that passage: so that unless the hall is very large, it does not follow that this is a wasteful plan as to either space or cost of building in a moderately large house, and it is certainly a very convenient one if the rooms are judiciously arranged round the hall, as it gives people the smallest possible distances to travel, like an army moving upon inside lines, as they call it.

There is however one apparent difficulty in it, and indeed in any plan for putting the large rooms which require to be high in the same block with small rooms and offices, to which such height is of no use, *viz.*: that you must either waste that height or else have a generally awkward change of level in what is absurdly called the first floor, being really the second: *i.e.* it is awkward unless it can be managed in the way I shall describe presently. That led to the common plan in large houses of the last century of putting all the superior rooms, both day and bed rooms, in one block of two high stories, and all the inferior rooms in another block of either two or three lower stories; so that you have what looks like two houses of differend kinds stuck together, the inferior one being generally set back or otherwise concealed as much as possible, but often very imperfectly, being sometimes as large and as high as the principal block.

Basements.—Another common plan for the great houses in the Italian style of the last century was to put the offices in a low ground-floor story called the basement, with a gigantic external flight of steps to the front door and the hall and all the living rooms; and the inferior bedrooms in a fourth story or attic. This was perhaps the strongest case of sacrificing convenience to what was called architectural taste that we have ever had. The grand external staircase, often 30′ wide, provided for getting people well rained on between the house and their carriages, and so led to their using some obscure door and stairs in the basement for real business if they could, and leaving the other for show. It was also far more inconvenient inside than having the offices on the level of the living rooms, and gradually involved the addition of a kitchen outside in order to get sufficient height for it and to keep the smell of cooking out of the house. That plan is now completely abandoned for country houses, where they have not the excuse of being confined to the smallest number of square feet that land speculators and builders will allow. The basement plan had however the advantage of lifting the living rooms out of the damp and into a better view. We now run into the opposite extreme of making our drawing room floors a continuation of the garden, and therefore just as damp as the old basements not actually sunk; and in one respect worse, for they had never windows down to the ground, which most architects give you now, and most ladies desire, with their usual contempt for the laws of nature.

Two and Three Stories.—If you want to have some of the servants' rooms in the main house, without unnecessary height, and high reception rooms, the best way is to make the back of the house of three stories and the front of two. I have done that both in a parsonage of ordinary size and in a much larger house, and yet both of them are symmetrical in front, though of course the front and back are different, and the ends unsymmetrical enough to please the most vigorous and rigorous Gothicist. If the ground suggests it, the 'ground-floor back' may be a few steps lower than the front; and in that case the front and back rooms may be on the level of the alternate landings of the stairs; which has the advantage—but also some disadvantage in a small house—of bringing all the rooms near together.

In a house with reception rooms 14 or 15 feet high, the stairs are best divided into three flights, and the approach to all the back 'first floor' rooms may be at the second landing, 3 or 4 feet, *i.e.* 6 or 8 steps, below the front bedrooms. I have done this so that there are no odd steps off the regular stairs through the whole of a house 152 feet long inside. Odd steps in passages, or anywhere where they are not expected, are both inconvenient and dangerous. If a slight change of level cannot be avoided it is far better to make an easy slope, though no architect will ever do it voluntarily; but accidents sometimes teach people to lay down a slope afterwards, when it is sure to be more clumsy and conspicuous. Such a slope as 1 in 20, or the height of a single step run off in 10 feet, is hardly perceptible, and not the least inconvenient. I knew a lady who died of an unexpected step in a house where she was visiting, and the stumbling of Lord Lyndhurst over another in a public building led to the substitution of a slope which looks an ugly makeshift. The step was a mere architect's mistake originally. In some modern houses, without the excuse of successive alterations which caused many of the inequalities in old houses, the architect seems to have aimed at making as many inequalities and surprises as possible in the level of rooms nominally on the same floor, as well as in the general plan and elevation and everything else, of which mode of building I expressed my opinion in the last chapter.

Front Door.—It is now generally agreed that the principal entrance is better not in the principal front of the house, or that front which contains the best rooms, which should be left private, looking into the garden. The entrance may be on any of the other sides according to local circumstances. If the kitchen and dining room are at the east end of the house, which they should be if possible, the entrance cannot well be between them, and therefore can only be either north or west, assuming the garden front to be south. In some cases however the entrance must be at the east and then you cannot have a back door from the dining room. Care should be taken to place the kitchen door so as not to invite the kitchen smells into the dining room or the rest of the house, but rather to send them the other way if possible: not that anything but great distance will keep them out if you will have a close 'range,' or any kind of 'patent kitchener,' whatever theoretical ventilation it may profess to have. You should also remember to allow space enough near the back dining room door for a large shelf or table to put dishes on; *i.e.* there must be more than a passage of the ordinary width; and such a small thing as that—or almost any other—may affect the plan throughout. In grand houses there is generally a place called a 'serving room,' or closet, with hot shelves in it; but I do not mean to speak of houses of that class, which are always left to architects to build as they choose.

Sitting Rooms.—In all classes of society, from duchesses down to cottagers, there is a passion for keeping an uncomfortable 'best parlour,' or by whatever grand name they may call it, for show or use on great occasions only, and another for common occupation, which is called by auctioneers the morning room, or sometimes it is the library. Even where people are sensible enough to enjoy the daily use of their best room, the lady of the house generally wants another for her private use, unless the dining room is used for a sitting room as it usually is in moderate sized houses and sometimes in larger ones. At any rate it may be assumed that some kind of second drawing room will be wanted in any rather large house. It may or may not be made capable of being used as an enlargement of the principal room, as in most London houses. The gentleman of the intended house had better make up his mind whether he means to inhabit the library himself, or leave it for visitors; and provide another room accordingly either for himself or them.

There is also another reason for such a room. The late Mr. Hope Scott said to me when he was very ill, knowing that I was planning a house, 'mind you make yourself a room where you can sleep without going upstairs: you may want it some day.' I have known several 'old men and heavy,' whose life would have been a burden to them if they had had to go upstairs over high sitting rooms, even once a day. Besides all these it is convenient, and prevents litter in other parts of the house, to have a small room near the entrance, for which the polite name is the gun room, the scene of the celebrated untold joke about 'the grouse in the gun-room' in Goldsmith's Play, 'She stoops to conquer.' In more humble establishments they call it the 'children's shoe room,' and mechanical gentlemen make it their shop. I never could understand the object of what is called a 'breakfast room' besides the dining room, except on the principle of a large hole in the door for the cat and a small one for the kitten, which Newton is said to have proposed in one of his fits of absence.

I am only speaking of rooms usually on the ground floor, which determine the plan of the main part of the house; and therefore I omit the modern fancy for a special smoking room, because that is generally and best upstairs. And as architects or their employers nearly always think they must have a tower somewhere now-a-days, though for no other use generally, it may very well be so occupied. I have seen in one new house a hideous large tower containing the billiard room. Of course a clock tower has a use, but architects too often do their best to make them useless, building them without the smallest knowledge of or attention to the requisite conditions, as to the space requisite for the weights and pendulum, and sometimes even for the clock itself, apparently supposing that any little square elevation wide enough to paint a dial on is sufficient for a clock tower. I shall not repeat here what has been over and over again published in another book on that subject; for if building people will not read one they will not the other.

A billiard room need not form part of the ground plan of the main house, especially as it is now generally treated as a smoking room. It will probably often make the house too large, unless an unusual number of upper rooms are wanted. It is often built as an appendage, upstairs, but it should be well cut off from the bedrooms. A billiard table in the hall is a nuisance, on account of the noise. Schoolrooms, which afterwards become 'the young ladies' room,' are generally upstairs, and therefore do not directly affect the plan. Nevertheless the upper arrangements, and even the construction of the roof, ought to be considered together with the ground plan, and amateur designers will sometimes find that their designs must be modified on account of some unforeseen difficulty in the roof; for which it is impossible to lay down any rules *à priori*, beyond this, that no large piece of the bottom or 'wall plate' of the roof must be left without a solid wall to stand on. I shall have more to say about the roofs themselves afterwards. I only add here that where a house has a long passage down the middle the walls of that passage may very well be carried up so as to hang a low-pitched roof upon them, and so save a great deal of trussing and beaming, which is otherwise necessary to prevent the outward thrust. It will be seen afterwards why I confine it to a low pitched roof—at any rate not a very high one. The wing of offices to a large house is often built with a passage down the middle, and this mode of construction is particularly convenient for attics half in the roof, which in that case is generally wanted to be low, so as not to reach the main roof of the house.

I give the following specimen of the plan of a house with all the five living and best bed rooms looking S.S.E., or about magnetic south, with a central hall and lantern, and three stories at the back and two in front under an uniform roof all round, with some of the offices in a lower wing constructed as just now described. I do not propound it as the best plan for all circum-

Fig. 6.

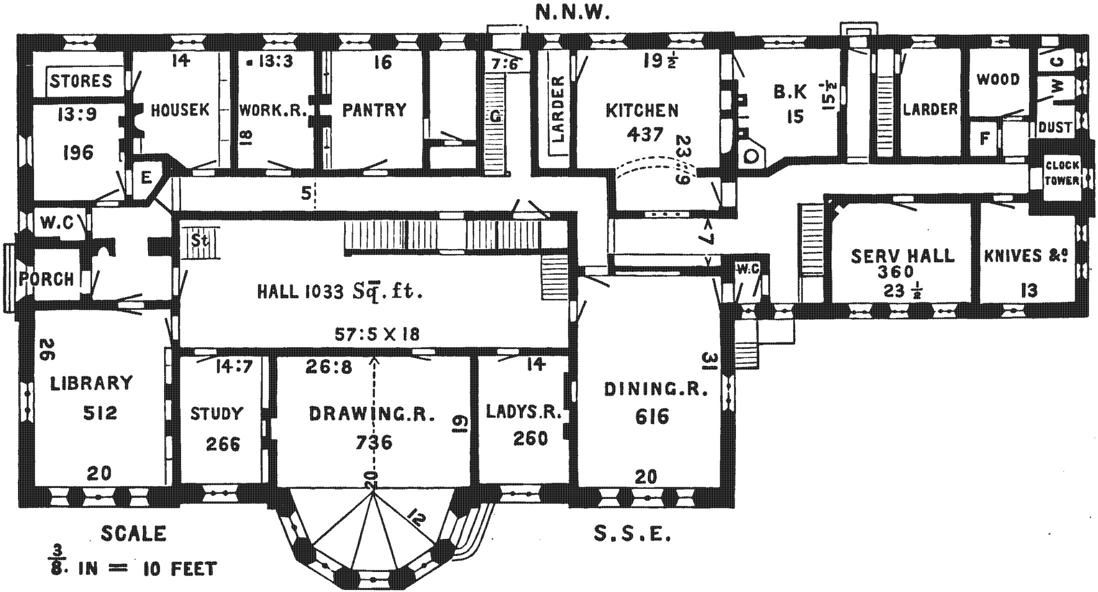
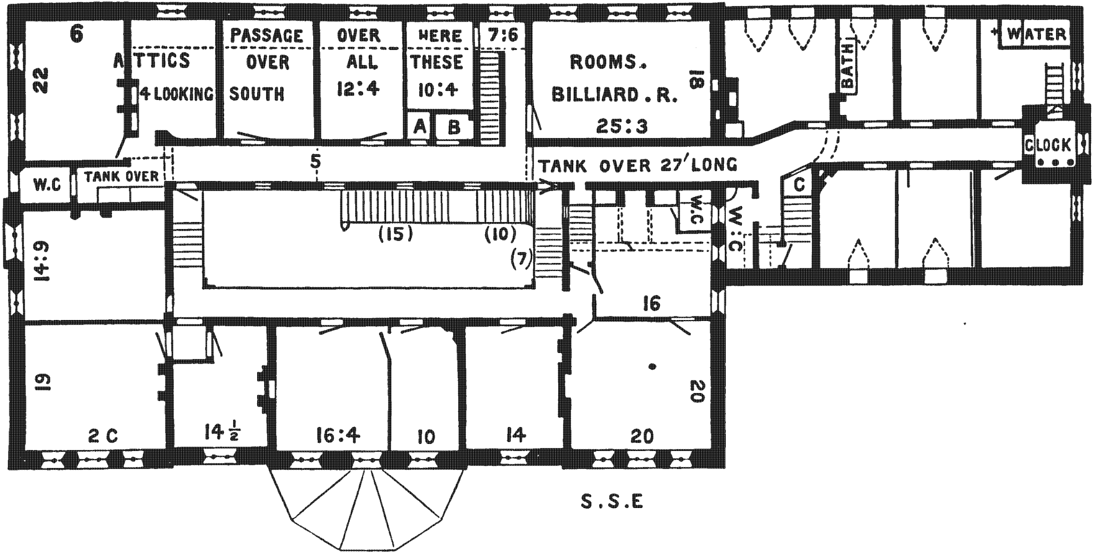

N.N.W.
STORES
14
HOUSEK
13:3
WORK.R.
16
PANTRY
7:6
G
LARDER
19½
KITCHEN
437
23:9
B.K
15
15½
LARDER
WOOD
W.C
DUST
F
CLOCK TOWER
13:9
196
18
E
5
W.C
St
7
PORCH
HALL 1033 Sq. ft.
57:5 X 18
W.C
SERV HALL
360
23½
KNIVES &c
13
26
LIBRARY
512
20
14:7
STUDY
266
26:8
DRAWING.R.
736
19
20
12
14
LADYS.R.
260
31
DINING.R.
616
20
SCALE
3/8. IN = 10 FEET
S.S.E.

Fig. 7.



Bedroom Floor of same House.

stances, or according to some tastes, even for the actual circumstances of that house. But it combines as many conveniences or desiderata as could be combined in a house of that size, and with the entrance necessarily at the west. It was tempting to try to dispense with the wing altogether, but it would have wasted room instead of saving it, besides other evils. The length of the hall and of the whole house might be reduced 15′ by omitting one of the small rooms behind and another in front, all the way up, making five altogether, and of course the general dimensions might be reduced a little also, so as to make the ground covered by the main house about 5000 sq. ft., instead of nearly 7000, in which case it would hardly be called a large one.

Again the plan may be varied by putting bays at the south end of the dining room and library instead of the drawing room (but not to all three) and making that a long room with three windows in front, and then the fire place must be at the long side opposite the windows, unless you wish to spoil the room and make it like a common London drawing room; for a long room with the fire at the end is practically little better than a square room of the same width. And you may have a narrow passage to a garden door in the south front, instead of the one out of the dining room and the door window in the drawing room. All these variations are consistent with the principle of this plan, and some persons may like one and some another.

You may be puzzled with the peculiar shape of kitchen and ask why it did not simply include the larder beside it and not project southward as it does, making that angle in the passage, and the kitchen an odd shape. The object was to get the door looking eastward towards the wing, and not southward, and so to keep kitchen smells out of the house, while the kitchen itself is as near as it can be to the dining room, and also to the servants' hall. When the wind is west kitchen smells will blow away from the house, and the east wind cannot blow them into the house, but up the chimney and ventilator. If you observe the shelf behind the dining room wall opposite the kitchen, you will see how so small a thing as that may affect the whole plan. Also you see the back passage leads to the front door and library, so that servants need only cross the hall to come to the drawing room and the two small adjacent rooms, through the door under the stairs, and the distance from the pantry is only a few yards. The billiard room is over the kitchen and larder, except the projecting piece of kitchen where there is an arch in a 14 inch wall, carrying solid wall above. A cast iron tank $25' \times 6' \times 7'$, therefore holding 6560 gallons, lies over that part of the upper passage, leaving a good headway under, though it is all below the roof spouts. This is possible from there being three stories in that part of the house. There is another similar tank at the west end of the same passage, or rather beyond it, over the western W.C. There is a small hard water cistern in the N.E. small room of the wing, where are the steps into the clockroom.

The clock tower becomes hexagonal above the wing roof, so as to present one face to the dining room and the dressing room over it and to the front garden, and another to the kitchen-garden and stables behind the house. No more dials were wanted. There is a short spire above. The attic windows both in house and wing are dormers. Those of the house look southward over the lantern, the passage having the northern windows, that the rooms may have the sun. The partition of course is wood, as there is no wall under it. The men's bedrooms are in the wing, which has a staircase from the garden door; and you observe a kind of private staircase to the bedroom and dressing room of the master and mistress, so that the servants may go there without coming into the front gallery and stairs. This curtails the dressing room a little, but leaves it quite large enough, 16 × 16′. The W.C. in it has an external window, which is essential, and there is just room for it over the wing roof; and that small matter also required some scheming and a little shifting of the whole wing northward. There is a luggage door close to the back stairs, which is now common and very useful to avoid knocking the best walls with those huge arks of ladies' dresses for a three days visit, and the loading of carriages at the front door. I should mention that both the kitchen and the billiard room are higher than the other back rooms, but not too high to prevent there being a large attic over the billiard room, which may be a children's play room if it is wanted, where unlimited noise may be made.

The drawing room bay of five windows is not carried up because it would make an awkward shape to divide into a bedroom and dressing room. The wall is carried by a tubular iron beam, so as to leave a flat ceiling underneath. The front door is set back to leave a porch, with a tall open doorway, instead of a projecting porch outside. There are cellars, and some small rooms with windows under the wing, which covers 2080 square feet; and as the ground falls in that direction, there is a sliding entrance for casks under the clock tower straight into the middle passage. Those windows look up a bank in the ground, like that of Stone Buildings, Lincoln's Inn, not into a narrow enclosed area as usual. The other windows looking into the garden have the lower panes of fluted glass and the sill too high to see over sitting. The lower windows of the front rooms of the house are all 10′ high and the sills 3′ above the floor, except that the eastern one of the drawing room bay has a dwarf door under it, with a few steps into the garden.

Carriage Porches.—Not only are the grand external flights of steps of the last century, with a basement floor of low rooms, abandoned, but instead of having to mount in the wet, we have sometimes now porticoes and porches for carriages to drive under. They are called porticoes in the Italian style and porches in Gothic ; at least that is the only difference that I know. The once fashionable form of a portico as high as the house, in imitation of a Greek temple, has at last been perceived to be the worst possible form of it, as it is too high to prevent rain from blowing in and the platform is in a constant slop in rain ; and it darkens the room over the hall. Accordingly lower ones of the height of one story are now generally used, and are convenient enough when the approach is straight and easy. But they too are apt to darken the hall unless it has windows beyond the portico. Of all abominations in window-planning, hall windows down to the ground are the worst I have seen, both in appearance outside and for lighting and general effect inside. These porticoes require some care in construction, if they are in the Classical style, with a pretence of single stones forming lintels long enough for carriages to drive under, which must be at least 8 ft. clear. No such stones are to be got, and therefore they must really depend on iron beams inserted somehow to carry them.

I did indeed know one case where a London architect thought he had overcome that difficulty by dovetailing the stones endways. I happened to visit the place just before this portico was finished, and when I learnt how it was done I said, 'then there will be a pretty smash there some day.' The very day the props were removed the whole thing fell and killed one of the men I had been talking to. I see by the newspaper report of it, which I kept, that that conversation was mentioned at the inquest (which I should have gone to if I had known in time), but nevertheless an intelligent coroner and jury found a verdict of 'accidental death.' The architect, by way of putting a good face on the matter, called on the contractor to rebuild it; but luckily he had before protested against it to the employer, who had the sense to stop the repetition of it. I have seen smaller porticoes in London houses built of bricks, without either a bar of iron or any kind of support except from the cement, which may either stand or crack as it may happen. Large external cornices built in the same way may almost be said to be chronically falling. Gothic porches built with arches and real vaulting are of course safe against this calamity, provided they are sufficiently buttressed at the corners, and do not look disposed to burst for want of it, like the Albert memorial in Hyde Park. But in these days of iron and glass surely the best way is to make a projecting glass roof wide enough to cover a carriage at the front door (allowing for a step outside) which will neither darken the hall nor have pillars to drive against. Such things are certainly difficult to make handsome, but I suppose architects will not avow themselves incapable of doing so.

Stairs.—Passing from external to internal stairs, it is wonderful how often one hears the old joke realized as a fact, that the architect has forgotten the staircase. I have myself known it forgotten in a church tower, and what made it more curious was that it was a case of restoration. The plans showed an old staircase removed, and no new one; and I have heard of several other cases both by amateur and professional architects, and so there must be many more, as I cannot know them all. I do not mean houses actually finished without them, but the stairs forgotten till so late that they had to be added in any makeshift way that remained possible. Some people have a notion that two successive flights of steps should not be put against the same wall in a long hall, and I was told they would not look well. The notion is absurd, and such a staircase may be and is now admitted to be very handsome. The first flight should always be the longest, and looks better closed in under the steps; and the second also if they are on the same wall. This makes convenient places for closets, which may open either in front or on the other side of the wall, and also a good place for a door under the landing to a back passage, as the door will be a good deal screened. I need hardly say that a large staircase should turn its face and not its back to the entrance, unless there is some strong reason for turning it the other way.

Winding stairs, even of the grandest sweep, and all the more so if they have a narrow 'well,' are both uncomfortable and dangerous, though sometimes inevitable. And they are generally made worse by having no rail on the outside, where the steps are widest and easiest. The consequence is that people taking hold of the rail are driven to the narrow end of the steps, which is practically much steeper than the other end, or than the middle; and so those grand looking stairs are no easier than a common back staircase with the narrowest possible tread. I was struck with that in one of the largest Carlton Gardens houses, and it is conspicuous in the much lauded 'geometrical staircase' of St. Paul's; which is merely an enlargement of the common old cork-screw staircase with the solid newel omitted. I have known a great architect actually begin to change a large external staircase 9 feet wide, which had been designed with straight flights and a square landing, into a winding one. The mistake was luckily perceived in time and stopped. The practical effect on the steepness, especially with such great width, and therefore great difference between the ends of the steps, had never occurred to him. Besides all that, it looked much worse, as we could judge from the temporary wooden steps that had been made. In all widish staircases it is better to put a rail on both sides, so that there may be one ready for either hand, or for people passing, and also to keep their hands off the wall. The Gothic builders usually cut a handrail in the wall round any corkscrew staircase of considerable size. I put one in the new library staircase at Lincoln's Inn.

About the most ingenious thing in handrails that was ever done has left traces of itself behind in some small bits of stone which you may see inserted at a hand-rail level down the side walls at the Duke of York's column. About 30 years ago some prudent or infirm person persuaded a First Commissioner of Works to give the public the benefit of a rail there, which is certainly much wanted. So he set some architect to work, who erected a huge cast iron rail thicker than an ordinary wooden one, and carried it out a good way from the wall to make it look more imposing. Of course it was forthwith appropriated by the boys of London for sliding down, and was so continually occupied by them that it became a nuisance instead of a help to the infirm or cautious people who wanted a banister, and then it was removed, the intellect of H. M. Board of Works being unequal to the problem of making a rail too small and too close to the wall for sliding down, which would also have been easier to handle.

It is well known, but often neglected because it requires a little more stone, that a flight of stone steps standing out from a wall ought to be stepped or notched into each other, and not merely the lower edge of one laid on the top of the other. In the former way they make a kind of arch, having a horizontal thrust as well as vertical support; in the latter case they have none, and depend entirely on the strength of each step at its junction with the wall, and if one cracks they are all sure to go, as in the famous accident which ruined the old Polytechnic Company, the steps of a staircase having been improperly weakened by cutting out pieces at the top to insert new treads.

The easiest slope of a staircase for the average of human legs is a rise of 6″ with a tread of 12, measured (remember) on the square, or exclusive of the 'nosing' or projection of the top of the tread. For back stairs 7″ by 9″ does very well, or even 7 by 8. They are often steeper, but such steps are felt to be very steep; 7″ is the highest *riser* that is not too steep for people of average height, whatever the tread may be: anything under 6″ is disagreeably low to most people, and is felt to multiply steps unnecessarily; 7 × 7 is better than 6 × 6 where you must have a very steep slope, for want of length.

Banisters are generally too low to be either safe or comfortable; except for very short persons, and of course higher ones are not dangerous nor even inconvenient for them. Accidents are not uncommon from people falling over banisters; but architects go on all the same with their stereotyped height of about 3 ft. from the middle or even the back of the step, whereas it should be 3 ft. 3 in. from the nosing or front of the step to the top of the rail vertically. Another absurdity is making the handrail in grand staircases so large and of such a shape that no hand can grasp it. If you want a large rail for appearance it should be of this kind of section, with a 'roll' or cylinder at the top not more than 2 in. thick, and any ornamental shape you like below. The Gothic builders knew that and made their handrails so; but the Renaissance people, who thought more of show than use, introduced those wide-topped monstrosities which seem made for boys to slide down rather than for anybody to handle. I had a marble roll of this kind put on the top of a thick stone balustrade to the Doncaster pulpit, which looks very well.

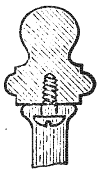


Fig. 8.

Again one sometimes sees in new houses the banisters covered on the inside with muslin. The first time I saw it I asked what that was for. 'Because the spikes catch the ladies' dresses.' For with their usual regard for convenience and duration our architects have taken to make all sorts of spiky wrought iron ornaments sprout from the banisters, costing three times as much money as plain cast iron ones and doing all this mischief. I saw some, too late to stop them, actually introduced into the new staircases at Lincoln's Inn, to tear the lawyers' gowns, and afford amusement to briefless young clerks in kicking them to pieces. All this comes from that foolish aiming at an appearance of originality which does more harm than the undisguised copying of stereotyped forms up to thirty years ago, and from the modern architect's idea that nothing should be left plain which he can find an excuse for making complicated in design. The iron rails of stone staircases in large houses used to be as plain as possible, without even any bases appearing to rest upon the steps, which strengthen the balustrade very much, or any kind of capitals at the top. This was an extreme the other way; but if you look at any book of iron patterns now you will see that they run into mere extravagance without any rational idea of combining ornament and strength. The favourite pattern seems to be that which may be called the foliated tuning fork, of which there are many varieties. Wooden banisters are easier to make handsome than iron ones, but they are only suitable for wooden stairs, though I have seen them let into iron sockets in stone steps; but there is an unnatural look about them. It is a mistake to make iron banisters, or even their bases, to imitate wood patterns. They look best tapering very slightly, and with a short base spreading out widely, with such ornamental mouldings as any man of taste may devise, and the possible ones are very few.

Chimneys in rooms with more than one external wall may either be in one of those walls (assuming another to be occupied by windows) or between that and an adjacent room; and both plans have such advantages that the question is not to be dismissed in either of the two usual summary ways—Gothic people saying that chimneys are always more picturesque and 'Gothic' on the outside, and others saying with equal truth that they make the house warmer in the inside, and generally also suit the roof better. There is another point which is often overlooked—or rather two, in favour of the outside, which I do not say are conclusive, but material. In our modern inside walls, which are never more than 18″ thick, and seldom more than 13½ (called 14), and generally 9, the chimney involves a chimney-breast, projecting more or less according to the thickness of the wall; and that both practically narrows the room and makes it less handsome than the flush or flat walls of all good rooms in large houses of the best period of building after the great open hearths of the middle ages. A chimney in the outer wall has its projection (if any) in the garden, and so avoids both of those defects. When it is so however, you must take care to have at least 9″ of outside brickwork behind the flue, or the heat will be spent in warming the garden at the expense of the room. The large chimneys of mediæval houses were generally in the outside walls whenever they could be. At the same time it is desirable to avoid multiplying chimney stacks, and you should consider the probable arrangement of the room and furniture; indeed that should always be done, or you will run the risk of having no comfortable places either to sit or sleep in, and may find your wife's piano occupying the middle of the drawing-room because there is no side where it can stand. In libraries the recesses by the side of the chimney-breast are convenient for book-cases, which practically make a flush chimney-breast; and in bed rooms, for closets and other furniture.

Therefore this question has to be settled on the balance of advantages in each case by itself. Where a large and handsome room, except perhaps a library, has an inferior one next to it, the common chimney-breast should certainly be in the inferior room, or in the hall, if there is one on that side. The least depth required for a chimney is 2½ bricks, or what is called 22″, *i.e.*

9″ for the chimney, 9″ for the back and 4½″ for the front; and that small thickness of front (as a very experienced builder, Mr. Longmire, reminds me) has caused many fires. One often reads how a fire was first seen at the skirting board. The wooden plugs to which it is nailed have been driven into the fronts of chimney flues and have been gradually turned into charcoal and at last ignited, just as beams do which have been carelessly let into chimneys. I have felt the back of a 4½″ chimney in the next room very hot, and seen ivy on the wall burnt brown when the grate back had been a good deal burnt away. You should take care that no plugs are driven into flues. Unless your builder is a very good one this has to depend on the clerk of the works, for no architect can look after it himself. I shall speak of grates afterwards.

I do not profess to have any nostrum for curing *smoky chimneys*, and I need not enlarge on what is well-known, *viz.* the inexpediency of having chimneys overtopped by roofs, or walls. M. Viollet le Duc says that the most certain cure is a bifurcated chimney pot, though it may be very ugly, because the wind is sure not to blow down both pipes at once; which seems probable at any rate, and I have had a chimney so cured. Revolving cowls, he rightly says, are a delusion, and they are also a nuisance from the noise they make. He advocates another thing, which is right in one sense thought doubtful in another, *viz.* bringing in fresh air to the fire through a pipe from the outside. A draught from somewhere is essential to the burning of a fire, and I have heard of doors and windows being so well made that the fire would not burn when they were shut. But you must remember that human beings require fresh air no less than fires, and every person wants nearly 4 cubic feet of it every minute.* And it is more important to give them the first use of it, by letting it come in the old vulgar way through openings under or above the doors and windows, than to seal them up as close as possible and give all the fresh air to the fire from a pipe; or by a pipe rising in the room over people's heads, which I have no doubt is the best plan, though rather ugly. I remember reading of the monkeys in the zoological gardens dying unaccountably till somebody observed that all the ventilation was near the floor, and consequently all the vitiated, warm, and therefore light air remained unpurified above. But fresh cool air admitted above necessarily falls and diffuses itself all over the room. Yet how few people recognise the value of opening their windows at the top, and especially in bedrooms, because it is a little more trouble, unless they have a pulley and a rope on purpose, which they think ugly.

The accidental bad fitting of the old window casements and doors, and of new ones too in cottages and small rooms, saves many more people from being destroyed by their dislike of open windows. The female mind generally seems to have a special enmity to air and light, and considers the preservation of the colours of carpets and curtains of more consequence than health or eyes; and housekeepers and housemaids are taught to think it elegant and fashionable to keep all the blinds drawn half way down the windows or muslin curtains all over them; just as cooks make half their dishes to look at, or according to their notions of what is fashion-

* I take this from an oldish book now, Tredgold on 'Warming and Ventilating.' He also says that about 11 cubic feet of air a minute come in through the chinks round an ordinary window; but that must vary considerably with its fitting.

able or vulgar, the vulgarity being generally what most people like to eat and the attempt to avoid it being the essence of vulgarity.

Fireplaces ought always to be in the long and not the short side of a room, if possible, though in the stereotyped London drawing room they are nearly always at the end, for constructional reasons not easy to avoid. A room is practically larger, *i.e.* more of it is pleasantly usable, with the fire in the side, and it also looks better to have the fire opposite the windows, which manifestly should be in a long side if possible. It is not so easy to determine where the fireplace should be in a room with a large bay in the long side, making the dimensions both ways much the same and the total depth much over 20 feet. Even that certainly looks handsomer with the fire opposite the bay; and if there is another outside wall and a single window in the end, that is the best of all arrangements, provided the room is large and not overwindowed, as too many are now, and yet not pleasantly lighted, because the windows reach the floor instead of the ceiling nearly. But when there is no such end window, the room would be too dark near the fire if it is opposite the bay windows, and it is better in a side adjacent to the bay. Thereby you have a good place for writing and reading near both the fire and the light, and the general arrangement of the room is more comfortable.

Windows near a fire are a mistake, because there is always a cold draught both through the window and from the continually cooled glass, (which is often confounded with a draught through) so that you cannot sit there when you most want to sit near the fire. A fireplace under a window is a mere whimsicality: it looks pretty for a few minutes, but is in every way inconvenient and unpleasant. I will speak of grates afterwards: at present we are only considering the general plan of a house. A door near the fire is inconvenient, as it destroys one comfortable place to sit; but in a long room it is admissible, if it can be a good way from the fire, though on that side of the room. In small rooms a corner fireplace, in one of the corners opposite the window, is by no means inconvenient, especially in a dressing room, and far better than narrowing a small room by a chimney breast. It also has the advantage in an upper room, where there happens to be no other chimney under it, of requiring no 'corbelling out' or 'oversailing' to carry it, which is top-heavy and unsafe on a thin wall. Let no one be persuaded by his architect into having that instead of a chimney in the corner, whatever he may tell you about difficulties in the roof; which are practically nothing in comparison. It is true that roofs must be considered in various arrangements all through the house, and I can give no rule for measuring the reality or non-reality of objections on that ground. But any man with some mechanical knowledge will be able to judge of them for himself if he will take the trouble; and if he will not he may expect much worse evils than that in his house.

Doors, except in very large rooms, should never be in the middle, as they leave too little space on each side of the door for furniture and generally make the room altogether uncomfortable. On the other hand they are sometimes too much in a corner, so that you feel as if you had to squeeze into the room past the door, and the room does not look so well on entering as if the door is a moderate distance from the corner. I have seen a handsome dining room quite spoilt by moving the door from the end into a corner of the long side. But when the fire is in that side it is difficult to avoid it and to retain room to sit between the fire and the door, unless the room is long. Doors should open so as not to show the whole room when they are ajar, though it is sometimes necessary to vary this.

Size of Rooms.—The commonest of all sizes for the principal rooms in moderately large houses, of the class of good rectories for example, is 24′ × 18′, and in somewhat larger houses 27 × 20. And that is certainly a better proportion than 3 to 2, except for a dining room; though it does not follow that 24 × 18 is not better for that than any other proportion which gives the same area of 432 sq. feet, because a dining room narrower than 18′ is inconvenient; and if it is shorter than 24 the loss of length is not compensated by the increased width. Anything beyond 21 feet in width from the fire at the side of a long dining room is useless, and only tends to magnificence. A dining room or drawing room 22 × 33 or more may be called a grand one, if proportionately high, *i.e.* about 15 feet. Greater height than that only makes the room look smaller, and is of no advantage whatever and makes going up stairs harder work.

Libraries are of all sorts of shapes, very large ones being almost necessarily long, and sometimes very narrow. In fact from its nature a large library ought to be a very long room, as great width cannot be usefully occupied, or lighted unless it is a good independent room, like some public libraries, lighted on both sides. They also in old times always had the windows at a considerable height, with the book cases under them; and much the best light that is, when you do not want to look out of the windows. The smaller rooms of a house must in some measure take their chance, as the walls and height are determined by the large ones. Though the word 'large' is almost as indefinite when applied to a house as to a stone, we may say that for a large house short of a very grand one, the drawing room will contain from about 600 to 750 square feet, the dining room 600 to 660, and the library, considered as a study and not a great collection of books, 500 to 560; but as I said, it may be much more. It should be remembered that high book cases against library walls diminish its size very sensibly, even if they are only 6″ deep, which is enough for the upper shelves; and those should always be less than the lower ones, so as to leave a shelf to put a candle or odd books upon, about 3 ft. from the floor. Low book cases holding only 2 or 3 rows of books have not that effect of making the room look smaller, and they form a sort of table on their top, which is very convenient for use, or suitable for carrying what people call ornaments.

A room containing less than 225 feet, or 15′ square, is too small to sit in for any considerable time and not fit for any sitting room or bed room in what would be called a good house. A billiard room is considered to require not less either way than 24 × 18, and a good kitchen for a moderately large house about the same, or say 400 square feet clear of the fireplaces.

So many persons confess that they have just spoiled their houses by making the rooms a foot too small one way or both, though it saved very little in the cost, that these figures may be useful. Others discover when it is too late that they have made the offices or servants' rooms too small for the house, and occasionally the other way, when they have to rebuild old offices on a larger scale. The size of a servants' hall again depends very much upon the habits of the house as to receiving company, and its distance from a town. It need not be more than 15 or 16 feet wide, but it is prudent to make it from 20 to 24 long in a somewhat large house, and in very large country houses it must be more. In small ones the servants often prefer dining in the kitchen, and the small servants' hall (if there is one) is used for other purposes, such as brushing clothes, &c.

In any house above quite a small one care should be taken to make room for some kind of shelf or table outside the dining room wide enough to put dishes on; though it need not be more than about 20″, otherwise the dishes and covers are put down on the floor and kicked. Grand houses have what is called a 'serving room' for that purpose: but grand houses are always left to architects and I am not writing for them. Such a small matter as this may affect the whole plan of a house, as I know by experience. No one who has not had experience in designing would guess what small things do sometimes affect the whole arrangement either of a house or a machine. I need not say that a back door towards the kitchen from any good sized dining room is desirable. A hatch or opening in the wall for dishes can seldom be possible where a door is not, for it should not open directly into the kitchen or it will let in kitchen smells as well as dishes. But a hatch from the kitchen into the passage, or a divided door, like those in colleges from which bread and butter are served out, are sometimes convenient. They are sometimes made as a mere shelf to let down across the open doorway.

Windows.—There are various points connected with what some people call the 'fenestration' of a house, which I should advise any one who is building to attend to for himself. First, as to their position in the room.

They are obviously better in the side than the end, wherever there is much difference between them. But this ought not to prevail over the value of a good aspect or prospect, especially the former. Some persons appear to have a prejudice against cross lights, which is quite unfounded, provided you take care not to over-window the room thereby, which is too often done; and in that way you can sometimes get the advantage of a south window or a good view besides the general lighting being in the side which is otherwise best. In some such cases it is better to have the chief lighting at the end, with a single window at the side, opposite the fire, as where the end looks south or over a good view, but the room is too long to be well lighted from the end only. But whenever a room is chiefly lighted from the end, and *à fortiori* from the side, it is essential to the good and pleasant lighting of the room to have one window in the middle. As the end of a room is seldom wide enough for three distinct windows, where one is not sufficient the right way is to have a three-light window, composed of one of ordinary width and two narrow ones beside it, or all combined into a very wide one of whatever kind may suit the style of the house. The effect of a dark piece of wall, in the middle of the side where you look out is always disagreeable. I have seen good rooms quite spoilt thereby. Somehow or other, wherever you sit you feel always looking at the wall instead of the window, and the light does not fall on the table in the middle.

Bow or Bay Windows.—So far as there is any difference between these terms, I suppose a 'bow' means a rounded bay, and a 'bay' a polygonal bow, or what is called in Gothic building an 'oriel.' Round ones have very rightly gone out of fashion. For it is impossible to build them strongly and so as not to crack, or at any rate not to be always trying to crack, unless they are very thick and built of large through stones. In church apses with only narrow lancet windows they may stand, if the walls are pretty thick. But those also should be always tied with plenty of hoop iron. Moreover all the woodwork is more difficult and expensive to make and keep in good condition, and the glass of the windows awkward to manage. If it is straight there must be a disagreement with the circle of the bow somewhere. An attempt to make the whole window on the curve is worse, and it is not easy to get a window mended. On every account therefore round bows are to be eschewed.

There are no such objections to polygonal ones. The commonest of all, and in most cases the best, consists of three sides of an octagon with angles of 135°. In that case each side is ·414 of the square width of the octagon, and the depth of the bay ·293, and the area ·707 × ·293 or just over one fifth of the square containing the octagon. Thus if such a bay is 20′ wide its area is 82 square feet. But this kind of bay, when beyond 20 feet wide inside, makes the windows and the sides of the bay look too large and sprawling; or else they are not enough to light the room. I have seen the middle side made wider and with two windows, with only one in each of the others, but the effect is not very good. That shape is better treated in the Gothic way, with one very wide mullioned window for the middle bay, making the side ones of the same width as each of the spaces between the mullions, but I shall say more of them presently.

A 24 ft. bay being too wide for only three windows, I adopted a fivesided one for the house of which the plan was given at p. 126, though I never saw one like it in a room before. This is exactly the same size as one

I had before used for the inner apse of Headingley church. Such an apse is a semidecagon, and each side is ·618 of the radius (to the corners) or ·309 of the width of the bay, against ·414 in the octagon. And the area is 1·474 or 211 sq. ft. in a bay of 12′ radius. But this kind of bay projects ·95 of the radius, or 11′ 5″ in a 24′ bay while the octagon would project only 6′ 9″. You must remember that an octagonal bay of three sides is less than half the octagon, while a five-sided bay is half of the decagon. It is generally expedient in building to push both of them a little farther out, or to put the diameter of the decagon, and the line which cuts off the three equal sides of the octagon, about half way through the thickness of the general wall of the house and not flush with the inside: otherwise the windows come too near the corners of the wall outside and the sides look too unequal. A semihexagon is not generally so good a shape as either of the others, because the sides are even wider than in the octagon, and the middle side projects ·866 of the radius, or nearly as much as the semidecagon with its two more windows. It may do however for a narrow bay. This sketch shows them both for comparison. To avoid confusion I have only drawn the fivesided bay complete.

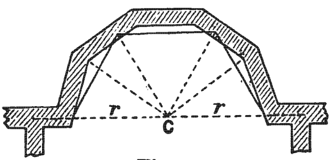


Fig. 9.

Gothic bays or oriels start square out from the wall whatever their number of sides may be, at least internally. They are often simply rectangular with no oblique sides, but with the front much wider than the sides. They have only mullions, rather than wall spaces between the windows, except at the corners, in which case you may as well remember that the only tolerable way of making shutters is to make them draw up. A huge many-leaved shutter sweeping half over a large polygonal bay is very heavy and liable to get out of order. Curtains also in that case are troublesome to draw and keep in good humour. Even the narrow window sashes go heavily unless the mullions are wide enough to contain the weights and pulleys of the adjacent sashes. Casement windows by way of evading the difficulty are almost a return to barbarism; and all the attempts to make them light by civilized contrivances are complicated and expensive and liable to fail.

