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The Architectural Exhibition at the Brooklyn Museum

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THIRD PAPER

FROM the sketch given in my last paper of the origin and development of the research which is represented by the Brooklyn Museum architectural exhibition, it is apparent that the Pisa Cathedral was not only its *original point of departure,* but that this cathedral also offers the best individual illustration of the general results of the investigation in its later stages. This importance is due partly to the complexity and variety of its asymmetries, in which no other single building which has been examined by this research is as rich, and partly to the fact that no other building has been so thoroughly surveyed. In the multitude of measurements that can be cited it has, at present, no parallel in modern publications of cathedrals, either inside or outside the limits of this investigation.

In spite of this importance no sequent and comprehensive account of the Pisa Cathedral surveys has so far been published, aside from that given in the exhibition catalogue.

In *The Architectural Record* articles of 1896-7, which furnished a general report on the results of the Museum expedition of 1895, the subject matter was arranged according to various phases of asymmetry which were united in classes, without reference to a complete account of any given church. This method was the best at the given time, for the given purpose, but it had the disadvantage of not offering connected accounts of individual churches. Thus, although the Pisa Cathedral figured in all seven articles, it is hardly to be expected that readers could gain a connected idea of the facts relating to this church which were scattered through those papers.

An instance of the importance of such a connected view is offered by the preceding paper of this series, although not mentioned there. For instance, if the gallery bends in elevation (Figs. 2, 3 of the preceding paper) are presumed to be due to accidental movement, such a theory is negatived by the fact that they correspond in height with the adjacent oblique exterior stringcourses (Fig. 5 of the same paper) which continue to rise toward the façade, where the gallery parapets bend downward. On the other hand, if the oblique stringcourses were attributed to settlement, there would be the difficulty, among many others, that the façade leans in the opposite direction, and that the gallery bends would compel us to assume two settlements in opposite directions, whereas the line of the stringcourses would compel us to presume that only one settlement had occurred. Of course, the multitude of published facts for the stringcourses on the north and south walls, west of the transepts, renders such an argument superfluous in their case when all these facts are known, and it is equally true that the con-

FIG. 1.—FACADE OF THE PIEVE NUOVA, AT SANTA MARIA DEL GIUDICE, NEAR LUCCA (12TH CENTURY ROMANESQUE).

FIG. 2.—THE PIEVE NUOVA, AT SANTA MARIA DEL GIUDICE, NEAR LUCCA.
View of the North Wall, Looking Up the Hill.

structive facts in the case of the gallery bends would make the argument superfluous which is derived from the stringcourses. It is, however, still worth observing that the same parts of one building cannot settle in two different directions at the same time.

Another illustration of the importance of a connected view of all the facts in a given building may be derived from a study of the Pisa Cathedral stringcourse beyond the west sides of the transepts, which is one main topic of the present paper. This study, however, will be assisted by illustrations of the hitherto unpublished church known as the Pieve Nuova, at Santa Maria del Guidice, near Lucca (twelfth century Romanesque, Figs. 1, 2, 3, 4, 5).

The surveys in elevation (Figs. 4, 5) show the plinth course (base moulding, or water-table), at Santa Maria del Guidice, as following the slope of a hill and conforming to variations in that slope on opposite sides of the church. This is most unusual in mediæval Italian building. Compare, for instance, the levelled water-table of S. Martino at Lucca, which is also built on a slope. At Santa Maria del Guidice we therefore find a bold defiance of symmetry, even from the standpoint of mediæval building. This defiance consists in a rough-and-ready acceptance of natural irregularity, a habit or method so constantly found in other directions of mediæval work (although unusual in this one) that it has inspired the criticism, in some quarters, that this investigation is a fruitless and uncalled-for study of fortuitous accidents.

In this instance the acceptance of a hill slope, as establishing the line of the base moulding for two sides of a church, might raise the presumption that the builders were incompetent in leveling. The elevations show, however, that the cornices on both sides are built to an accurate level. What, then, shall we say as to the wave lines, or bends in the lines, of the pilaster capitals, as figured on these elevations, or what shall we say as to the lines of arches, which are also out of level (feet 1.60 on the north side)? Do these obliquities bespeak careless construction or incompetence? If they are due to carelessness or incompetence, how does it happen that the cornice just above them is level?