I am only speaking yet of what belongs to the general design of a house and postpone other details of window construction. But there is another matter of design which is generally neglected or misunderstood now; and that is the much greater value of light from above than from below. People seem always to be aiming at having their window sills as low as possible, even down to the ground, and auctioneers advertise houses with 'Italian' or 'French' windows, made as doors down to the floor, as if they were an advantage; whereas they make the rooms colder, and bring in the light in the worst direction, and are impossible to open a little, or indeed at all without bringing in all the cold air at the floor. The single advantage of them is that they enable people sitting in the room to see more of the garden or the street; which may be pleasant sometimes for a quarter of the year, and has the abovementioned disadvantages for the other three quarters. But we have got into the way of building houses as if all the year were summer, both in this and other respects. Windows should go as high as possible, except in rooms of very unusual height. I have occasionally been surprised at the unusual pleasantness of certain rooms by no means high in themselves, until I saw that from some accident of roof construction the windows had been carried very high. And conversely, many rooms otherwise good are completely spoilt by the window tops being too low. The climax of bad lighting is a low window near the ground, which sometimes comes from a floor having been raised to make the room below higher. The very same window set near the top instead of the bottom of the room might be quite sufficient. That is one objection to Gothic house building, that the windows are nearly always too low. Low wide-spread windows of many lights are picturesque outside, and were necessary in the old-fashioned low rooms; but they are otherwise very bad, if it is considered the business of windows to light rooms inside and not merely to look picturesque outside. Windows with high arches are bad for the same reason, except in very high rooms, as they bring the square part down still lower, besides that blinds cannot fit them.

But a far worse thing in a constructional point of view is the modern abomination called a flat arch, which means at the best a number of slightly wedge-shaped bricks very seldom more than 13½ inches high, and much oftener only 9. Such things are scarcely arches in reality, and are quite unfit to carry weight, and practically depend upon the mortar, and are sure to crack and drop some day. Any one who knows the elements of mechanics must be aware that unless the two straight lines from the top of the middle of an arch to the lower corners of the spring make some considerable angle with each other the arch has very little supporting strength and very great bursting force. You may read a striking proof of that in some of the Lives of Sir Christopher Wren: *viz.*, that he said he would show the builders how to build the flat stone arches under Trinity College Library so that they should never drop; and yet, as I remember from my early days there, nearly all of them have dropped. There is however a still worse style of window head than that, where the middle piece consists of two or three bricks making a very wide wedge, the whole being made in this way (fig. 10). One would think there

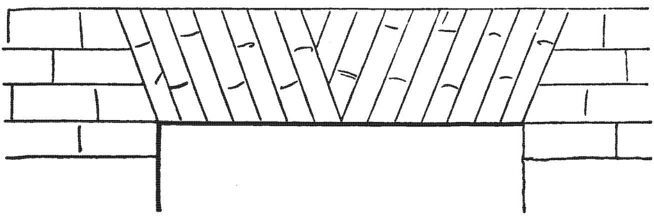


Fig. 10.

could not be a builder so ignorant as to believe that that is an arch at all, or that it would stand for five minutes independent of cement and friction; but when one finds architects trusting to long stones dovetailed at the ends to make a stone beam (see p. 132) perhaps one ought not to be surprised at speculating builders doing such things as these. Indeed many of these window tops must have been either designed or approved and certified by architects.

It is true that a flat arch of sufficient depth does contain a real curved arch within it, and the middle below and the two ends above that real arch are little worse than superfluities. Still they are worse; because a less amount of horizonal giving way will show cracks in the bottom, and let the half bricks (of which there must be some) get loose and drop. And they are worse in another way too. It is well recognized by engineers, who have no architectural fancies to regard, as you may see in railway bridges, that the several courses of an arch ought to be independent; and though at first sight it looks weaker to unmechanical eyes, it is really stronger not to have long through bricks or stones from intrados or 'soffit' up to the extrados or outside; because there can only be three bearing points in an arch or any section of it, two at the intrados and one at the extrados. And as this applies to each course of brickwork, an arch of many separate courses is so many arches, while one of the same thickness of 'throughs' is only one arch. All this of course disregards the mortar, as one always must in considering the mechanical conditions of arches: an arch that will not stand without cement is not a *bonâ fide* arch at all.

A large stone lintel is another thing: that acts on the principle of a beam, not an arch, though if very thick it will act also as an arch. All brick arches or arches of small stones ought to be and to appear real ones with some elevation in the middle, and undoubtedly look better than flat ones. But when you have them it is better not to make the top of the window sash curved to fit them, but to fill up with a separate piece or 'tympanum;' for a convex sash always looks ill when open and is a weak construction besides. Stone lintels are however liable to crack, unless they are deep, and sometimes even when they are; because the pressure of all the weight above is carried by a few inches at the ends, and there is nothing under the middle of the stone, which consequently cracks just as a flat arch does. And unfortunately you cannot treat a lintel as all builders who know their business treat stone sills, leaving a space under the middle to be filled up at the last with mortar after the ends have got well squeezed down by the weight upon the window jambs.

Discharging Arches, as they are called, are frightfully ugly, but useful in diminishing the pressure on a long stone lintel. Over Gothic moulded arches, where our modern architects are very fond of putting them, as if the real window arch had been stuck in like a wooden frame, are totally useless, and a ridiculous and ugly display of 'vigorousness.' The old builders hardly ever used them. I should say 'never,' using the word in a practical common sense way; but somebody would perhaps find one or two which may have been put in for some special reason, and then make an outcry about my ignorance or boldness of assertion. Many people have not the sense to see that things which were done very rarely by the great builders of the genuine styles, were left rare because they were perceived to be not worth copying, while the good things were continually copied. Again many persons do not know that a tolerably sharp pointed arch opening hardly requires any arching at all to make it stand: much less a discharging arch besides.

Cellars and Concrete Floors.—I am told by those who are more learned in wine than I am, that cellars are best without external windows, so as to keep the temperature as uniform as possible. A friend of mine at Buxton considers his cellar much improved in that respect by the flowing of a small stream of the famous Buxton water through it, which has the constant temperature of 84°. They should however have some internal ventilation both at the top and bottom of the door, or the air will be unwholesome.* There is a

* See the Ingoldsby Legend of *The Wedding Day* on this point.

common notion that rooms are never warm and dry unless they have cellar arches underneath; and in one sense it is true; because nobody (so far as I have seen) ever thinks of doing anything to keep the damp from rising, as it always will from the bare ground; and the more the air is warmed above it the more the damp will rise. It is wonderful that no one ever thinks of specifying that 6 inches of concrete should be laid under every ground floor. Not only that, but where the floors are not much above the natural level of the ground the best and strongest way of carrying them is to lay the joists on single bricks bedded on the concrete, or on plates or sleepers simply laid on it, instead of building 'sleeper walls' at much wider intervals; which however must be done if the floors are much above the ground, as filled in ground can hardly be depended on not to sink. I have had the floors of every building I have had to do with, from Doncaster Church downwards, made with concrete under them, and the floors laid on it where the level suited. Cellar floors cannot be made of anything better than concrete with some kind of cement, or asphalte, laid on it. Cement concrete made with sand only instead of gravel is probably the best to finish with. The best vaulting for rather wide spaces is three courses of flat tiles laid in cement, which practically form a beam and not merely a 'barrel vault' with a bursting pressure.

A Damp Course, made of any waterproof substance, lead, asphalte, pitch, slates laid in cement, is well known to be necessary in order to prevent the damp from rising up the wall by capillary attraction. But it is too often omitted through carelessness or something worse. The best place for it is just below the floor timbers, to secure them from damp, as that is pretty sure to be above the ground outside. If any room is at all below the ground the outside of the wall ought to be cemented or covered with pitch, or it will be always damp. But the most valuable protection to a house throughout from damp and cold and heat is—

Hollow Walls: which are now at last generally admitted to be expedient, though architects are still wonderfully slow to propose them. They seem to have been used in Italy long ago by an architect named Alberti, who was also a writer on architecture. In old times, when walls were always very thick, they were not so necessary, though even a thick wall is drier, warmer and cooler for being divided by a stratum of air. In those days two walls were generally lined with wood-panelling, and afterwards with '*stoothing*' 'or *battening*,' which is laths for the plaister nailed on battens or strips of wood built into the wall. I happen to possess (though not to inhabit) a remarkably well built house of the last century where reeds have been used instead of laths. This process is sometimes used still, but it is not equal in some respects to hollow walls, and it does not prevent the damp coming through to the battens and rotting them in time. But architects will build you 'a great house with large windows' and 'paint it with vermilion,' and give you only 14 inch walls and the plaister bare upon them, and spend ten times what either stoothing or thick hollow walls would cost on good for nothing decoration, leaving you with a house not fit to live in, because the whole is damp right through in every rain, and heated and chilled through with every extreme of temperature. Any wall not stuccoed outside absorbs a vast quantity of moisture from rain, especially if it is not pointed with something more waterproof than common mortar. Pure cement will not do, as it swells and cracks off, but a mixture of cement and lime and sand or brickdust will do, as we shall see under 'mortar and cement' afterwards. Stone walls are generally even more porous than brick, and are notoriously damp inside unless some other surface is interposed.

Hollow walls also afford peculiar facilities for ventilating rooms and floors under them without making openings outside, which are sure to be stopped up in the first very cold weather. This is particularly important in rooms where gas is burnt, and in small bedrooms and any without fire places, and it is probably a good thing in all rooms. Kitchens should have special ventilation either into or by the side of the chimney; but some 'air bricks,' *i.e.* perforated bricks so called, opening into the space between walls must be useful there also; and there should be as many at the bottom of the house under the floors with an opening to them from the cellars, as at the top under the roof, so that there may be a general circulation of air, and none stagnant. All this should be done by air bricks with small holes through them to keep rats and mice from running all over the house. The roof itself should also have some ventilation. Most roofs have plenty, through imperfect jointing of slates and tiles, but that of course is a defect. I remember once consulting the architect and surveyor to a Society about making some ventilators in the windows of a vaulted chapel with a leaded—or more accurately, a coppered roof, which is much closer than tiles or slates can be. He said he had made some ventilators himself a few years before into the roof. I answered, 'Yes, I know that, but what becomes of the air when it gets there?' That he had never thought of, and his idea of ventilating had been to let off the air of the chapel into this much hotter place between the vaulting and the copper blazed on by the sun. I shall have a little more to say about modes of ventilating afterwards, but this is a question of literally fundamental construction, as these air bricks should be just above the concrete inside, or just where the hollow in the walls begins. They are often put outside, right through the wall, and they are doubtless a good thing at first to dry the building; but, as I said, they are sure to be filled up in the first frost because they make the floors too cold.

The two vertical strata of a hollow wall are best connected by bits of iron tarred over (not with gas tar, for I understand that rusts iron very quickly instead of preserving it), and it is thought better even to give it a twist to prevent the wet creeping across. For the same reason the connection should not be by bricks. But solid bricks should go across at window jambs and outer doors, or they will never be decently air tight round the frames. The two walls are generally made 3″ apart, but sometimes only 2″: of course 3 is better. The only objection that I know is that a hollow wall is not so strong as a solid one of the same thickness, but it is easy to make them strong enough. Also you must remember that the inner wall carries all the weight of beams and floors and most of the roof, although the wall always becomes solid under the roof, or should do so. Consequently the inner wall must be the thickest, except in the single case of two 9″ walls, which it is perhaps better to divide equally, though I am not quite sure of that where wooden 'plates' or bearers to carry the floor beams are built into the walls as usual, which reduce the brickwork of a 9″ wall one half, and so cut it away as far as the centre of gravity.

However in a 14″ wall it must be so, and nothing less than that is fit even for a cottage (I mean besides the hollow); nor anything under 22½″ for a large house; at least for the best parts of it, where the windows require deep shutter-cases, which ought never to project into the room, and in old good houses never do, though they do in flimsy modern ones, and tell the tale of the thin walls immediately. Even in the inside of a house the doorways look thin and give an appearance of leanness and weakness to the house, in walls less than 14″ thick, and when they are less than that they would be too weak if made hollow. The 'lining,' or wood round the doorway, (not the architrave or border round it in the room) can then only be a flat board, and not panelled, which looks much better. Therefore all such walls should be 14″ at least, if you want the house to look and to be massive and not flimsy; and a little money spent in that way will produce infinitely more effect than if spent on decoration. In the back parts of a house 9″ will do for the inside walls. Stone walls are almost always thicker than brick ones, and rightly so, on account of its porosity.

Stone.—Sandstone looks more porous than limestone, but that is a mistake. The only stone short of marble that will hold water in a trough, or a church font, that I have met with yet, is the coarse looking millstone grit which looks about the most porous of any. Sand flagstones also when put together as a trough will do so. Nevertheless most London architects and builders persist in laying small Portland stones as flags to London front doors, which always look damp or dirty, while the few Yorkshire flags which you may happen to see dry very quickly after rain, because they don't absorb it, and look clean—if they are cleaned—and one flag covers the whole doorway without a number of patchy looking joints. I understand the Portland stones have not even the advantage of being cheaper. All sandstone however is not equally waterproof, as I know from trying some other finer looking stone, for a font. Limestones, at least all those that are workable in square blocks called freestone, are very pervious to water. It is becoming more and more impossible (if impossibility admits of degrees), to find any stone that will not soon decay in an atmosphere of coal smoke with the sulphurous acid which it produces in the air. Some churches that had stood for centuries with no symptoms of decay, and would manifestly have stood on if there had been no change in the nature of the air, have lately turned white instead of greenish, which is a sure symptom of decay; besides the multitude of others which have never reached the green or brown stage though built of stone of the highest reputation.

No *à priori* test seems worth any more than the 'scientific' recommendations of the Irish Commission were on the preservation of potatoes. I have seen tests of hardness, of colour, of specific gravity, of position in the quarry, tests with acids, with heat and cold and wet, and I daresay other things, described as conclusive, until some case turned up which entirely refuted the induction which had been founded on too few premises. I wonder how often I have been told by people who thought they might pass it off for a piece of valuable scientific information showing how much they knew, that 'you have only to see that the stone is laid on its natural bed to keep it from decaying,' as if every builder did not know that it is generally better to do so, though it is of much less consequence with stones like the millstone grit for instance than with laminated ones; and as if everybody with a little experience did not know also that it is no absolute security against decay. It is curious too that where the stone is most protected from wet, *i.e.* just under string courses, is generally the first place to show decay, and the slopes of buttresses and window sills the last. In window mullions the stone can never be laid as it lay in the quarry.

A few conclusions however seem to be tolerably certain. First there are stones which experience has proved to be totally unfit for outside work, even in unsulphurised air, such as the Headington stone of which most of the Colleges at Oxford were built, and the Totternhoe stone of Bedfordshire, which is little more than 'clunch' or a superior kind of chalk: it does however stand inside. Again, Bath stone, though a favourite one with builders for its softness, is at least uncertain in its behaviour, and if built in before it is quite dry will probably fly all to pieces if the next winter is a hard one. I have seen a grand new hotel almost reduced to ruins in a single winter, all the 'dressings,' or all except the rough walling, having been built of Bath stone; and all except that same rough walling of millstone grit from close by, which was quite good enough to have been used throughout, was blown to pieces when I saw it again the next year. Of all buildings erected for the benefit of architects and builders and probably some official of the company and the ruin of original shareholders, those large hotels have the preeminence. Nobody evidently has had or has exercised the least control over them, and the object of everybody concerned has obviously been to spend the largest quantity of money they could get hold of. But some railway Boards seem to aim at outdoing even the hotel speculators themselves in splendour and absurdity: the Pancras one (exclusive of the station proper) cost half a million, as I heard from very good authority, and that was only an estimate, for it was not finished then.

Among the best stones besides the millstone grit are undoubtedly those of Steetly near Worksop, Ancaster, and Ketton, from which many of the new buildings of Cambridge were erected about fifty years ago; which is quite long enough to show decay if they are meaning to decay. It has however a yellower colour than is pleasing. The Anston stone, which acquired such celebrity from having been chosen by a scientific commission for the Houses of Parliament, lost it again through their early decay, and the same is the case at Lincoln's Inn Hall, which was built about the same time. One would suppose the Temple church to have been refaced 300 years, not 30. It is said however that there was nobody employed to see that the public got the best stone of the quarry for the Houses of Parliament. Barry probably knew nothing at all about it; and it is said that the quarry people naturally sent the worst, keeping the best for those who knew it. In nearly all quarries there is some stone, in some cases the highest, in others the lowest, sometimes the whitest, sometimes the brownest, which is known by experience to be the best. These are among the things which architects ought to know, and possibly some do; but whether they do or not the public cannot possibly ascertain, unless a particular architect has gained a reputation for attending to these things.

There is a popular notion that sandstone will stand fire more than limestone, and after old Doncaster church had been burnt down people were anxious to have the pillars of the new one as fire-proof as stone could be. So we tried the experiment of keeping two large blocks in a fire until something decisive should happen to them. The sandstone flew to pieces very soon; while the limestone was only superficially calcined after 24 hours; so of course we used that. The secret of all materials that resist fire for a long time is this: they give the fire some chemical work to do, which keeps the heat 'latent' till all that work is done, as boiling water keeps the pot below 212° until it is all boiled away into steam if the steam is allowed to escape, and you may boil it in an eggshell. Iron gives the fire nothing to do beyond heating it red hot, when it collapses—and indeed before. Limestone or plaister, which has been proved to be extremely fire-proof for a long time and is often found unburnt among ruins of a fire, uses up the heat in calcining it again, *i.e.* making quick lime of it. It is true that it is no better than powder when it is all done, especially when water comes on it, but it proceeds gradually inwards, whereas the damp in the sandstone blew it up as soon as it was heated. Bits of granite soon crumble in a fire, though granite is an igneous rock, and was once fluid, but probably cooled under tremendous pressure, as marble also was. In the same way bricks use up a great deal of heat in becoming vitrified, and consequently they are more fire-proof than any stone; for besides that, it is their nature to remain hard even under long continued heat, and especially those called fire-bricks, of which the backs of grates are made, from a particular kind of clay.

Hollow-faced bricks.—A practice has grown up of making bricks with a hollow in one or both faces, which I have heard absurdly called a 'frog;' and no less absurdly defended on the ground that it enables the mortar to hold them better, and again that it enables them to lie closer. There is plenty of old brick work quite as close as any new. And if bricks are inclined to tear asunder under any force enough to overcome the 'friction and sticktion' of ordinary good mortar the extra bit of mortar in the hollows would not hold it. The real reason I have no doubt is to save some material to the brickmakers. It has long been known that hollowing the 'beds' of stone to make the edges close weakens it enormously, so much as to crush the edges, and the practice is accordingly abandoned. And though the hollows in bricks are smaller in proportion, there can be no doubt, and indeed it has been proved by experiments, that a wall built of such bricks is weaker than when they are solid and have a flat bearing. It may be thought that no such a thing as the actual crushing of the bricks in a wall ever happens; but I happen to have sad experience that it does; for two houses of an institution of which I was treasurer had to be rebuilt because a dishonest builder about 100 years ago had used soft bricks which had begun to crush into dust, and so cost us about 8000*l.* by saving himself perhaps fifty.

Some architects are not content without having special bricks made, either smaller or redder or in some other way different from usual, which are always more expensive; and most uniform-coloured bricks are by no means always the hardest; perhaps it would be nearer the truth to say they never are, as they are apt to be underburnt, and I have seen them decaying in a few years in one of the most extravagantly built houses that I know. In some parts of the country all the white bricks perish while the red do not; and possibly the converse may hold elsewhere. They are made of different clay. The common yellowish 'stock' brick of London clay when well burnt is said to be the strongest of any, though a very ugly colour. I refer to what I said at p. 41, as to the incompatibility of white bricks with any good architectural effect when you are near enough to see what they are. It is however well worth while to have what they call 'purpose-made' red bricks, instead of the common 'square' ones, for window jambs, cornices under eaves, and other places where moulding can be appropriately introduced and stone would be too dear, and I am glad to see that practice is reviving; for it was used with very good effect in old Gothic houses in districts where stone was too expensive. I have lately been doing it myself, in a house not Gothic.

The importance of laying hoop-iron bonds in walls is too well known now to need dwelling on, especially over openings and round bays and apses. What are called *wood bricks* are generally required in specifications to be built into the walls, to nail door jambs and other woodwork to. But such thick pieces of wood first swell with the damp and then shrink and are loose. I have seen them quite loose and out before the walls were plaistered. A very good builder first told me this, and that thin pieces occupying the space of the mortar instead of the brick are thick enough to nail to and never come loose, and I find it is so.

Ashlar.—There are a few points worth noticing as to the mode of executing stone work. It varies in external character, from rough walling of stones only self-faced, as it is called, *i.e.* not dressed with any tool, up to the finest rubbed stone. When the stone is dressed at all and laid with flat thin beds of mortar it is called *ashlar*, a word of which I never saw any satisfactory derivation. The most important practical point to be considered there is the depth to which these facing stones should go. It is usually specified that they are to be 7 or 8 inches deep 'on the average;' for of course they ought to vary in depth to make the bonding hold. Now here is just one of those defects in specifying which nobody would discover without experience, but which architects ought to have found out and guarded against long ago, but apparently they have not. 'On the average' of what? If you go upon the wall and all the stones you can see manifestly short of the 7 or 8 inches on the average of them, the builder or his foreman has the ready answer, 'O, but the stones of the last course were much deeper, and so these will be all right on the average.' Of course they were not; but it is not everybody who will challenge him to take some off anywhere he likes, to let you see: which challenge will certainly be declined. The fact is that the expression is wrong and only calculated to encourage bad building and deceit: it ought to be, 'on the average of every 5 or 6 feet of every course,' and then the clerk of the works or architect (when he comes) can see at once anywhere whether the work is being done properly or not.

In connection with that, the 'filling in' with rough stones or bricks is very often simply scamped, and they are merely loose rubble or brick-bats flushed with 'drowned' mortar. In this respect it must be confessed that our Gothic ancestors were great sinners, and consequently many of their walls have fallen, and especially their towers, as that of Chichester Cathedral did in 1861 and St. Albans was on the point of doing; and the Doncaster tower fell upon its knees when the outer casing of its legs was burnt. If they had been solid throughout it would have stood. The old builders relied upon the immense thickness of their walls, and also expected their grouted rubble inside to become more solid than it did. It is essential to the security of walls that have to carry much weight that they should be built of flat-faced stones or bricks throughout, so that there may be no bursting pressure without relying on the mortar. Roundish stones between two ashlar faces are really very little better than fluid, except so far and so long as the mortar may keep them together. Not only the piers but the walls of towers containing heavy peals of bells should be built throughout of large squared stones.

Random Walling, in which the joints are not horizontal and vertical, but anyhow, looks picturesque, and may do well enough in long walls which form a continuous abutment and have no great weight to carry; and the same of flints. But they depend entirely on the mortar for their strength, and have practically no bond at all, especially as the stones are generally somewhat wedge-shaped inwards, and therefore under a constant pressure outwards. Mechanically that can only be pronounced a very weak kind of building. Some of the old flint work in the eastern counties has been done so well and with such good mortar that the walls are almost like 'plum pudding stone,' a kind of natural concrete of the hardest kind. Other specimens of it, when the mortar has been bad, are as rotten internally as the worst modern work.

'Self-faced,' or as it is sometimes called 'rock-faced' walling is used a good deal in so-called Gothic buildings now of a plainish kind, and I do not know that it can be reasonably condemned. At the same time it was never used in real Gothic, except for the roughest kind of walls, or when it was intended to be plaistered; which Gothic buildings were a great deal more commonly than is allowed by our architectural prigs and inventors of maxims founded on no real experience, a breed of men by whom every art and business and profession has become infested.

There is a wonderfully absurd imitation of natural or rock-faced stone in what is called the 'rustic basements' of the Renaissance style, in which far more trouble is taken to work the stone with small chisels into artificial roughness than it would take to work it smooth, and ten times more than it would take to 'boast' (as they call it) into a fairly level surface. The opposite extreme to that is 'rubbing' into the smoothest surface that the stone will take. Hundreds and thousands of pounds have been spent on that folly; for it is nothing else, even in the styles of architecture to which smooth surfaces are most appropriate, inasmuch as it cannot possibly last long, whether the stone decays, as in nine cases out of ten, or preserves itself by vegetation on the surface, as it may do if it is lucky, and tolerably free from smoke. It took modern architects many years to find out or to admit that smooth rubbing is absolutely fatal to Gothic effect: indeed very few of them have found it out yet to any practical purpose; for the drag, which is a kind of 'smoothing file' in the form of a scraper, is almost invariably used for final spoiling of the work inside, and very often outside too, in order to make a church or other building look neat and pretty for the opening.

Marble is a different thing in this respect, because its effect depends on the variety of its colour, which does not come out without polishing. It is singular that all *obviously* careful working of stone is injurious to its effect, and yet it is wonderful how difficult it is to prevent it, because the much vaunted working man, whom some theorists dream of as the Hope of Architecture, has come rather to pride himself on being a mere machine and not a thinking animal, and sometimes tells his employers if they find fault with his doing anything unusually stupid, 'that it is not his business to think.' Either you have the 'corduroy' work of 30 to 40 years ago, though that lucky nickname did a good deal to extinguish it, making the stone like a fluted surface which was thought peculiarly Gothic then; or the 'scabbling' in diagonal lines, leading from a centre of the face, the omission of which in Mr. Bass's Burton church I saw specially noticed in a newspaper as a 'novelty.' If you order it to be worked obliquely, but in no particular direction, you will probably find the men first ruling diagonal lines over it to make the direction as particular as possible; and then, last of all, if you do not look sharp you will find all the joints carefully picked out with straight white bands, inside the church with the white mortar which they call putty, and outside very likely with that vilest of all mortary abominations, raised bands with sharp edges, which is sometimes called 'tuck-pointing.' All these things are done by builders because it is the custom; but the custom was invented and is sanctioned if not enforced by architects who profess to have learnt all about Gothic architecture by careful studying of old Gothic churches. Having eyes they see not, both this and many other things which they profess to follow.

It is impossible to lay down any rule for the degree of 'finish' or smoothness and exactness which suits different designs. The only approximation to a rule that I know of is that the design should always appear to have been more thought of than the execution; and that there should be no final dressing up, except to remove obvious defects. In Doncaster church the architect and I made a sort of compromise that he should have his way in leaving all the nave pillars to be pointed at the end of the work, with the favourite putty, and that I should have my way, of pointing as the work went on, in the tower piers. The consequence was and still is that they present a variety of colour which is pleasing, while the nave pillars are a monotonous brown except where they look as if they were painted round with neat white lines.

We have not got into woodwork yet, but the finishing of that involves so much the same principles that it is as well to dispose of it now—still speaking of work professing to be Gothic, not Italian. If you have ever seen one new beam across a church together with some old ones you must have been struck (if you have eyes that see differences) with the comparatively monotonous and dull look of the new one, and very likely wondĕred why. It is simply because the old ones were generally dressed with either an adze or an axe, which take off chips and make a slightly undulating surface, while the new one has been planed; and that is exactly the kind of difference which you see also between the old and new stonework both in walls and mouldings; the old ones being left from the chisel which brought them into shape, and the new ones being worked as true as possible and scraped smooth afterwards. So again, finishing of woodwork with sandpaper ought to be rigorously prohibited, so as to leave the chisel marks on all the carved or chiselled parts. Architects have learnt the value of carving stone with 'claw tools' instead of square faced chisels, but most of them have got no farther, and drag and scrape and polish just as they did fifty years ago.

Tiles and Flags.—I am surprised at the modern preference for common small square tiles over large flags, for paving inside both houses and churches. Encaustic tiles of handsome patterns are a very different thing, and the only objection to them is their dangerous slipperiness. But the common black and red ones were only used in old times because there were then no *large* flags worked, which are handsome and grand-looking things stretching across the whole width of a passage. Flags should not be laid on the ground, without concrete to keep the damp from rising into them, or they are then apt to split. Moreover the black and red tiles seldom or never keep a pure colour, but show streaks or stains as if they had lately had lime upon them. Marble is sometimes intermixed with encaustic tiles, but they do not match well, though each makes a handsome floor by itself; but marble scratches and gets stained and dirty-looking far more than good encaustic tiles. Marble should be in very simple and symmetrical patterns which the eye can grasp at once without having to wander a long way to make it out, as it has to do in the new flooring of the nave at Worcester, which I think very bad.

Some of our encaustic tiling is the best architectural work that is done now. But I doubt the propriety of setting tiles up on edge against a wall for ornament. Everybody knows what they are, and it is impossible to get rid of the idea that they are only stuck on and may all slip down together some day. Nothing ought to look less secure than it is, and nothing should appear to depend on cement for its security against gravity, a force which never sleeps and is always ready to take the smallest advantage that is offered to it. White tiles certainly make a nice wall lining in dairies and larders, but Keene's cement will bear washing and is almost as white as tiles, though not glazed, and very hard, and has the advantage of showing no joints as tiles do.

Mortar.—I should say nothing on this, as a subject which may be fairly left to architects and builders, but for the curious fact that directly opposite ways of making it are sometimes prescribed in specifications, besides another which is manifestly wrong. The majority of specifications that I have seen, both written and printed, provide in effect that the mortar is to be used as soon as possible after it is made. The opposite extreme is to keep it a good while, not of course till it is hard, but only so hard that it requires beating up again into proper softness. The intermediate practice is adopted by some of the best builders, who say that the common specification is quite wrong and that mortar ought never to be used while it is warm from the slacking of the lime, because it always shrinks after that; as indeed any one may see who looks at the top course of brickwork a few hours after it is laid in such mortar. In other words, it should not be used the day it is made, but may be a day or two after. The still worse thing which is sometimes allowed, and even directed, is the pouring in hot of what is mere lime broth out of a bucket, which is expected to be kind enough to part with all its superfluous water somehow and settle into strong mortar. Some people seem to think that mortar is a kind of mud, and are ignorant that it is a hydrate of lime, *i.e.* lime with as much water as it can hold in chemical composition, which never dries out of it or it would become quick lime again; and all beyond that merely goes to 'drown' it, and keeps the wall damp for a long time, if indeed the lime so treated ever sets at all into mortar: which it sometimes certainly does not. I remember putting up a clock face in a tower, then about thirty years old, which I expected to take some days to get through, but as soon as the outer shell of bricks was taken off, which was sound enough, it was nothing but loose bricks and lime dust inside, and had evidently been 'grouted,' as they call it, by pouring in lime water.

Again most specifications require the mortar to be ground in a pug-mill; but one that is copied in Mr. Donaldson's book of specifications actually prohibits it. The grinding, or at least passing through the mill, mixes the mortar better than you can practically get it done by hand. But it is also better for another reason: it was known as long ago as Vitruvius's time, which is supposed to have been about the Christian era, that brick dust mixed with mortar strengthens it very much and makes it nearly equal to cement, which contains burnt clay (but clay unburnt is fatal to it). It is indeed superior to a great deal of cementing that is done, partly from inadequate mixing with proper sand and partly from adulteration. The best way to get in the brick dust is to throw broken bricks into the pug-mill to be ground up and mixed with the mortar while it is making. Vitruvius recommended that the brick dust should be about a third of the sand. Different limes take different quantities of sand, and generally one measure of lime to three of sharp sand and brick dust; for the sand must be that which feels sharp and not soft between the fingers. Limes have other peculiarities which can only be learned by local experience. Some set quicker than others, and yet are not so strong when set. I have known a builder on that account prefer getting lime at his own expense a long way off to using that of the neighbourhood. The Warmsworth lime near Doncaster, though very good for building, does not set very quickly, and breaks out obstinately in blisters through painting over plaister made of it, at any rate if done before a considerable time. And so you might have all your plaistering to do over again because this was not known. A room at Lincoln's Inn Library had to be replaistered from a similar cause, and I have seen paint in smears elsewhere, I suppose from being done too soon over plaister or cement.

Smeaton the great engineer found smith's forge ashes, *i.e.* iron scales mixed with mortar, make it stronger. But I know a building where they began to use it and had to give it up because it rusted and disintegrated the mortar, whether from using the scales too large or some other mistake, I do not know, but Smeaton was not apt to be mistaken. Sharp road dust, *not from limestone roads*, is also good to mix with mortar, provided all mere dirt or clay is washed out of it; and so are flints and gravel thrown into the mortar-mill and ground with it. I have seen plaister sink into mere dust from having been made with what was called sand but was really little more than earth.

When mortar joints turn white it is a sign of decay. They are particularly apt to do so in the Leeds district, and show most unpleasant lines against the sandstone, which gradually turns very dark, not merely in the smoke, but even in the country. The loose blocks of millstone grit lying about Wharfedale from some antediluvian disruption are almost black though very little decayed. To be sure, this ought to please the architects who like picking out their joints 'neatly' (according to the favourite word in specifications) and have not yet learnt that such work belongs to no style but their own. I am surprised to see how few persons have yet learned the superiority of pointing red brickwork with dark mortar instead of white. It produces such a different effect that I have found people unwilling to believe that the bricks were the same. The pointing mortar is coloured with soot or lampblack, and it is very much improved by having as much cement as lime in it. Some people try to make their walls waterproof by pointing them with neat cement, but it generally cracks off, which a mixture of cement lime and brick dust does not.

Cement Concrete is a new material for building walls, and apparently a very good one, though I could not find that it saves anything in cost over ordinary building, except in the most straightforward work which can be done in a simple kind of framing moved up with the work. It consists in pouring in concrete, made of cement and gravel and broken bricks, between a framing of boards which is carried up with the wall. It sets very quickly, and so not much framing is required. I have also seen a very large underground tank made of it, and even a winding staircase round a newel without external walls; and slightly arched vaulting for floors. The walls must of course be plaistered or stuccoed, as they show the joints of the framing, which look very ugly, and so does the material itself. It is also far more waterproof than brick or stone walls, but not waterproof enough for tanks without being cemented over like bricks. I have no experience of my own to recommend it, but these advantages are obvious and it is well worth the consideration for large and plain buildings. I should say the same of Ransome's artificial stone, except that any such machine-made work is quite unsuitable for Gothic building. For Renaissance architecture, where there are a multitude of stones of the same size and patterns, artificial stone is cheaper than any other, assuming it to be durable, which perhaps there has not yet been time to prove.

Pebble Dash or Rough Cast.—I don't know why this picturesque and valuable old method of keeping cottages and outbuildings waterproof has been abandoned. The pebbles embedded in the plaister by being dashed on from a peculiar kind of trowel make a very hard and waterproof surface, which looks much better when whitewashed than the common brown paper looking stucco. Many old village churches were so treated when built of rough stone, and many picturesque old cottages in the hills. I should certainly do it on any 9 inch walls, though I do not say that it is equal to a hollow 14″ (*i.e.* 17″) wall, as before described. The value of every good kind of plaistering outside in keeping houses dry has come to be forgotten altogether in the absurd rage for what is called reality and truth by people whose work is often good for nothing, and who seem incapable of perceiving that plaister which does not pretend to be anything else is just as genuine as bricks.

Cornices.—I spoke in the last chapter (p. 92) of the almost universal inferiority of modern cornices to old ones, from neglect, and in fact ignorance, of what they were really meant for and originally were. I have had experience of the difficulty of getting the proportions well adjusted even when the proper general shape had been prescribed, but I cannot go into details of that kind here. One cause of the general propensity to make them hollow just where they ought to be apparently solid is that solid ones, of any size suitable for large rooms, require a framing of laths to be fixed for them to the wall and ceiling. What ought to be done—especially by the purists who rage against shams—is to build offsets in the brickwork as real cornices to carry the ceilings and then plaister ornamental mouldings over them; and I have done that myself for increasing the support of a stone gallery. There is a kind of false framing (called

Scotch) sometimes stuck on to the cornice behind, and not nailed to the wall, so that the cornice only sticks by its edges, and is as likely as not to come down. That should never be allowed. It is not an uncommon event for a whole ceiling to fall upon a dinner party in new houses cheaply built, in consequence of the omission of hair in the mortar. Indeed a great many modern houses will have hard work to live out the leases on which they are built. Nothing has done so much to promote bad building as building leases for the ordinary terms. People naturally ask, why should they build well for the benefit of their landlord or his son?

Garden Walls.—In most old gardens and other walled places on sloping ground the walls are built in courses parallel to the ground, not in horizontal courses with the tops broken up into steps as is the fashion now. The steps look very ugly and make the walls weak, and have no advantage whatever, and some inconvenience when the trees reach the top of the walls. I believe the fashion of making steps arose from it being less trouble to build by the plumb level than by the eye or measuring from the ground, and perhaps also from that passion for irregularities and ups and downs which infests modern architecture. When there are buttresses, as in high garden walls, there is no difficulty in building the buttresses themselves upright, though the courses in them are not quite horizontal. As to the buttresses themselves I know from experience that buttresses of the ordinary thickness on the outside of the wall are of no use if the wall is exposed to the west wind outside. But if they are put inside, the wall cannot be blown down without being lifted up so as to turn on the feet of the buttresses, which would require enormously more force. Some gardeners dislike them inside, but there is no real objection to them if put at proper distances for the trees, and other gardeners rather like them as protection against a sweeping wind inside. It is astonishing what small obstacles will break the force of wind, but of course trees are the best. I find gardeners differ as to whether the walls should have a wide coping to protect the trees from wet. The preponderance of opinion seems to be in favour of only 3 or 4 inches projection, the coping being sloped backwards to throw off the rain that way. But they also recommend iron brackets about a foot long on which boughs or cloths can be laid to protect the trees from frost, *i.e.* from the radiation of their own natural heat upwards in cold and clear nights; for cold is the radiating away of heat from trees as well as men. The best coping for such or any brick walls, is the heavy blue lumps with rounded corners which they call *bull noses*, about 15″ × 4″ × 7″ which the railway companies introduced for the edges of their platforms. They should be set in cement with sand, as mortar soon works out. The common thin flag coping always gets loose after some years, and the top course of bricks with it.

Chimney-pieces.—In small rooms, and indeed in all but very large ones, the jambs or piers should not project much, or appear to be very thick (for of course in reality they are hollow), as they occupy space, and make the fire-place appear too deep, and cut off some heat from it. There is however no objection to a deep shelf, and it is very convenient, except in a billiard room with only the usual space round the table; in which case a deep chimney-piece may interfere with the cues.

CHAPTER IV.

HOUSE-BUILDING.—CARPENTRY AND OTHER FITTINGS.

Roofs: shapes and covering—Spouts—Tanks—Hot water—Stoves and Fire-places—Ventilation—Windows—New window fastener—Doors—Mahogany and Oak—Floors—Closets—Locks—Enlarging Houses—Cost of building—Tables, new construction.

Roofs.—The most important article of carpentry is the roof; and the first point to be considered is the pitch or the degree of slope, as that affects the whole construction. Viollet le Duc, even for the moderate-sized house which he teaches his pupil Paul to build, makes the roof 'equilateral' or of 60° slope, which may also be called the hexagonal pitch and is the full cathedral pitch for walls as high as 80 or 100 ft. and not always used even on them. Some of our ultra-Gothic enthusiasts insist on having this height of roof in their houses and small churches, which the old builders did not. But it is extravagant and useless, and on walls of any moderate height, ugly, because it makes the building look all roof; not merely from its size, but also because a very high-pitched roof looks higher for its height than a low one, for the low one is seen more obliquely or foreshortened by an eye near the ground. The idea of the equilateral pitch being necessary to throw off snow is altogether a mistake; and besides that, it is much better to keep it on. For snow does no harm lying on a roof of any good slope; on the contrary it keeps it warmer than leaving the roof exposed to frost; and if it runs down too fast into the gutters it chokes them up and makes the water overflow into the house or the church, if the gutters are within a parapet or on the top of the walls and not beyond them.

A sufficiently high roof over any walls lower than say 60 ft. is what I called in my book on church building the pentagonal pitch, having a slope of 54° instead of 60°, or the angle at the ridge 72°, which is the angle formed by the radii of a pentagon. I found the original roof of Doncaster church had been so near that angle, if not exactly so, that I had no doubt it was intended; and a very fine roof it makes for a building of that height, the walls being 52 and the ridge 75 ft. high. There are several other modes of constructing a pitch hardly distinguishable from the pentagonal in appearance, two of them rather higher and the others rather lower. Let ABC be equilateral, and $\therefore$ CD the height = AB sine 60° or ·866 AB. From centre A with a radius = CD draw an arc cutting CD in P: then PD will = ·707 AB, which would make AB the diagonal of a square with PD (not AP) for its side; whereas if P is the centre of a pentagon PD = ·688 AB. Another method is this: take AP = $\frac{6}{7}$ of AB, then PD = ·696 AB or a very little lower than the last, but still higher than the pentagonal pitch.

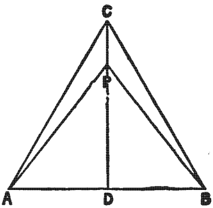


Fig. 11.

Another, slightly lower, but quite high enough for buildings of moderate height, including lowish towers with a pyramidal roof, not being a spire, is that of the oldest building in the world, the Great Pyramid, of which I shall give a more particular account in the last chapter. The slope of its sides is 51° 50′ or 51′, which we shall see produces several curious numerical coincidences. The easiest way to construct it is to make the height $\frac{7}{11}$ of the width, which also makes the height ·9 of the diagonal of the base of the pyramid. Here PD = ·636 AB. A square pyramid formed by a large pile of cannon balls* has all its edges equal, and its height PD = ·707 AB, as in the first construction which I gave. Comparing all these heights for a span of 30 ft., the Great Pyramid height is 19′ 1″, the pentagonal 20′ 8″, the 6 to 7 roof 20′ 10″, the pile of balls or the one reduced from equilateral 21′ 2″, and the equilateral 26 (the ′ and ″ here meaning feet and inches).

These suggest a simpler rule than any of them, for all but roofs on very high walls, *viz.* making the height two thirds of the width. But the pyramid slope is certainly high enough for all roofs of what may be called moderately high pitch, especially for houses. The old roof of St. Alban's abbey, of which the 'weathering' remains all round the tower, was even lower than that; in fact little higher than a slope of 45°, which is generally too low for such high walls, 82 ft. to the top of the parapet.

A slope of 30°, or height = half the length of the slope, is considered the lowest that is fit for slates, and much too low for flat tiles, because each tile lies at a lower slope than the roof, being tilted up by the two

* In all calculations about piles of balls it is necessary to assume the number so great that the inequalities at the margins may be neglected, and the outlines taken as if they passed through the centres of the outer sets of balls. It is singular that a triangular pile of balls leaves the same quantity of vacant air space as a square one, though the square one is lower in its proportions, where each ball lies upon four instead of three. The vacant space is ·293 of the pyramid or of a box containing balls packed as close as possible, the sum of the balls being ·707 of the whole.

which it overlaps; for they ought only to leave one third of their length uncovered; though common pantiles, or the corrugated tiles now used instead, overlap much less and are therefore less tilted and will do on a lower pitch. It is a common mistake, which requires looking after, to make the ridge tiles which sit astride of the top of a flat tiled roof, of the same angle as the roof, in which case they will only touch at the edges, instead of bedding flat on the others, and will be more likely to split or blow aside.

I spoke at p. 125 of hanging low pitched roofs of houses containing a passage down the middle on the walls of that passage carried up nearly to the top. If the pitch is high it would make a single roof over a building 36′ or 40′ wide too high, and you must have a double roof with a gutter in the middle; or else a flat lead top over the middle part of the house. The gutter need not be as low as the eaves of the roof, but may be only a few feet down. That however belongs to another kind of construction and enables you to get large attics in a moderate sized house. When the roof is to be carried by such passage walls, there should be beams across these walls bolted and notched into the principals, and these are all the tie beams that are required, and such a roof helps to hold the outer walls together instead of thrusting them out.

Lead Roofs.—All buildings except churches are now so generally roofed with either slates or flat tiles that one need only speak of lead for church roofs; and there it looks so much better than anything else that I regret having to say a word against it. And yet it is more troublesome than anyone would imagine who has not had some experience of its behaviour, especially on the south and west faces of a roof. For it expands on them so much with heat by day, contracting again with cold at night, and in winter, that we may say it is always on the move. And it is so much weaker in pulling itself up than in slipping down, with both gravity and friction against it, that it will tear itself to pieces and tear out any nails and screws, if it is in long pieces, fastened down along the edges or 'rolls.' The old lead roofs were not fastened down at the rolls, but the sheets rolled or folded over each other at the side edges, and only nailed to the boards at the top of each sheet, which nails are covered by the sheets above. And I believe this is after all the best way, though the common way now is to lay wooden 'rolls' and nail the lead to them at the upper edge which is covered. But it is quite essential to its standing that the sheets so fastened should not be more than 6 ft. long, especially on the sunny side of the roof. All the south roofs of Doncaster church had to be releaded with short sheets instead of long ones within ten years after they were done.

Moreover lead, like nearly everything else of the common kind, has got worse under the advance of science. Copper unquestionably has, as I showed in my book on Clocks and Bells, from more metal being got out of the ore than formerly; and iron the same. Whether that or something else is the cause, the fact is certain. And the same is true of lead from another cause, whether the modern rolled lead is inferior to the old cast and not rolled, or not, as to which there are different opinions, but as to its chemical condition there is no doubt.

The new Hall of Lincoln's Inn was roofed with lead in 1845, and in 1865 it was found full of holes. Chemists were consulted and they reported that the lead was being turned into sugar of lead by the acid of the oak boards on which it was laid being brought out by the steam of the hall. We asked why the lead had not likewise perished on all the cathedrals and churches with oak roofs hundreds of years old, and the answer was that the old lead contained a little silver which preserved it, but that modern lead is spoiled of its silver, and so spoiled for laying upon oak, and also made poisonous for some kinds of water, especially very soft. The hall is now roofed with slates. The architect ought to have laid his lead upon deal boards on the top of the oak, as was done in Doncaster church, where there is also asphalted felt between, perhaps unnecessarily with two strata of boards. I know another church which had to be reroofed because the architect persisted in laying slates on single boards without felt, forgetting that they were sure to shrink and let the wind in beyond the power of any warming apparatus to overcome. Copper has been sometimes used instead of lead, and does not tear so much, but it costs more though it is much thinner, and is more likely to be stolen, as even lead often is by the 'honest British workman,' who not unfrequently cuts off and steals the lead from the house adjoining the one he is repairing; and copper cannot be 'dressed' or beaten into shape at the gutters like lead.

Slates.—The common blue slates will make any building look vile. The old-fashioned gray Cumberland or Westmoreland slates look well, both from their colour and a pleasing roughness. But they are so dear that they are almost disused. There is a greenish Welsh slate which looks better than the blue, but not so well as the gray. Flat tiles look better than any slates on Gothic buildings, and are now so generally used that it is superfluous to recommend them. In some places a thin kind of stone slates are used, of flagstone in Yorkshire and limestone in Northamptonshire, and they make picturesque roofs, but rather heavy; which however does not signify when the timbers of an open roof are as thick as they should be for architectural effect only. The common nibs on tiles are never deep enough to hold safely on steep roofs, and either oak pins or cast iron nails are better. Slates too, especially the large ones, which by some odd fancy are called after the ranks of the female nobility, ought always to have three nails and not only two, so that if one breaks, or the slate breaks away from it it may still be held straight by two, though this is hardly ever done. And it is doubly necessary on very steep slopes. Flat tiles must not be bedded in mortar throughout, or the water draws in under them by capillary attraction, but only laid in mortar at the top, *i.e.* for a third of their length, for they overlap two thirds, or there are everywhere three thicknesses; and the same with slates. I have known tiles laid wholly in mortar have to be taken off. Tiles and slates are or should be pointed from within except when laid on boards; which they call by the odd name of 'torching;' why, I have no idea.

Tie Rods.—The only point in roof construction which I think necessary to notice is that iron tie rods ought to be used in heavy open roofs without wooden tie beams much more frequently than they are. I remember a school having to be rebuilt after a few years because the architect had refused to use them; and in a large church the clerk of the works told me they could not have fixed the principals with all the framing attached to them, if they had not had the ties which I had suggested behind the great arches formed by the principals. I do not mean that there need be horizontal tie rods right across all kinds of roofs, though I have not scrupled to use them in roofs of not very ornamental character. They just make the difference of the roof helping to keep the walls together or to thrust them out, if not at first, yet some day when the pins in the various joints have begun to decay. In that way many a church wall has been pushed out of upright and some have fallen. Some wiseacres at Doncaster have taken out the ties which were put across the very heavy roof of the new Grammar School, though it is of a lowish pitch and therefore specially needs ties, or will do after some years strain upon it.

Mansard Roofs.—This is a name given to a kind of roof formerly fashionable in France and lately introduced here by some architects at every possible opportunity. They are a kind of very steep truncated pyramid, but in two forms: some running up to a ridge like a common 'hipped' roof immensely steepened, and others to a small square top fringed round with iron work, like a square spire truncated. They are generally made to contain bedrooms—an aggravation of the intolerable height to which town houses are now carried, in the greediness which refuses them sufficient area to stand on, and the absence of a proper Building Act. It is difficult to believe that anybody really thinks there is either beauty or convenience in such roofs. Convenience there cannot be, because no room in such a roof can have either any upright wall or a decent window. Beauty cannot be demonstrated, but I believe that these, like most of the monstrosities of modern architecture, are designed not with any serious belief in their beauty, but simply on two principles: one, to be in the fashion generally, and the other to add to it some little queerness of detail or arrangement in order to give an impression of originality. To these designers one shape is as beautiful as another, and their authorities are nothing but the stock designs of the office where they got their education, or which they have made their own by continual use, until they believe that they are genuine Gothic or Italian or Grecian as the case may be. This is no guess of mine, for I have actually known cases where an architect thought he was copying details from York Minster and other such buildings, but found, on my disputing it, that they had only come from the office where he had been a pupil. Perhaps the worst case of spoiling a building with a Mansard roof is the Victoria tower at Westminster, which looked infinitely better before that vile iron roof was stuck on, and would have been better still if the turrets had been lower, as they doubtless would have been but for that. On a tower above all places such a roof is a constructional absurdity, besides its ugliness. Not that anything would make that tower look well, though I suppose it is the largest in the world; for its complete straightness of outline makes it look bursting at the top, like the great tower of Canterbury Cathedral also, and its details are on a scale far too large for the surrounding buildings. It is not to be compared to that of Lincoln in grandeur, though that is much smaller.

Roof Spouts, and Eaves.—Roofs should overhang the walls a good way, both for architectural effect and for dryness. A gentleman told me that he had cured his house of damp by putting on a new roof with very deep projecting eaves. In this respect a roof coming over the gable and finished with 'barge-boards' (as they are oddly called) is better than one kept behind the gable, though it is not appropriate to churches or public buildings of high architectural character; and besides, the walls there are generally thicker than in houses. But church roofs may overhang at the eaves to any extent, and they are generally very defective in that respect; and it is sometimes associated with the worst construction of spouts that could have been invented, *i.e.* spouts cut or bedded in the top of the wall itself. Though they may project a little and be lined with lead it is impossible to keep narrow spouts watertight at the joints, and so the wet gradually soaks in and destroys the mortar and loosens the wall. The best as well as the best looking plan is to carry the spouts on long stone corbels so as to be quite clear of the wall, which has an excellent architectural effect, besides being stronger than hanging them in the usual way with bits of iron at the ends of some of the rafters. Those corbels should be at least a foot long in a building of any considerable size: the spouts are flat-bottomed and slightly bedded in the corbels, which look well even if they are merely long pieces of stone chamfered at the end, but of course may be moulded or carved into handsomer forms. The spouts should be of cast iron, which suffers from wet much less than wrought iron.

Lead Gutters.—An analogous plan in brick buildings with a deep projecting cornice, is to put square bottomed spouts on a course of bricks projecting a little below the top one, and it is desirable that the centre of gravity of the spout should lie just within the bricks, so that they only want screwing to a facing board which is fixed along the bottom of the rafters, without the screws carrying the weight. This is quite different from lead gutters in a channel on the top of the wall. The down spouts or 'conductors,' as they are absurdly called, should also be of cast iron, and look better and take less room square than round, because they fit close against the wall, especially if they are in a corner. Lead ones are sure to get kicked or damaged in time and droop from their own weight. It is sometimes necessary to cut through deep string courses in order to avoid quick turns in the spouts, which get choked up. I have known all the spouts round a church have to be altered and the strings cut through for this. I need hardly say that all the drains ought to be planned beforehand, and not left to take their chance afterwards.

Gutters of roofs within a parapet are generally laid on boards supported by cross pieces of wood, and many a building, including the choir roof of Canterbury lately, has been burnt down from that cause, when plumbers were mending the roof and set their firegrate on the gutters. Besides that, the wood rots and the gutters sink; so that this ingenious contrivance has the double chance of destroying the building by fire and water. At Doncaster church accordingly I had all the gutters laid upon stone, which costs no more, and is perfectly solid. But even then all gutters within parapets involve more risk of water getting in than spouts outside, and require constant attention to keep the outlets free. So indeed do all spouts: their great enemies are birds and vegetation. I have seen a tree growing out of a spout between two roofs of a church in a place not visible from below. Indeed I hardly know what I have not seen in the way of neglect and decay in the upper parts of churches notwithstanding all the fuss that is made about their restoration and decoration. Archdeacons and rural deans should be men of capacity for ascending bad staircases and ladders, and should cultivate an 'eye for defects,' in which too many architects as well as archdeacons are sadly deficient.

Tanks and Cisterns.—There are very few places, outside of public waterworks supply, where it is not necessary to provide large tanks for rain water. Even where there is well water not too hard to drink, softer water is almost sure to be wanted for all other domestic purposes, and there are few places which are lucky enough to have it. And though moderately hard water is generally nicer to drink than filtered rain water, very hard water is injurious to many people. If rain water drops through a good height from the filter it gets sufficiently aerated again to be pleasant to drink. The idea that it is dangerously soft, for want of lime, is refuted by abundant experience. In some places where all the water is quite free from lime, the natives are anything but deficient in the size of their bones. They get as much lime as is wanted into the system from other foods. The provisions for storing water are generally shamefully deficient. I know a great house where the architect employed to put it in order deliberately turned all the spouts into an adjacent river which is too dirty to use, and built a huge water tower and machinery to pump up water which is too hard to use.

It is a generally accepted rule that nearly every country house (which are more spread out and catch much more water than town ones) catches as much water as its inmates want, if it is all stored and not wasted. Allowing for evaporation and the loss of showers too small to produce any run of water, 18 in. of rainfall is the most that can be reckoned upon in the districts of average English rainfall—less in the east and more in the west. And as consumption goes on concurrently with rainfall, tanks which will hold as many cubic feet as the square feet covered by the house must be enough to avoid any waste, or to keep store enough for the dry part of the year. It is true that much more water is used now than formerly, and I doubt if the above rule will hold for houses which contain a good many people for their area all the year round. But a friend of mine has proved it to be true for his cottages, for which he has built tanks in a place where there is no other water, and I have heard of it being found true in moderately large ones, though of course it will depend on whether there is any check on waste. Where there is, 2 cubic feet a day per head is quite enough for mere domestic use.

There is one way in which a great deal of waste may be prevented, and that is by having the watercloset cisterns supplied by clean (*i.e.* not soapy) bath water, instead of treating it as 'slops.' Those on the ground floor can easily be so managed by having a special sink from the bedroom floor to their cisterns; and for the others (or for all of them) that water may as well be pumped as any others, from a cistern in the ground made for that purpose. It may be expedient to have a subsidiary supply from elsewhere in case that is insufficient; but the baths of the bedrooms will be generally sufficient for the W.C.'s on the ground floor.

It is also very desirable in planning a house to have one or more cast iron tanks just below the roof, so as to gain at any rate a large quantity of rain water without any pumping. The amount of it must depend on circumstances, and on the space that can be afforded. Sometimes a tank can be put over a passage, as described at p. 129, or some back room where height is of no consequence, without sacrificing a whole room or enlarging the ground floor of the house, especially where there are three stories in the back and two in front. In other cases it is well worth while to build one outside on walls strong enough to carry it: the space underneath can always be utilized for something, such as coals. It is now well known that cast iron is better in every respect for cisterns than wrought iron, and you can have no other material on a large scale beyond the size of slates. Cast iron joints too never leak after they are once caulked with iron cement rusted. The only place for very large tanks is underground; and most architects seem to delight in showing their superiority to the laws of nature and mathematics by building them rectangular, so that the earth, which is practically a kind of fluid twice as heavy as water and nearly 2000 times as heavy as air (which occupies the empty part of the tank) is always trying to break them inwards; whereas if they are round the pressure of the earth only tends to squeeze the walls together and keep them tight. Another common mistake is to make them too deep, forgetting that an increase of depth by one third, as from 6 to 8 ft. only increases the capacity a third, but an increase of diameter of one third increases the capacity in the proportion of 9 to 16, or not far from double, and also requires no more lift in pumping, which increased depth does. The greatest capacity for a given quantity of walling, including the top and bottom, is where the diameter and depth are equal. It is expedient to make the bottom slightly concave or domed downwards to counteract the bursting pressure of the earth upwards, or what is the same thing, the desire of the walls to sink in loose soils.

In hard chalk no walls are necessary. My friend whom I spoke of just now makes his tanks by merely cementing the chalk and doming over the top, no walls being requisite for carrying the dome, and he says they are found sufficient; and that it is better not to have pumps for cottages, but to give them the trouble of getting out the water with a bucket, as it makes the people less wasteful.

Generally however walls must be built for tanks. It seems that a common 9 inch wall cemented inside is enough, unless the cement cracks, of which there is always some risk. It must be safer to build the walls with cement than lime, or at any rate with hydraulic or lias lime, which does not perish with damp; and better still to back them up with about a foot of concrete. In that case a $4\frac{1}{2}''$ wall is enough, being only wanted to form a case or centre for the concrete. I have known a tank cracked by roots of trees pressing a bit of wall inwards, and the concrete would probably resist that. For the same reason trees must unfortunately be kept away from artificial ponds, or the roots will perforate the 'puddle' and let the water out, though trees are useful in preventing evaporation from natural ponds and so repay much more than their roots steal from the water. All tanks for domestic, and not merely for garden use, should have a preliminary filtering chamber divided by a slate or plate nearly down to the bottom, which is covered with about a foot of fine gravel, not sand, through which the water has to descend and ascend under the flag. This saves having to clean out the whole tank frequently, the filtering gravel, or perhaps only the top of it, requiring to be taken out and washed clean again. The filtering chamber need not be so deep as the whole tank, and so that water can remain in the tank while the filter is being cleaned. This is more important for underground tanks than for high ones which can be let off by taking up the waste pipe.

Pipes freezing.—Pipes exposed to frost, either outside a house or in very cold places inside, are certain to burst some day from the water inside freezing, which expands and cracks the pipe, and then as soon as a thaw comes the pipe appears to burst though it was really done in the frost. The only way to prevent this is to enclose them in a wooden box lined with straw or thick felt, or with that extraordinary-looking wool which is made by blowing steam into the slag of iron furnaces, and which is said to be better than anything else for 'jacketing boilers' to keep the heat in, and as a nonconductor of heat generally. It is also incombustible.

Taps.—I have heard a great deal of evidence in parliamentary committees on water bills about the superiority of 'screwdown' taps over the common 'ground' ones, *i.e.* ground in, which always grind loose in time and so leak; and also about the obstinate resistance of plumbers to them, and how they either wilfully or carelessly make them fail by not taking out the leather washer before soldering them on to the pipe, which burns the leather. They can however be made to screw on without any soldering. 'Autogenous' soldering with lead is in all cases very superior to the common tin and lead solder, which is used because it melts easier; but it expands and contracts differently from the lead, and therefore cracks in time. They are also made of better metal than the common ground taps; what is called tap brass is notoriously the worst of any. Screw taps also have the advantage of not stopping the flow of water quite suddenly, which tends to burst pipes, and will even make water rise far above the level of its head, as in the 'hydraulic ram,' where a stream of water forces some of itself up hill to supply houses far above. There does not seem yet to be invented an entirely satisfactory tap which will close of itself when the hand is taken off, and many a flooding of rooms takes place for want of it. A servant opens a tap and no water comes because there is none there; the tap is left open and in a few hours the water 'comes in,' and of course goes out on to the floor and probably destroys the ceiling under it. There is a kind of screw tap which professes to close of itself after a few minutes, but I am not satisfied that it will keep in that condition long. A weighted lever valve tap answers perfectly, but is large and ugly. It would be easy to make a tap with a spiral spring, which would keep it closed except when it is held open. Such a tap should have a long handle.

Water-closets.—I cannot say that I think a perfect one is yet invented. Bramah's original 'valve' closet, *i.e.* with a valve at the bottom of the basin, is the best in all respects but one; that you are never sure that a bit of paper will not stick in the valve, which forthwith drains off all the water. The old valve tap at the cistern worked by bell wires and cranks is quite superseded by better contrivances near the seat. I think Underhay's the best, which has a lever tap, such as I mentioned just now, prevented from falling suddenly and so stopping the water too soon, by a piston descending in a nearly airtight cylinder. This is equally applicable to a 'valve' or a 'basin' closet, or to any other kind, of which there are several. It is superfluous to say now that WCs without an external window are most objectionable, at least unless they can have a divided ventilating tube up to the top of the house with each division not less than 4″ square. This is independent of the question of a pipe from the trap to discharge sewer gases constantly, which are more dangerous though often less perceptible than the ordinary smell for which the external ventilation is required. The window should be anywhere rather than behind the seat—a very favourite position for it—as it is disagreeable to keep it open there, except in hot weather. Some people think it necessary to provide another sink for 'slops,' which always smells worse than the W C, because that is easily and frequently flushed with clean water and a sink is not. For W Cs in cottages and the inferior parts of a house, and for any outdoor ones, the common 'sanitary basin' (as it is absurdly called) without any machinery underneath, is quite sufficient, working merely by a syphon trap, but supplied with water. In fact, where the water supply is worked by a spring treadle, I consider that the least troublesome of any; but the female mind cannot be persuaded that it is sufficiently elegant for the inside of a house. I must add that the perverted ingenuity of giving a spiral motion to the water entering the basin is a complete mistake, for it destroys the force of the water and makes it wash the basin worse instead of better. Of earth closets I have nothing particular to say. They doubtless answer very well where the earth can be conveniently supplied and is regularly attended to.

Hot water.—Many people are not satisfied now-a-days unless they can get hot water on the upper floors, and most people have not the smallest idea of the quantity of heat and coals they waste thereby, especially if the work is not done very well—and even if it is. The principle of these upstairs hot-water cisterns is simply this: one pipe goes from the upper part of the kitchen boiler to the cistern, and another from somewhat lower in the cistern down to lower in the boiler. Consequently the hottest water, being lightest, is always flowing upwards through the first pipe and downwards through the second. And the same is the case with the much larger pipes which go round a house or a large room to warm it. The result is that the fire is being continually cooled by the carrying off of all that heat with the water; and if the upper cistern is large it is in effect a large cooling tank in the roof of the house, carrying the heat from the kitchen fire into the roof. A bath room with such a cistern in it is kept hot continually at the cost of the kitchen fire. And the further consequence is that you can never get any really hot water early in the morning under these new-fashioned arrangements, nor until all the water in the roof is boiled.

The proper way to do this manifestly is to carry the waste steam from the boiler, which must go somewhere, into a small cistern upstairs instead of up the chimney and let it heat the water, as it soon will. It is however liable to the objection that it is apt to make a noise when it is going into the water strongly, which is heard in the neighbouring rooms; though that is not likely to happen either very early or very late. There are some other difficulties—or alleged ones, as to the feeding of the boiler, for fear the steam should blow backwards into the small feeding cistern which there always is by the side. But all that may be easily overcome by any one with the proper knowledge who will take the trouble. But architects and builders and workmen and servants of all kinds, who do not want to do anything new, can always find or make such difficulties in it that a man who has not time to superintend his own domestic science had better leave it alone, especially if it is anything requiring continued attention. But even the common plan of circulating hot water admits of right and wrong ways of doing it. First, the upper cistern should be as small as will do for ordinary use, so as to waste as little heat as possible. Secondly, all hot water taps should be on the rising pipe, which has the hottest water, and not the falling one which has the returned colder water; and much less on an independent pipe, in which the water will be always cool until a pipe-full is drawn off. Thirdly, there should be two boilers to the kitchen fire, the second being for kitchen use only with the ordinary steam waste-pipe into the chimney. This is recognised by good builders. It must be remembered too that on this system the water in the circulating boiler is always at the high pressure, due to the height of the upper cistern above it; and therefore there is more risk of leakage and of accidents, for the water and steam under high pressure become hotter. It is necessary in every case to keep a boiler pretty full, or it will very soon burn away either under high or low pressure; a high pressure one of course will be quite full if there is any water in the cistern above. A steam pipe must have no downward bends or inverted syphons in its course, or water will condense and lodge there and obstruct the steam of ordinary pressure. Steam pipes and even hot water pipes which have to go far are best wrapped in thick felt or something of that kind, which I mentioned at p. 193, except when they are for warming the air.

Warming by hot water is the favourite plan with most people for warming churches and halls. But the ugliness of the pipes above ground is a serious objection to it, and also the mess from occasional leakages, which cannot be prevented. If the pipes are under a grating a great proportion of the heat is wasted by being sent into the ground. It is some improvement on that to make the pipes hemispherical, with the flat side upwards, and widened out into a kind of perforated web or flange on each side, so that the air warmed by the under side of the pipe also can rise through those holes. But even that is very inferior in effect to pipes completely above ground. I must say however that I greatly prefer warming by what are called gill stoves, *i.e.* those in which a number of wide iron plates stand near together which join at the inner edges so as to enclose the fire. There are two kinds of them; one called Gurney's which are round, with the hot air plates radiating, and the other Stuart and Smith's of Sheffield, where the plates are parallel. And I consider the latter much the best, because they never get overheated; at least I never saw one with the plates too hot to touch, while I never saw a Gurney stove which either was not then or had not evidently been at some time red hot in the lower part; and it is well known that iron much hotter than boiling water burns the air and makes it unwholesome. This is attempted to be prevented by putting a dish of hot water round the bottom of the Gurney stoves, but it clearly often fails; and filling the place with steam is no compensation for burning the air, though it mitigates the effect a little and tends to keep the iron from getting red hot, but not sufficiently. Yet these round stoves somehow or other managed to puff themselves into much more extensive use than the square ones. The patents for both have long expired. They may either be used as independent stoves above ground, or in a separate chamber under ground in connection with channels and gratings for keeping up a distinct circulation of the air to distant parts of the building, and that is thought the best way when it is large. I examined and inquired about all the methods of warming before Stuart and Smith's was adopted in St. George's and

St. James's churches at Doncaster in 1858. There was a wonderful uniformity in the estimates, but I was satisfied that that was on the whole the best though architects generally recommend another. And it is still more decidedly so for a moderate-sized hall where a single stove above ground is sufficient.

Fire-places.—No one who has not tried both experiments in the same large room can have any idea of the superiority of grates with only bars in front of a fire-brick back and sides over those of any shape in iron: *i.e.* where the fire-place is sunk in the wall as usual, not in front of the wall as in stoves, for which the conditions are different, as we saw just now. It is a common mistake with those who want to have as small a fire as possible to put in a lump of fire-brick at the back to diminish the depth of the grate, and also sloping upwards; which is doubly wrong; first because a fire too shallow will not burn properly, *i.e.* not so well as the same quantity of coals in a square form, and secondly because a back sloping upwards sends the heat towards the top of the room, or just where it ought not to go. That has at last begun to be understood and some later brick backs are actually made sloping forward, which is right if the grate is also set high, and not low, as usual.

The fact is that nearly all grates now are set too low. Some people once got it into their heads that the best way to warm the floor was to put the fire on the hearth, or as near it as possible, which is just the way not to warm the floor, because no heat then can radiate on to the floor. It wastes also an immense quantity of heat by sending it below the hearth; and such a fire is particularly disagreeable to the eyes; and it is the worst place that could be invented for ventilating the room: there is a very sensible difference in the quality of the air of a room with a low chimney front and a high one. Another effect of low grates is that a fender shuts off the heat altogether from all the floor near it. Yet this stupid thing was done over and over again till people found out at last that those grates upon hot bars were intolerable. But still nearly every grate is too low. I am sure that there ought to be at least 7″ clear below the bars, and 9″ are better. Moreover you must remember that the top of the fire-place opening must be raised with the bars, or the opening will be too small and the fire will blow up the chimney as when a temporary 'blower' is put on.

Two other wonderful bits of coal-saving science may be noticed. One is the discovery, which was written about in all the newspapers a few years ago, that a close instead of an open bottom to the grate burnt less coal. The revealer of this great secret might as well have gone a step farther and announced that a close front too would burn still less; and finally that admitting no air at all would save all the coals. Besides all this, imperfect or very slow combustion generates carbonic oxide, which is unwholesome, and is apt to spread into the room for want of heat enough to carry it up the chimney: so at least it is said in chemical books, for I do not profess to vouch for that myself, though the utter badness of such stifled fires I do vouch for, and of low ones. Another fashionable bit of science that flourished for a winter or two was that lumps of chalk would do as well as lumps of coal, whereas they do no more than the older invention of fire clay balls, which increase the red hot surface in a tolerably large fire and so make it look bigger and perhaps radiate a little more in the room, but they kill a small fire; and the idea of their actually increasing the heat is absurd. I doubt whether they even radiate any more than a brick back and sides. The sides should of course make an obtuse angle with the back, unless back and sides together are a segment of a circle, which is probably the best shape of all.

Hearths of encaustic tiles with low marble fenders are a real modern improvement, or revival. They nearly always look well, and are less trouble to clean than a quantity of iron and brass work—in fact hardly any. Many people fancy that white or statuary marble is the hardest of any, whereas it is about the softest, and therefore the least fit for those fenders for feet to tread and fire-irons to fall on. Sienna (yellow) marble is very hard, if not the hardest. White marble must be kept quite clear of grease and cleaned with soap and water, but most of the other marbles are improved by a little greasing. I learn this from Mr. Boucneau of Warren Street, Fitzroy Square, whose stock of chimney pieces I advise anyone who wants such things at any rate to look at. The architectural monstrosities in that line that one sometimes sees are prodigious, especially in so-called Gothic houses of much pretension.

Ventilation is generally treated of with warming. I have already said almost as much about it as is necessary. Some ladies, especially in London, are so afraid of 'blacks' that they prefer the infinitely more noxious invisible dirt of bad air, and hardly ever let their windows be opened. The blacks may be kept out to a great extent by wire-gauze blinds of the old-fashioned kind, or by muslin stretched on a frame; both of which are in every way better than those absurd bits of wicker work which have lately come into fashion and do absolutely nothing that a blind is wanted for. Moreover people ought to know that a few minutes' draught right through a room, especially a dining room after meals, with both door and a window well open, will do more to purify the air and will let in much less dirt than a bit of window open for a much longer time. The best way of ventilating halls and schools which require constant fresh air while they are filled with people, when open windows will not be tolerated on account of either cold weather or noise, is by divided large tubes through the roof, depending on a principle which is usually illustrated thus:—If you put a short lighted candle down into a large bottle it will soon go out; but if you divide the neck of the bottle by a card, or by putting a smaller tube into it, the candle will burn, because one division makes itself a down-draught and the other an up-draught. To make the circular spaces equal, the diameter of the inner tube must be not half, but ·7 or rather more than ⅔ of the outer one. If you make two such concentric ventilating tubes of considerable length, they have the further advantage that the down-draught gets a little warmed by contact with the tube of the up-draught. The only objection to them is that these chimneys generally look very ugly in the roof; but they may he enclosed in square fabrics with louvres like bell cotes, which do not look inappropriate on schools and some other buildings, though they will not do for churches on account of their defacing the roof. Besides they can always have opening windows in the clerestory if there is one. Bedrooms with fire-places ought never to have the chimneys closed, and for that reason I would never allow a register stove in one.

Rooms without fire-places should have some constantly open hole or holes as high up in the room as possible, into the roof or the passage. Such holes are often well placed behind the top architrave of the door so as to be invisible, though the love of bad air and stuffiness is so inveterate that you can never be secure against such openings being stuffed up, and the best way perhaps is to let the doors have a wide opening, or we may say, fit badly both at top and bottom in all bedrooms. I have seen pretences of ventilating rooms by some small holes in the cornice leading into a tube going somewhere, of which all that can be said is that they are a little better than nothing. I need hardly say that small rooms are harder to keep at a pleasant temperature and well ventilated than large ones. I advise everybody building a kitchen not to be persuaded to have only one chimney, in the belief that nothing but a close grate or 'kitchener' will ever be required. In time people will find out that they save nothing and that the smell of the kitchen cannot be kept out of all the house. I never saw one where it was. Then if you want an open grate afterwards and also a 'hot plate' stove for occasional cooking, you will be baffled by the architect not having provided any chimney for it.

Skylights are notoriously difficult to keep watertight, from several causes. If they have not a very steep slope the wind drives the rain under the overlap of the glass, and then it runs down inside. Consequently the panes should be as long as possible. Again if the putty has separated the least from the bars, the wet soaks in. And this is particularly liable to happen with iron bars, from their continual expansion and contraction, which often cracks the glass besides, especially if the panes are large. Setting windows in stone without any frames is still worse, for the same reason; I have seen a large window full of plate glass cracked all over in that way by the frost. Then as soon as a drop of wet gets into iron frames rust begins and widens the breach, and wet settles there; and that freezes and cracks the glass still more. In this respect, I mean as to destruction by rust everywhere, wrought iron is always worse than cast. The only chance then of keeping skylights tight is to have the bars of wood, strong enough to bear snow without bending, and wide flanges for the glass to lie on, and well painted at first before puttying and after, and kept so constantly. Nothing is worse economy than saving outside painting: inside is of little consequence except for appearance. And that is no less true of oak than deal externally. It is remarkable too that an oak door painted oak colour looks much better than a deal one; and though imitation oak painting is specially denounced by architectural prigs, it is the most lasting kind of painting by reason of the varnish. But varnishing alone will not preserve unpainted oak exposed to the weather. This therefore is a case where the sham is actually better than the reality. I have already spoken of those larger skylights called lanterns. Glass tiles, either curved or flat, make a very sufficient skylight among tiles or slates where you do not require them to be perfectly watertight, as for various kinds of out buildings.

Windows.—I have already spoken of windows in relation to the plan and masonry of a house, reserving further details of their construction. Dismissing French or Italian ones as a relapse into barbarism, for the reasons given at p. 149, at least for nine months of our year, except in the single case of wanting one to serve also for a door, I just mention two other kinds before considering the common up and down sashes, the most usual and rational kind of window for ordinary use. One is sashes sliding sideways, which are sometimes convenient, as they require no weights, and are easier to manage when the window is low and wide. They are also very cheap, and in every way suitable for cottages or small upper rooms, but require a little care to prevent the rain driving it at the bottom, *i.e.* they required a proper bead and groove to run on and a channel to drain the water off. I have had no trouble with them, though I once lived three years in a room with them and have had them made since in houses of my own; but for some reason or other they have gone out of fashion and I have found architects unwilling to adopt them.

The other kind are common enough in very small windows, *viz.* sashes swinging on horizontal centres, or pivots; which however are invariably made wrong, and with the most persistent obstinacy, if you do not with equal obstinacy reject them until they are right. I have just seen a whole lot of them made wrong although I had specially ordered how they should be made. The architectural mind seems incapable of appreciating the mathematical fact that a window hung on centres in the same vertical plane as the centre of gravity when it is shut, *i.e.* in the middle plane of the window, is a mere pendulum offering no sensible resistance to any force tending to displace it only a little from the vertical position; *i.e.* the slightest puff of wind into the room, as from opening a door, will blow such a window a little open, because the lower part is longer than the upper. Consequently such windows will not keep shut without being either tied down inside or weighted outside. Whereas if the pivots are put inside the window, as well as above the centre of gravity, its weight tends to keep it shut and will resist a moderate force tending to blow it open.

The modern passion for making window bars as thin as possible, even when cheapness is no object, is extremely foolish. The difference between the thinnest possible bar, and a fairly thick one is quite inappreciable in either light or weight, while there is a very great difference both in their actual and apparent strength. They should not be thinner than an inch (finished size, not a builder's inch, which is $\frac{3}{4}$) where the panes are as much as 16 inches wide, and $\frac{7}{8}$ for small ones of ordinary size. Old ones were undoubtedly too thick, especially for the small panes which only could be made then. For very large panes $1\frac{1}{8}$ is not at all too thick and looks well. All I need say about plate glass is to remind you that it has to be thicker and heavier the larger the panes are. Windows have increased enormously in weight since plate glass came into use for the whole of a sash or even half of it.

Sash-pulleys.—Here I mention a small invention or improvement of my own in pulleys. Some new ones of superior make were brought to me to look at, with large cast-iron pivots running in cast-iron cheeks; for it is curious that cast iron works better on cast iron than any other metal. But it is also desirable to be able to oil them, especially for heavy plate-glass windows; and for that purpose I have had them made with a pair of ears behind the front, with two oblique holes leading from the pivots to the front plate, in which there are corresponding holes, down which a little oil will flow easily. You can make nothing of attempting to oil them in any other way. The man who brought me them without holes actually talked of taking the pulley out to oil it: *i.e.* holding up the weights, or the window, unscrewing the four screws, oiling, and putting in again! It only proved that he knew they wanted oiling and did not know how to manage it.

Another difficulty arising with heavy windows, or indeed with any tall ones (as all windows ought to be) is how to open the upper sash, which is much the best to open in bedrooms, and often in living rooms too, when it is not desired to leave the room exposed to visitors from outside. The simplest way is to have a ring fixed under the top bar of the upper sash, and to keep a rod in the room with a hook at the end to pull the window down or push it up. And I don't know that there is any objection to it. Another and rather easier plan is to fix a strong pulley above the window, with a kind of endless rope over it, *i.e.* with the two ends fixed to the same hook in the upper bar of the sash, the rope hanging down in a narrow festoon in the middle. This is particularly adapted for bedrooms, where there is generally a dressing table before the window, and the appearance of the rope hanging down is of no consequence, which it may be considered in drawing-room windows which have no middle upright bar. There is another patented plan on the same principle, but more complicated, and it involves a pair of ropes and handles hanging on each side of the window, and requires the use of two hands to work it. I prefer the single rope in the middle very much and have had it in use for many years in such of my windows as required it. I need hardly say that windows cannot be properly cleaned without a ladder unless the upper sash does open, and they are made to do so in all decent houses now, though I had to alter them all through a house in London thirty years ago. When you wish either the upper or the lower sash of a window to keep generally closed, the best way is to make it overbalance the weights if it is the lower one, or the weights overbalance the sash if it is the upper one—only not enough to bang up or down. This is often desirable in servants' room windows looking into the garden, with the lower panes of fluted or rough glass.

It is a small matter, but worth notice, that the projecting hooks often put on the lower bar of sashes of one pane are always catching the blinds, and that either sunk openings or rings above the bar are the proper way of enabling you to lift them when there is no cross bar to take hold of. Another thing which often gives some trouble is this. When the old-fashioned endless blind string is used going over a small pulley at the bottom, the string is continually getting stretched and loose, and nobody seems to observe why. It is because every pushing up of the lower sash bends the string and so stretches it, and in time breaks it. The simple cure is to put in a smooth pin or hook for the back string to go over at the same place where the sash would cut it when raised as high as possible. The strain upon it is then constant instead of variable.

Blinds.—As I have to mention blinds I warn everybody against spring rollers if they care about having any certainty of the blind going up straight. Tassels are also troublesome things and always getting in the way of your eyes. The best arrangement for blind-strings is to have one end attached to the bottom rod of the blind, and the other to the roller at the top in the usual way where the old double string is not used. The string hangs in a festoon or *catenary*, a very elegant curve, and is always at a convenient height whether the blind is up or down: otherwise you have two tassels to dispose of, and to get dirty, and one is often on the floor. Venetian blinds, whether of the drawing up kind or with thick louvres fixed in frames or hinges, are much more effective outside the glass than inside, though more difficult to manage, and the pulling up ones are of course more liable to be damaged by weather when outside. Thick linen blinds outside, close to the windows down nearly to the bottom, are the worst of all, cutting off all the best light and admitting the worst. There are some made of thin strips like wicker work, only with strings instead of wicker in the vertical direction, and going on a roller at the top, which admit a fair quantity of light in sunshine and also enable you to see out, but not outsiders to see in, and these I think the best on the whole for outside blinds in a very hot aspect. The best internal blinds for the lower part of windows are the old-fashioned wire gauze.

After some years' trial I have come to the conclusion that copper wire rope sash lines last no longer than *good* hemp ones, either twisted or plaited. But properly twisted ones of four strands which will not untwist are hard to get, and the common plaited lines are rubbish, and look like mere tow when untwisted. The good plaited ones are composed of distinct fibres down to fine threads (Buckingham's); the difference is just the same as between coarse thick string of one twist and whipcord, or 'blind-line;' which is composed of a succession of twisted strings. A recent invention, of a sash line made of a pair of narrow steels wrapped round with copper wire, must have come from some crinoline steel maker in despair at the female change of fashion to close skirts. The steels and the wire surfaces must rub over each other with a heavy friction all the time they run over the pulley, which wastes force or makes the lifting harder and tends to break them.

Window fastening.—There are several contrivances for preventing the common lever window fastener from being pushed open from the outside by a knife. The simplest and therefore best of them all is Hopkinson's, with a kind of shoulder to the lever, which pinches a knife tighter the more it is pushed. And that, or some equivalent fastener, is expedient, to hold the windows fast against both thieves and wind. The old-fashioned loose thumb screws did that most completely, but they are liable to be lost, and look untidy lying about; and as they take a little time people will not use them. There is also a new contrivance for holding the sashes together at some definite intermediate height, and pulling them up and down; but it involves two cords and two handles on each side of the window.

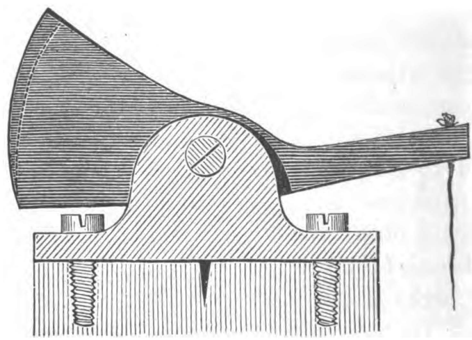


Fig. 12.

I have invented this much simpler one (fig. 12) which will act anywhere, and allows the windows to be shut without lifting it, though not to be opened any farther, and also prevents their shaking by the wind. It is nothing but a short weighted lever with a heavy eccentric end, fixed on pivots to the top bar of the lower sash, so as to press against the upright or side rails of the upper sash.

A couple of sharp pins are fixed in the plate to help you to screw it in the right place by trial. A string hangs from the tail of the lever, which you pull down when you want to open the window, and either hold by a loop on to a pin, or pull the string through a bit of india-rubber nailed to the window, which will hold it by friction. When the string is let go again the eccentric falls and will jam tight if you try either to raise the lower sash or to lower the upper one, and also if the windows shake with the wind. I do not mean that this fastening is impregnable when the window is a little open; but impregnable fastenings are not required then; and when the windows are shut, if the 'meeting rails' are properly rebated so as to overlap each other I do not see how anybody outside could lift these eccentrics without boring holes through the window frame, if he could even then. It must be remembered too that no one can reach the middle of a tall window outside with a sill a yard above the floor. These fasteners may as well be made of cast iron as of brass, and indeed are all the better for the eccentric face not being very smooth, especially against hard and smooth wood. They are not patented, any more than my pulley oil holes; so any one can make them. I am aware that the meeting rails are constantly made with only bevels and no rebate, because it is less trouble, but they are better with it, especially with a view to keeping out wind. The two bevels and the rebate together make up the thickness of the 'parting bead' between the sashes.

A habit has grown up of making the bottom rail of windows as much too deep as it used to be made too thin, in order to make room for sunk 'lifts' to put your fingers in, where there are no cross bars. These very deep rails are ugly, and shut out as much view as if the sill were 2 or 3 inches higher. The lifting can be done just as well by rings on the top of the bar.

Doors.—I have spoken of the mouldings and panels of doors as involving architectural principles of construction at p. 96, but I have a little more to say about their shape. Look at the doors of any good house of the last century and compare them with either the grandest or the poorest doors of almost any similar house now, and if you have an eye for such things you will see the superiority of the old ones probably in every respect. I only say 'probably' because there are a few good ones made still and there were always some bad ones. But the great majority have the feeble, stuck-on, sprawling mouldings which I spoke of before, and thin panels, or some new-fangled disposition of the shape of the frame and panels, which the architect has thought would look original, or Gothic, or something else requiring very special treatment; or very likely all those faults together. No pattern looks so well as the old six-panelled door, exhibiting a cross in the top, which makes a handsome figure in itself, unless they spoil it, as they sometimes do, by making the head as long as the arms, or longer; for I have seen even that. The top panels should be very distinctly wider than their height, about as 4 to 3, and the grain of the wood horizontal, not vertical as in the long upright panels. It is odd that such a small thing as that makes a great difference in the look.

The best height for the handle, and therefore for the middle of the cross rail, is 3′ from the floor, to suit the average height of male and female hands. It is true that some doors of the last century were very tall and had a pair of small panels at the bottom, making eight altogether; and the handles consequently higher; but they were exceptional and are ugly and inconvenient. In the inferior rooms, however, with doors under $6\frac{1}{2}'$ high and $3'$ wide, we may be content with four panels and square-edged rails.

Gothic oak doors or stained deal ones may perhaps be made with three narrow panels in width, provided the outer rails are kept wide enough to look—and to be—strong, which they very often are not. For if the rails are not wide the mortices have not bearing and leverage enough to keep a heavy door from drooping in front and making all the joints gape. The best thick doors, of any heavy and strong wood, should have double tenons in the thickness, though not one person in 1000 or more will ever see it. But anyone who understands carpentry will know that they are far stronger than single ones, in several ways, having twice as many surfaces for the glue to hold by, and more than twice as capable of preventing the styles from twisting just enough to open the joints on one side or the other, which is fatal to the appearance of an unpainted door. This also I learnt from Mr. Longmire of Osnaburgh Street, who volunteered to do it for all the thick doors in the house I have described.

Another odd fancy of some people is that doors can be made to look better by running a bead down their middle, making a pretence of their being double, or folding; which is a very bad thing in itself, even when real, for doors of ordinary width, because it practically results in using one narrow door, which looks very inferior to a handsome large one, and also because folding doors never fit firmly, *i.e.* the under one is never firm, except church doors with heavy bolts at top and bottom. The Gothic builders never divided doors unless they were wide enough to make two large ones. Then came the usual modern fallacy that the eye can be tricked into believing that things are large by dividing them into small parts, and we are expected to be deceived into thinking a common door a grand one by making a sham slit down the middle, which only spoils it. The best looking size for the doors of a large room is about 3′ 6″ by 7′ 4″, and for a moderately large one 3′ 3″ by 7′. But 3′ is quite wide enough for practical purposes and for small rooms.

Hinges are generally specified in first class houses (as the builders call them) to be of brass, the very worst material for heavy doors such as those are likely to be, being much too soft. It is slightly improved by steel washers at every joint if they are also kept oiled, which they very seldom are. Consequently they wear down in a few years and leave ugly gaps and let the doors fall too. Even wrought iron is inferior to cast iron of sufficient thickness for hinges of heavy doors, for cast iron on cast iron wears longer than anything. I have had large cast iron hinges, both long and wide and with steel instead of iron pins, made for some unusually heavy mahogany and oak doors. Of course they cost more than usual, but less than brass ones would have done, especially if fitted with steel washers which is their only chance of wearing long. Heavy doors and long shutters should have three hinges and not two as usual, the extra one above the middle of the door, and the screws must go into blocks behind the ordinary 'lining' or door case, or they will pull loose in a few years, beyond any power of fastening them again. A good width of hinge makes a great difference in the leverage and strain upon the screws.

I warn people against rising hinges for making doors swing to, especially heavy ones, as they never keep firm: besides, I think a door which will not stay open when you want it is a nuisance, except in special cases, and for them some kind of spring is better. A mere long bit of steel wire fixed to the door at one end, near the top hinge (say) and to the architrave at the other end, so as to act by torsion, makes a very good door-spring, and a quiet one, whereas the common door springs are abominably noisy. India-rubber springs are also quiet. Window-shutters should leave some space above them to let light into the room even when they are closed. I see no use in divided shutters in that case, and they look better all in one length.

French polish.—It is better not to varnish or French polish oak before it has been left for some years to get dark; and then you will probably be so well satisfied with its appearance that you will like to keep it. Church work is entirely spoilt by varnishing. But you must bear patiently its looking dirty for a year or two. Yet it is extremely difficult and requires some resolution to prevent all the oak work, even in a church, from being rubbed and polished with bees wax or some other stuff. I stopped it in Doncaster church after a little had been done. For a year or two people kept talking about the dirty look of the unpolished oak, but by degrees they found that it came right and now looks just as it ought to do, and goes on improving. I am glad to see Sir G. Scott has left all the new oak in Bath Abbey unpolished. Mahogany however, and Spanish especially, goes on getting darker under the French polish, which is really necessary to bring out the beautiful 'figure' or natural colouring of the wood. The common or Honduras mahogany improves very much by mere oiling, and in some cases looks even better than when French polished. There is an intermediate kind of mahogany called Tobasco, which sometimes passes for Spanish, to which it is by no means equal.

In some cases mahogany, and still more, oak and deal flaps or wide boards on hinges, are spoilt and made to crack by the fillets at the edges being 'mitred.' (A mitre is a joint at 45° of two pieces with the grain at right angles, which makes all mouldings fit when there are any.) But the worst of mitred joints is that the very smallest shrinkage or swelling tells on them severely, and opens a wide crack either at the inner or the outer edge; and therefore it ought never be done unnecessarily in wide boards, where the whole shrinkage will tell upon the mitred joints of the fillets. When they are left square a little shrinkage or swelling produces no visible effect, provided of course it is not enough to crack the board through the middle. Wide boards for drawing on, being of deal and unpainted, and wide table tops, are specially subject to this defect, and are sometimes screwed to fillets or bearers, with 'slotted holes' to allow a little play for damp and dryness. It is by no means a waste of money to spend a little on painting which will never be seen again at the back of panels against walls, to keep the damp from affecting the wood.

Oak floors are generally made now of thin and narrow bits of foreign oak or 'wainscot' nailed at the edges on a thicker deal floor and glued at the edges, and also to the deal in order to keep them all as flat as possible. English oak an inch thick is so strong that it will not keep absolutely flat. Nevertheless it looks so much better than wainscot that I prefer it, especially for such a place as a hall, and where the floor is not going to be kept polished. For a wainscot floor unpolished shows very little more than dust colour, while English oak has a 'figure' quite strong enough to show under any use if kept clean, as of course it would be by occasional washing. And I am told, but have not yet had experience of it, that it should be washed with hay tea, *i.e.* with an infusion of hay in the water to darken it: otherwise washing tends to make oak white, which spoils it. English oak boards thick enough to lie alone must be screwed down, for they will tear up any nails, and the screw heads counter-sunk and covered with bits of wood, or with putty. I consider polished oak floors a special contrivance for breaking legs and other accidents, and an utter abomination; and encaustic tiles are not much better. Well made deal floors look nearly as well as oak when coloured round the borders between the wall, with a loose carpet smaller than the floor, as the carpets on oak floors generally are; and they should not be nailed down with tacks which spoil the floors, but either quite loose or with a few rings hooking on to permanent nails.

Fixing floors.—The practice of 'matching' floor boards, as builders and architects call tonguing them together, is rather out of fashion, though I suspect for no better reason than that it is invisible. But it is still frequently prescribed in specifications for good houses. There is however a better reason for omitting it, *viz.* that cutting the grooves leaves the cheeks on each side of the groove too thin, and they are consequently liable to turn up and splinter off; and this is especially the case if the tongues are made of hoop iron as they generally are now if there are any; for the iron rusts and swells and so splits the wood. When it is really necessary for keeping out dust to have tongues they are best made of wood cut obliquely across the grain: otherwise they have no strength themselves. Ordinary floors are all the better for the ventilation between the boards, which never remain so close as to be airtight. Of course no tongues do anything towards preventing them from shrinking if they have been put down before they were as dry as possible, or before the plaister of the room was dry, or even if they are planed over afterwards. There is not the same objection to dowels or pins, and where the floor is wanted to show no nails, as floors of billiard rooms which have no carpets, the only way is to nail each board obliquely by the advancing edge and dowel the other edge to the preceding board, making them all narrow. I have seen a pitch pine floor so made in which I could not see a crack. The thin oak floors laid on deal are made in that way.

Hurry in building.—The fixing of floors with no cielings under them should be postponed as long as possible, in order that they and the rooms may be perfectly dry, if you mean them to be like that same pitch pine floor, which was in a house not hurried up in a year, as nearly all my friends have done who have built houses, but taking two or three. It is absolutely impossible for any house to go through all the stages requisite for drying one thing before another is begun, in much less than two years. Yet nothing is more common, even in large and costly houses, than to see men plaistering down to the floors, and even the skirting boards, which have been put in before the walls were dry from their own building. Unfortunately nailing down a floor over a cieling is apt to shake it loose, and therefore in upper rooms we must risk the damp which inevitably rises from the cieling plaister. But there is no such necessity in lower ones, which are the most important, and there the nailing down of floors and the skirting over them may even be postponed—and I have known it so—until the rooms have been lived in for some time with fires. Kitchens now generally have deal floors instead of the old-fashioned stone, and there it is especially desirable to leave the boards loose till they have been exposed to the fire for a few months. The present cut floor nails cannot possibly be pulled up with the boards if once nailed down, as the old ones could, which were forged separately and much smoother.

Parquetry Floors consist of squares made up of bits of oak glued together in patterns, and sold separately, and then nailed and glued down on a deal floor. In a certain way they look pretty, but their apparent weakness of construction is offensive to mechanical eyes, especially when the joints open, as many of them in every floor invariably do, sometimes very wide.* In nothing is the inferiority of nearly all modern work to old so striking as in the standing of wood panels of all kinds without cracks. You can get it done perhaps by a few of the very best builders; but in former days it was done by common ones, as you may see—or rather might have seen till lately—in oak and elm doors of farm houses and others, and in quantities of church pews of the last century or two, which have been *restored* away for the vulgar and ill-made rubbish of most modern architects and builders, who, with a little ingenuity and care, might have modified that excellent old oak work into seats of better shape than the old ones undoubtedly possessed.

* If anybody wants to see what it is liable to become let them look at the floors of the new Royal Academy rooms. A greater waste of money was never perpetrated than laying such floors in such a place; which however is no excuse for their cracking as they have.

Sound-proof Floors.—It is thought inconsistent with the character of the best rooms in large houses to be able to hear the noise of people overhead. The only way to prevent it is to have the cieling joists distinct from the floor joists over them. They may, and almost must be, fixed to the same great beams over a wide room, but that transmits the sound very much less than when floor and cieling are fixed to the same joists. A still more complete floor, when the room above is likely to be very noisy is to lay something of a loose kind over the cieling on thin boards. Sawdust, straw, and shavings will all answer, but they are all dangerous on account of the risk of fire from a match or a cinder falling through the floor. Gravel is still better, and I always recommend it over belfry cielings when there is not a room between the belfry and the bell-chamber, but it is too heavy for ordinary house cielings. There remains only what is called 'pugging' or plaister upon laths, which is in fact a second cieling; and felt, either the common very thick felt which is made for such purposes and for wrapping round pipes, but is by no means incombustible, or that new slag-felt which I mentioned at p. 192. But I am told by an architect of considerable experience that he thinks pugging does not make much difference, and that if the cieling joists are independent ordinary noises will not be heard through. I have no doubt that it is inferior to all the porous substances which break the waves of sound much more than anything that becomes solid like plaister. Wooden or lath and plaister partitions between rooms should be filled with shavings, if you wish to keep them tolerably sound-proof; and a single door between rooms is quite inefficient for that purpose.

Closets.—It is wonderful how much trouble is frequently given by the omission to provide proper closets for buildings of all kinds, or any room to put them afterwards. It is impossible to suggest any general rules for them. I can only advise people to consider and inquire of their friends what provision of that kind is likely to be wanted and generally is wanted in similar buildings, and then to see in the plans that it is provided, and not to take for granted that it is or will be. They should always have both light and ventilation if possible. I do not mean W.C.s only, of which I have already spoken, but closets for linen, china, and other things. A borrowed light will do for some purposes if it is opposite to a window and high enough not to let the room be overlooked from the closet. In churches there should always be a large closet provided for the sexton's tools, and for coals if the stoves are above ground; in some places large enough for a wheelbarrow and spades and also for the bier. I have known great inconvenience and dirt caused in churches by the want of it, and yet it is hardly ever thought of in plans; and as superfluity of area is the last kind of redundance which architects think of any value it is often impossible to provide such a place afterwards within the church at all, and so some shabby lean-to shed has to be built outside.

You must not even assume that a coach-house will hold as many carriages as it professes to do, without measuring the plan. I have seen one built by an architect whose chief experience was in house-building, with the assurance that it would hold two sets of carriages, large ones behind and small in front; and behold, when it was too far built to alter it was found to be only 17 feet deep, while every full-sized carriage is 13 feet long, as he could have ascertained in five minutes. The least that will do for that purpose is 24 feet deep. Just in this same way I have frequently been assured that churches would hold from a quarter to a half more people than could sit in them. With some people neither space nor time seem matters of calculation or measurement, but of mere guess.

Locks, being good or bad, materially affect the comfort of a house. There is however one apparent cause of locks ceasing to act for the purpose of keeping doors shut which belongs rather to the doors and the hinges. Either the doors are so ill-made that their joints in the frame have given way, and the front drops, so that the spring bolt of the lock comes below the hole in the 'striking plate,' or else the same thing happens from the failure of the hinges of which I have already spoken. I cannot go into the construction of locks here, and as to locks for the purpose of extreme security I may refer to my article on them in the 'Encyclopædia Britannica' (afterwards reprinted in a book with the article on clocks).

But extreme security against skilful lockpickers is not much wanted in house door locks, and there is little to be considered except the general goodness of the construction and ability to keep in good condition under the constant banging to which they are liable. I may say that the small bolts worked by a second smaller handle inside the room are now generally abandoned; and they are of course useless if a key is left in the lock. If the locks are really good ones, so that no key but their own will open them, every lock and its key throughout the house ought to be numbered, or you may spend hours in finding the right one, if they are all taken out, as they sometimes will be; especially as the keys of the best locks look the most alike; for the difference depends, not on complicated looking wards, which are worth nothing for real security, but in imperceptible differences in the stops or notches, which in good locks work four levers or tumblers while common locks have only one. Without advertising any absolute superiority of one maker's house-door locks over all others, it is a fact that the great improvement in the construction of domestic locks, as well as of bank and safe locks, was begun by Mr. Hobbs from America in the year of the Great Exhibition, when he picked all our best English locks, and invented a new one of his own—not the famous and costly 'changeable' lock, but one costing no more than Chubb's or Bramah's which he taught us to pick. The firm is now Hobbs, Hart and Co., of 76 Cheapside, and Mr. Hart has from time to time introduced fresh inventions and improvements; and at any rate I can say that I have seen no house locks superior to theirs, nor any safe locks equal to them. Nettlefold's door locks seem equally well made, and nobody can do wrong in having either of them.

There are different tastes as to the mode of fixing in what they call the 'furniture' or 'follower,' which ordinary human beings call the handle. (For some mysterious reason trades of all kinds seem to dislike ordinary language, as you will soon see if you look at a specification and try to understand it without previous experience.) There may be other locks as good as these which I have not examined; but I have seen some of very inferior make substituted by a great architect's managing clerk throughout a large building for Hobbs's which were in the specification. I found it out just in time to have them all sent back, and of course the architect (who was undoubtedly ignorant of the transaction) said it was very wrong, but could not believe that his excellent clerk could have had any but the best unknown motives for so going out of his way to meddle with a matter he had nothing in the world to do with, and to spoil his master's work, for he did not even pretend to think the substituted locks any better. The moral of which is, that if you mean to have locks or anything else of any particular manufacture—or in short to get anything done as you want—there are two operations to be performed; one to order it, and the other to see that it is done. Until we acquire the common sense to make it a criminal offence for any agent employed by one party to receive anything from the other party to any transaction, bribery of agents not to do their duty—as bad a form of cheating as any—will continue and increase.

There is one mode of fastening on the 'furniture' or handles which I warn people against, as peculiarly bad in the long run, however well it may answer for a time, and that is where the handle pulls against the screws which fasten on the bosses or wide rings under the handle. Such screws are necessarily very short and are sure to pull out after a time. Such an invention, and its adoption by multitudes of builders, is a proof how little they care about the durability of anything. The old-fashioned short screw in the handle itself (though not the older one right through it), is nearly as bad. The three best plans that I know are Hart's (Hobbs and Co.), Nettlefold's, and Macey's, but I cannot describe them here; the builders all know them. Macey's I have seen under another name, I suppose by some trade arrangement.

Latch and Safe Locks.—Some years ago I invented the addition of a small 'spring curtain,' or steel plate which is pressed up against the key-hole of street door locks, to keep out the dirt of London and other such places. It does not really cost sixpence to add, and plenty of them have been made at Hobbs and Hart's; but I have heard of shopmen making absurd difficulties about them without any authority except their own ignorance. I also introduced a mode of locking safes without the key, and yet without the inconvenience and risk of spring locks, which lock by merely pushing the door to, to which there are various objections, except for street doors and boxes. By turning the handle which works the heavy bolts of the safe as far as it will go at first you merely shoot them, but by pressing a button and turning the handle a little farther you fasten the lock so that it requires a key to open it. Masters who want to go away and do not like to leave their keys, but have a clerk that they can depend on to shut the safe, can thus have their safes locked after they are gone. Mr. Hart makes these also.

Bells of proper thickness to sound well, for either rooms or hand dinner bells, are no longer to be bought in shops, as it is nobody's interest to put more than the smallest quantity of metal into them, and not one person in 10,000 who buys them knows anything about it, or how they will sound at a little distance. If you want good ones you must specify that they are to be of thicknesses running from a 16th to a 20th of the diameter: that range being necessary in a set of house bells to get sufficient variety of note without an inconvenient difference in size. Larger ones, such as dinner bells, and still more for outside use as clock bells, must be still thicker, not less than a 12th or a 13th of the diameter, as explained in my book on Clocks and Bells.

Altering houses.—Though it would be absurd to say that houses should never be enlarged or partially rebuilt, yet many a man repents when it is too late that he has spoilt his house for ever for the sake of keeping two or three old rooms. The best excuse for it is that the work in them is generally superior to any new work that he can get now, both in substantial and in decorative construction; and also, that a new plan nowadays is often no plan at all, but a mere throwing together of rooms with the avowed intention of their looking irregular and accidental, as if they had been done from time to time, of which I have spoken in the second chapter. It is impossible to suggest any rules on such a point, but all experience suggests that, if it is fairly doubtful whether you should rebuild or add, then it is almost certain to be best to give rebuilding the benefit of the doubt, if you can afford it, and can trust your architect or yourself to make a better plan for the whole. One thing is quite certain: a small house turned into a large one, either by one alteration or by several, is invariably a failure. In like manner many a person repents of not having made his best rooms a foot wider, which increases the cost very little unless it affects the whole plan, but the comfort and appearance of the rooms a great deal. On the other hand, the cost of what is called 'making a place,' *i.e.* building a house and its appendages in a field, necessarily exceeds all calculation, besides taking many years to get over the appearance of novelty, unless you have been singularly lucky both in your site and your designer and your builder, even if you fancy you are building in the most genuine antiquated style. A quiet-looking square brick house in the fashion of the last century (provided it has not blue slates) will appear older in a year or two than ninety-nine out of a hundred of the fussy and pretentious mansions, all roof and chimneys and gables and projections, which architects and their employers believe to be extremely Gothic or old English.

Cost of building.—I wish I could give more information than I can as to the probable cost of building a house of any given size; but their conditions vary so much that it is impossible to give more than a very general idea of it, at present prices; and how much more may have to go in beer and idleness as the world goes on being educated, it is impossible to guess. If any optimist likes to persuade himself or be persuaded that the quantity of work done varies inversely as the number of working hours in the day, or does not vary at all (assuming men not to overwork their strength) I am not going to argue with him, any more than with one who believes that all men are born equally clever. Taking things as they are, they appear to me to justify the following rough estimates.

The Ecclesiastical Commissioners' parsonages are a convenient standard for what may be called a moderate-sized, or perhaps I should say a rather small gentleman's house, and they have a fixed standard of size and conditions. About forty years ago 1,000*l.* was enough for those houses: indeed some were built for less. I remember their being advanced to 1,100*l.* Now they allow 1,600*l.*, and that is not enough to include the necessary incidental expenses. Such a house will contain about 1,800 square feet of ground floor; so that nobody need reckon on building one for much, if any, less than 1*l.* a square foot of internal area. And you will not build one of twice the area for anything like twice the price. I assume them to have the usual heights of country houses in each case, say on the average 30 feet of wall above the ground for the large one, and 23 for the small, exclusive of gables. Still smaller houses in the same way will be something less per foot.

Large houses cost more for their area and height than small ones because everything in them is done more expensively: the walls will be thicker—or at least they ought to be; the beams thicker also because longer; passages and stairs larger, and more room wasted for the sake of appearance; besides the merely ornamental features which may run to any cost, far beyond the *2l.* a foot which ought to be sufficient for a good house containing an area of 5,000 ft. An area of 10,000 ft. will probably approach *3l.* a foot. But at that size it is useless to think of estimating without a plan, because such houses depend more on the fancy of the architect and his employer than smaller ones. You may easily interpolate an approximate estimate for any other size between these limits. If the heights exceed what I gave of course the cost per foot of area will be greater. Some perhaps are done for less, either under some exceptional advantages or by building in a flimsy and unsubstantial way, if not complete scamping. But probably these estimates are oftener exceeded than excessive. Up to a very large size you need not trouble yourself for this purpose about the particular plan, but make up your mind what ground floor rooms and hall you want, and their sizes; and then, however they are put together, in any plan decently compact, the expense will be much the same. Other modes of calculation, by cubical contents, may be found in books, but I have found them no more certain as to the result than mine, and considerably more complicated; and they must all be varied by local circumstances affecting the carriage of materials and other things.

Dinner tables.—Though I do not propose to speak of moveable furniture generally I must make one remark about the construction of tables on a point which affects the comfort of nearly everybody who has to sit at them. It never seems to occur to table-makers that either the legs or the framing between them which carries the table can possibly be in the way of human legs which have to sit under it, and they think it may be of any depth. Further than that, in an evil hour, some genius who knew where to strike the folly of mankind, invented what he called telescopic tables, which contain a system of elaborate sliding framework all for the purpose of doing what a couple of strong sticks or bars do just as well, and better, viz.: supporting the extra leaves for turning a short table into a long one. It seems never to have occurred to anybody that the pair of sticks or bars can be put away with the leaves when they are not wanted; and if necessary, two pairs of them of different lengths, instead of all this 'telescopic' framework, which costs more pounds than the loose bars cost shillings, and seems designed with the special object of knocking people's knees, and sometimes sticking fast when the table is wanted to be expanded for a dinner party.

Not only that, but by a proper arrangement of the table legs they may be kept entirely out of the way of human legs. Over the page is a plan of such a table, with the bars and three leaves, which I have twice had made for myself. It is convenient to have one of the leaves narrower than the others in order to obtain a greater variety of sizes of table. The pieces of frame AB, CC, are only required to keep the legs stiff, not to support the table lengthwise of the grain of the wood, and AB should be of the shape shown sideways in the section, so that they may be clear above the knees of people sitting at the table. The loose bars DE, DE, are quite out of the way, and may go through AD, BC, anywhere. These tables cost also much less than telescopic ones. The common modern form of table edges is the section *m*, which furniture-sellers fancy makes a thin board pass for a thick one, as I suppose the authors of all the sprawling class of mouldings do, which I spoke of at p. 96. An old form and a better one is *n*, at any rate for a decently thick table; and thin ones are often thickened at the edge for appearance, and this equally suits them: *m* has the disad-

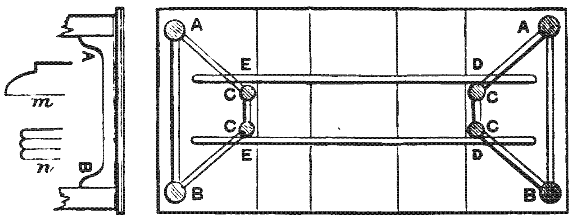


Fig. 13.

vantage of practically making the table smaller than its outline, as of course nothing can be set on it beyond the square edge: it always seems to me to give a particularly mean and scamped appearance to a table.

Library tables of all kinds should only have a very shallow drawer where your legs have to go under it, and are much better with none. Cabinetmakers pretend that they are difficult to make so, but you may take my word for it that that is nonsense, whether they are tables with 'pedestals' full of drawers down each side, or only with a single drawer in depth all round. If there would be three in the length of the table, leave out the middle one if you mean to sit comfortably. If only two, you must be content with making them shallow. All drawers, especially in dirty towns, must have linings, *i.e.* boards right through, or between each successive drawer, if you mean the things in them to be kept tolerably clean. The quantity of dust that gets in somehow over them if they are not completely inclosed is wonderful. This is one of the many differences between bad and good furniture. The front of a set of cheap drawers is nothing but a set of rails; of good ones, it looks like the drawers themselves only without their fronts.

Spring-bottomed Chairs I consider one of the worst inventions going. It never seems to have occurred to anybody that the springs which suit light people sink down into nothing under heavy ones, and of course they are all made as light and weak as possible. In my opinion the best of them are nothing like so comfortable as a well stuffed hair seat, and as soon as they get a little out of order, as the cheap ones soon do, they are intolerable. It is also a common mistake, and especially in railway carriages, to make the arms too high. A really easy arm-chair ought to be wide enough for your arms to go down within the arms of the chair, even if they are not too high. People try chairs by sitting down in them for half a minute in a shop, and are surprised to find that after half an hour the effect is very different.

Of all the contrivances for making rooms uncomfortable and useless, except for lolling in low chairs and reading books (in every sense) light, the recent fashion of abolishing a central table is the worst. Drawing rooms have become mere places for the exhibition of what are called ornaments, mostly rubbish, and a sort of subsidiary green-house. And this nuisance of abolishing useful tables for useless and uncomfortable seats of various forms is extending to clubs, under the influence of either furniture-men or professors of taste and fashion. This however is beyond the scope of building, which only extends to what is called fixed furniture, and luckily these things are not.

It is generally forgotten that flowers and shrubs in a room at night make the air unwholesome, though not by day. People sometimes feel it so much that they have to remove them. A greenhouse open to the room is liable to the same objection, and to the further one that it always keeps the room damp. This should be considered in building them.

CHAPTER V.

CHURCH BUILDING.

Style—English *v.* Foreign Gothic—Brick Churches—Modern Slopes too Steep—Towers and Spires—Modern ones too thin—Hexagons and Octagons—Capacity generally overrated—Apsidal and Square Chancels—Vaulting and Open Roofs—Transepts—Windows—Acoustics—Pulpits and other Fittings—Metalwork—Pews—Restoration.

A GOOD deal of what would be appropriate to this chapter if it stood alone has been already treated of in the foregoing ones. And in this as in the others I only mean to notice things which are generally or frequently neglected, or which require some special attention.

The question of style being quite settled by public consent in favour of some kind of Gothic for church building, it is needless to say more on that point. The subordinate question of 'what kind of Gothic,' divides itself into English and foreign; and again, what kind of English Gothic. The annual catalogue of churches building, such as that in the 'Companion to the Almanac,' shows that nearly every church which professes to be English Gothic professes also to be Early Decorated. It is therefore no longer necessary to repeat the proofs given in my former book on church building, and by other people, that this was the climax of the old English styles; that till then, architects, or designers of whatever kind they might be, were working upwards and gradually developing, if not inventing, and therefore improving; but that there was then nothing more left in that direction to invent, except weaker variations and degradations of what had already reached perfection. Just as no Greek temple was ever able to surpass the Parthenon, so there is one best and perfect spire in the world, Salisbury, and all the later variations were for the worse. Tower-building alone (without spires, I mean), improved after the early Decorated times, because it had not been much cultivated in them, and so there was room for invention and improvement, especially at the top, where the spire would have affected the design.

I have said in Chapter II. all that I have to say about the other so-called Gothic styles, and their modern imitations and exaggerations and the fashionable attempts at originality in that direction. The problem of building a satisfactory-looking church in brick is yet unsolved. In old times it seems hardly to have been attempted in this country; for the brick churches in districts where stone was too expensive for walling, were (I believe it may be said) invariably plastered, and stone was imported for the window mullions and tracery and other decorated parts only. It does not seem to be certain whether the whole of the walls made of old Roman bricks in St. Alban's Abbey were plastered originally, and possibly some parts may not have been; but certainly a great deal was very early. And whether it was or not, the parts which are bare of plaster now look very ill, except the tower, which is redeemed by the large quantity of dark cement used in its late restoration, and partly also by its distance from the eye. It was however plastered before that, probably when it was built in Norman times. If any kind of brickwork can be suitable for church building, it is the dark Hertfordshire bricks pointed with dark mortar.

Some old colleges, schools, tithe barns, and other large buildings, as well as houses, look very well with jambs and mullions of moulded bricks, though they could not manage tracery. Now, however, there would be no difficulty in that; but it would probably cost more than stone, considering the number of patterns that would be wanted for a small number of bricks; whereas jambs require only a few patterns for many bricks. This suggests windows in the Early English style for brickwork. But not the common square jambed ones, which always look mean, especially when 'neatly' picked out with white mortar as usual; dark pointing is essential. Good E.E. windows can only be made with moulded bricks, 'purpose-made' for the arches also; and they should have 'labels,' which are among the eyebrows that modern architects are so fond of shaving off. I take the opportunity of remarking, what is often disregarded or unobserved, that very sharp arches were less used in the old narrow lancet windows of that style than for the large windows of the later styles. They were sometimes, where narrow windows or doors had to stand beside wide ones of the same height, and occasionally in other places; but the normal lancet windows had arches no higher than equilateral, and for some reason or other they look much better so, though large arches will bear much greater elevation—provided they are not 'stilted,' *i.e.* provided they are genuine arches curved from the bottom, and not an arch set on upright bits.

Square-topped windows, with mullions and a low arch between them, under the general flat top, can of course be built easily in brick; indeed they are common,—one may almost say, universal, in old buildings of the kind I have mentioned, and would do very well for small and cheap churches, though below the dignity of large ones. The doors may have arches of almost any pitch, as indeed brick windows might but for the difficulty of tracery, and mullions carried up without tracery are abominable. Railways however have made such a difference in the facility for using stone, and so much more is charged for fancy bricks than common ones, that I doubt if much is to be saved by using them instead of stone, except perhaps the common patterns of bevelled bricks and round-cornered ones called 'bull-nosed.'

The value of deep cornices, of gradually spreading bricks, some set zigzag and others square, some continuously and others discontinuous, like dentils, is sufficiently well known, but requires more boldness in execution than is often found. I added two or three courses lately to one designed by an architect under the impression that he was making it very large, and I wish I had added more; for one piece, where more was added to cover a slight recess, looks much better than the rest. I also found a great improvement in making the continuous course over the dentils project beyond them—as courses carried by dentils in genuine architecture of that kind always did. They represent beam ends, and nobody would think of carrying beam ends quite up to the edge of the cornice or whatever they are to carry: but the whole theory of cornices seems to be treated as if they were promiscuous ornaments to be stuck on anyhow, as I intimated before.

Buttresses, though not peculiar to church building, are seldom found in houses, and are only required for wide rooms like churches and halls, with no internal walls to help the roofs. I have spoken before of the general want of depth in modern architecture, *e.g.* in windows especially, and their mullions, and it is equally conspicuous in buttresses generally; though by way of compensation one sometimes sees them of an absurd depth for anything they either have to do or make any pretence of doing; for the appearance of having work to do is a sufficient justification for architectural features really added for ornament.

Here again, let anybody compare most modern churches with most old ones, or the sections and plans of them in well-known books. It is enough to say that the buttresses of all the pointed styles were generally a good deal deeper than their width, and that in modern churches they very seldom are so. It has sometimes been alleged that buttresses were only to resist the thrust of vaulting. But that is certainly not true, for they exist in hundreds of churches where there was no idea of vaulting; obviously because they were perceived to be ornamental, and because the pressure of a roof is necessarily in some degree outwards, and it suggests the idea of requiring some redundance of strength in that direction even if it does not really want it.

But in a church of any considerable size I should always make them do real work, and connect the whole together by light flying buttresses within the aisle roof, which add greatly to the architectural effect besides, giving both an appearance and reality of connection and support from the open roof of the nave down to the foot of the buttresses outside. This is especially desirable when there is an apse with an aisle or *periapse* carried round it, which I shall speak of afterwards. The nave walls or clerestory of many old churches have been pushed outwards by the roofs when the joints began to decay, and would have been materially helped by such supports as these, though they come lower than external flying buttresses which carry vaulting. Sir G. Scott introduced them at Doncaster, probably from Nantwich, which he was restoring at the same time, and they are also in the old church at Hatfield near Doncaster. He added half arches springing from the pillar caps to meet them, which makes the internal vista of the aisles appear completely arched at each bay. But that has no constructional advantage, and I have not followed it in St. Chad's Headingley, or in Mr. Bass's church at Burton, both of which I designed with the internal flying buttresses alone. Headingley church absolutely required them, having an apse and periapse, and it was natural to carry them throughout, even if they were not an evident advantage anywhere, both mechanically and in appearance.

For some reason or other architects have taken to making all slopes of buttresses, and still more of plinths and set-offs, steeper than they were in the styles which they profess to copy. One hardly ever sees them now less than 60°, and often more, whereas old ones in the plinths and bases were very seldom, if ever, more than 45°. And in these, as in the slope of roofs, old architects observed the difference between those which are high up and require a high slope to prevent them from receding from the eye too much, and those which are nearly on a level with or below the eye.

Towers and Spires.—This is a very large subject, and I gave a whole chapter to it in my book on church building, which I am not going to repeat, but only to notice a few practical points of design and construction. As towers historically came first, though they afterwards went out of fashion for a time and returned, I will treat of them first. The Saxons evidently knew that a plain unbuttressed tower ought to diminish in size upwards; not merely by slight set-offs at each story, which I think came in afterwards, but by a gradual tapering, just enough to be visible, especially in the diagonal view of the tower, which magnifies it in the proportion of 1·414 (or $\sqrt{2}$) to 1. The Greeks, as is well known, did the same with their columns, and a little more; for they gradually increased the tapering with the height, giving the outline which is called entasis. Some old towers, and notably old Doncaster, which was inferior to none in outline and vastly superior to the new one which professed to follow it, had that kind of outline on the whole, even though made irregular by buttresses. Such towers as the central one of Canterbury, and still worse, the Victoria tower at Westminster, rising sheer out of the ground for about 300 feet without a set-off, look as if they were top-heavy, and bursting at the top, or wider than at the bottom, through some optical illusion, for which different explanations have been propounded. The best of them is that we see things in spherical perspective, or as if they were engraved in a hollow sphere with us in the centre; and that what the eye considers upright are what we may call meridians, converging to a pole or zenith over our heads. Therefore two parallel upright lines, not so converging, appear to lean outwards, and the more so the higher they go. Another explanation is that a tapering tall body is at once recognised by the eye as more stable, if it tapers or decreases upwards. Take the familiar, though gradually expiring, form of a tall windmill; nothing looks more stable for its height; and a spire is the same.

But whatever may be the theory, there is no doubt about the fact, that towers not tapered by set-offs look better if the walls diminish upwards at the rate of about 1 in 120, and rather more towards the top if very high. That I did learn from an architect, Mr. Teale of Doncaster, but some of the most eminent of his fraternity have evidently never learnt it, nor have I seen it noticed in any book.

The great difficulty of tower building is at the top, and I do not know a single modern one that is quite satisfactory, except where some original design left unfinished has been completed, though partly by imagination, like that of Worcester cathedral, where the rudiments of the peculiar corner turrets existed, so that there was no doubt as to the plan, but only as to the elevation of them and the intervening pinnacles. As I had nothing to do with the restoration of the lower part, I may say that I know of no such conversion of a great fabric from one of the meanest of its kind into almost the best, by the judicious restoration of features not merely perished by decay but by complete excision. A face without a nose hardly differs more from a handsome one than that tower as it was up to a few years ago differs from what it is now—very superior, as I think, to Gloucester, which is rather higher and was much more famous, but of a later style.

A good many old towers are unfinished as to pinnacles, and it is very difficult to guess how some of them were intended to be finished, if indeed it had been ever settled, and was not left to be determined by trial of patterns, as I have not the least doubt that many were in old times; both because the designers could not draw in perspective, and because they knew the fallacy of drawings, especially for things at a great height. It is a great pity that the same practice is not oftener followed now. Four very fine towers in that condition occur to one immediately: York, Durham, Howden (which two have a great affinity, and Howden was a 'peculiar' of Durham), and Lavenham; and we may add the western towers of Wells, and that of Tarvin near Chester; in all of which the construction evidently leads up to some kind of large pinnacles, but indicates no more. Pershore was so, but some pinnacles have been added, from either conjecture or invention, which have the usual fault of being much too tall. And I am justified in saying that, by the universal admission that the Doncaster ones are greatly improved by being rebuilt 4 feet lower than they were at first, as mentioned at p. 100. But it is impossible to lay down rules for the construction of tower tops, or in fact any other decorative feature.

Spires.—It requires some ingenuity to build a very bad spire. There is so little room for variety, either in the outline or general construction, that a man must go out of his way to spoil the spire itself, though the junction with the tower is by no means easy to effect dexterously, especially when the tower has pinnacles and a parapet. Yet the feat of making bad spires is sometimes accomplished, and in this way for one. A few of the old spires, either from accident or design, are contracted or become rather blunter towards the top: no doubt because the builders got afraid of the sharpness when they came near the top and thought it safer to contract it more quickly. It is possible that in a very few cases they may have deliberately made an entasis. But if anyone will lay his head close to the bottom of the king of spires, as I have, he will see right up the 200 feet to the very top, proving that the outline is quite straight. And so far as I have been able to observe, the same is true of all the great spires, except a few which are known to have had the top rebuilt at some time and lowered and blunted, as at Grantham. There is no more doubt that it was the established rule to build spires with straight edges than to build Grecian pillars with an entasis; and the singularity—and ugliness—of the very few exceptions ought to have taught architects to avoid and not to copy them. I allowed it to be done once, against my own opinion, and the result was so unpleasing that I spent 800*l.* in pulling it down and building a new one, somewhat larger also. There is a peculiarly abominable entasised spire to an Independent Meeting House near the Halifax railway station.

The perforated spires of the Continent fortunately never took root here, and have not been imported yet by our modern foreign Gothic imitators. The nearest approach to them in English spires is the breaking up of the outline by a multitude of spire-lights, or little windows with canopies; and these require very careful treatment and keeping within due bounds. Salisbury has none; nor Grantham, Norwich, or Chichester. Newark is the best specimen of a many-lighted spire, and that looks best in the direction in which they least interfere with the outline. Salisbury has only windows at the bottom, and placed with the peculiar felicity of everything in that perfect work. If you want to see a modern contrast to them look at those in Mr. Street's spire at St. Mary's Lichfield. The body of the church was rebuilt, not by him, some years later in memory of Bishop Lonsdale, as the spire was in memory of his brother the Vicar. It is said by those who knew the old spire of Chichester that the new one is inferior to it by reason of some alteration made by Sir Gilbert Scott at the bottom or junction with the tower, and also that St. Mary's Oxford was seriously damaged by some such alteration, without the excuse of having to rebuild it. Without mentioning dozens of inferior ones, all these things prove what a delicate matter the junction of a spire with the tower is. And so far as I can judge from pictures, the foreign builders very seldom were successful there. The transition ought to be decided and unmistakable and yet should appear easy and natural. In some modern spires and some ancient foreign, but no English ones, you cannot say where the transition is. In many others, a man seems to have picked up a spire somewhere as he might an extinguisher and dropped it on a tower. I must confess that I am not quite satisfied in all respects with one which is substantially my own, St. Chad's Headingley; but I had no opportunity of seeing it while it was building at the critical point; without which no one can infer from drawings what the effect will be. If I had seen it I should certainly have altered it by trial with some wooden patterns, to fill up the corners better, which are too abrupt—a better fault however than the opposite one.

A few old spires rise from an octagonal addition to the tower, but the old builders evidently perceived that it is a mistake and appears to lower the dignity of a tower to a turret, and so those few examples were not followed, but remain as warnings what to avoid.

A 'brooch' spire, or one where the cardinal faces at the spring quite reach the sides of the tower, is very apt to look too heavy for the tower when seen on the square, though it may not when seen diagonally, especially if the tower has not deep buttresses and the spire is as tall as the tower, as at Salisbury and most of the great ones. Accordingly many E. English brooch spires were not so tall as the tower, *i.e.* were blunter a good deal than many of the non-brooches, where the bottom of the spire is quite within the tower, often leaving a passage all round. Probably the angle $11\frac{1}{2}°$, or the width = ·2 of the height, or 20 feet wide to 100 high, is the sharpest spire that looks well. Some modern ones look more like spikes than spires, by reason of the miserable thinness of the towers, which on the average have barely, or not half the sectional area of old ones of the same height, or 14 ft. inside where old ones would be 20, and 11 where old ones would be 16. This is constantly being brought to my notice in connection with bells, about which architects will not condescend to learn anything, as if it was not their business to learn how to provide properly for all the objects of a building. They will dictate to you about desks and seats and altar cloths, and leave the weightier matters of the building, which can never afterwards be cured, to be done as wrong as possible. I must refer to my book on Clocks and Bells for instructions on those subjects. Even independently of that, few people seem to know as a mere matter of architecture, that the towers of old English churches were very seldom higher than four times their width without the buttresses, and generally much less. Boston is the only notable exception, and 60 ft. of that are due to the lantern at the top, which is more of the nature of a spire. The tower of Dundry near Bristol is narrower than usual for its height, but it is only a small one altogether.

Spire Beds.—There is a point of some consequence in spire-building which I have never seen noticed in any book, viz., whether the beds should be horizontal or at right angles to the faces. Though the former is almost invariably done, the latter is certainly the right construction and the strongest against any accident by storm, because in that case every successive piece of spire from the top downwards lies in a kind of cup, which tends to prevent the stones from spreading; or you may say that any narrow vertical slice of spire forms a straight-sided arch, which cannot fall in by reason of the adjacent stones, nor outwards by reason of this construction, while the stones can slide outwards if they have a horizontal bed. The tops of spires and pinnacles are oftener loosened by wind, decay of mortar, and, I suspect, lightning, than most people have any idea of; and it is certainly desirable that the construction should be such as will be safe even if the joints get loose. I do not find either that builders say that square-jointed stones are more expensive than horizontal ones. The face stones manifestly take less trouble and less waste, while the fewer corner stones perhaps take more. As many of the top courses of a spire as can be should be tied down by a long iron rod through the finial and a cross bar inside the spire with a nut at the bottom.

Conductor.—This rod, whether ending in a vane or not, should be the first part of the lightning conductor, which is always now a wire rope $\frac{3}{8}$ or $\frac{1}{2}$ in. thick, which should be attached to the very bottom of the rod, or it may be to the nut at the bottom. It is wonderful how inveterate the folly is of putting glass rings or neckcloths round the conductors when they are fixed to the wall; as if the 'electric fluid' (as the newspapers call it) wanted to leave the wire which is a good conductor for the wall which is a bad one; or would be deterred by a bit of glass if it did.

I have always thought the climax of architectural science was reached at Christ Church Doncaster in 1830, the spire of which was capped in great triumph by the architect's own hand with a glass cone or finial to frighten away the lightning: which however was perverse enough to disregard the intimidation and knocked the spire over in the short space of four years. Another common piece of folly is taking the conductor outside through a window instead of the shortest way down inside, as if the 'electric fluid,' like a bad smell, would be less dangerous in the open air. And yet another is the idea that it ought to go down into water, which these philosophers seem to imagine will dissolve the lightning like salt, or kill it as if it were gunpowder, while it will be dangerous if left dry. All these absurdities were proposed to me at the rebuilding of the great Doncaster church in 1858, and for the satisfaction of the alarmists I got Faraday's opinion: I need not say what it was. The Houses of Parliament were *conductored* by Sir W. Snow Harris, who perhaps had even more experience than Faraday in that matter, and he laid the copper bands actually in the walls under the plaster.

Wooden Spires.—Church spires now are almost invariably of stone; though occasionally we do see wooden ones on small churches, covered with lead, or slates, or those pieces of split oak called 'shingles,' which look like narrow flat tiles, but whiter, and look very well too, and last a long time, perhaps as long as any other covering, without repair. Slates do not look well on spires, if they do anywhere, which certainly the common smooth blue slates do not, as I observed before, though the old grey Westmoreland slates do. Every objection to lead for roofs (see p. 181) applies *à fortiori* to spires, the steepest kind of roof. The old ones were leaded in diagonal pieces, which also look the best. The tallest spire in the world, that of old St. Paul's, was leaded, until it was burnt down, some years before the burning of the whole cathedral in 1666; and so is the curious twisted spire of Chesterfield church, which some people are silly enough to believe is really upright, or the top vertically over the centre of the base; whereas the twist is also a bend of the timbers through some defect of original construction, which, like all such defects, has a tendency to increase itself, as gravity is always acting with it, and gravity never sleeps.

Spires are so generally octagonal that it may appear superfluous to speak of any others. But there are cases where it is better to make them hexagonal; the corner turrets of Worcester cathedral tower are part of the original design as to their plan, and are perhaps unique as hexagonal ones in that position. There are however two reasons for making a small spire hexagonal in certain cases; one is, where you want a tower rather wider one way than the other with a spire on it; for you may see in a minute that a hexagon will only fit a parallelogram whose sides are in the proportion of the height of an equilateral triangle to its sides, or ·866 to 1, or 19 to 22 very nearly. The other reason is that reducing a small square tower to an octagon sometimes makes the faces too small for clock dials, or even for windows, and these two causes may often concur in a small bell-tower which also forms a sort of porch at the west end of a church, either engaged (inside) or disengaged (outside). Sometimes also in domestic building turning the square into a hexagon enables you to make a dial face more directly as you want it. I have had a case of that kind myself where the square would have faced wrong and an octagon would have been too small. The face of an octagon is ·414 of the side of the square, while that of a hexagon is ·5 of the larger side, and ·577 of the smaller side of the parallelogram on which it stands.

Everybody knows how to draw a hexagon, dividing the circumference of a circle into 6 by its own radius. But the way to make an octagon out of a square is not so obvious. This is one way: from a corner A draw the arc B G, cutting the diagonal A D in G. Draw H G F and K G *k* parallel to two sides of the square: K, F, will be corners of the octagon, and K F or G D the length of every side. Another way is this: Draw the two diagonals bisecting each other at C. With radius A C draw the arc H C; and in like manner draw the opposite arc *h* C. Then H, *h*, are corners of the octagon. The area of the octagon is ·828 or nearly 5-6ths of the square, and that of a hexagon is exactly $\frac{3}{4}$ of the parallelogram which contains it.

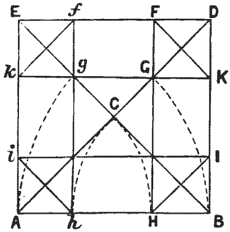


FIG. 14.

Octagons.—The celebrated central octagon at Ely is not a 'regular' one, *i.e.* its cardinal sides exceed the others, in the proportion of 1·414 or $\sqrt{2}$ to 1, because the smaller sides are only diagonals of a square division of the aisles, which are only half the width of the nave, as in nearly all cathedrals, and many of the old churches. The aisles of a church to fit a regular octagon must be ·707, not ·5, of the width of the nave. The octagon under the dome of St. Paul's is 'irregular' in the same way, the aisles being only half as wide as the nave.

Mr. Fergusson calls a central square tower 'the bathos of Gothic architecture internally,' and lauds the superiority of an octagonal one. But I do not agree with him. Both external appearance and mechanical construction are, however, unfortunately opposed to octagons. It is only a church of immense length like Ely that will bear a central tower as wide as the whole church, even with the corners cut off into an octagon. And at Ely the octagon is not *the* tower of the church. Moreover the wide octagon judiciously stops at a little height above the roof, leaving only the minor or interior one, of the same width as a square tower would be, to go up higher. And further, that minor one is not and could not be of stone, because it stands on nothing, except oblique abutments. Such abutments to carry a stone octagon would have to be as large as if they carried a dome, and what that would be you see at St. Paul's, or St. Peter's, or any of the domed churches: whereas at Ely the octagons—both the major and the minor one—are carried by the ordinary pillars of the nave and choir; in fact that ingenious lantern was built on them after the old Norman tower with its four piers inside the octagon had fallen, as many Norman towers did from bad building and foundations.

The only genuine stone octagon of any great size that I know, except spires, is the old Glastonbury kitchen, a square room gathered at the top into an octagon by oblique arches of the kind called by the appropriately sounding name of squinches, such as you may see under many stone spires. But after all that is not wider than the Salisbury steeple, which very few people have any idea is as large outside as a first-rate house five windows wide, and the inside larger than almost any drawing room, containing about 1000 sq. ft.

Central towers are not indeed the most convenient plan of church building where economy of space has to be considered; but so far from agreeing that they are the bathos of Gothic architecture even internally, I think those four great piers, when well designed, are the grandest internal feature of a large church. In a small one they are absurd, blocking up and shutting off an immense proportion of the space without any grandeur of their own. But it is singular that the earliest tower-builders, though often failing in their building, from making the piers of rubble instead of solid stones, understood how to plant a central tower better than any of their successors, *i.e.* without making it so obstructive of the view down the church. Look at Winchester cathedral, Norwich, Tewkesbury, Malvern Abbey, or St. John's Chester, where the tower is gone but the piers remain, or even the later ruins of Rievaulx, and you will see no contraction of the nave by the front shafts of the tower piers. In the Norman ones they are kept back, and at Rievaulx they are 'bracketed out,' *i.e.* the lower parts cut off and the upper carried on corbels. That is imitated in the Gordon Square Irvingite church, which as far as it goes is one of the best specimens of modern English Gothic. In the church which I designed for Mr. Bass at Burton, with Mr. Teale of Doncaster as architect, the innermost 'order' of the piers and the great tower arch towards the nave are omitted altogether, care of course being taken to make the tower strong enough in other ways, and especially by building the walls of large squared stones throughout up to the bell-chamber. In a smaller way I did the same with the tower of the Railway church a mile north of Peterborough station, which is a good deal larger than it looks from the railway. That is also rather peculiar in having no transepts, but the aisles simply carried past the tower; which is as low as it well could be, and is open as a lantern to the church, like that of the neighbouring cathedral.

There is one other case in which a central tower of a cross church need not materially contract the nave, *viz.*: where there are no aisles; because then the transept walls form such an abutment that the tower arches may be as wide as the nave. I need not say that that is an expensive mode of building, as you have the greatest possible quantity of outside walling and gables for a given area. But prodigality of space is an important element of beauty, and far more effective than the same cost expended in mere decoration. The south transept in a small church of that kind naturally contains the seats of the patron and his family, and the north the organ, and perhaps a vestry behind it. For there is no greater mistake than the common one in modern church-building of making very short transepts, and also low and narrow chancels. I do not believe that any old church was built originally, or all at the same time, with the four limbs of different heights, as modern ones are nearly always, from the mere pleasure of doing wrong, so far as I can see. Where they were different there was always a difference in date.

Capacity of churches.—As I am speaking of waste of room I may say here that the capacity of churches, and the size of congregations in them, is almost always overrated. I have seen boards of the Incorporated Church-Building Society stuck up declaring that the church contains more sittings than it would if it had no passages at all. I never measured an architect's plan, from the great Doncaster church downwards, without finding that nothing like the professed number of people could, or would, sit in it, except under some great attraction which makes the church 'fuller than it will hold.' It sounds excessive, but it is the fact, that scarcely any church, however well arranged, will hold (except on such occasions) more than one adult person for every 8 square feet of floor, and much more often 9. The actual clear sitting space required for each person is 5 square feet, or 34 in. × 21. Practically they will not sit in less width than 21 in. on the average; and that, remember, must be clear of the seat ends. When we came to divide the two new Doncaster churches which were finished together in 1858, we found by trial that we must mark one less sitting for each pew than the architect had reckoned on. Barry's House of Commons turned out to be too small, as everybody knows it is, exactly in the same way, or rather worse, for they had to put one row of seats less on each side than he had designed.

Chancel and corner towers.—In a few churches the tower has come, by some local necessity or by destruction of the old chancel proper, to be over the chancel or the eastern part of it, sometimes called the *sacrarium*; and it is by no means a bad plan where circumstances favour it. In that case the chancel roof should on no account be lower than the nave; in fact there had better be no distinction between them. In like manner a nave between a higher chancel and a western tower looks very ill; and so does a bell gable between a nave and chancel of different heights: the gradation of the three heights in succession is the only proper and ancient arrangement. A chancel tower certainly ought not to be condemned as an oddity by those who are always looking out for oddities by which to show their originality. For instance, there has just come under my eye a picture of the east end of Balliol Chapel, which Mr. Butterfield the architect, with evident malice prepense, made to look as if the building of the chapel was an afterthought, and the sill of the east window obliged to be set upon the south end of a long wall which is supposed to have happened to be there: which is every bit a mere pretence and affectation. Even if it were not, and if the wall had been really there before, nothing can justify such a lopsided and ridiculous construction, and the not making a vertical break in the wall to mark the north-east corner of the chapel, and make the wall an appendage to the chapel, not the chapel to the wall. There are plenty of other things which might be criticised there if it were worth while; but it is not; and it was by mere accident that this picture came under my notice just now, instead of some other example of lopsidedness and absurdity, such as the frightful tower of Mr. Street's Law Courts, according to the published design.

A chancel tower is far better architecturally, and no worse practically, than one stuck in some odd corner of the church, and making the outline a continually varying mass of confusion from every point of view. The N.E. towers of St. Mary Redcliffe and St. John's Chester are of a different age from the churches, one earlier and the other later, and are therefore no exception to the rule that a single tower should be in the axis of the church, so that it may look symmetrical from every point of view, subject to minor variations only visible when near; just as the pairs of towers at Lichfield and Exeter are alike in general shape but not identical in details, and as a great many south aisles differ in details from the north. I have already spoken of this principle of Gothic symmetry and the modern ignorance of it in the second chapter.

Every now and then the tower was completely distinct from the church, as at Ledbury and elsewhere, or like the separate campanile of Chichester, and the larger one which Wyatt the destroyer swept away with many other fine things at Salisbury; but those are of a different class altogether and no exception to the rule I have stated. And there are a few old small towers forming porches in the usual place. Nor are the thin Lombardic towers, which also were not axial, and could not be, an exception either to that rule or to what I said just now of the thinness of most modern Gothic towers compared with old ones.

Tower stairs require more attention than they sometimes receive, and sometimes they attract too much attention by being put in one corner turret out of all proportion to the others and rising high above them. It is true that that is done in some old ones, but I think in none of any great architectural importance; and it is rather a defect than a beauty. In the old Doncaster tower, which was unrivalled in elegance of outline, unhappily missed in the new one, care had been taken not to spoil it by that kind of lopsidedness, for the staircase was ingeniously turned inwards above the lower windows. It is not worth while in any ordinary tower to carry the stone staircase to the top. A ladder from the bell-chamber is sufficient for every purpose of a staircase there. When there happen to be large corner turrets, or a spire which will overpower one larger than the others, as in the grand spire of Grantham, there is no objection to carrying the staircase up to the top of the tower; only you must remember that it weakens it considerably for carrying the spire. It is little known that Tamworth church tower has a very curious staircase, or rather pair of staircases like a corkscrew with two threads, one opening to the inside and the other to the outside at the bottom. It must have been made for mere fancy, as the two emerge together at the top, and one staircase might have had both an outside and an inside door at the bottom. It makes them both too steep.

Porch.—Although a west tower door is very common, and looks well outside, there is no denying that it is practically almost a nuisance and is generally disused, from allowing the wind to blow straight into the church, and therefore it is no use to build them so. A west nave door always requires an internal porch. I do not know why there should never be south porches to towers, which would avoid that inconvenience. There is no doubt too that the usual place for a porch, *viz.* one bay short of the west end is practically wrong and wastes a good deal of room, except where the font is beyond it. It is far better at the western bay, like the fine one at the S. W. tower of Canterbury, and in a humbler way, St. Chad's Headingley. I wish it had been so at Doncaster. It must depend on local circumstances whether the porch is to be on the south or the north side; but I need not say that the south is best whenever circumstances admit of it. A northern one generally requires an internal wooden porch or screen besides, on account of the cold. Porches are very often made too low, and when they are they produce the impression that the whole church is on a small scale before you enter it. It generally comes from mere carelessness in designing, treating it as a matter of course that the porch roof is not to rise above the aisle wall; whereas it may as well 'die into' the aisle roof anywhere, even at the top, as it does at Headingley. Of course it should not on the other hand be on too large a scale for the church. This, like everything else, requires an eye for proportions and a constant recollection that a man's stature is the ultimate scale for everything in a building.

Apses and square chancels.—Apsidal chancels have come or returned into fashion very much of late: not that they were uncommon in England in Norman times, when there were many round ones, as at Peterborough, Norwich, Tewkesbury, and many more which were absorbed into longer square ones in later times. I remember no Early English round apses. Those Norman chancels were very short compared with the later fashion of making the chancel practically the whole church for service, when the close and thick stone screens came in, such as in York Minster, Ludlow church, and a multitude of others. A round apse is an undesirable thing to build, except with very narrow windows, for the reason given at p. 147. I made one with narrow E.E. windows at the Peterborough railway church, as a variety, but I prefer the five-sided semidecagon of St. Chad's Headingley, which is described at p. 148, especially on a rather large scale. No other form of apse looks well except these two, though semihexagons and octagonal ones were sometimes used, as at St. Michael's Coventry and Westminster.

Periapse.—It adds immensely to the effect of an apse to carry the aisles round it in what I call a 'periapse,' generally called an 'ambulatory'—though nobody ever walks in them, and sometimes by the French name 'chevet,' which I do not see that dictionaries recognise as meaning more than any space behind the altar, without reference to its shape or construction. The periapse is very useful for vestries clerical and lay, a priest's and choir door, and sometimes for the organ, and saves building ugly appendages for these purposes, while this is a handsome one, and gives a peculiar appearance of completeness to the plan inside and to the church outside.

Even the ground plan of a grand and well proportioned church has a kind of beauty. York Minster, the largest church in area north of the Alps, notwithstanding the beauty of some of its parts, is clumsy and ill proportioned; and if you look at any book of plans you will see how unpicturesque its plan is, compared with those of Lincoln, Ely, Canterbury, Salisbury, Beverley, and many others, dead and living. In one thing our old builders declined sadly from the oldest, *viz.* in the designing of west fronts. We have nothing left like the once vast spread of front, flanked with large towers, and sometimes another in the middle, of the old monasteries of Bury and St. Albans (if the latter were ever completed) and Rochester according to pictures, and Ely if it had its north-west transept. Wells alone is of the same type, the towers being beyond the aisles, though small compared with Bury and St. Albans. The now transeptal Norman towers of Exeter were built for flanking towers to a west front much wider than even York or Lincoln, where the towers terminate the aisles.

The semidecagonal apse with periapse requires the capitals and bases of the pillars to be either round, or decagonal, which looks very well at Headingley, though I have seen them nowhere else. The arches are necessarily a good deal narrower than those of the nave or chancel, supposing them to be of ordinary proportion to the width, which is generally rather more than half;

since each side of the apse is only ·618 of half the width. Consequently it becomes a question how their height should be managed; and I am convinced that it looks best to make them reach as high as the adjacent side arches, with a continuous string all round. But the bases will naturally be raised by the altar steps (I only use the word altar in these matters architecturally and for brevity, not theologically; for the Church of England has no altars, as the supreme ecclesiastical tribunal has several times decided). And the caps of the apse pillars may very well also be raised above the others, and look better so. The reredos or altar screen should be only of the necessary height all round, so as to let the tops of the windows of the periapse just be seen from the far end of the church. The finest example we have of this kind of treatment, though not a regular five-sided apse, is at Canterbury, where the chancel is gradually narrowed, so that a number of pillars come into view with the Lady Chapel behind them.

At Salisbury, St. Albans, Exeter, Hereford, Romsey, and a few other churches, there are three or two arches square across behind the altar, with a short east window over them, and over the roof of a lady chapel lower than the chancel; which then has the defect of adding nothing to the length of the great back bone of the church. Accordingly St. Albans and Winchester, which are actually the longest of our cathedrals, look nothing like so long as Ely or York or Lincoln. I put them in that order because Ely looks much the longest in the back, though York is really, but its apparent length is injured by the huge tower in the middle, which no one realises to be as wide as the length of an average church nave of 5 bays. Lincoln is about the same as Ely, without its low Galilee at the west. Canterbury is longer in the back, only it is broken, and the eastern piece called Becket's Crown looks severed from the rest. But these were all far exceeded by old St. Paul's, which had an unbroken length of roof of about 200 yards. The lengths in the table at the end of the book are all internal ground-floor lengths.

Tower over Font.—When there is no tower door, that makes a capital baptistery, or place for the font. Fonts are generally about the worst things built in churches now. They have a truly Victorian style of their own. Their various characteristics of ugliness and prettiness and flimsiness are beyond description, and worthy of a book of 'modern fonts' to match the book of ancient ones, of which the variety is wonderful, and nearly all handsome in one way or another, from the rudest Norman to the most elaborate Decorated and Perpendicular. A flat cover spoils the look of any font, and any cover at all is absurd and useless. As a practical matter, the pipe for draining it should go into a larger pipe, to prevent any risk of it being choked up, and of course a drain provided through the foundations of the church, which is very apt to be forgotten. I warn any one against trying white marble for a Gothic font, though any dark marble will do, and in fact is the handsomest material for them. I once tried a very good red marble, at St. Mary's Lichfield, but it is decidedly inferior to dark. One of the finest large fonts of dark marble is one which I do not remember seeing in any book, at St. Mary's Beverley, and there is another of the same material but not so good design, in the Minster of that venerable town, which is unique in the possession of two of the finest churches of the cathedral and parochial type.

Bell Gables.—From towers one naturally turns to bell turrets and gables, but I have nothing particular to remark on turrets. One of the most striking illustrations of the difference between 'Eyes and no Eyes' is the modern perversity of putting a bell gable between a nave and a chancel lower than the nave, not perceiving the necessity for gradation in the successive heights. If the nave and chancel are continuous, it is right enough to mark the division by a bell gable, as it is by a central tower: but not otherwise. They are generally also made too high, and look as if they were top heavy and would blow over. This comes partly from their being thin, and partly from the roof of the church being too steep, which necessarily makes the square base of the bell gable larger, and partly from the arch or arches for the bells being too high—much higher than the bells require.

Square Chancels.—I do not mean to recommend apsidal chancels as superior to square ones, but only as an occasional variety. They have one obvious inferiority in admitting no great east window, which is such a valuable adornment to a church. I am surprised that in no new long chancel that I know of has the reredos been advanced, leaving one bay behind for vestries. That plan however is only suitable for a chancel of at least four bays, and a long church, of which there are very few. Doncaster would have been immensely improved by such lengthening, all its limbs being too short for its height, as I have said before in speaking of proportions. There are a few fine churches with vestries behind the reredos, such as Wakefield and Lavenham, but they are only low appendages hardly visible outside, and not at all inside, and with the inconvenience of being entered through the space within the altar rails. I am sorry however that I cannot commend the way in which it has been lately done at St. Mary's Beverley, a church which it is distressing to see in any way spoilt by modern whimsicalities, after so much restoration done so well.

Few church builders seem to appreciate the value of a wide chancel, both for convenience of the choir and architectural effect. It seems to be thought orthodox to make it narrower than the nave, though it is orthodoxy of quite modern invention. It is not so in a single cathedral or monastic church, nor in any of the great college chapels, such as King's, though it is 289′ long, or Trinity (200′), Magdalene (Oxford), St. George's Windsor (225′), Eton College, multitudes of old parish churches, and indeed all the cross ones, whether with central towers or without, like St. Mary Redcliffe and every cathedral with a second transept; beyond which the choir is never diminished in either height or width. And in many, where the chancel is narrower than the nave, it is only just enough to mark the difference externally; for which however there is no necessity, except that when each part is of good size it gives an appearance of greater length, generally. With an apse it is peculiarly unnecessary, for two reasons: first the apsidal roof alone makes a sufficient variety in the outline; and secondly, as that shortens the back bone of the roof by half its width, it makes the straight part of the chancel roof look very short indeed, unless it is longer than the ordinary proportion. And when you have really great length, you may almost treat it as you like; but that is very seldom now.

Any one who wishes to see how easy it is to mark an external division of the nave and chancel without sensibly diminishing the width may see it at

St. Mary's Lichfield. We were hampered with the difficulties of a strictly confined space in re-building the church. Although, as I said at p. 3, the design of that church (except the tower which had been rebuilt before) was substantially mine, the old church, of the Renaissance style, was a simple parallelogram, and the problem was to make a Gothic one of fair proportions on the old foundations of the walls and pillars, not showing the inevitable shortness of the chancel too conspicuously. (I hope nobody will give me credit for the pulpit and some other internal phenomena which it exhibits.) Notwithstanding all these facts nobody seems able to build a little bit of a chapel for 200 people now without sticking on a still smaller bit at the east, more like a pantry than a chancel; and some really decent larger ones are spoilt in the same way. I say of this, as I did of the system of cutting up into little bits in general (p. 9), that instead of giving an appearance of increased size in stone, whatever it may do on paper, it is a mistake of the very worst kind, an attempt at imposture which invariably fails; for after the first minute the eye recognises nothing but the universal littleness, and regards the whole building as a kind of baby house.

Vaulting.—I have little to say on this subject, as it is fully treated of in Mr. Garbett's 'Rudimentary Treatise on Design,' and Mr. Fergusson's 'Handbook.' But I have to protest against that abomination of the vigorous style men, showing rough stone work in vaults instead of plaistering it, as was always done in the days of real Gothic architecture. And there is another quite as bad, which the great professor of 'conservative restoration,' Mr. Street, has thought fit and been allowed to introduce into the south transept of York Minster, *i.e.* substituting mere boards, visible as such, instead of the antient plaister; indeed he has done both, one in the middle and the other in the aisles. Nobody ought to subscribe another shilling to a restoration carried on in that way. Besides the other objections to such a change, he does not see—or care—that it has the effect of making the vault look much lower. I had some difficulty in convincing some visitors lately that that transept is really as high as the other. Mere geometrical details about vaulting would be interesting to few readers, and so I do not give them.

I contributed a little to some papers on it at the R.I.B.A. in 1874-5, chiefly for the purpose of correcting the common fallacy of treating Gothic vaulting as if it all depended on the ribs, and as if the filling up or panelling did nothing; whereas it does a great deal, and indeed is essential to the stability. I also defended 'fan tracery,' which it has been the fashion of late to denounce as base and unreal, whereas it was one of the few real originalities of the Perpendicular style: not when it runs into the unmechanical monstrosities of heavy pendants from the 'springers,' like those in Henry VII.'s chapel at Westminster (see next page), but in its genuine and perfect form at King's Chapel, which is the widest vault in the kingdom, and the Lady Chapel at Peterborough, behind the round apse, and some others. That kind of vaulting is as genuine mechanical construction as the plainest Norman, or the most elaborate Decorated with any number of diagonal ribs filled in with plain stones. But if people start with an erroneous theory, which is entirely wrong mathematically, that vaulting means ribs, and then find a class of vaulting in which the ribs are manifestly subordinate ornamental appendages to the general

St ace, they naturally jump to the conclusion that it is

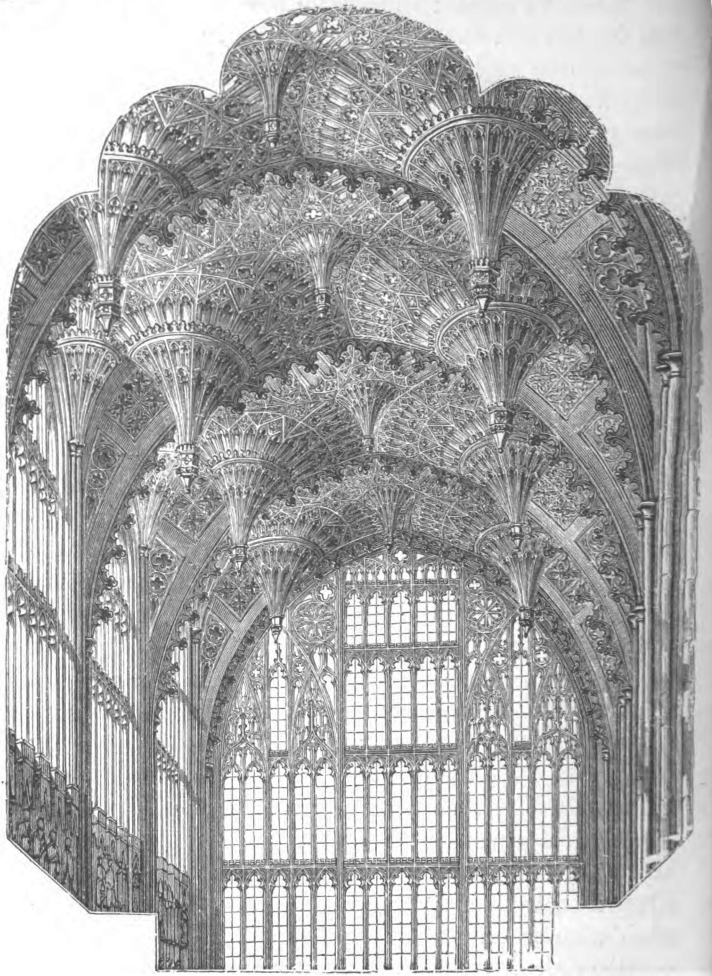


Fig. 15.

a clever and orthodox and 'vigorous' thing to denounce such vaulting as a 'sham;' whereas it happens to be rather more real than the other, and the ribs an appropriate ornamentation following the lines of pressure, and displaying them more clearly than any other kind of vaulting. Still all the kinds are good in their way, though I should rather call this the most perfect than the least.

It is worth notice that the vaulting over naves (in which I include all main roofs constructionally) hardly ever rises above the top of the walls; so that the beams of the wooden roof above can lie over it without touching. Consequently vaulting must be lower than an open wood roof by as much as the width of the building if the roof is equilateral. The pits (called pockets) in the spandrils over it were not filled up, but merely plaistered, except on the aisles, where the pockets are filled up with concrete to make a floor for the triforium: which is the space between the stone vault and the wooden roof. The value of vaulting with a wooden roof over it as a protection against fire has been exaggerated, though of course it is something. The damage to Canterbury cathedral would have been far more serious when the roof was set on fire in the usual way by plumbers in 1873 if it had been an open roof falling down into the choir. Lincoln Minster was saved from a fire, when the great tower roof was ignited by lightning, by a tank for rain water which had luckily been put up there not long before. No fire engines will send water to such a height. I had a tank put in the tower of Doncaster church when it was rebuilt in 1858.

Roofs.—I have already treated of the various roof pitches at p. 179 without any special reference to churches. It is impossible to discuss the various internal forms of open roofs without drawings. The handsome volume of them by Mr. Brandon is well known. I have one remark to make about a very common form of roof—or rather a feature common to several kinds, *viz.*, that the shortest upright rafters from the inside of the wall, which meet the longer ones from the outside, should not be upright; for if they are they always appear to lean outwards, just as the upright part of a 'stilted' arch does. They should lean a little inwards if they are meant to look upright.

A very good and strong form of roof over thick walls is six-sided (see fig. 16), though it is not a semidodecagon; for the topmost angle A, should be sharper than the others, or the internal contour of the roof higher than half its width; but all the sides of the hexagon (not using that word mathematically) are equal. To a certain extent the form is arbitrary; for the point A may be, within certain limits, anywhere. But if you wish the angles at E and F also to be equal, the place of A is not arbitrary, but is fixed by drawing lines B A and D A parallel to *ba* and *da*. You may then find E and F by trial with a pair of compasses, making AE, EF, FB, equal, though of course that is not the mathematical way of doing it, but the formula for it is not so easy as to be worth considering as a practical way of doing it.

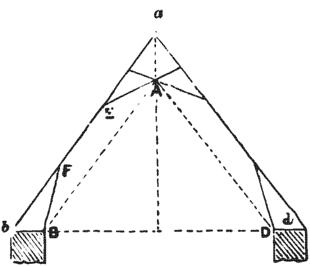


Fig. 16.

Roofs of that kind—or of any kind—do not look well unless the rafters are thicker than they actually need be; and it is singular that they look better not laid the strongest way; *i.e.* 4″ × 5″ beams should not be set edgeways but broadside downwards, with not more than a foot between them, in a roof over a nave (say) 24′ wide and about 32′ high. You may see that they were so laid flatways in old roofs, at Howden and elsewhere. Architecture is not engineering, and should not look as if pains were taken to economise materials and strength, but prodigal about them.

It is a great mistake to varnish deal roofs besides staining them oak colour, as indeed it is to varnish seats or any other woodwork in churches. Builders are sometimes negligent in not making the junction of the roof with the walls air-tight (which they call beam-filling): and architects and clerks of the works do not find it out, and so the first cold weather chills the church beyond the power of any stoves to warm it, and people go on for a long time without finding out the reason, and then have to pay somebody else to do what three persons have been already paid for doing and seeing that it is done. It is common to finish off the walls at the top with only small stones, whereas they ought to be the largest, in order to hold the wall together, with the aid of the roof, and to protect it from decay. At St. James's Doncaster I remember specifying that the walls should finish with a course of large through stones, and the importance of it has been brought to my notice by the alarming state of the nave walls of St. Albans lately. Small stones, depending only on mortar and with no great weight upon them, have no real tenacity, and get loose altogether when any damp reaches them, as it always does in time. The top courses should be set in cement.

Clearstory.—Some persons who denounce Gothic architecture are not aware that the division of a long and wide space into a nave and aisles, with a story for windows rising clear above the aisle roofs is the best mode of lighting and the cheapest mode of building over such a space. (How the absurdity of spelling the word *clearstory* arose I cannot think, unless it began in the days when people spelt anyhow,* and has been kept up under a sort of notion that it looked clerical or ecclesiastical; ladies are rather fond of pronouncing it accordingly *clerrestory.*) Mr. Fergusson thinks that Greek temples were lighted by an analogous contrivance of something like dormer windows sunk in the roof. Yet some architects after building a clearstory seem afraid of putting it to its proper use of lighting the church, inserting only a few little holes, and sometimes putting painted glass even into them; which never ought to be in any clearstory, except perhaps those very large ones as full of windows as possible which were built for that purpose in Perpendicular times. They began doing it at Lincoln some years ago and were obliged to stop. Where a clearstory is carried round an apse the eastern group of windows may be painted.

For the sake of light also it is necessary to leave the west window unpainted if the aisle windows have painted glass, as the light then comes from behind the congregation. But somehow no clergyman seems capable of refusing an offer of a painted window, however injurious to the church, or even if as bad as the north transept window of Doncaster, which would have been a disgrace to a large church in the days when painted

* In some old Scotch statutes I have seen *abominable* spelt *abhominable*—or far from man. No doubt the speler thought he was doing a very learned thing, forgetting all about *absit omen.* Some auctioneers and surveyors in like manner think it looks learned to spell the site of a house 'scite,' whereby they only show themselves *insciti.*

glass was at its worst.* Semiopaque windows also are a decided mistake, at least in churches, being too dark for lighting properly, and entirely wanting the intrinsic brilliancy of good coloured glass. Although you may be able to condemn absolutely the design of a window on paper, or to approve it so far, no paper picture can prove that it will be a good one, as far more depends on the execution and the character of the glass than on the drawing, or what is called the 'subject' of the window.

Short transepts.—I have already said in chapter ii. that deficiency of length is one of the commonest faults of our modern churches, though any architect with eyes that can see must know that length was a distinguishing feature of old English large churches over foreign ones, which rather expatiate in height. And that difference is still more striking in our transepts. As to the old ones, a glance at the table of dimensions at the end of the book will show you the kind of scale on which they were built; but it is not so much a question of proportion to the nave or to the whole length of the church, as of securing a length which looked considerable independently. For instance St. Albans with the longest of our naves has a transept shorter than Salisbury, and Winchester the next longest has a transept practically the same as Salisbury. Yet nobody will say that the Salisbury one looks too long or the others too short. The only British cathedral that I remember with a transept strikingly too short is Glasgow. Generally each transept, north and south of the tower, was 3 or 4 bays long in cathedrals and 2 or 3

* I recognise the design as one which I succeeded in 1861 in keeping out of the east window in favour of a fine one by Hardman. The maker has been kind enough to convince everybody that I was right.

in large parish churches: always distinctly longer than the width of the tower. Compare with these such things as the new St. John's Chapel with a tower of almost cathedral size and a pair of transepts like overgrown porches, stuck to it, which would be far better away altogether; or Ossett near Wakefield, with the general dimensions of a large and fine church spoilt by a transept only 75′ long and a nave much higher than the transepts and chancel, and innumerable modern churches not worth naming, and you will see that the art of effective transept building is lost; besides the generally bare and starved look for which the ends of modern transepts are remarkable.

Then there is that peculiar modern abomination, *the* double-barrelled transept, which Mr. Street actually wanted to add to Eccleshall church, which has a west tower and no transepts, as a specimen of what he called 'conservative restoration,' and you may see them in various new churches. Some men think that they have built a transept when they have stuck a gable facing north and south on the last bay of an aisle, and that they have improved the aisle thereby. Others go still farther and stick a gable over every aisle window, like a whole brood of young transepts. It is true that there are a few foreign aisles built in that way, but they are on a very different scale from these new ones here. Besides the fussiness and want of repose of such building it increases the cost, and makes a number of gutters or valleys in the roof to get out of order, just as the promiscuous roofs in modern Gothic houses do. What I said about the modern mistake of nave and chancel of a cross church of different heights applies equally to transepts. The four limbs of old cross churches were always intended to be of equal height, whether round a central tower or without it, as at Redcliffe church and the second transept of the cathedrals which have two. The intention was occasionally frustrated by an alteration of design after part was built; and a few unimportant parish churches may have been originally built with abnormal transepts, but the rarity of such exceptions proves that the contrary was the rule, and that the exceptions were considered a mistake. Four unequal limbs round a tower look bad enough, but even they are far surpassed by the clumsiness and confusion of four unequal roofs brought together without a tower to 'stop' against: yet this kind of confusion is just what modern architects and their abettors think extremely Gothic. The more inequalities they can get, vertical and horizontal, the more vigorously Gothic they flatter themselves they are.

Windows are such an important part of architecture, that I almost fear to touch upon them, lest I should either say what will seem absurdly little, or else be led into too much detail. But I shall keep to the plan of only noticing what appears to need special notice. One must deal with them according to the styles. Norman is at last rightly disused except in restoration, and I have nothing to say about it, except to remark on every occasion that fine and even very regular work, such as masons delight in, so far as they do in anything, is utterly fatal to it; and the natural rudeness of the original Norman work is now unattainable. It was then the work of men doing perhaps as well as they could, and always thinking more of the general design than the execution; and that you cannot have now.

There is, or was till lately, a notion that Early English was a very plain style, and that any slits in a wall with very pointed heads, would make good E E windows. I have already corrected the mistake about the very pointed heads (except when there were special reasons for them), and the other is a great mistake too. Wherever E E work and even the best Decorated come together, the former is nearly always quite as elaborate and massive, and often of more elegant proportions. It is a style that requires very careful handling, as everything depends thereon; whereas in the two Decorated styles the window tracery is apt to overpower everything, and if very good, really may compensate for serious defects of other kinds.

Perpendicular window tracery is below notice, and was a mere expiring and desperate attempt at novelty where invention and variety were exhausted. I said a good deal about various patterns of Decorated tracery in my book on Church building, and on the vital importance of sufficient thickness and depth both of mullions and tracery, and shall not repeat it here. I will only add one caution, not given there. Remember that any new pattern that you can invent, will be an old one as soon as it is up, and will be criticised as to its beauty only, and not as to the question whether it occurs anywhere else. In windows of few lights there are very few possible patterns that are fit to use, and therefore if you determine to have new ones, they will necessarily be bad; such for instance as bringing a tracery circle as wide as the whole of a two-light window far down below the spring of the arch; and other vagaries of that kind. The spring of the tracery arches, or the small heads of the 'lights' may be, and is, better a little below the spring of the great arch, but so little that it is hardly visible, and only just enough to make the general filling with tracery occupy the whole of the great window arch; otherwise it looks somehow starved. For the same reason, large and tall windows are better with arches somewhat higher than equilateral, as most of the great old ones were, but not all. Indeed, any arches which stand high, *i.e.* on high pillars, are generally better for having a high pitch, and especially the arches of a great tower, as they look, and are, stronger for it also. The arches of the nave of Westminster Abbey, which is much the highest of our naves for its width, and as high as York absolutely, have also the highest pitch of any. On the other hand, those of Lincoln are too low, and spoil that externally perfect cathedral inside sadly. The pitch of an arch is always taken from the inside, as being the part which strikes the eye most; and I need hardly say that the deeper the mouldings are, the lower the pitch becomes of the outer mouldings or extrados of the arch compared with the intrados or soffit. The pitch of an arch is not measured by its curvature, but by the sharpness of the angle at the apex. The intrados is necessarily more curved than the extrados, though the pitch is necessarily higher if the mouldings are parallel or concentric, as usual in all English Gothic.

Window tracery.—There is one piece of very common if not universal slovenliness in architects' offices, against which I think it right to warn church-builders. They will not take the trouble to design any patterns for the glazing in the tracery to suit the quatrefoils, trefoils, and other figures of the stonework, but actually let them be glazed right through with the common diamonds, which of course do not fit the tracery. At Doncaster, where there were at first no painted windows, an enthusiastic clerk of the works (since dead) designed all those patterns himself, but the execution of them had to be paid for as an extra; and he did the same for St. James's church Doncaster, where most of them still are. Nobody who has not seen it would guess what a difference it makes in the effect. Some of those in the great east windows of those two churches were so good that I was sorry to lose them even for the painted glass. It is a pity that architects will not attend to simple and obvious things of this kind instead of looking out for every opportunity to stick on or paint ornaments, and stick in little bits of marble like raisins on a pudding, and cut short shafts in two for pretended rings to hold them; not that many of them know that that was the meaning or origin of such rings, any more than they know the true meaning of cornices, but consider them mere ornaments for the corners of cielings; and their only notion of an architrave is a board round a doorway with some sprawling ogee mouldings laid on it; and they nail large beads round panels projecting above the 'styles' of the door, which could by no possibility have been the real construction, though ordinary spectators don't know that; and then they go and prate against plaister and oak painting for being shams.

Window bars.—Some architects will put the iron window bars, to which the glass is tied, outside instead of inside, fancying they look better. That is a matter of taste; but it is a matter of fact that in that case the wind is always tending to tear away the fastenings of the glass; and further, that the bars outside are certain to get rusty, for they have no chance of getting painted after the first time. I have seen them rusted quite away at their insertion in the stone, or rather lead; which rusts iron by galvanic action besides the ordinary tendency to rust. I always insist on their being inside.

They do no harm crossing the diamonds visibly, and it is a great mistake to try and hide them by putting them oblique to coincide with the lead framing, or to make them very thin; or to take any particular pains about the distances being equal; or to put a narrow border of small panes round the diamonds; or to substitute large sheets for them, which spoil the effect of the best Gothic church windows; while diamonds look equally absurd in common square windows in good houses. No shape or size looks so well for the diamonds of church windows as the usual old one of $4'' \times 5''$, which fits any width of an even number of inches between the mullions. A strong copper bar at least $2'' \times \frac{1}{2}''$ should be built in across the full width of a very large window at the top of all the upright lights. An iron one is sure to rust and split the mullions.

Ventilation of churches is nearly always done by some kind of swinging frame in the windows, which are nearly all wrongly made. Nothing seems able to convince architects and builders of that very elementary piece of mechanics mentioned at p. 205 as to the necessity for putting the pivots of a swinging window frame not only above the centre of gravity but within the middle plane of the frame, so that they will shut themselves and the wind will not open them, as the pressure and the weight of the lower part will prevail over the upper; and they should fit easily in two other angle-iron frames, of course facing different ways for the upper and the lower half; and should be in the clearstory windows where there are any, and if not, as high as conveniently can be. They look better occupying the whole width of one light, and they should be taller than their width. If it is found necessary, wire netting may be added to keep out birds, but it has not been found so in the Doncaster churches, where these ventilators are both large and numerous, nor in Lincoln's Inn chapel. Weights are often added to the bottom outside to make them shut, the makers having never reflected that if the pivots were in the proper place no weights would be needed. The things called 'hopper ventilators' are frightful, and admit of no modification that I know of that will make them tolerable; and they admit very little air for their size besides, compared with a swinging frame. I have seen an apostle's head made to drop down by pulling a string for the purpose of ventilation; but swinging ventilators keep out rain better than sashes, which have to be left open frequently without attendance in churches.

Louvres, popularly called luffer boards, cannot be dispensed with in bell-chamber windows, or the tower will be sometimes flooded with rain. Thick rough glass is the best material for them, as it does not darken the room as wood, stone, or slate ones do. The large projecting louvres which some architects affect are very ugly, and were used in no old English churches, though they were abroad. They should barely overlap, or they confine the sound of the bells, as any louvres unfortunately do to some extent. All the bell-chamber windows and any openings in a spire should have wire netting fixed round them in the most permanent way possible. And with the usual preference of wrong to right, the people who put up such things, and wire caging over painted windows, will make them with the thick wires tied together by very thin, which soon rust away and then the whole fabric perishes. The proper kind to use is wire of 17 or 18 (iron) gauge woven by machinery in square half-inch meshes, which will hang together and keep out birds even if it gets damaged to a moderate extent. The quantity of sticks and dirt which birds accumulate in towers would astonish those who have not seen it. It was through them that the second, or clockmaker's fire in York Minster happened in 1840; and they tend to rot the floors and beams by damp, when the rain and snow come in as they generally do.

At the same time there is no doubt that any louvres confine the sound of bells, and single bells not hung for ringing may very well be quite open either on the top of the tower or in an open bellcote or bellgable. At the Westminster clock tower the bell-chamber is paved so as to throw off the rain into gutters outside, and there are no louvres; but those bells do not swing, and the frame is iron. Louvres cannot properly be dispensed with in church towers with all the apparatus for bell ringing. In some old towers there are large round holes in the walls above the windows, obviously for letting out the sound.

The best kind of glass for church windows is that to which the name of cathedral glass has been given, and it is also called Hartley's rough glass. It is about $\frac{1}{8}$ in. thick, or 23 oz. to the foot, and irregularly rough, not the ribbed or corduroy glass which is used in house windows intended to let in light but to prevent looking through. I mention this expressly, because through the stupidity of a contractor and the carelessness of an architect I once had this latter kind substituted for the former in a church. But if there are any particular windows in a clearstory through which the sun will come into the preacher's eyes, the ribbed glass is better for those windows than 'cathedral glass,' as it dissipates the light more.

Acoustics of churches.—I wish I could throw more light than I can upon this subject. It is a lamentable fact that nearly all old churches are easy to hear in, including many very large ones, and most new ones hard, though there are exceptions both ways. All sorts of arbitrary or imaginary rules have been pretended to be discovered and laid down in books as if they were deduced from experience. But that is the modern way of making theories, *i.e.* to make a guess from one or two instances—or none, and then to invent something looking like a plausible reason for them, and then set to work to deduce conclusions from it as if it were an axiom. I have never read or heard a single rule about acoustics which I could verify by experience, and I have been struck with the very small difference in construction or dimensions which sometimes makes all the difference between a good and a bad result. Generally it seems to me that buildings of which the proportions look satisfactory are also good for sound; and I think I may say that the disproportion which produces the worst results is excessive height in proportion to length—which is the very thing that modern architects are most prone to. In confirmation of this view, I have known several churches acoustically improved by being lengthened. On the other hand some churches with very ample length have a very bad echo, such as Bath Abbey, which has ample length for its width, and no inordinate height, with fan vaulting, and has a dreadful echo, which they have in vain tried to destroy by stretching wires across. You may see in the treatise on 'Acoustics of Public Buildings' in the Rudimentary Series of the publishers of this, particulars of some successful and unsuccessful large buildings; but the author has found it as difficult as I have to deduce any certain conclusions as to the proportions and sizes which can be relied on for producing good results. Lining walls with wood unquestionably does good, and bare floors are bad. In some cases coved elliptical roofs seem remarkably successful, as I also have observed, but not invariably.

School rooms with bare floors are especially apt to be *anacoustic*. Churches are generally better because the floor is broken up with the seats. But I cannot say that all low churches, even with massive seats, are good. The Temple church is very low and yet very hard for preachers; and so is Lincoln's Inn chapel, which is no bigger than a moderately large hall and also rather low—but much too short for its width. The Temple church may be affected by the Round beyond the available church, and I have little doubt that Lincoln's Inn chapel would be improved by lengthening, as the library there has been. I remember two new churches at Bournemouth, one very high (in more senses than one) which was extremely bad, and the other low with a barrel roof, which was good. One of my own churches, St. Chad's Headingley, which is as high as its entire width (the old cathedral proportion) is as easy to read in as any old church, but I cannot take credit for having designed it with any knowledge of what its acoustic condition would be. St. James's Doncaster is not quite so good, at least not for all voices. Its height and width are about the same, but the ends square, whereas Headingley is apsidal. St. George's Doncaster, which is certainly too high for its length, is good for music and manageable by good voices, and on the whole successful for such a large church, though it would probably have been much better if its proportions had not been spoilt by that foolish rage for height of which I have so often spoken. On the other hand, All

Saints Halifax, by the same architect, is extremely bad —not merely with an echo, which is the most common fault, but that utter deadness and resistance to every kind of voice, which I have met with in some quite small churches, such as Meanwood near Leeds, which is too narrow for its height. They are both very high for their length, and so is St. Saviour's Leeds, which is about the worst I was ever in.

I cannot find that the existence or non-existence of pillars, or division into a nave and aisles, makes any difference, as some persons have alleged, judging hastily as usual from a few examples. Some large open halls are very good, and others very bad; and so are some churches with aisles and pillars. Nor can you say beforehand that any one kind of roof will be either successful or unsuccessful; *i.e.* the result does not depend upon the shape of roof. Some vaulted buildings are good, and others bad, as the naves of Westminster Abbey and York Minster, I have no doubt from their great height. The choirs of both are better, perhaps from the screens and enclosures. Whitehall chapel used to be the worst preaching place of its size I was ever in: a simple parallelogrammic room with a flat cieling. It has been improved by hanging curtains all round the upper part of the walls; which however would be impracticable in a Gothic church, or at least would completely spoil the architectural effect of the clear-story, and probably darken it too much. Most, if not all, the polygonal chapter-houses have such an echo that you can hardly hear anybody speak in them.

I cannot say that I have found wires stretched across churches which are afflicted with an echo produce such improvement anywhere as it was stated in newspapers that they did. Some are better when the congregation is in, and some worse. I have heard that some have been improved by giving more ventilation; but I have no trustworthy information about it. It is certain that the ancients had devices for improving the acoustics of large buildings, besides their better knowledge of the requisite proportions, which we have lost altogether: for in the days of the vast ancient theatres, such as the Coliseum at Rome, ten times as many people could see and hear as in any modern church; and they had a peculiar contrivance of horizontal pots along the seats, which are understood to have augmented the sound in the same way as a short and wide tube presented to a hemispherical bell when struck augments its sound.*

Pulpits naturally follow the subject of acoustics. And first, their position for effectiveness, if there is any doubt about it, should be tried by drawing lines from the pulpit to include all the pillars, and observing how much space is hidden by them. The proper height for it in any large church is best determined by trial, as we did at Doncaster, and found that the pulpit floor 5ft. above the floor of the church was the best height; but that is higher than is requisite in smaller churches. The best direction for the preacher to face must also be found by trial. There, and in some other churches, even very small ones, the preacher is best heard facing S.W. or N.W. (acording as the pulpit is on the north or south side) rather than straight down the church or west. Sounding boards are entirely exploded, most of the old ones removed, and no new ones built except that in St. Paul's Cathedral, under the Dome.

* I showed this experiment in a lecture on bells at the R.I.B.A., in 1855, as may be seen in their Transactions.

Theoretically it would seem they ought to help the voice, but practically it seems they never do, except in that one case, where it really seems to be useful. It was made of hyperbolic (not parabolic) shape by an architect of unusual mathematical knowledge. I do not mean Wren, who was a professor of mathematics before he was an architect, but Mr. Penrose.

The architecture of pulpits seems to be very little understood now-a-days. Monstrous sums are sometimes spent in building them of the most ostentatious ugliness. The 'tubs' of the 17th and 18th centuries were nearly always fine specimens of woodwork at least, such as you could not get made now for any money; and though certainly very unhomogeneous in style with Gothic churches, they were not at all more so than the marble boxes of no style ever known upon earth, which we see now where the architect has meant to produce something very grand indeed; or those stone tubs to which Sydney Smith gave the name of parson-coolers, designed as the plain and neat article in pulpits when economy is demanded.

A pulpit does not indeed admit of much variety in the principle of its design. The fundamental idea of a Gothic one must be an arcade of small arches carrying a wide rail or desk, and supported either on a large base or platform, or else (the exact opposite) by a smaller stem or short pillar or cluster of pillars. Or there is one other form, viz. a large bracket or corbel from the wall or great pillar against which the pulpit stands, of which the most famous specimen is at Trinity church Coventry. The arcade may be either close or open; but the latter generally looks the best, because it shows more depth, especially when lined, as it always should be, with red cloth, hanging all round inside from a cloth cover on the top or desk: by which I do not mean that little sermon-holder stuck upon a prop which architects delight in, but a real wide desk or slope running all round at the proper height for a tall man, *i.e.* about $3\frac{1}{2}'$, leaving short men, who are not short-sighted too, to stand upon a stool. I am surprised that nobody discovered before we made the new pulpit for Doncaster church how much better the effect is of that wide desk running all round than of those little elevations of either brass or marble just wide enough to hold—and to display the sermon.

That plan has another advantage too. When the whole enclosure or preaching gallery, as we may call it, is about $3\frac{1}{2}'$ high it is easier to get a handsome set of arches than when it is as low as usual. The few extra inches of height, though little in themselves, make all the difference between the shafts looking dumpy, and so giving an air of smallness to the whole fabric, and their looking a sufficient height. It may save trouble to mention that the best way of treating such a pulpit internally is to put a number of brass-headed nails about $9''$ apart, all round the top of the desk near the outside, to serve as buttons for a thickly lined cloth covering all the desk; for which the pattern should be cut out in paper on the spot, if you mean it to fit; and then hang the curtain quite flat and smooth from the inner edge of that. Anyone who will take the trouble to look at the pulpits of St. George's Doncaster, St. Paul's Burton, or St. Chad's Headingley, and compare them with the far more pretentious marble fabrics, solid or open, of modern architects will be able to judge better than from any further description which kind is the best both for convenience and appearance. There are so few old Gothic pulpits in England of any importance beyond the very small number given in the 'Glossary of Architecture' and some other books, that our architects have been thrown more upon their own resources than for most other subjects of design, and I cannot say their success has been remarkable. Candlesticks for pulpits with moderately sloping tops, such as these I have described, are best made with large weighted wooden bases cut to the same slope, which enables them to stand upright anywhere along the top.

Reading desks might be disposed of, so far as antiquity is concerned, in a chapter like the famous one on snakes in Ireland, consisting of the word 'None;' for no old ones survive, as far as I know. In cathedrals, as everybody knows, the desk is never more than a slight elevation in front of one of the stalls. In parish churches now-a-days not one clergyman in a dozen is content to read the prayers facing the congregation as they all did in parish churches from a long time back until lately; and most desks are made facing either north or south, and I have nothing more to say about them, except a small piece of purely practical advice not impinging on any theological views; and that is, both in pulpits and reading desks, and also at the communion table, to have the kneeling stools open underneath, so that your feet can go under them when standing. Architects and ladies are fond of getting up large kneeling *boxes* covered with decorated cushions. The cushions and the decoration may be right enough, but I have seen and heard clergymen, and even bishops, kicking about the boxes in the vain attempt to find rest for their feet when they rise from kneeling to standing, especially in small pulpits.

Another practical matter is that desks and lecterns are often put so low above the floor, that people sitting a good way off can hardly see the reader over the heads of those in front of them, and I have found clergymen complain of architects for designing these articles to suit the look of the church when it is empty, forgetting that the people's heads will be considerably above the seat backs. As I have said so much of the pulpit of Doncaster church I think it prudent to add that the reading desk is no child of mine, except in its position and its size: on the contrary, I thought it so bad that I managed to stop there being any pulpit, which was designed in the same style, and we lived on a borrowed wooden tub for some years, until at last the architect accepted my general design of the present one, which I also gave, in order to keep out a worse offered by another person.

Lecterns are now of more use and much more largely used than formerly, as it has become more the custom for either a second clergyman or a layman to read the Lessons, and few reading desks are large enough to contain two persons comfortably. Both they and pulpits are always much smaller inside than they look outside. The lecterns themselves are generally very poor and flimsy things, besides being too low, as I observed just now. As brass eagles have returned into fashion, it is worth while to mention that 99 out of 100 of those birds stand too upright, and exalt their beaks so as just to come before the reader's face. Go and look at Wren's eagle in St. Paul's, and you will see how he attended to this, as he did to every detail, keeping his eagle's back at a low inclination, and his beak low besides. As I have often read the Lessons from a variety of lecterns and reading desks, I must confess to the weakness of liking some kind of rail wherever there are several steps. The want of it is sometimes dangerous to old men; and indeed any man may fall from treading on his surplice,* or in stepping down backwards.

Altar Steps or Footpace.—This absurd name is applied by high church architects to a step surrounding the communion table on three sides, and the step is as absurd as the name, and more inconvenient. I am quite aware that that is a matter of indifference to those who fancy that they are thereby evading or defying the law and making the Table as much as possible into an Altar, and that they are altogether beyond

* A clergyman at the Church Congress 1875 said that he made a point of doing nothing in the service which he could get a layman to do for him, and either said or implied that laymen read for him not only the Lessons (which is common) and the Psalms (which are equally lawful for a layman to read, and I have sometimes done it), but the Litany and some other prayers. That, I have no doubt, is uncanonical and unlawful, although by some Cathedral statutes a 'lay Vicar' sometimes reads or chants the Litany jointly with a 'priest Vicar'; but that is a different thing. I may add that a Lord Chancellor, who has often sat on ecclesiastical cases in the Privy Council, told me that that was his opinion also. The old idea, and probably the correct one, was and is, that all persons who take a part in the service distinct from the general congregation, ought to wear surplices, as the undergraduate readers of the Lessons in college chapels and the choristers in cathedrals always do. Indeed in some of the colleges all the members wear surplices on Sundays and holydays, and in others all the 'scholars' or members of the foundation. It is quite clear that the visible clerical distinction is not the surplice, but perhaps the black stole, or scarf, or 'decent tippet' of the canons, whatever may have been its origin: so at least it is held by some persons learned in such matters. The days of female singers in smart bonnets are happily gone with the galleries in which they displayed themselves, and the surplice is the old ministering uniform: whereby I mean the long white linen surplice with equally long sleeves, of old pictures and brasses; not that modern copy of Mrs. Squeers's jacket in an inferior half-cotton fabric, over a long dark petticoat, with a row of close rivets up the front like a boiler, which the ritualists have adopted, with equal regard for antiquity and beauty.

the reach of argument. But for more rational people I remark that whenever one more step is really required than can be conveniently got outside the rails, it is much better carried right across the front of the table than returned round the ends, besides looking larger and therefore better. A step just behind where you are standing is always dangerous in case you forget it, and at any rate troublesome, and there is no conceivable advantage in it. In fact everybody knows very well that they are only built as favouring the illegal altar theory. But I warn church builders or restorers that if they mean not to have them they must take care not to make their architect their master, as I said in the first chapter. I have known an architect persist in doing it, even in a narrow apse, leaving therefore a little wedge-shaped hole for the clergyman to drop into, in spite of his objecting to it. The Vicar of Doncaster and I had some difficulty in making Minton's men understand that the orders of the Committee were to be obeyed in re-building that church, and that they were not to lay their tiles for a step. The clerk of the works told me afterwards that even he could hardly persuade them to believe it. At Bath Abbey and some other large churches the long step carried right across the large space within the rails looks very handsome, and more elevation is required in a very long church or chancel than in a short one.

Another modern ritualistic folly is that of making the communion table look like a large box with a lid to it, by the construction of 'the altar-cloth' fitting tight and square all round it, with a fringe or border 5 or 6 inches below the top of the table, just where the lid of a box of that size would be. I do not suppose that the object is to make it look like a box, but that is the effect of the architects' and ladies' established modern altar-cloth, a shape which no genuine table-cloth in the world ever had. Some tables are actually made as boxes, as you may see on week-days when their garments are tucked up, obviously in order that they may be as unlike tables as they can within the letter of the law. By way of unconscious rebuke to this absurdity one sometimes sees over them a copy of some famous picture, or a carving, of the original institution of the Lord's Supper at an ordinary table covered with a common table-cloth, with the corners hanging down naturally, which looks much better.

The most convenient height for the Table is 3 feet, and it need never be more than that width, and in small churches may be less. The length may be anything from 5 to 10 feet, according to the width of the chancel. We may say it should be nearer to a third than anything else, except in chancels of unusual width, for which that would be too much. Nothing requires more care in making than an oak table top. If you mean it to stand without cracking, it must on no account have ends mitred in, and must be screwed to the frame so that it can expand and contract with the inevitable variations of damp and dryness. I believe 99 out of 100 of them are cracked at the joints of the boards.

Metal work.—Some architects have a passion for introducing as much brass work into churches as people will allow or cannot help. Coal-smoke is utterly fatal to brass, especially where it is so little attended to and cleaned as it is sure to be in churches. I have reason to know this both from clock-making and church-building. I have seen the thin brass work of a clock in a London tower completely rotted in ten years, so that it fell to pieces when dropped on a table, and thin tubes fell from their own weight; and every town now is only a greater or less approximation to London in smokiness. Neither is modern brass or copper at all the same thing as the old metals, as I know from other tests. All the brass screens, rails, 'gaseliers,' gates, pulpit desks, and other things which our architects have been making people pay great sums for in the last 20 years will have perished superficially at least in 20 more. The gas standards of brass in Doncaster church are utterly spoilt already, though they are not yet 20 years old, and the Doncaster atmosphere is pure compared with many others, though far from what it was before the railways came. Iron is infinitely better whenever metal must be used; because it visibly cries out for paint, becoming too ugly to be tolerated when rusty; and moreover it only rusts externally, and much more slowly (inside a building) than brass, which decays right through. I have found brass wire laid by for some years even in non-smoky places become quite brittle, though not visibly decayed; and that is not the case with iron even when rusty.

A great deal of modern ornamental metal work is miserably flimsy and weak, under pretence of being particularly strong and 'real' and superior to cast metal. If the old builders and artists had possessed the scientific knowledge that we do we may be sure they would have produced artistic and beautiful results with cast metal, instead of talking nonsense about its being impossible; and at any rate their wrought metal work was sound and stiff, and not liable to be pulled to pieces or twisted out of shape even by cleaning.

Seats or pews (for I know of no constructional difference between them) are generally made a few inches too low in the back. They should certainly not be less than 34 in. and are more comfortable 36. It is at last generally conceded that sloping backs give more room, but it took a long time to produce that conviction. And architects will not learn yet, nor many clergymen, that closing up the space under the seat completely makes the pews practically 3 or 4 inches narrower than if they are open for a few inches above the floor. If the board is put forward, as it is sometimes, it prevents kneeling and also leaves no room for hats, which must go somewhere. If they are entirely open, hassocks become *feræ naturæ* or common property, instead of the proper number of them remaining in each pew. The best plan is to have a strong rail about 4 × 2 in. running all along the back of the 'standards' under the seats, just enough above the floor to let people's toes go under it. Seats are now generally made to slope a little upwards towards the front edge, which really is a valuable modern improvement, or rather revival of some of the old stalls, which were comfortable enough both in this respect and in their sloping backs, though sometimes spoilt by a stupid projection which catches your neck, just as many modern chairs assume that people are convex at the back, instead of flat, as they at any rate ought to be.

The best height for the front edge of seats is 17 inches from the floor. It is a great mistake to cover them with thick cushions; persons who want some covering had better have those woollen mats which are made for this purpose, and for altar steps, by French of Bolton, and I dare say other makers of church furniture and surplices, &c.: but so far as I have seen, his are generally the best. Kneeling boards of any kind are very inferior to hassocks. I have said before with regard to oak in general, but it applies specially to church work, that the common practice of rubbing it with wax is fatal to its proper effect for many years, *i.e.* until it has all worn off or got destroyed by the air. Varnishing is worse, and is generally given up on oak, though still too often used on deal. Oiling spoils it altogether, but there is no harm in slight staining of deal. The chisel marks of any kind of carving or ornamentation should be left. Patience is the only finishing that oak fittings want, or stone either, as I said before; but the usual idea is to smarten up everything for the consecration and the newspapers, and to care nothing for what may happen afterwards. See also what is said at p. 94, about the bevels or chamfers of seat ends.

Somebody invented an absurd plan of prolonging the seats backwards into the next pew to form a ledge for books nominally, but really to knock your shins against, instead of putting a book board in the proper place near the top; and it found great favour with the high church clergy and their architects, and was published as the only right plan of seat making. They fancied that persons kneeling in such pews, without a book board for their arms to rest on, would drive those in front of them to kneel also; but in time they found out that the effect is just the contrary, and that an obstinate sitter has much the best of it and prevents any one from kneeling behind him in a pew of that construction.

Church Restoration is an architectural business peculiar to this age. In old times churches were 'restored' by pulling them down and building up others, almost always quite different, because in the fixed style of the rebuilding age. That cannot be done now, for the simple reason that there is no style of the age, and nobody avows the intention of restoring in his own style. But it would be amusing if it were not lamentable, to contrast the architects' disavowals of that intention with their frequent practice. Here is such a declaration from an architect of almost the largest practice, in a printed letter respecting a particular church: 'I wish to say in a few words what I mean by the word Restoration in connexion with such a building. I wish to confine the work, which I should do in it in the most *vigorous* manner (remember what I said of that phrase at p. 97), to preserving the old work and exhibiting it with as little alteration or addition as possible of any features which are at all conjectural. I do not at all agree with church restorers who allow their work to be seen all over the face of an old building.'

Nothing can be more admirable than all this, except the 'vigorous' nonsense; but I am sorry to be obliged to add that I have seen not one restoration by the propounder of these admirable principles in which he has not 'allowed his own work to be most conspicuous all over the face of the building,' not certainly in adding any features which were at all conjectural, in the sense that anybody could conjecture that they were ever designed by a genuine Gothic builder of any style or period. And the same may be said of most of the architects of that school especially. Fortunately most of our cathedrals and great churches have fallen into other hands. I have indeed heard and seen in newspapers unnecessary destructiveness attributed to our greatest church-restorer; and for what I know, in some cases it may have been justly. But on the other hand I do know that some of such charges have been made in pure ignorance, and utter disregard of what is after all the primary consideration in buildings that are not kept as mere ornamental ruins. Strangers of the dilettanti kind, and people who would be writing about gigantic gooseberries if they could find nothing else to write about, see something that they think picturesque or ancient in a church, and know nothing of its condition or capability of standing. Next time they come they find it gone. Off goes a letter to a newspaper, 'The church has been restored by Sir. G. Scott, and to my horror I found that such and such a thing of the most venerable antiquity had been removed to make way for'—perhaps the most important thing in the building; but that is nothing to the antiquarian great gooseberry man.

The truth is that all these matters are beyond the reach of rules, but within the reach of common sense, as to what should be preserved or destroyed in a restoration. I defy anybody of real experience to deny that practically speaking our great churches are conservatively restored, as much as possible in the spirit of their own builders, by the school of architects of which Sir G. Scott is the head, who do not talk about it, and that they are restored in the style of radical reformers by those who do talk the cant of conservative restoration. A church which has passed through their hands, has practically ceased to be a building of any known English Gothic style, and become a mongrel of their own style, if they have been allowed to have their own way, and it requires a pretty strong hand to prevent it. At the same time I never would rebuild a thing which is incurably decayed, as a copy of the old one, if I thought it bad. It has lost the value of genuine antiquity by the course of nature, and it appears to me mere prudery and nonsense to copy that particular thing rather than build something more suitable or beautiful, as completely in the old spirit as you can. It is no use denying that some old things were ugly. While they have the interest of antiquity let them keep it; but when that is gone the ground is open to do the best we can.

Refacing old stone.—This is about the most destructive and wasteful operation that can be performed under the name of restoration. Stone which has kept a tolerably good face for centuries, or what is better, has got covered with that brown vegetation which is a symptom of the surface not perishing at all, will sometimes be hastened to destruction by having that surface 'tooled off.' A few years ago some architectural idiot persuaded the Dean and Chapter of Lincoln to begin it there. Luckily the alarm was raised before they had done much and the mischief was stopped. Even the black parts of St. Paul's are sound, and it is the white parts that are continually decaying.

Worcester cathedral tower, which was reduced to the meanest of them all, by all the decorative work having been at some time cut off, I suppose to save repairs, and all the top, above the upper windows, finished in mere brick and plaister of the meanest design, has been restored, chiefly at the expense of Lord Dudley, to one of the finest of our towers; indeed none of its own kind is in my opinion equal to it. And this shows how much more may be done by the judicious outlay of a few thousand pounds in restoring some fine old building than by setting an architect to work to spend far more in building up some fantastic little 'gem' of a chapel of your own; which will be praised by the bishop and the newspaper reporters on the consecration day, and the architect's health drunk, and then no human being will ever care to look at it again. That is the real test of good building, whether people want to see it more than once, and it is one of the differences between the effect of good proportions on a large scale and extravagant decoration without them. I will venture to say that nobody ever went twice for the purpose of admiring, though they may go to show their friends, the most costly little churches which have been built in modern times, nor ever really thought them admirable for anything but their cost.

While Doncaster church was re-building, at the cost of 37,000*l.* for the building, which was cheap for its size, compared with many other modern churches, and 43,128*l.* including everything, except the organ and painted windows since introduced, a gentleman in the neighbourhood used to condemn our extravagance; but soon after, he set to work to build a chapel in a hamlet of his own parish, and spent on it twice as much per sitting as Doncaster church cost. I wonder which of us got the most for our money. I remember an equally costly little chapel being built in a small place near Bridlington, while that grand nave, of large cathedral dimensions, was crying out for restoration, being almost in ruins. It has since been restored, but, for want of funds, very inadequately for its merits. Rich people, who know little of these things from their own experience, may take my word for it as a builder of no small experience, both on a large and small scale, that the restoration of a great old church, whose proportions modern architects can neither spoil nor copy (as it seems) will pay them infinitely better interest for their money in every way that they can wish to have it, than anything new that they can build. Of course I am only speaking of ornamental outlay in building.

Just now there is St. Albans Abbey, with the finest part of the longest Gothic nave in the world, and the oldest great church in this kingdom, only kept from actually falling by being shored up with timber. It wants at least 30,000*l.* to restore it safely and thoroughly. Set the best architect you think you know to build you the finest church he can for 30,000*l.* Do you imagine that you would get anything comparable to St. Albans? Yet some persons have spent much more than that in building mere chapels overlaid with costly decoration which gives nobody any lasting pleasure; and multitudes of people turn a London 'decorator' into their drawing rooms to spend in paint and gilding and silk and satin, which will all be shabby in ten years, twice as much as would restore that cathedral if a dozen of them combined for the purpose.

CHAPTER VI.

Domes—The great Pyramid—Sizes and Proportions of large Churches and Halls.

I SAID that I should treat of domes separately from octagons in the position of a central tower. I may as well repeat the introduction to a paper of my own on the theory of domes, in the Transactions of the R.I.B.A. of February 1871.

'Perhaps in this age of iron no great dome of masonry will be ever built again, yet we must all admit that the two great iron and glass domes of the 1862 Exhibition, of which one was afterwards moved to a much handsomer (but equally short lived) building at the Alexandra Park, or that of the British Museum reading room, though they are as large as any masonry dome in the world, or the flatter oval dome of the Albert Hall, which covers twice the space of those, being 220 ft. × 185, (and now the still larger one of the Vienna Exhibition, 360 ft. in diameter) have excited no such interest as is still felt in the comparatively unscientific fabrics of the Pantheon and St. Peter's at Rome, the Cathedral of Florence, the Gol Gomuz of Beejapore, and even the flat segmental domes of St. Sophia at Constantinople and St. Vitale at Ravenna, which last is made of pots. I suppose everybody will agree with Mr. Fergusson that a dome is the most perfect roof that has ever been invented, especially on a large scale. But the cracks and bands of St. Peter's, the immense thickness of the Indian domes and the Pantheon, Wren's evasion of the difficulty at St. Paul's by building a cone to carry the lantern and the external wooden dome, and the non-existence in the world of any very large masonry dome of moderate thickness, have raised an impression that no such dome can exist, and that large hemispheres of masonry must either be enormously thick and heavy, or else must depend so much on ties that we may as well build iron domes at once.

'The subject has naturally been discussed here several times; and I see that on nearly every occasion a wish has been expressed for a more complete investigation of it, which should be at once mathematical and practical. Mathematical writers have hitherto been content with proving what is practically known to every man who ever turned a flat segmental dome over a well; viz. that a dome of about half the height of a hemisphere is stable, or has no tendency to fall in anywhere if it is sufficiently tied round the bottom, however thin it may be. But there they have stopped, and left us to conclude—and some of them have asserted, that below that point, about half-way from the top of the hemisphere, where this natural stability ends, we cannot continue the dome at all without the aid of ties or bands, or reliance on the tenacity of cement, or some very great thickness, almost enough to make the dome contain a cone. Indeed that conclusion was expressly enunciated in the paper read here in 1859 by Mr. Lewis, Professor of Architecture at the London University, who said (p. 117), "I believe that the real secret of constructing lantern-bearing domes of large size," and others in a less degree, "is to make them approach so closely to the conical form, that their section shall include that powerful outline . . . . although by careful attention to the goodness of the materials and the general bond of the work, it may no doubt be made secure with other outlines; . . . . but that any departure from this entails risk:" which would require a thickness of at least 14 feet in a dome 100 ft. wide, smaller than St. Paul's, which is only 18 *inches* thick. Mr. Fergusson, on the other hand says "It is as difficult to build a dome that will fall as a vault that will stand." (*Handbook*, p. 441.) Between these widely differing views it is time that we should come to some more definite conclusion as to the true conditions of stability. . . .

'The problem is practically insoluble by any but tentative or approximate methods. The introduction of the thickness so deranges all the natural relations of sines and cosines, that the formulæ soon become unmanageable for any direct solution; and that is probably the reason why it has been left unsolved in mathematical books.' But though the thickness makes all the difference in the geometrical conditions of the problem, the mass and the centre of gravity of the pieces of all domes of small thickness compared with their width, may be practically treated as if the dome were a perfectly thin shell at the middle of its thickness, multiplying by the thickness only as an element of weight. If you call the thickness t and the diameter d, this only involves an omission of $\frac{t^2}{3d^2}$ of the mass, which is always a very small fraction in a thin dome. But where the thickness is great that fraction becomes larger and the mass must be treated as the difference between two solid domes of the outer and inner diameters. One such case is dealt with in the paper, viz. the Gol Gomuz, whose thickness is a 14th of its diameter.

I cannot reprint the calculations here, and probably few persons would read them if I did.* The most important of them were also verified by models, made to illustrate the limits between a barely stable and an unstable dome and arch. The making of such models requires attention to the fundamental difference between domes and arches. Many people suppose that the 'element' (as mathematicians call it) of a dome is a narrow vertical slice through the middle, which of course is nothing but a round arch. But that is a fundamental mistake. You could not make up a dome of any number of such elements, for all their middles would overlap, and if you took an element only 5° wide at the equator or base of the dome you would have 36 of them overlapping at the top. The true element of a dome is the piece called a *lune*, included between two meridians or vertical circles through the top, and very near together, *i.e.* so near that the piece included has no sensible horizontal curvature.

And that is not a very easy thing to make a model of, consisting, as it must, of a number of small pieces, each of proper width and weight, to represent the stones or courses of the lune, inasmuch as it has no width at all at the top. The way to do it is this: calculate the weight of the pair of pieces on each side of the top, down to say 20°, and then make a straight piece of wood of the proper weight in proportion to the parts below, and with the proper bevel at the ends of this

* I have some spare copies of the paper. Anybody who thinks it worth while to send six postage stamps to 33 Queen Anne Street, W., with a stamped wrapper directed to himself, may have one, as long as I am able to supply them.

cross piece; so that it will look like a section of a dome with a flat top. Then how are we to build it up? There are two ways: one is to make a semicircle of wood of the size of the dome inside, and cut off the upper 20°, and build up the stones on it as a 'centre'; lay in the straight piece to represent the weight of the top, and then let down the 'centre' gently by wedges or screws, and see whether the pair of lunes stand or fall, the bottom stones being held from bursting outwards by stops. The other way is to build the pair of lunes and top piece on a board laid down flat, and then gently turn it up on its lower edge till it becomes vertical and gives no support, even by friction. That has the advantage too of showing whether the dome proposed is very far from stable; for if it is it will fall before the board becomes vertical. But it requires a little scheming besides to enable the stones, which ought to have oblique sides, to lie flat. Make each of them of the proper weight and size, but give a double obliquity to one side, and then the other may be flat on the board. That was in fact the kind of model that I used at the R.I.B.A.

The result both of the calculations and the models was that a dome only requires a thickness of ·022 or a 45th of its diameter, while a round arch, or a barrel vault, requires ·072 or a 14th of its span (reckoning to the middle of the thickness) to be stable when standing alone. Moreover cement can help an arch very little, but may help a dome a great deal, by converting every course into a ring with considerable tenacity by virtue of the bonding with the courses above and below.

The next important result of calculation is, that as soon as you have got 23° from the bottom in a dome of proper thickness, it completely ties itself above, or has all its pressure inwards, and therefore no good would be done by inserting any more ties higher up—provided there is no heavy lantern on the top. But a dome of no thickness at all, if such a thing could be built, has not all its pressure inwards until you get 38° from the base of the hemisphere, or 52° from the top; which again is very different from a round arch or a barrel vault, of which no part will stand without thickness. In other words, a very flat and moderately thin dome, such as St. Sophia's or the Ravenna one, which are a long way short of hemispheres, would stand without cement, if strongly enough tied or resisted horizontally at the bottom.

The bursting pressure at the bottom of a dome is very great, being ·215 or rather more than a fifth of the whole weight, still disregarding cement in the dome: which weight is the same as of a cylinder of the same height width and thickness as the hemisphere, or twice the weight of its own floor of the same thickness. But that bursting pressure may be counteracted without any tie by making the drum underneath conical like a windmill and leaning inwards with a slope of 12° or ·215 or about 1 to 5, and carrying it down deep enough into the ground to be secure at the bottom, or to a sufficient number of cross walls to make a firm abutment.

Tapered domes.—A dome need not, and indeed had better not be uniformly thick, for if it tapers or grows thinner upwards it will do with a less thickness throughout. Suppose the thickness decreases with the vertical height or distance from the top, in such a ratio that it becomes half at the top what it was at the bottom; its thickness there need only be ·016 or a 64th of its diameter; and the weight is then only $\frac{3}{4}$ of $\frac{3}{4}$, or little more than half of that required for an uniform stable dome of the same size. In round numbers, a stone dome 100 feet wide and 1 foot thick would weigh something like 1000 tons; from which any others may easily be calculated, remembering that the weight increases as the square of the diameter, and directly as the thickness—assuming that to be small compared with the diameter, or else these rules do not hold good. Therefore we might build a dome 200 feet wide, covering twice the area of the largest masonry domes in the world which would be stable without any ties if only 3 ft. 3 in. thick at the bottom and anything less than 1 ft. 7 in. at the top, standing on a drum of the same thickness and of any height, provided it contains a slope of 12°; for the tapering makes very little difference as to that. The drum need not display the slope, which would be ugly beyond a small amount, but it could be concealed by arcades outside towards the top and inside at the bottom, which would look very well in themselves besides. Moreover the slope of the drum may diminish downwards, so much that if it is as high as the dome the slope need only be half as much at the bottom as at the top.

In practice we should certainly build iron ties in the lower quarter of the dome, and thereby the thickness might be much more diminished. The calculations all assume the absence both of iron ties and of the advantages of bonding and cement; but on the other hand they assume the stones to be or act as *throughs* and to be strong enough not to crush at the edges.

Some of the architects who were present at the lecture suggested that it would be better to make the beds of some of the lower courses horizontal, as is sometimes done in arches and generally in spires. There it may be unobjectionable, though I doubt if it is expedient, as it makes acute angles in the stone just at the most likely place to chip. But domes differ essentially from arches in walls, in having nothing on or against their haunches; and the fact is that the lower courses ought not to be more horizontal than the radial direction to the centre of the base, but less; as is clear at once from this: with the radial inclination the few lowest courses would not differ sensibly from horizontal, and consequently there would be absolutely nothing to resist the bursting pressure except 'friction and sticktion,' which would be far too little to be safe. The thrust outwards of a dome is enormously more than of a spire, and even they are safer if the beds are square to the face (p. 245).

The nearest approximation to a hemispherical dome which will stand without sensible thickness anywhere is a hemisphere with its shoulders at about 20° from the top pushed outwards by about a 50th of the diameter, and the haunches about 20° from the bottom pulled in as much; so that it does not begin to rise quite vertically like a hemisphere, but a little leaning inwards, and is rather flatter at the top. And as things which are mechanically right generally look so, I think it probable that such a dome would look better than a perfect hemisphere, though the difference is hardly visible in a small drawing. A paraboloid would also be practically stable with a very little thickness, and a dome of which the section is a catenary would be quite stable, but they are both ugly shapes for solid looking bodies.

Domes with eyes.—Domes, like that of the Pantheon at Rome, with a large hole or 'eye' cut out of the top, are obviously more stable than others, and therefore require less thickness, because it is the weight of the upper and flattest part which is far the most oppressive or bursting, and that is lost by the 'eye.' I found that an eye with a radius of 20°, which covers only a 25th of the floor, takes off ·06 or a 17th of the weight of an uniform dome, but would enable it to do with a fifth less thickness. Semicircles cut out of the bottom on the contrary diminish the stability, partly by the loss of their weight leaning inwards, but much more by the contraction of the base at those places, or the loss of so much support as would be cut off by vertical planes just covering each opening like a shutter.

Ribbed domes.—It was taken for granted in the former discussions at the R.I.B.A., as requiring no proof, that domes must be stronger for being made with ribs. But exactly the contrary is the fact, unless the thickness is greatly increased, as may be easily proved thus: Take a pure dome of the proper thickness for stability and turn it into one of ribs and panels of the same total weight, and see what would happen. Unless the ribs or arches are three times as thick as the dome they will not stand themselves, as we saw at p. 301, much less bear the intervening panels too; and the panels will themselves be quite unstable by losing so much of their thickness as is thrown into the ribs. Or again, begin with a dome as thick as the ribs are intended to be: then if you thin the intervening spaces down to panels you take away far more weight near the bottom where the weight tends to stability, than near the top where it tends to instability. In the Pantheon the ribs are not uniform arches, but are themselves of the shape of *lunes*, or the slice between two meridians of the dome, and therefore are as stable as the dome itself; and the whole is a vast deal thicker than is requisite for bare stability, the panels being filled up so as to show very little dome outside. Another objection to a ribbed and panelled dome of small thickness is that you lose the benefit of horizontal ties or bonding; in short this, which was assumed to be the best, is in every way the worst mode of dome-building; though of course adding ribs enough to be stable to a dome already stable increases the stability, especially if they are either thinned or narrowed upwards.

Pointed domes.—It is evident that pointed domes are more stable than round ones, and I calculated in the paper referred to in what degree they are so, and found that a dome of equilateral section, or one containing an arc of 60°, only needs a thickness of ·0137 or a 73rd of its width; which is also in that case its radius of curvature; or such a dome 100 feet wide need not be quite 17 inches thick. And one of 70°, of which the radius of curvature is very nearly $\frac{3}{4}$ of the width, requires a thickness of about a 60th of its width, or a dome of 100 feet requires about 20 inches. Tapering does not make much difference in the stability of pointed domes, because they have already lost the top of the hemisphere, which is the most oppressive part. These domes too require no tie at the bottom if they stand upon a drum with a slope of only 9°, or about 1 to 7. But pointed domes are never built, except where there is a lantern to carry, which is the real difficulty of dome building on a large scale, and those which carry lanterns are generally of rather pointed section, though of course no point is seen.

Lanterned domes.—Just as cutting out an 'eye' increases the stability, so adding a lantern decreases it in a much higher ratio than the weight cut out or added. I calculated these results, first for a hemispherical uniform dome. Let M be the weight of the hemisphere, or say 2500 tons for a dome 100 ft. wide and $2\frac{1}{2}$ feet thick, the least thickness that will carry any considerable lantern without help from ties: L the weight of the lantern as a fraction of M, t the thickness in feet. The tons in the third column are the weight of lantern which can be carried by a dome 100 ft. wide and of the thickness t. The table then is this:—

t	L	= Tons	$88\,(2t)^3$
feet			
$2\frac{1}{2}$	·038 M	= 95	110
3	·06	180	190
$3\frac{1}{2}$	·084	294	301
3·78	·1	378	380
4	·1122	449	450
$4\frac{1}{2}$	·1425	641	641
5	·177	880	880

The $(2t)^3$ in the last column is only multiplied by 88 to show at once that the weight of the lantern increases very nearly as the cube of the thickness of the dome; and this proportion is so near that it would doubtless have been exact if all the calculations were not necessarily approximate and tentative, the equations being such as cannot be solved directly. The result is also probable *à priori*, because each lune must increase in strength with the square of its thickness as a curved beam, and it increases in stability besides by its lower part being wider than the upper, and therefore gaining more by the increase of thickness.

The lantern also materially increases the thrust or bursting pressure R at the bottom of the hemisphere by exactly the weight L; so that if L = ·1 M, $\frac{R}{M} = \cdot 215 + \cdot 1$ and $\frac{R}{M+L} = \frac{\cdot 315}{1\cdot 1} = \cdot 287$ or tan. 16°.

Therefore the drum to carry such a dome without ties must have a slope of 16° instead of 12° as it was without the lantern.

L represents any other weight or force as well as the lantern, and in fact it must include the leverage of the wind upon the lantern, which acts as weight on the side farthest from the wind. The effect of either wind or snow on an unlanterned dome is inconsiderable, for a dome must practically have an enormous superfluity of strength beyond what could be affected by any possible snow on the top or wind on the side. A dome is in fact the strongest against wind of all structures of the same height weight and size except a cone, of which the stability is limited by nothing but the compressibility of the stones.

I calculated a similar table to the former for a pointed dome of 60° with a lantern, which is as follows; only it must be remembered that M (for reasons of calculation) is still the weight of a hemispherical dome on the same base, which bears the proportion to the taller equilateral dome of 1 to 1·372; and 1 to 1·177 of a dome of 70°. But as I have given L in tons also that does not affect the result.

t	L	= Tons	·88 $(2t)^3$
feet			
2	·044 M	= 88	128
$2\frac{1}{2}$	·1052	263	250
3	·142	425	432
$3\frac{1}{2}$	·2	700	686
4	·268	1072	1024

Showing that the weight of lantern again increases with the cube of the thickness very nearly, though the required thickness is much less than in a hemisphere.

Therefore Sir C. Wren was mechanically quite right in setting the heavy stone lantern at the top of St. Paul's on a hollow cone like a glass blower's chimney, and making the inner dome within that, both having a common base, and the outer one only a wooden framework; and the cone itself is tied with a chain at the bottom, where alone a cone wants tieing. Besides that, you may observe that the dome, and therefore the cone within it, stands so much within the outside of the drum, that the pressure is really carried down obliquely, just as if the drum itself were coned or sloped in, exactly as I said it might be. Inside, the slope is not concealed, but visible enough, and perhaps looks better than if the walls were upright, as upright walls at a great height are apt to look bursting outwards. The same thing had been done before on a smaller scale in the baptistery at Pisa, where the lantern at the height of 175 feet is carried on a cone 59 ft. wide at the base, and the stone dome, Mr. Fergusson says, was long afterwards built round it.

A dome with an aisle all round the drum would afford the very best facilities for resisting the thrust by flying buttresses, either within the roof as described at p. 237, or outside as in most cathedrals. The drum might then be reduced to arches and pillars as in our four round churches (all of which have aisles round them) and the baptistery at Nocera (Fergusson, p. 511) or an apse with a periapse. And then also a great domed church might have supports occupying a much less proportion of the area covered than St. Peter's or St. Paul's, where the supports occupy twice as much as in some of our Gothic churches. I warn everybody against expecting any good architectural effect from small domes, though large ones are grand

Most of those in London have been the subject of much more ridicule than admiration, from the 'national pepper-boxes' in Trafalgar Square, back to the caricature which I remember, of 'that curious little architect (Nash) sitting on his egg'—the little dome of Buckingham Palace, in the time of George IV.

Polygonal domes.—Very nearly the same considerations apply to octagonal or other many-sided domes as to round ones (*i.e.* round horizontally), so that it is not worth while to distinguish them. So far as there is a difference it is in favour of the round ones, inasmuch as polygonal ones are not so independent of cement, and the middle of each side might fall inwards, which is impossible with a round dome of any kind or shape, until other parts burst outwards.

The domes of St. Peter's and Florence, which last is octagonal and pointed, of about 70° (St. Peter's is rather less pointed), are composed of double shells joined in various places by ribs. Some persons have fancied that that construction has something of the strength of bones and quills and hollow iron pillars; but that is altogether a false analogy; for their strength arises from one side always resisting extension while the other resists compression; but masonry has practically no power of resisting tension directly tending to separate the stones. The only value of the double shell is that it takes firmer hold of the bottom of the lantern so as to resist the leverage of wind upon it. Otherwise the double dome merely increases the weight and thrust at the bottom for nothing.

Though it is the fashion to condemn what is called the sham construction of the dome of our St. Paul's, there is a good deal to be said for it, as we have already seen. St. Peter's being of brick covered with lead has no visible superiority over St. Paul's of which the outer dome is wood covered with lead. And when we look at the lantern of St. Paul's, proportionately larger than St. Peter's or Florence, standing with absolute safety on that thin cone of only 18 inches, with the other equally thin dome within, and compare them with the huge mass of masonry in the Italian ones, or with the three shells of the smaller dome of the Invalides at Paris of only 92 feet, where both the outer dome and the lantern are of wood, I cannot help pronouncing in favour of what every one admits to be the grandest looking dome externally, and which is managed in the most scientific way. We must also give Wren due credit for the science displayed in bringing down the cone so far below the base of his external dome that its slope is 24°, which diminishes the thrust immensely, and yet leaves the inner dome, which springs from the base of the cone, quite high enough above the ground. Indeed with all the knowledge that we have now of what can be done in dome building by the aid of hoop iron, we could do no better than copy the very same construction of two domes and a cone to carry the lantern, except that one would perhaps like to make the outer dome of stone, which could easily be done.

According to the best authorities, including some measurements made by Mr. Donaldson for large drawings of his own, the internal diameters of all the masonry domes in the world above 90 feet are as follows:—

Pantheon	142	St. Carlo, Milan	105
Florence	138½	St. Sophia	105
St. Peter's	137½	St. Paul's	102
Beejapore (Gol Gomuz)	137	Invalides, Paris	92
Monsta in Malta	124		

The $138\frac{1}{2}$ is the smaller diameter of the octagon at Florence. The Malta and Milan domes are both of this century, as may be seen in Mr. Fergusson's Handbook, where they are fully described. The Milan one is very ugly, but the other handsome, though designed by a builder who could neither draw nor write, and received two shillings a day. The Gol Gomuz is 10 feet thick, and stands upon a square, whose corners and their turrets make an enormous abutment for the dome, though it would be hardly stable (apart from cement) if it stood upon a round drum only as wide as the square. The peculiar construction of the vaulting of that and other Indian domes is described by Mr. Fergusson: but I do not assent to his theory of the mechanical conditions of domal stability, which very much underrates the importance of the weight of the upper part of a dome; but he does not profess to have investigated it mathematically.

A question was asked at the R.I.B.A. as to the possibility of building domes entirely without scaffolding, beyond a mere radial pole travelling about to regulate the position of each stone as it is put on. For a considerable height the stones will evidently stand by friction and cement until each ring is successively closed in, and then it cannot fall; after which the mortar should have time to set, or the ring will be squeezed too small and sink a little by the addition of more weight. As soon as the inclination becomes too great for the stones to stand alone, they may be notched or stepped so as to hang on the preceding ring; and the Maltese dome was actually built so without any centering: otherwise there must be as much centering as will carry each ring in succession when you have reached the height at which the stones will not stick separately.

Lanterns on arches.—Such steeples as that of St. Nicolas Newcastle and a few others on a smaller scale, where lanterns stand on flying arches, suggested a little enquiry into their power to support weights. It is evident that a pointed arch will carry as much weight as would complete it into a stable round one; but that does not come to much, as it only means that an equilateral arch will carry half its own weight as a load on the top, assuming it be just of the proper thickness for a round arch. Consequently a set of flying arches will carry no great weight of lantern unless they are deep enough to contain a straight line or very nearly so. In like manner flying buttresses to resist the thrust of vaulting ought to contain a straight line, and they generally do.

Weight of spires.—As I have given the weights of hemispherical and other domes I may as well add that the weight of a thin spire, either polygonal or round, is half that of a hollow prism or cylinder of the same height and standing on the same ring or base; which, remember, is rather more than the thickness of the spire measured square to its face. Or the weight is equal to that of a prism or cylinder of the same actual thickness as the spire but of height = the oblique height of the spire. The bursting pressure at the bottom of a sharp spire is inconsiderable, and in one sense nothing, as it is less than the mere friction of the stones will resist if the spire is not cracked. Still it is prudent to provide against it by a tie, for fear of cracks. But the thrust at the bottom of a wide spreading cone is much more than of a dome on the same base. It depends in a complicated way upon the thickness; but if very thin, the tension of a right-angled cone, or one which would just lie within a hemisphere, is more than three times that of a hemisphere of the same width and thickness. But a right-angled cone standing on the same ring as a hemisphere is only half its weight, being thinner as well as lying much within it except at the top and bottom.

If the slope of the cone is 30° its tension is ·577 M while that of the pointed dome of 60° is only ·208 M, M being the weight of a hemispherical dome of the same width and thickness. And with a slope of 24° the tension is ·545 M, still assuming the cone to be very thin for its size. Therefore at St. Paul's a strong iron chain was rightly put by Wren round the bottom of the cone which carries the lantern, besides the leaning inwards of the drum below, which I mentioned before. I say nothing of the iron domes noticed at the beginning of this chapter, because they belong to engineering and not architecture and involve no difficulties of construction.

THE GREAT PYRAMID.

I PROCEED to treat of a building at the opposite extreme of architectural science, except that it involved the raising of enormous stones to a greater height than in any subsequent building; for the still larger stones of Babylon and Jerusalem were not raised to anything like the height of the Great Pyramid, which was built by Cheops, as Herodotus called the king otherwise called Suphis or Shufu in the hieroglyphics painted on the large stones over the 'King's Chamber,' about 2170 B.C. or in the time of Peleg, ages before the Israelites were in Egypt, whom some persons have hastily guessed to have been employed in building the pyramids.

If I needed any excuse for a book on architecture devoting a few pages to the largest and oldest building in the world, and one designed and executed with as much care as the grandest cathedrals, it would be enough to add that it has engaged on other grounds the attention of Newton and Herschel and other eminent scientific men. Perhaps it is not strictly right to call it the oldest, for that rather smaller one which is now called the Second Pyramid, is thought to have been begun a little earlier, but it is not comparable to the great one in its design. Unfortunately this great Pyramid of Cheops was skinned by the 'barbarous people of the country' in comparatively modern times, of the beautiful limestone casing which was yet perfect and the inscriptions conspicuous upon it when Herodotus saw it 1700 years after it was built, almost as smooth as marble, and more durable than the granite with which some of the smaller pyramids were cased. They used the stone for other buildings, and so their spoliation was not so utterly base as that of our people much later who burnt some of our finest abbeys into mortar. Luckily a few of these casing stones escaped in the rubbish, and in 1837 the four corner sockets cut for them in the rock were found; and the two together furnished the means of ascertaining the original size of the base and the slope of the sides, which fix all the dimensions of a pyramid. The lowest course of casing stones had a square or upright plinth as high as the pavement which was laid for a considerable width all round the building; and such was the precision of the builders that this pavement was varied in thickness at the rate of about an inch in 100 feet to make it absolutely level, which the rock was not.

But it is singular that no two successive measurers of the base have brought out quite the same result. There is a difference of no less than 4 feet in about 761 between the measures made by highly competent persons. And though there is the excuse that direct measurement is impeded by the heaps of rubbish at the foot of each side, that ought to be no obstacle to astronomers and engineers measuring the distance between staffs set up at the original corners in the rock. Probably 761 feet, which is that of Col. Sir H. James, the head of our Ordnance survey, and pretty near the mean of the others, is the best measure to adopt. Mr. Piazzi Smyth the Astronomer Royal for Scotland took a journey to the Pyramid in 1865 for the purpose of measuring every measurable thing about it, and yet after all was dissatisfied with the smaller measure taken by two Scotch engineers with him and adopted this as a mean; which was afterwards substantially confirmed by Sir H. James; for it is not worth while to dwell upon differences of a few inches when there are variations of 4 feet in a length of 761 or thereabouts.

Mr. Smyth afterwards wrote three large volumes of his travels and his measurements and the amazing theories which he built upon them; enlarging some which had been started before by the late John Taylor, the first expounder of the more modern mystery of Junius, in a small book of great ingenuity and information certainly; but far exceeded by his follower; for a wilder illustration of what has been called 'the province of the imagination in science' than Mr. Smyth's book has been hardly ever seen. An amusing review of it was published in a pamphlet by Mr. F. D. Wackerbarth, an old Cambridge man, but Professor of Mathemathics in the University of Upsala in Sweden. It is not worth while to say more of those theories here than to mention the unlucky fact that neither the 'Jewish sacred cubit of 25 inches,' which is the imaginary basis of them all, nor any multiple of it, is to be found in a single one of all Mr. Smyth's multitude of measurements, except two evidently accidental multiples of it in the diagonals of two of the four corner sockets in the rock; which are not even square, and could never have been seen again after the Pyramid was built, if the superstructure had not been broken up and stolen, which was probably the last thing that Cheops or his architect expected. The idea that a building was designed to perpetuate a measure which it exhibits absolutely nowhere, and a multitude of other things as multiples of it, such as the days of the year and the years of the precession of the equinoxes, in the width of the base and its two diagonals (which of course depend on each other and could not both be arbitrarily selected), the length of the earth's axis, the density of the earth compared with water (with the figure wrong, according to all the received measures from Newton's to the present day), a standard of heat, a new division of the circle into 1000°, the distance of the sun, and the earth's velocity (neither of which is yet certain) and a variety of other wonderful things, savours more of Zadkiel's Prophetic Almanac than of real astronomy or mathematics. At the same time the Pyramid and the famous marble 'Coffer' in the King's Chamber (which was doubtless also Cheops's coffin, until his body was 'resurrectionized' by the thieves who first broke into the Pyramid) do contain clear indications of having been designed in very careful proportions and by means of another 'rule' or cubit, of which definite multiples appear everywhere (unlike Mr. Smyth's imaginary cubit nowhere), with an astronomical indication of its date, which satisfied no less an astronomer than Sir J. Herschel.

Besides what I said about the pavement, it is no small indication of design and precision that the Pyramid stands so exactly cardinally, or N.S.E.W., that there is no greater error than 5′, or a foot in the whole length of each side.* And the facing stones, of which a few were found still stuck together, are described as having joints no thicker than paper; so that the beds must have been polished no less than the faces.

It is constantly said that the Pyramid covered a square as large as Lincoln's Inn Fields, the largest square in London; but in fact it covered much more, even reckoning up to the houses. The N. and S. sides of the Square are indeed about equal to the width of the Pyramid, but the E. and W. sides are considerably less. It covered 13½ acres, while the whole space of Lincoln's Inn Fields so reckoned is only 12.

The condition which fixes all the proportions of a pyramid is the slope of the faces, and several theories have been propounded for that having been exactly 51° 50′ or 51′, which the casing stones prove indisputably to have been the slope; for the difference of 1′ is too small to be measured on that scale, being only the 100th of an inch in 3 feet, or an inch in 300 feet. When the proportions of a building are found to satisfy several mathematical conditions, either exactly or so nearly that one of them is as likely to have been intended as the other, we can only notice the coincidences, and guess from other circumstances which of the conditions was uppermost in the designer's mind, or whether he selected that proportion because he found

* It is not quite certain that the ground has not received some slight subsequent twist from below, for the second Pyramid has exactly the same deviation, and what is more, the whole of the King's Chamber has received a tilt towards one corner, so that the axis of the room is no longer quite vertical. It is inconceivable that it was built so, and impossible that it could have got wrong relatively to the Pyramid, which is built of squared stones throughout.

that it satisfied a variety of conditions, which would make his building more striking as a kind of mathematical curiosity. Different people have perceived that the Pyramid does in fact satisfy the following conditions:—

1. The first is the one mentioned by Herodotus, at least according to the only rational interpretation of his statement that each face was equal to the height; which is absurd taken literally, being equivalent to saying that an acre = some number of linear yards; but if we substitute (height)^2 it is right. For the area of each face with a slope of 51° 50′ does = the height^2 of a four-sided pyramid.

2. Another property, which is identical with the last mathematically, is that the height h is a mean proportional between the length down the middle of each slope l and b half the width of the base, or $h^2 = b\,l$, which is the area of the face; or $l \cdot h :: h : b$, if you prefer it in that form.

3. Another, and that which Sir H. James thinks was the working rule of construction, is the fact that the inclination of each edge of the pyramid is what engineers call 10 to 9, or 10 horizontal to 9 vertical: for ·9 is the tangent of 42°, which is the angle at the base of a diagonal section, and ∴ 96° the angle at the top; or half the diagonal of the base, $d : h :: 10 : 9$. But I do not at all agree with him that the builders worked by any such inconvenient rule as that—carrying up diagonally slanting standards at the corners and making the courses 'lineable' by eye with them, however easy it may sound theoretically. I am sure that if such a rule were prescribed they would very soon avoid it by finding out what the direct slope of the faces was to be, and working the stones accordingly by a template and setting them by a longer template or

bevel with a plumbline to it. And Mr. Pi. Smyth discovered a fact which is conclusive as to that, *viz.* some long trenches cut in the rock at an angle of 51° 51′ or 50′, apparently as models for the slopes on so large a scale as to avoid the risk of error.

4. Then comes the fact made so much of by him, and previously by John Taylor, that the slope of 51° 51′ 14″ makes the width to the height as the length of a quadrant to its radius, or $4b = \pi h$; or $2b : h :: 11 : 7$ nearly; which last rule makes the slope 51° 50′ 45″, which is practically the same as the other.

5. But neither do I agree with them that this was the primary motive of construction, especially having regard to the record of Herodotus. For if it had been, that would have been quite as easy to record as the partially corrupted tradition that the height^2 = the face; and I prefer actual history, when it is not demonstrably erroneous, to modern guessing that something else is more probable, by which too many people fancy that they can rectify every kind of history and reject everything that they wish to disbelieve. But again, I do not suppose that the builders were ignorant of this circular coincidence or 11 to 7 relation: on the contrary I shall give a reason presently for believing that they did use it for fixing the size, probably taking it approximately from the slopes.

6. A friend of mine has noticed two more coincidences; one in the diagonal section, and the other in the 'principal' (or square vertical) section. The diagonal angle at the top, 96° or 4 × 24°, is that of four sectors of a quindecagon (Euclid iv. 10, 11, 16). And the lines which I have called l, b, h, bear the same proportion to each other as the lines AB, BD, BC, in the triangle for constructing a pentagon in the first of those

propositions of Euclid, which is the sector of a decagon, and the element of that elegant star figure called a pentagram. It follows that the slanting edges were about 724 feet long, and the height 484, or very nearly two-thirds of the length of the edges.* It certainly is singular that this slope of 51° 50′ or 51′ should produce all those numerical coincidences; and the fact that it does is likely enough to have determined the designer of the Pyramid to use it; assuming that he had some reason for adopting a slope of about that amount to start with. And that reason very likely was, as several people have suggested, that it is about the slope at which mounds of earth (gravel, not clay) will stand naturally. For the other pyramids which were built with much less care and precision have all something near that slope; and mounds of earth or artificial hills probably preceded pyramids of squared stone.

But now comes the question, why was the base the particular size it is? For we may be sure that that also was not left to chance, but was intended to be some definite and round multiple of the working rule or cubit of the builders, quite as much as the King's and Queen's chambers, and the passages, as it had no combination of parts to depend on and determine its size like a cathedral or temple. The first point is to ascertain as nearly as we can what the working cubit was; and there has never been any doubt that it was something very little differing from 20·73 in. either way. Several such

* You may like to know that a square pyramid whose eight edges are all equal, has a slope of 54° 44′; and the diagonal section has angles 45° and 90°. This is the pyramid formed by a pile of cannon balls on a square base, and seems *a priori* a likely one for builders to have adopted: only they did not in any of the pyramids of Gizeh. You see it is only the 44′ steeper than the pentagonal pitch of roof (p. 179).

wooden measures or rules have been found, which are all roughly described as 20·7″; and another, to which still more importance has been attached, called the double cubit of Karnac, which was found accidentally imbedded in a wall there, and is now in the B. Museum. But even that is variously described as being from 41·398″ to 41·472″ long, and a great deal too much weight has been attached to it, as if one such wooden rod used by masons and dropped into their mortar were capable of fixing to a minute fraction of an inch the precise standard of the time, or rather of many centuries before the time. If anybody will collect a dozen workmen's rules now, though tipped with brass, and measure them carefully, he will soon perceive the absurdity of taking one of them which might happen to survive the others 1000 years hence as the exact British standard of 24 inches in the reign of Queen Victoria. For, besides the natural inaccuracy of a common wooden rod, the temple of Karnac is nearly 1000 years younger than the Pyramid; so we might as well pronounce on the exact length of the yard before the Norman Conquest from the length of a yard wand picked up in a shop now, as determine the Pyramid cubit to a small fraction of an inch from a wooden cubit used by workmen in the temple of Karnac. We must determine it as well as we can, and without pretending to extreme accuracy, from the evident multiples of it which we find more or less agreeing in the various parts and dimensions of the Pyramid itself.

The principal chamber, called the King's, which contains the famous porphyry coffer, before mentioned, is 10 × 20·63″ wide, 20 × 20·63″ long, and 11 × 20·91″ high. Another chamber, called the Queen's, is 10 × 20·6″ wide, 11 × 20·63″ long, and about 12 cubits high; but the floor is too uneven to give any height precisely, though the walls of limestone were quite as highly finished as the King's, of granite. The long entrance passage is 2 × 20·75″ wide, and the horizontal passage to the Queen's Chamber is the same; and, without going through more of the dimensions, it is evident that nearly all of them were intended for simple multiples of some cubit as near to a mean of about 20·73″ as our workmen's rules are to 24″; and it is further evident that they did not care about being so exact in that respect as they were about angular measurements and position. The Coffer is no exact multiple of a cubit in any of its dimensions, inside or out, and the sides are not quite straight. But, according to Mr. Smyth's measurements, and others before him, it must have contained, and therefore we may be sure it was intended to contain, the capacity in liquid or corn measure of the cube of a double cubit of about 41·46″. And on the whole I have little doubt that Professor Greaves, John Taylor, and Mr. Smyth were right in adopting 21·73″ for the working cubit, as a fair average of all the measures most likely to have been done carefully by the builders.

Then, if the base was anything near the 9132 inches wide, which he and Sir H. James substantially agree on, it seems impossible to doubt that it was intended for 440 or 11 × 10 × 4 cubits, and the height for 7 × 10 × 4 or 280 cubits. If 11 is thought a queer and unlikely number to be used as a factor, I answer that in fact it was so used in the two chambers which the Pyramid was built for; and we have already seen that the 11 to 7 proportion of width and height stared them in the face, by virtue of the slope they had adopted, whatever was the motive for it. Then the only question was, what shall the 11 and 7 be multiplied by? and 40 cubits was by no means an unlikely answer, for various other multiples of 10 and 4 cubits occur.

It is remarkable too, that, as each side of the Pyramid was 440 cubits, so a quarter of a mile is 440 yards. Again, the same number 11 is the principal factor in the 22 yards of a chain; and the 4840 square yards of an acre, or 10 square chains, are $11 \times 11 \times 10 \times 4$. These are not the same kind of fancy coincidences, which, as Mr. Wackerbarth showed by a number of amusing instances, you may pick up for anything, from the sidereal system down to the piano in his room; but they are coincidences between measures of the same class, which are very likely to have had a common origin. For though the cubit and the yard are very different units, it was not unnatural that the same multiples of the unit should be used in making up a larger measure from them. We may call the whole circumference of the Pyramid a mile of cubits, instead of yards.

I do not profess to know why Cheops wanted his pyramid to be about that size, except that it must be some size; and if the Second Pyramid was older, or begun earlier, as is supposed, it was very natural that he should make his rather larger, as he manifestly meant it to be superior in all other ways. It is only 30 cubits wider and 10 higher, the slope of the other being rather steeper, and of an angle which gives no such peculiar numerical relations, 52° 50′ (Smyth ii. 271). That pyramid, and all the smaller ones, have only one chamber, and that in quite a different position, not skilfully contrived as the King's Chamber in the great pyramid so as to escape discovery; and altogether it has never been felt to deserve the attention which has been bestowed by so many people on the great one.

I am surprised that this view of the intended relation of the dimensions of the Pyramid to the working cubit of the Egyptians was never advanced until I suggested it in a note at the end of the 4th edition of my 'Astronomy without Mathematics.' Of course it could not be by Sir I. Newton, or any one else, until the true dimensions of the base were revealed with the sockets in the rock. Col. Vyse and the French engineers at that time propounded no theory of dimensions. Sir H. James takes for granted that the Karnac double cubit wand, of 1000 years later, was the standard yard (as we may call it) of Cheops, and so makes the base 442 cubits, which is what we may call no number at all, *i.e.* no multiple of any simple one. And again, he thinks it was intended for 500 Greek cubits, which are many centuries younger still, though the European foot and inch have varied at least 8 per cent. in about as many centuries. John Taylor, and much more, his follower the Astronomer Royal of Scotland were too intent on finding all sorts of mysterious relations to things which the Pyramid builders could not possibly have known, to perceive this simple relation of the dimensions to the working cubit. Indeed either that or something else made Mr. Smyth absolutely silent about the really striking identity of the capacity of the Coffer with a double cubit cubed, though his leader had noticed it before and dwelt upon it at great length, and had shown that that last measure agrees very nearly with the old English chaldron, or 4 quarters, of 71,680 cubic inches, bearing in mind that the coffer sides are not quite straight, and one of them broken by mischief, and also that standard measures of all kinds were not preserved with much exactness in old times, as is shown by the variations of the foot among the European nations. Taylor remarks that the word *chaldron* manifestly comes from *caldarium*, a warm bath, which was exactly the shape of the coffer; and it is not very unlikely that the Romans derived their principal corn measure from their principal corn-producing country Egypt.

The internal length of the coffer is nearly 78″, the width, 26·7; and the depth, 34·3; and it is about 5″ thick. I see nothing inconsistent in its being designed for a coffin, and also made of some definite capacity, as definite measures both linear and angular manifestly prevailed throughout the building, though they could not be of any real use. I reject altogether the idea of recording standard measures by hiding them with the utmost ingenuity.

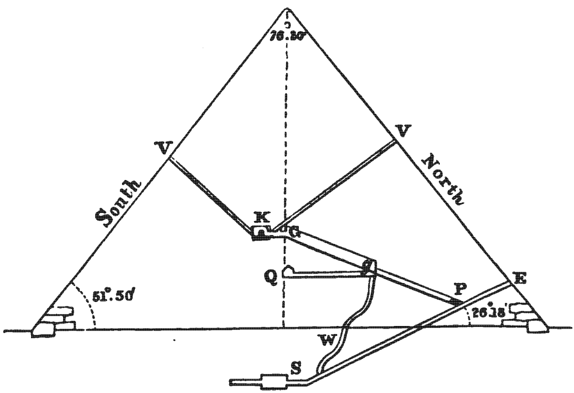


Fig. 17.

Copying the well-known vertical section through the Pyramid from North to South, it is evident that Cheops meant, first to hide the entrance altogether, as soon as his body should be put into the ready-made sarcophagus, by filling up the door and completing the facing stones which would be left open until his death; and secondly, if that design miscarried and people found their way into the passage, to send them down it on a wrong scent to a third chamber S in the rock, far below both the King's Chamber and the Queen's, which they would reach by simply following the passage, and where the sarcophagus actually is in the other pyramids: whereas the way to the two royal chambers K, Q, was by a hole into another oblique passage overhead a good way down the entrance passage, with nothing visible to indicate it; and further still, that hole was to be—and was—blocked up after his funeral by sliding some great blocks of stone, which they call the Portcullis, weighing altogether 13 tons, down the overhead passage, the lowest of which stones fitted like a tapered plug at P, and closed up the hole and formed a roof to the passage, under it. At the same time another tortuous exit W was provided for the undertakers and masons after they had so plugged up the hole where they and the body had gone in, by which they could drop down to the lowest end of the descending entrance passage near the underground chamber, and then walk up it to the open air. By way too of making these royal chambers still more difficult to find, they and the entrance passages are none of them in the central plane of the pyramid, and they might never have been found by the Caliph Al Mamoun, who began cutting into it centrally in 850 A.D. but for the accident of the aforesaid plug stone having broken a stone loose at the bottom of its passage, and the effect of its own concussion and the further shaking by the workmen made it fall and guided them by the noise. The Romans appear to have been in the underground chamber, for Roman letters were found smoked on the roof; but they do not seem to have discovered the secret of the other chambers.

I do not mean to repeat here what may be found in other books except when it is needed for further remarks of my own. Ventilation was thought necessary for the King's Chamber, either for the benefit of the mummy of the king or the breathing of the undertakers and masons, and it is worth while to observe that the Egyptians of as many years B.C. (and more) as our A.D. knew what some of our architects and builders now do not, that ventilation requires both an inlet and outlet. Accordingly you see in the section one air chimney going to the north or right side of the Pyramid and another to the south, so that there would always be a draught through the chamber—unless they also were to be closed up by the facing stones like the entrance for men after the funeral to prevent any discovery.

The great puzzle of the building is the enlargement which you see in the section of the small passage into the large one called the Grand Gallery G *g*, which again is suddenly contracted before it reaches the King's Chamber. The floor of the gallery is 4 cubits wide and the middle 2 cubits are sunk about 1 cubit below the sides, which therefore rise along it like benches, except that the whole is on a slope of 26° 18′. These benches, or raised parts of the floor, are what Mr. Smyth calls 'ramps'; and the channel clearly was for something heavy to slide down between them. Probably Sir H. James is right in saying that the portcullis stones were kept there at the foot of the deep step at the top of the gallery, where the channel ceases, and were slid down afterwards, and over some planks which must have been laid for them across the end of the horizontal passage to the Queen's Chamber, and there is actually a recess cut for the lower end of such planks, and poles for beams to carry them. But that is not enough to account for the great size of the gallery, which is 14 cubits high (on the square); and I think this is the explanation.—The portcullis stones are 2 cubits wide and 48 in. high, to fit their ultimate place exactly; and the channel between the ramps is just over 2 cubits, and the ramps themselves just under a cubit, leaving about ·7 in. on each side as clearance for the stones to slide down easily. The width of the ramps, and therefore of the whole gallery was wanted for the men to pass by those stones while lying there, and there are besides a series of upright holes in them, evidently for posts; but what the posts were for is not so clear, as the men could easily guide the stones down without them. But the width of the gallery being so determined, they made it so high in order to contract it very gradually to a narrow top for fear it should be crushed in by the immense weight above. You may see in Fergusson's Handbook how they protected the flat roof of long stones over the King's Chamber by four other roofs of equally large stones over it, and finally an arch of two stones. And there is a niche in the Queen's Chamber about 15 feet high and 2 cubits deep, gradually contracted by short set-offs from 65 in. wide at the bottom to 25·3* at the top in the same way as the

* This is the nearest approach that Mr. Smyth could find to the 25 inch cubit which he went to Egypt and searched the whole Pyramid to look for. When he found it he exclaimed, 'Why here is the very sacred cubit of the Jews.' But that unlucky decimal ·3 is fatal to his rejoicings; for 25·3 is nothing like the 20 millionth of the earth's axis, which he wants it to be, and instead of giving him 365¼ of such cubits in the base of the pyramid for the days of the year, it only gives 361½: a hopelessly impracticable number.

gallery. No one knows what that was for: perhaps for a queen's body to be walled in upright, as there was no stone coffin there. I am not aware that there is any real authority even for calling it the Queen's Chamber. It is curious that that niche too is not in the middle of the wall, as if to help it to escape detection when walled up, which however it never was.

The use or object of the ante-chamber to the King's Chamber is by no means evident, except that a more genuine, but much smaller portcullis, *i.e.* a flat stone or slab sliding down in grooves was apparently intended to be worked there, though it was found sticking up and had never been let down. And there are some other grooves in which no slabs were found.

It is no answer to this explanation of these parts to say that the business of stopping up the passages might have been managed more simply. The simplest contrivances often do not occur to designers till too late, and often not to the original designers at all. No other rational explanation has been thought of, so far as I know; and though that is not conclusive in favour of the one that has been thought of, it tends to confirm it if the theory is probable in itself and involves no unexplained difficulties, even though there are some details of grooves along the walls of the gallery, &c., of which the objects are not yet known, and perhaps never will be.

The only remaining question of importance is, why was the slope of all the passages 26° 18′ rather than 25° 55′, which would be exactly half the external slopes, or 26° exactly? For the circle was divided into 360° from the earliest times known, and the builders were evidently skilled in mathematics. Sir H. James says the 26° 18′ is the 'angle of repose' at which those heavy portcullis stones would either stand or slide on the stone floor under very little pressure either way. And I daresay that is true. But it is no more true of 26° 18′ in particular than of other inclinations near it; and in fact it was not right, if that was all they meant; for the stones ran down too fast and cracked the passage with the bang of stopping them. I do not myself believe that the slope of the passages was left to be any approximation to the angle of repose which the builders might hit upon, any more than the external slopes were left to be anything from 51° to 53° as in the other pyramids. Moreover we must remember that no portcullis stones had to slide down the long descending passage, which has exactly the same slope: at any rate there were none in it, and the way to what we may call the false burying chamber below the Pyramid was left clear as soon as the entrance was discovered by the Romans, or whoever first found it.

I must say that Mr. Smyth's and Sir J. Herschel's astronomical solution of the inclination of that passage seems the most probable; and indeed the only definite one yet propounded; *viz.* that it was chosen because it looked straight at the pole star (α Draconis) of that period, about 2170 B.C., which is generally agreed to be the date of the building, at its lower transit over the meridian every day. For that star was then 3° 42′ from the pole, although now, by the precession of the equinoxes, it is 24° off, and the present pole star is β Ursæ minoris; for the Pyramid being in lat. 30°, we have $3° 42' + 26° 18' =$ the latitude, or elevation of the pole above the horizon. The building would be about the time when also the tower of Babel was built and 'the earth divided,' Gen. vi. Herodotus says it took 20 years to build.

Mr. Wackerbarth says 'that this hypothesis is liable to the objection that the mouth of the passage being walled up it is not easy to conceive how a star could be observed through it.' Certainly not, after it was closed; but what has that to do with the question whether the builders thought fit to indicate the date to any one who might in after ages find the passage, by reference to the celestial dial, in which the pole of the earth travels round the pole of the ecliptic in 25,827 years, like the hand of a clock round the dial? We might as well ask what was the use of all that exquisite building of the King's and Queen's Chambers, one of polished granite and the other of equally fine limestone, when they were intended to be hidden for ever after the death of their builder Cheops? The answer is, no use at all:* but there they are, as a matter of fact; and it is no more improbable that the principal passage was designed with a view to recording its date by the pole star than that an external shape should have been selected because it satisfied certain mathematical conditions, in themselves of still less use than the recording of a date. Mr. Wackerbarth has partly answered his own questions too by saying that Cheops, who reigned 50 years, pro-

* He might with much more reason ask, how can it be conceived that a civilised nation could bury people in two or three coffins, one sometimes lined with satin, another of lead, and another of oak, and put them in brick graves, which only tend to keep the process of putrefaction going on as long as possible? The Egyptians did at any rate preserve their bodies by mummifying them, and from their point of view building sepulchres to preserve them was rational, though of course intrinsically absurd. Our practice is utterly irrational from every point of view, and is only a manifestation of that spirit of corpse-worship which seems to be increasing in England, and is actually believed by some people to be a sort of religious manifestation, whereas it certainly has no connection with the Christian religion at any rate. See my Life of Bishop Lonsdale, 2nd edition, p. 109.

bably went frequently to visit his own mausoleum while it remained open. As for the ascending passages, all the hypotheses assume equally that the same angle would probably be used for both sets of passages, as there was no reason for varying it. But Mr. Wackerbarth would be puzzled to work out his mechanical idea of 'managing a system of balance cars united by ropes from one passage to another,' seeing that they meet at the lowest point and not the highest.

I have only further to mention that the casing stones are said by Herodotus to have had a surface of 30 [square] feet, and the present steps of the building show that there were about 210 courses, of which the lower were about 40 in. high and the upper ones something less.

SIZES OF GREAT BUILDINGS.

I now proceed to give a more complete catalogue than has ever been before published of the internal dimensions of most of the great buildings in the world. A good deal of it has appeared in the *Builder* and the *Times* in former years, and a few additions to my list were made by Mr. S. Saunders, which are incorporated in this. A few of the dimensions of the old monastic churches are taken from the Rev. Mackenzie Walcot's little book on them. It is necessary to say however, that perfect accuracy is more unattainable in such matters than anybody would suppose until he tries to get it: in some cases from the difficulty of measuring heights without more trouble and expense than it is worth, unless they happen to have been taken before: in others because people have different ideas of the points or surfaces from which they ought to measure, besides the carelessness and incapacity for accuracy which seems incurable with some persons. Others write books containing important architectural details about buildings, and even plans of them, without ever taking the trouble to get the principal dimensions at all accurately. Again there is a general tendency to magnify people's own buildings, even down to rooms in private houses, so much so that I always distrust mere parole evidence about them. Some will measure the length of their church from the west door to the glass of the east window, and adopt other contrivances to gain a few feet of apparent size. Then in calculating areas persons will take different views as to what should be included, and in buildings of rather irregular form there are sure to be different results. The most fruitful of all sources of error is the confusion of external and internal dimensions, and an ambiguous use of the word area, even in best books.

In many cases the measures had to be taken from published plans on a small scale, and nobody who has not tried it has any idea of the frequent inaccuracies of the engraved scales of small plans, and very likely of the plans themselves, which are sometimes inconsistent with the printed or engraved measures. Nobody ought to print plans intended to show dimensions accurately without figuring at least the principal dimensions on them—and that not so small as to be illegible, which the engravers always aim at: just as some architects and their clerks think it looks peculiarly knowing and mediæval to write the inscriptions on their drawings in some affected style as illegibly as possible. Even where plates are accurately engraved the scale may become distorted by the damping and drying of the paper. I remember some of the largest railway bills ever passed being nearly lost in Parliament on an allegation of an error of level in the plans, until the copper plates were brought in to show that it only arose from the alteration of the paper.

Some of the measures which I give only profess to be approximate, being got by stepping, or from some not very certain information. In those cases I attach the mark ~. I have been obliged to omit altogether some large foreign churches and halls for want of information, such as the rebuilt St. Paul's at Rome and St. John Lateran, which I believe come next after St. Peter's; and the famous Cloth Hall of Ypres, which Mr. Fergusson says has a frontage of 440 feet, and apparently 50 two-light windows, and all the interior on the ground floor open, though of course with pillars; but he does not give the width. I shall be thankful to any one who will send me (to 33 Queen Anne Street W.), any further information of this kind, which may be added in any future edition. Nevertheless I have no doubt that the table gives a very fair comparison of the dimensions of nearly all the great buildings of Europe, and a few others, and I believe it includes every English church of inside area above 9000 feet, and probably omits few as large as 8000. Some smaller ones are inserted because I have them, and the churches are worth notice. No order of arrangement can do complete justice, and on the whole I am satisfied that measuring by the area enclosed is the best rule to follow, though it sometimes gives undue precedence to a building by virtue of some low aisle or other appendage which adds nothing to its architectural importance.

Chapter houses are excluded from the dimensions, because they are not part of the church like vestries, and in some cases quite outside it. The largest now remaining is at Canterbury, 90′ × 37′, and that at

Durham was as wide, and 80′ long, till half of it was destroyed by Wyatt and Bishop Barrington, who carried their devastations there from Salisbury, though Wyatt alone was the Lichfield destroyer. The largest of them all are York and Westminster, each 63′ in diameter, or 58¼ on the square of the octagon, containing 2788 sq. ft. But York is incomparably the finest, both in its architecture and in having no central pillar, which all the other large polygonal ones have, except Southwell, viz., Lincoln, Salisbury, Wells, all 60′ in diameter, and Worcester, which is rather smaller and round inside, and Lichfield, which is oval. The rest are smaller parallelograms. The York Chapterhouse well deserves its inscription—

'Ut rosa flos florum sic est domus ista domorum.'

Lady chapels must clearly be included, where they are fairly part of the church, and visibly increase its length or width; and for that reason Henry VII.'s chapel must be included in the length and area of Westminister. The Lady Chapel or Trinity Church of Ely is not fairly part of the church, being only connected by a passage very like that to several of the chapter houses. And adding its area of 100 × 45 ft. would not alter Ely's place in the table.

The Galilee of Durham adds sensibly to the length, and I think may fairly be included in the length and area, subject to a remark to be made hereafter on the question of length. That of Ely is little more than a western porch with an external door; but it adds 45 feet to the visible internal length: and as all our measures are internal, it may be fairly reckoned in, subject to explanation. But porches are excluded, and with them the Galilee, which is a mere porch to the south transept of Lincoln. Vestries are included in the area, but not in the length where they are mere appendages beyond the proper east wall of the chancel, as at Lavenham and Wakefield. The length always means the length of the middle of the whole church and not of any side aisle which may happen to extend further. 'Nave' means up to the central tower, inside of the square, where there is one: at Ely it is reckoned to the octagon.

Some persons would class buildings according to the ground they cover. It is sufficient to answer that it is impossible to do so with any accuracy, without an amount of measuring of thickness of walls and buttresses and turrets, and all sorts of recesses and projections, which would be a mere waste of time, even if I had the materials for doing it. It has been done for a few great buildings, and the results are sometimes noticed by Mr. Fergusson and others, but that is a very different thing from making a complete list of a great number such as this.

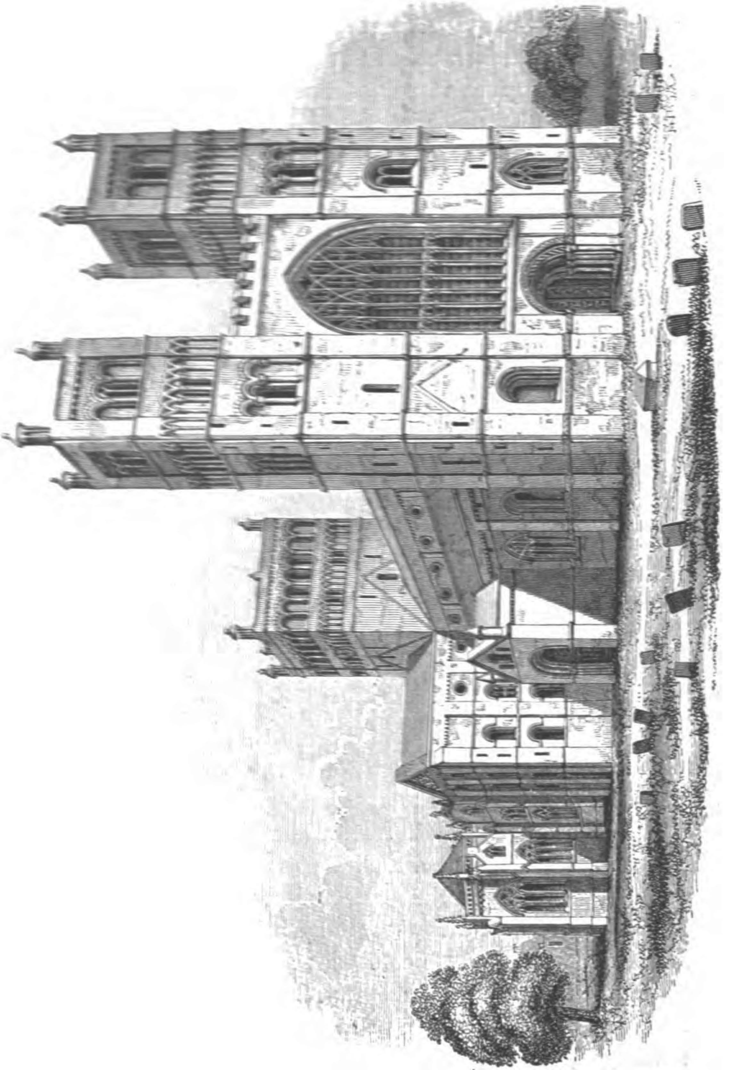
I put the foreign churches by themselves, as the difference of their characteristics from ours will be better seen thereby. The leading difference is that they are much wider for their length, and generally much higher too, though I have not accurate enough information about many of the heights to insert them in the table. The great width is generally due to their having two aisles on each side of the nave, or what is called five aisles altogether, which is very rare here. Chichester and Manchester are our only cathedrals with five aisles. It is singular that two of our widest churches, Boston and Yarmouth, have only single aisles, but very wide ones; Kendal and a few others have five and four aisles. Nevertheless it must be observed that York Minster contains the largest area of any genuine Gothic church in the world, or of any church north of the Alps. Most people fancy that Cologne is the largest, and Mr. Fergusson calls it so, and it may be if you include the height; but according to the plans in his book it is exceeded by Amiens, and still more by York. But Old St. Paul's far exceeded all of them, and was the longest-limbed church in the world, and had considerably the highest spire, though it was only made of wood; not that it was equal in area to Seville or Milan, or half as large as St. Peter's, which however most critics consider architecturally a failure. You may be surprised to see that next to York comes the totally ruined abbey of Bury St. Edmunds, of which nothing remains but a few lumps of flint walls. You may see a plan of it in 'Yates's History of Bury.' The nave had 14 bays, and was longer than that of St. Albans, though the whole church was not. But its great feature was its enormous western transept, forming the west front, with a great square tower in the middle, and two octagonal ones each 30 ft. wide inside, or 6 more than the York ones, at the ends of that transept. It was all Norman, like the bell tower which remains in the town, besides the larger and more beautiful Decorated Gateway, the finest in the kingdom.

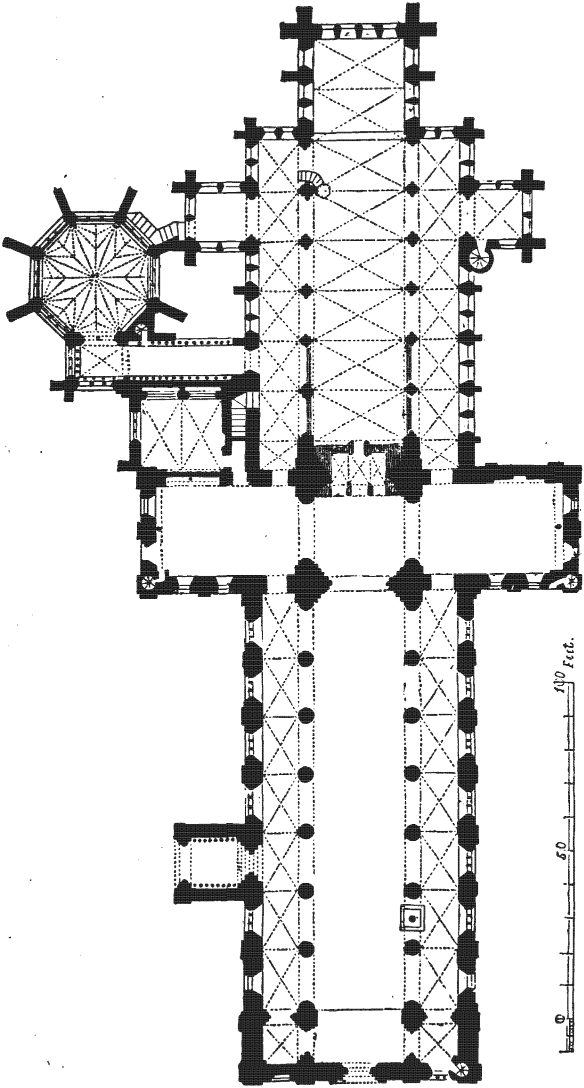
No other monastic churches, except perhaps Reading Abbey, of which not even so much remains as of Bury, (and I have no plan of it) were equal in size to the cathedrals of the first rank, down to Peterborough, though some, and especially St. Mary's Abbey, at York, were as beautiful as any of the cathedrals. It is remarkable that Yorkshire alone had as many churches of 20,000 ft. area as all the rest of England, except the cathedrals, among which may be reckoned Westminster, as it was one for a time. They were Beverley, Fountain's, St. Mary's, Ripon, Guisborough, Bridlington, Rievaulx, Whitby, Byland, Hull, and Jervaulx very nearly. Those of the rest of England were, Bury, St. Albans, Glastonbury, Tewkesbury, Tintern, Yarmouth, Coventry, Romsey, Southwell, Boston, and Newcastle. Guisborough was probably as large as Bridlington, but I was not able to get the full dimensions when I was there, though the foundations are said to have been traced. The east front, which alone remains standing, is on the scale of the largest cathedrals except York.

I have already made some remarks on west fronts, and the different modes of placing the towers, at page 257, and I only add that we have none left approaching York in magnitude or grandeur, except that the west tower pinnacles are a kind of false construction, looking as if they were carried on a tray, instead of rising out of the buttresses as they ought. Rickman said that the west front of Beverley Minster is to the Perpendicular style what York is to the Decorated, and they have certainly a strong family resemblance; but the most beautiful parts of Beverley are the Early English transepts, as they are at York. The construction of the smaller transept, with its series of set-offs or oversailing stages, which appear merely ornamental to ordinary spectators, make Beverley Minster the only church in England where that problem of the sudden stoppage of the principal arcade by an unbuttressed pillar is satisfactorily solved, the pressure of these set-offs being equivalent to buttresses. It is a pity that that beautiful church, which I never omit to visit when I am within reach of it, has no central tower, being in that respect like Westminster. I remember when it had a hideous cupola of ogee outline, which was removed about 1827.

Transepts.—Few people are aware too that it is the most complete of all our churches as to plan, being the only one that has a great transept with both east and west aisles, and a small transept with an eastern aisle besides. The minor or eastern transept of York is poor, and does not project beyond the choir aisles on the floor, but only in the clearstory, like the central transept of Glasgow cathedral. But the great transept of York is the grandest of them all both in size and character. That alone is larger than the whole of the great church of Boston. But Lincoln is longer, and Old St. Paul's was a foot wider, and had the immense length of 300 ft., and an area of 28,800 sq. ft. The Canterbury transepts are peculiar in the eastern one being larger than the central. The second transept seems altogether peculiar to English cathedrals; at least I remember no foreign one. It exists at York, Lincoln, Ely (at the west), Durham, Salisbury, Canterbury, Worcester, Wells, Beverley, and Southwell; which is a perfect cathedral in construction, and till lately was a collegiate church with Canons or Prebendaries, as Ripon and Manchester were, and it ought to follow them in being made into a cathedral, for the relief of the large dioceses of Lincoln and Lichfield: not for a second-rate half-endowed bishopric like St. Albans, but on the same footing as Manchester and Ripon were added to the old ones. More bishops are either wanted or not wanted with the increase of population and clergy and work. If they are not they ought not to be created at all. If they are, what business has the large surplus of the 'episcopal fund,' or of the old episcopal estates, beyond paying the fixed salaries of the existing bishops, to be diverted to other purposes, for the sake of a little claptrap about 'working clergy?' The Government which established the St. Albans bishopric had only to say the word and the pretence of an opposition to it would have turned into smoke, however big were those who threatened it. As Southwell Minster is not given in any of the books of cathedrals, I reprint the plan and picture of it (over the page) from the *Rudimentary Treatise on Architecture.*

The churches whose great transepts have both east and west aisles are York, Winchester, Ely, Westminster (north transept only), Beverley, Wells, Chester (south only), Redcliffe, Patrington, Melton, Faversham, and the ruins of Byland. Lincoln unfortunately has not, or its plan would be as perfect as its whole external aspect. The central tower is vastly superior to the unfinished monster of York of much later date. But it is not comparable to the perfect steeple of Salisbury, unrivalled in the world, or even to what that tower alone would be without the spire, except in being rather larger. Internally Lincoln has the fault of appearing too low, in consequence of the width of the middle space and of the arches, which is by no means compensated by the fact that its supports occupy a less proportion of the whole area covered than those of any other great building in the world, it is said. It would have looked far better and higher with at least one more bay in the same length of both the nave and the choir. The height is absolutely as great as almost any except York and Westminster, but the middle space is wider than usual, which makes it look too low. Canterbury choir is the same, but looks much better by reason of the narrower arches, which consequently look high while the Lincoln ones look low. The great defect of the plan of Salisbury is the nearness of the transepts to each other, and the want of a western aisle to the great transept. There ought to have been t

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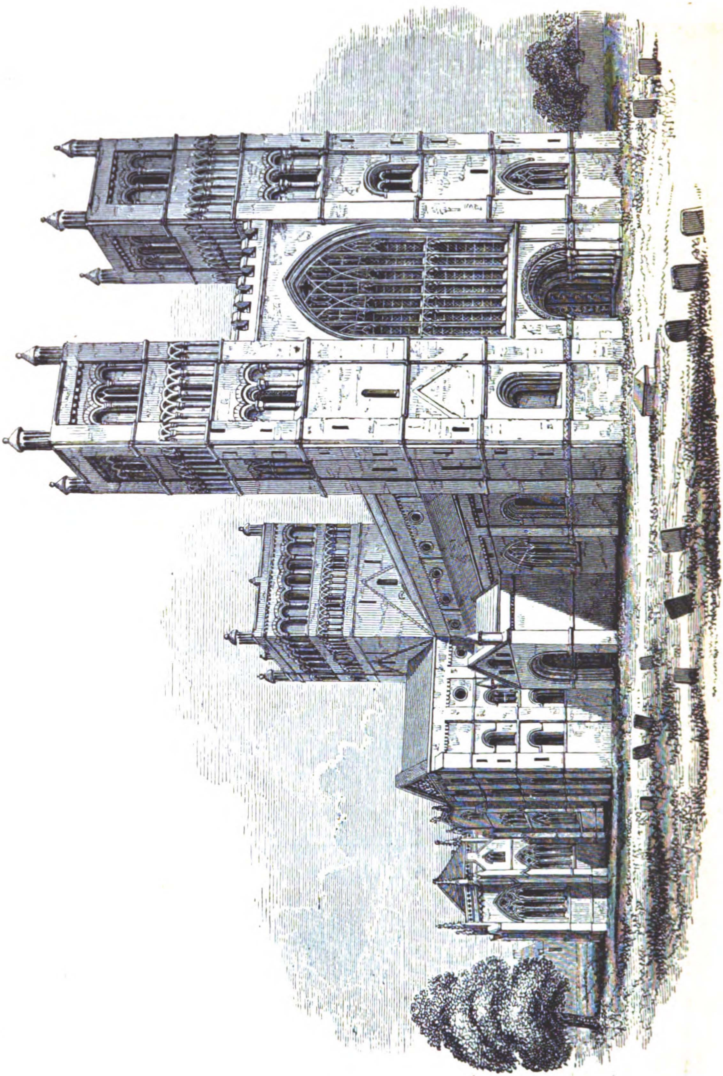

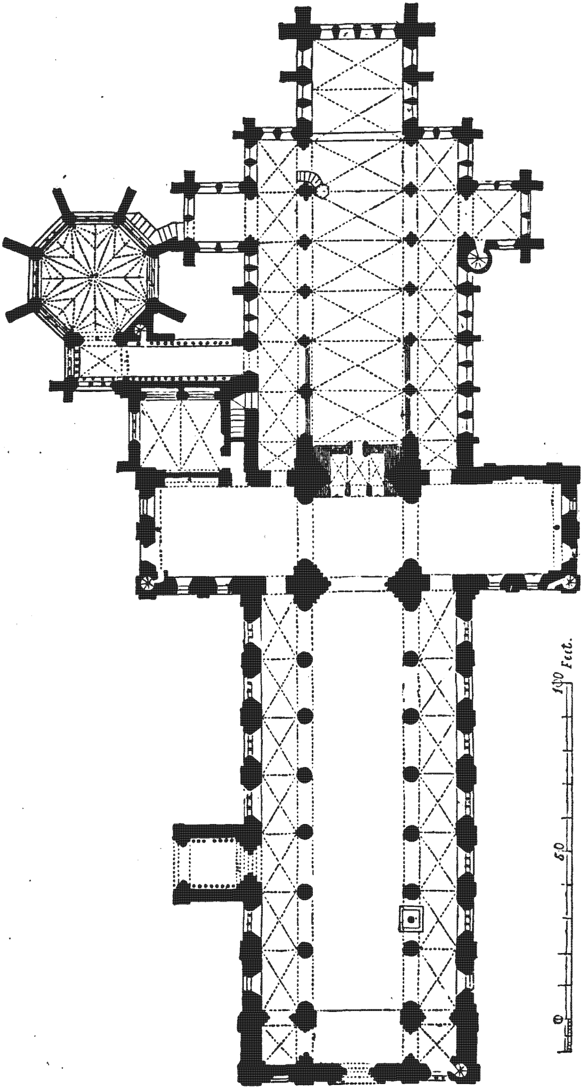
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more bays between them; and the main roof would thereby have been extended farther eastward, whereas the church now drops too soon into a cluster of low roofs which deprive it of the proper length, which its spire requires more than any church. It is singular how very few spires there are of any considerable size, of that the best period of architecture. Many people talk of Salisbury as if it were all of one style, which is a complete mistake. There is no doubt that it suffers from the monotony of the multitude of rather plain E E windows until you come to the Decorated tower, which there is good reason to believe was not even contemplated on anything like that scale when the church was planned and begun.

Length.—My investigation of this whole subject of dimensions arose from a discussion in the newspapers in 1864 as to which of our churches had the right to call itself the longest. Several of them may do so on different grounds; but taking the simplest test, of length on the ground plan, the order is undoubtedly, St. Albans (now the longest in the world except St. Peter's at Rome, and with the longest nave also), Winchester, Ely, Canterbury, Westminster, York. But St. Albans and Winchester are both obstructed by internal walls or screens, so that you cannot see the full length; and so is Canterbury, but not so completely, as you could carry a string right through over the screens. At Ely however you can see the full length of 517 feet from the west door of the Galilee to the east window, and it is a yard longer than Canterbury. Externally York has the right to stand first in length as well as area, having the greatest length of unbroken roof, except of course by the tower, while St. Albans and Winchester drop eastward into low Lady Chapels; and Becket's Crown at

Canterbury is cut off from the rest, almost as much as Henry VII.'s chapel is from Westminster, except that the Crown is much higher. Next to York comes Lincoln, in the length of backbone; for the Galilee at Ely produces no effect externally. Nevertheless Ely looks much the longest, as its central lantern is small compared with the York and Lincoln towers. But York Minster was far exceeded in that respect also by the old cathedral of St. Paul's, which had an unbroken backbone through its whole enormous length of 590 feet inside, and above 600 outside, according to the plan in Dugdale. The recorded length of 690 must have included something else, or else was a mistake. Mr. Longman's book on the successive cathedrals of St. Paul comes to the same conclusion.

St. Albans, Winchester, and Norwich have much the longest naves, reckoning them architecturally to the central tower, though the choir may pass it internally, as it does in all those churches and some others. After them, in another distinct group, come Westminster, Ely, and Peterborough. All these except Westminster were originally Norman. Worcester, Lichfield, and Beverley have the advantage over sundry others which are longer on the plan, by virtue of their full height being carried right through, and not dropping into low Lady Chapels or Galilees. Reckoning by roofs of the full height, but keeping the inside measures for simplicity, the order is as follows: York 486, Lincoln 481, Ely 472, Canterbury 470 (but that is not continuous), St. Albans 425, Winchester 405, Durham 400, Worcester 394, Norwich 388, Salisbury 380, Peterborough 376; and Westminster sinks from 505 to 350, losing both by Henry VII.'s chapel and the apsidal end like Norwich and Peterborough, and Canterbury between the choir and Becket's Crown. Indeed Westminster produces no effect of a very long church, especially with the interruption of that wretched St. Margaret's in front of it, which only looks contemptible itself and does not make the Abbey look larger, as some people fancy that it must.

Height.—That and York are much the highest, and both may be called practically 100 ft. high inside: but one is three times the width of its nave (ex aisles) and the other little more than twice, whereas the usual English proportion is from $2\frac{1}{4}$ to $2\frac{1}{2}$, and equality to the entire width: which York has. Westminster looks too high and York too low. Moreover the nave of York ought to have had two more bays of length, 8 being rather a small number, and twice the entire width or four times the middle width being a short length for the nave of a cathedral or a great abbey church. Some of these had 12 and even 13 bays, besides the western towers.

It is singular that Ripon, which can only be placed in the third class of cathedrals, by reason of its shortness, actually comes next to York and Westminster in height and sectional area, *i.e.* the height × the width of the nave. Indeed it exceeds Westminster and all but York in width; but like York it is not stone-vaulted. The church which really exceeds them all in height × width, and in width alone with a real stone vault, is King's Chapel, comparing it of course with naves proper, not including aisles. I again exclude St. Paul's on account of its entire difference of construction and immense thickness of piers. But our largest vaults have not half the sectional area of some of the foreign ones, such as Amiens and Cologne, and are greatly exceeded by a good many of their smaller churches, including some of which I have not the exact heights and widths. The rule of equality of height and total width holds even in King's Chapel, if you take in the width of the side chapels which fill up the deep space between the buttresses, making a kind of narrow aisle, as a passage runs through most of them.

It may also be observed that the aisles are generally about half the width and half the height of the naves in churches of the cathedral or monastic type, or we may say, in vaulted churches, though no rule was observed in mere parish churches. Bristol cathedral and the Temple church, besides many of less note, have no clearstory, or the aisles are nearly as high as the nave; but that is a bad construction both for light and appearance, and accordingly is very rare and not to be followed; and the aisles of Bristol are unusually high, especially for a church of that general size. The nave, which had entirely vanished, has been rebuilt, and is intended to have two western towers, which will look too near the central one at so short a distance as 100 ft. even if they are otherwise satisfactory, which they certainly are not in the drawings.

I have occasionally put two or three churches together in the list a little out of order, for reasons which will be apparent: *s* indicates a spire, and *c* or *w* attached to it means central or western. To prevent confusion, I put w^2 for two western towers, and *nw*, *sw*, when the two have to be distinguished. C means that the Chapter-house remains; and ~ that the dimensions are only approximate. In other cases *c* means choir and *n* nave.

Inside Dimensions	Area sq. ft.	Long			Wide			High	
		All.	Tran.	Na.	All.	Mid.	Tran.	Vlt.	Steeple
1 York. C. . .	63800	486	222	205	106	45	95	101 c 93 n	198 c 196 w²
2 St. Paul's, Old	72460	586	300	280	96	36	96	103 n	527 c
——— New	59700	460	240	182	94	42	94	88	356 d
3 Lincoln. C. .	57200	481	223 w 171 e	215	83 c 80 n	39	61 w 36 e	82 n 74 c	262 c 206 w²
4 Bury, was . .	56270	492	230 c 234 w	296	156 c 83 n	35	58		
5 Winchester . .	53480	526	209	262	83 n 88 c	32	80	78	140 c
6 Ely + L. C. .	46000	517	185	230	78	34	74	72	215 w
7 Westmʳ. C. .	46000	505	190	233	75	35	75 n 55 s	103	225 w²
8 Durham. C. .	44400	473	172 w 130 e	200	77 c 81 n	32	59 w 34 e	70	216 c 138 w²
9 Salisbury. C. .	43515	450	206 w 195 e	195	82	32	57 w 44 e	84	s 404 c
10 Canterbury. C.	43215	514	130 w 146 e	180	88 c 73 n	39 c 33 n	33	73 80	229 c 152 w²
11 Peterborough .	41090	426	185	228	79	35	58	81	143 c s 154 nw
12 Norwich . . .	34800	408	180	252	72	28	28	72	s 313 c
13 St. Albans .	34250	532	175	276	77	32	32	76	144 c
14 Glastonbury was . .	33800	390	166	200	74	34	65	—	— c
15 Worcester. C.	33200	394	128 120	173	78	32	32 25	68	196 c
16 Fountains, was	30800	351	136	199	67	35	32	—	166 n
17 Chester. C. .	31680	350	180	148	74	32	80	73	127 c
18 Gloucester. C.	30600	408	142	180	83	35	35	67	225 c
19 Exeter. C. .	29600	383	140	140	72	34	27	69	140 n & s
20 Beverley .	29600	334	161 101	171	64	26	64 35	67	186 w²
21 Wells. C. . .	29070	371	135 106	160	69	32	72 19	67	165 c 125 w²
22 Chichester . .	28000	380	130	156	92 n 60 c	26	34	61	s 277 c
23 Lichfield C. .	27720	379	149	140	66	26	50	57	s 252 c s 183 w²
24 St. Mary's, York, was	27315	348	135	145 n 156 c	71 n 68 c	28	48	—	— c
25 Hereford . .	26856	325	144 106	130	74	30	54	70	144 c
26 Byland, was .	25540	328	130	206	64	27	68		
27 Ripon . . .	25280	270	132	136	87 n 68 c	40 n 33 c	50	88 n 79 c	110 all 3
28 Tewkesbury .	25110	304	124	170	71	33	53	57	132 c

Inside Dimensions	Area sq. ft.	Long			Wide			High	
		All.	Tran.	Na.	All.	Mid.	Tran.	Vlt.	Steeple
29 Bridlington ~ nave remains	25000	337	—	185	68	—	—	70	— w^2
30 Guisborough ~	25000	—	—	—	71	29	—	75	
31 Rievaulx, was	24340	348	120	172	65	35	48	60	— c
32 Rochester. C.	23300	313	122	126	65	28	30	55	156 c
33 Yarmouth . .	23085	228	148	112	110	23	23	52	s 186 c
34 Bristol, now .	22556	284	113	125	69	31	29	52	133 c
35 Coventry, St. Mich. . .	22080	280	o	106	120	36	o	—	s 320 c
36 Tintern, was .	22000	228	150	110	78	36	58	67	— c
37 St. David's . .	21950	298	129	133	70	29	27	46	124 c
38 Romsey . . .	21470	255	131	150	74	32	60	62	94 c
39 Jervaulx, was .	20830	260	117	150	64	28	47	70	
40 Southwell. C.	20440	306	121 / 98	151	60	27	27 / 13	49	111 c / — w^2
41 Boston . . .	20270	284	o	156	99n / 30c	40	o	46	268 w
42 Whitby, was .	20230	305	132	135	56	26	45	60	104 c
43 Newcastle . .	20110	243	127	—	74	23	48	46	194 w
44 Hull, Trinity .	20040	272	96	144	72	28	28	—	c
45 Dublin, St. Pat.	20000	300	72	—	63	—	—	85	225 c
46 King's Chapel ex chapels .	18550 / 13150	289	o	126	78	45½	o	78	o
47 Glasgow . . .	18355	285	63	130	63	25	25	—	s 219 c
48 Manchester .	18340	215	o	110	112	—	o	50	140 w
49 Christchurch .	18300	303	101	140	60	—	—	58	120 c
50 Furness, was .	18254	275	130	143	65	28	50	60	— w
51 Southwark . .	18200	272	121	—	61	—	—	—	150 c
52 Selby	17890	296	86	120	59	25	35	—	130
53 Newark . . .	16855	214	115	107	72	22	24	—	s 220 w
54 Bath	16600	207	126	112	72	31	20	73	162 c
55 Windsor, St. G.	16400	225	106	—	66	35	27	54	o
56 Redcliffe . .	15550	239	117	108	56	23	48	54	s—nw
57 Llandaff . . .	15440	245	o	110	66	—	o	65	w
58 Grantham . .	15440	198	o	—	78	28	—	—	s 274 w
59 Howden, was .	15360	233	101	108	58	24	43	—	139 c
is, ex choir .	10160	132							
60 Lynn, St. Mar.	15280	238	76	126	64	31	31	—	92 w^2
61 Carlisle . . .	15270	211	124	36	71	32	28	75	127 c
62 Roche Ab., was	15240	203	97	132	71	30	52	58	
63 Ludlow . . .	14860	204	135	90	80	27	19	—	162 c
64 Dunfermline Ab. ~ .	14800	220							
65 Kirkstall, was .	14766	224	118	140	60	26	45	52	
66 Edin., St. Giles	14600	206	129	—	68	—	—	—	121 c
67 Netley, was .	14320	211	118	—	56	29	42		
68 Louth . . .	14100	182	o	—	76	34	o	55	s 294 w
69 Kendal . . .	14000	140	o	—	101	18	o	—	— w
70 Beverley, St. M.	13960	197	113	100	60	26	39	50	— c
71 Kirkham, was .	13900	216	128	140	60	27	35		
72 Bury, St. Mary	13850	213	o	140	68	25	o		

Inside Dimensions	Area sq. ft.	Long			Wide			High	
		All.	Tran.	Na.	All.	Mid.	Tran.	Roof	Steeple
73 Kilkenny . .	13700	212	117	—	60	—	—	44	100
74 Hexham, now .	13645	150	156	—	51	—	—	—	100 c
75 Maidstone . .	13500	168	—	—	91	—	—	—	80
76 Warwick . .	13420	180	107	—	66	—	—	42	174 w
77 Lynn, St. Nic.	13282	193	o	—	74	—	o		
78 Cirencester . .	13150	158	o	81	104	—	—	55	135 w
79 Leeds . . .	13140	160	103	—	85	30	21	—	139 so
80 Sherborne . .	13110	200	95	—	60	26	26	60	109 c
81 Leominster . .	12915	123	o	—	105	—	—	50	99 w
82 Cartmel . .	12600	160	109	72	65	30	28	57	91 c
83 Austin Friars .	12600	153	—	—	83				
84 Halifax . . .	12560	175	o	—	66	—	—	—	117 w
85 Doncaster . .	12550	169	92	91	{ 85 c 65 n	27	27	75	166 c
86 Brecon . . .	12440	198	102	—	60	—	—	—	— c
87 Wycombe . .	12370	201	71	—	71	—	—	—	s—c
88 Walden . . .	12300	185	o	116	80	24	o	—	s 193 w
89 Crediton . .	12270	228	85	—	55				
90 Stafford . . .	12090	170	96	75	{ 72 c 61 n	28	{ 28 n 22 s	55	93 c
91 Bury, St. James	12080	195	o	136	70	26	o		
92 Nottingham .	12000	206	95	—	66	29	—	—	s—c
93 Malvern, now .	11820	171	85	84	63	27	28	63	124 c
94 Coventry, Trin.	11800	176	80	72	67	20	17	—	s 237 c
95 Kensington .	11780	155	100	72	65	30	33	—	—ne
96 Thaxted . .	11612	183	87	91	69	23	22	—	s 183 c
97 St. Asaph . .	11600	190	108	85	68	33	33	60	
98 Bolton A. was, nave is .	11525 3608	234	121	88	43	—	41		
99 Derby, All SS.	11500	160	o	—	83	—	—	—	180 w
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102 Brighton, St. Martin's .	11332	174	o	—	69	40			
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104 Kirkwall . .	11200	220	88	—	45	—	—	54	140 c
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107 Croydon . . .	11050	175	o	92	76	—	—	—	—w
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109 —, St. Mary .	10142	152	—	—	76	—	—	—	s 183 c
110 —, St. Margaret	10080	180	—	—	72	—	—	—	s 130
111 Lowestoft . .	10840	182	—	—	62	—	—	43	120
112 Wimborne . .	10725	185	106	74	{ 69 c 54 n	20	18	50	{ — c — w
113 Bangor. C. .	10650	214	107	—	60	—	—	34	— c
114 Buildwas, was~	10500	163	85	100	56	26	26		
115 Spalding . .	10420	157	92	100	92	26	—	—	—sw

Inside Dimensions	Area sq. ft.	Long			Wide			High	
		All.	Tran.	Na.	All.	Mid.	Tran.	Roof	Steeple
116 Boxgrove was, ch. remains	10400	226	65	110	47	—	35	—	133
117 Armagh . . .	10400	183	119	—	60	—	—	—	s 150 c
118 Rye	10226	150	77	—	60	—	—	—	— c
119 Dorchester, Ox.	10216	183	—	—	69				
120 Mancroft, Nor.	10007	181	89	—	60	—	12	—	— w
121 Ledbury . . .	10000	160	—	84	66	21	—	—	s 190 sep
122 Chesterfield .	9960	168	109	—	50	—	—	—	s 230 c
123 Hitchin . . .	9960	165	0	70	67	23	0	—	— w
124 Wisbeach . .	9790	140	0	—	84				
125 Bodmin . . .	9750	150	0	100	65	23			
126 Lavenham . .	9740	169	0	96	71 c 69 n	25	0	—	141 w
127 Melton . . .	9717	163	117	—	56	—	—	—	110 c
128 Tenby . . .	9600	144	0	71	80	22	0	30	152 s
129 Christ'shospital	9537	187	—	—	51	—	—	47	
130 Malmesbury .	9520	149	gone	140	68				
131 Wolverhampt'n	9500	188	80	84	70	22	22	—	113 c
132 Scarborough, now . .	9486	102	gone	102	93	—	—	—	— c
133 Melford . . .	9450	176	0	—	61	20	0	—	— w
134 Milton Abbey .	9432	132	108	—	61	—	—	35	116 c
135 Rotherham . .	9416	147	100	78	67c	26	22	50	s 172 c
136 Tickhill ~ . .	9400	144	0	104	66	23	0	—	— w
137 Hadleigh ~ .	9382	163	0						
138 Dublin, Christ Church .	9360	220	90	—	38				
139 Wells, St. Cuth.	9300	160	0	—	61	27	0	—	150 w
140 Beccles . . .	9270	148	—	—	62	—	—	—	92
141 Wymondham .	9250	123	0	123	72	18	—	—	142 w
142 Ashford . . .	9160	136	100	73	60	20	30	—	120 c
143 Peterboro', St. James ~	9100	181	0	—	60	—	—	—	— w
144 Chester, St. John's . .	9088	128	71	103	68	25	25	—	150 nw
145 Bolton, Lanc. .	9000	156	0	114	67	28	0	—	142 n
146 Taunton . .	9000	155	0	—	86	21	0	—	150 w
147 Nantwich .	8976	165	117	—	57	—	—	50	108 c
148 Stoke Nayland	8900	172	0	—	58	19	—	—	120 w
149 Worstead . .	8900	150	—	—	61				
150 Shrewsbury, St. Mary .	8772	142	90	—	56	27	—	49	s 222 w
151 Bromsgrove .	8600	138	0	—	75	29	0	40	s 180 w
152 Burton, St. Paul	8400	144	88	72	52n 54c	24	23½	60	123 c
153 St. Cross . .	8395	125	115	—	55	22	22	50	95 c
154 Sleaford . . .	8364	146	87	—	78	—	—	—	s 144 c
155 Cambridge, St. M. .	8380	142	0	—	66	—	0	—	130 w
156 Oxford, St. M.	8198	168	0	—	55	—	0	—	s 206 c

Inside Dimensions	Area sq. ft.	Long			Wide			High	
		All.	Tran.	Na.	All.	Mid.	Tran.	Roof	Steeple
157 Marychurch	8260	170	0	100	60	24	0	—	120 w
158 Henley	8200	112	0	—	90	19	—	—	— w
159 Grimsby	8140	144	90	—	60	—	—	—	144 c
160 Mirfield	8120	150	0	82	60	28	—	64	136 w
161 Hingham	8100	190	—	—	63				
162 Eton Chapel	8070	175	63	—	40	40			
163 Walpole	8033	180	0	103	63	—	—	—	— w
164 Wrexham	7896	174	0	105	60	22½	0	—	135 w
165 Ottery	7880	174	77	58	57	18	18	55	n & s
166 Baldock	7843	143	0	—	67½	21½	0	—	— w
167 Ossett	7820	144	75	85	55	25	25	—	s 224 c
168 Clun	7730	132	0	—	88	25	0	—	— w
169 Lichfield, St. M.	7725	126	0	68	66	25	0	—	s 198 w
170 Oundle	7700	150	—	—	60	21	21	—	s 200 w
171 Cottingham	7580	170	54	88	54	23	22	—	128 c
172 S. John's Chapel	7560	175	74	0	34	34	32	—	163 w
173 Eccleshall	7440	150	0	{ 65n 60c	68	24	0	—	— w
174 Birstall	7440	120	0	77	70	18½	0	60	123 w
175 Temple	7360	138	0	80	59	58	Round	37	
176 St. Pancras	7300	108	0	—	60	30	0	—	s w
177 St. Neot's	7270	152	0	82	60	24	0	—	s 128 w
178 Kettering	7340	146	0	61	63	22	0	—	s 117 w
179 Frome	7240	160	0	112	56	21	0	36	s 139 w
180 Hedon	7100	164	103	85	49	21	21	—	129 c
181 Patrington	7060	141	86	65	39	20	39	—	s 180 c
182 Worcester, Shrub Hill	7024	140	75	68	46	29	46	—	0
183 Tideswell	7020	162	87	80	56	26	24	—	— w
184 Trinity Chapel	6936	204	0	—	34	—	—	44	0
185 Hatfield, Yorks.	6800	130	62	70	{ 44n 61c	19	19	—	— c
186 Hunslet, Leeds	6400	118	80	90	51	23	30	—	— sw
187 Halifax, All SS.	6337	125	65	87	54	22	22	65	s 220 nw
188 All Souls, Lond.	6336	85	0	—	75	42	0	—	s — w
189 Skipton	6240	126	0	—	51	—	—	—	t — w
190 Kirkstall	6000	100	88	90	45	22	22	—	— sw
191 Doncaster, St. James } 192 Wakefield Asylum chapel	5876	113	0	—	52	26	0	51	s 120 w 0
193 Ashwell, Herts	5770	156	0	90	56	24	—	—	— w
194 Headingley, St. Chad	5500	126	0	78	52	24	0	51	s 186 w
195 Darlington	5300	126	78	—	45	18	18	36	s — c
196 Tarvin	5110	122	0	71	58	19	—	—	90 w
197 Peterboro', St. Paul's	4500	104	0	52	48	22	0	48	70 c

Foreign Churches.	Area sq. ft.	LONG			WIDE			HIGH	
		All.	Tran.	Nv.	All.	Mid.	Tran.	Vlt.	Steeple.
1 St. Peter's . .	150000	590	450	—	285	80	—	150	460 d
2 Seville . . .	102000	420	o	—	270	56	o		
3 Milan . . .	92600	475	250	280	185	56	120		
4 Saragosa . .	80000	416	o	—	212				
5 St. Paul, Rome	75883								
6 Valladolid . .	70000	375	o	—	190				
7 Toledo . . .	66000	395	—	—	178	38	—	100	
8 Florence . . .	65700	475	285	250	125	55			
9 Bologna . . .	65000	400	o	350	180	56	—	150	
10 Amiens . . .	60700	435	185	230	150	46	100	144	422 c 223 nw 205 sw
11 Cologne . . .	59340	405	216	—	132	40	86	152	510 w² intended
12 Antwerp ~. .	57600	360	—	—	170	—	—	—	403
13 Troyes ~ . .	57000	400	180	180	125	42			
14 St. Sophia . .	55647	243	—	—	229	—	—	—	183
15 Cluny, was . .	55600	530	240	—	120				
16 Segovia . . .	55300	344	160	160	—	35			
17 Notre Dame .	54050	410	154	—	154	46	46	—	204 w²
18 Chartres. . .	51460	415	195	170	190	46	85	106	403 nw
19 Bourges . . .	51300	363	o	—	128	46	o	117	
20 Rouen Cath. .	48200	435	176	200	102	30	77		
21 —, St. Ouen .	42400	420	150	—	85				
22 Rheims . . .	45550	430	135	210	95	48	—	—	422 c
23 Barcelona . .	39600	280	120	—	120	35	30		
24 Spires . . .	38900	360	150	190	110	44	50		
25 Vienna . . .	38750	337	—	—	115	—	—	92	441 n
26 Tournay, was .	38700	405	220	170	105	40	70		
27 Salamanca . .	38400	240	—	—	160				
28 Beauvais . .	37230	263	189	o	140	45	75	150	o
29 Strasburg . .	36700	250	—	—	121	—	—	101	468
30 Tours, St. Martin .	35600	350	170	210	105	30	40		
31 Toulouse. . .	35270	350	185	210	95	25	65		c
32 Leon	33760	300	126	—	126	31	—	100	
33 Poictiers . .	33000	310	190	160	100	30	30		
34 Florence, S. Spirito .	31260	296	176	186	93	36	93		
35 Sienna . . .	28750	285	165	140	80	30	70		
36 Caen	28480	333	126	180	100	28	33		
37 Vienne . . .	28300	290	o	—	105	33	o		
38 Florence, S. Lorenzo .	25580	260	171	—	82	—	82		
39 Rome, Maria Mag. . .	25400	275	—	—	100				
40 Genoa . . .	25270	250	o	—	115	35			
41 Gerona . . .	23500	270	o	—	100				
42 Worms . . .	22550	330	102	175	75	35	35		
43 Hamburg, St. Nicholas .	18260	266	123	110	83	36½	36	100	s 472 w

Halls, &c.	Area	Long	Wide	High
1 Karnac	54000	325	166	150
2 Albert	31920	219	185	100
3 Padua	20160	240	84	80
4 Westminster	17000	258	68	90
5 Spurgeon's	13050	174	75	
6 Liverpool, St. George's	12580	170	74	82
7 Leeds Town Hall	11664	162	72	
8 Bradford, St. George's	11400	152	75	60
9 New Law Courts	11040	231	48	
10 Manchester Free Trade	10452	134	75	32
11 Exeter Hall	10060	131	76	52
12 Surrey Gardens Hall	9330	155	66	72
13 Norwich, St. Andrew's, with aisles	9290	143	70	57
14 Christ's Hospital	9236	187	51	47
15 Birmingham Town Hall	9100	140	65	65
16 Durham, Hatfield Hall	9000	180	50	
17 Bolton Town Hall	8814	113	78	32
18 St. James's Hall	8400	140	60	60
19 Euston Square	8060	130	62	64
20 Trinity Library	8000	200	40	38
21 Guildhall	7500	152	50	55
22 Lincoln's Inn Library	5240	140	40	48
23 —— Hall	5200	120	45	62
24 Raby Castle	4655	133	35	
25 Christ Church	4600	115	40	50
26 Trinity	4386	102	43	56
27 Middle Temple Hall	4200	100	42	47
28 —— Library	4032	96	42	70
29 Hampton Court	4240	106	40	45
30 Worcester Cathedral School	4095	105	39	
31 Inner Temple Hall	3854	94	41	40

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