Here, then, are two obvious facts and a problem. The elevations illustrate a capacity for accurate leveling, but they also illustrate bold defiance of the customary preference for horizontal lines in an architectural moulding, as far as the plinth course is concerned, and they therefore make it probable, if not certain, that the same intentional defiance of conventional preference for horizontal lines in an architectural moulding is illustrated in the lines of capitals and arches. It is, at least, certain that these obliquities are not due to a settlement of foundations (see Fig. 3), and it is equally certain that they are not due to incompetence. If they are due to indifference to accurate leveling, that indifference disappears at the cornice just over the arches.

These elevations at Santa Maria del Guidice offer an excellent introduction to an intimate study of the Pisa Cathedral stringcourse, because they show that accurate leveling was understood, even by village masons of the

FIG. 3.—THE PIEVE NUOVA, AT SANTA MARIA DEL GIUDICE, NEAR LUCCA.
Detail of the North Wall. The Plumb Line Shows That the Window Ledge Above the Sloping Water-table is Level. Under the Window Ledge May be Seen the Wedge-shaped Blocks by Which the Rectification of the Slope is Obtained.

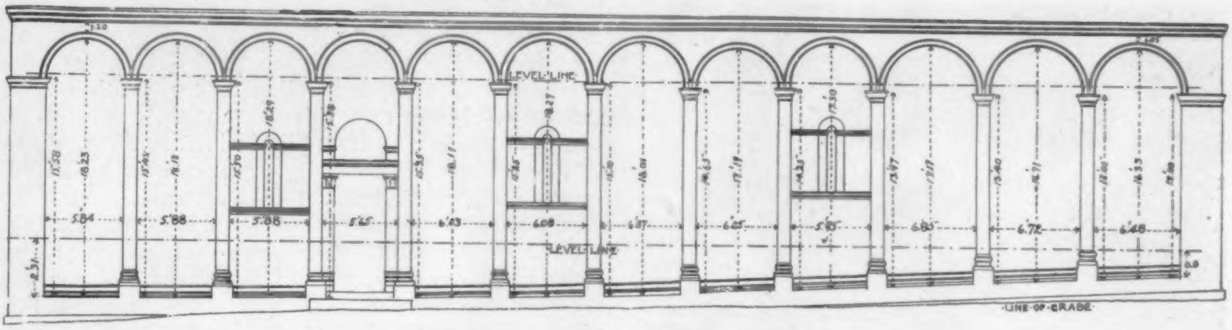

FIG. 4.—THE PIEVE NUOVA, AT SANTA MARIA DEL GIUDICE, NEAR LUCCA.
Survey in Elevation of the North Wall, Showing the Water-table as Built to the Hill Slope, the Cornice as Horizontal, and the Heights of the Pilaster Capitals and Arches as Asymmetric.

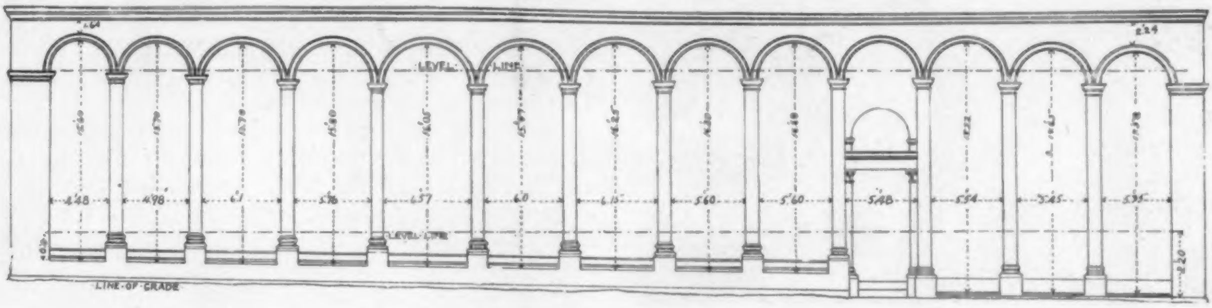

FIG. 5.—THE PIEVE NUOVA, AT SANTA MARIA DEL GIUDICE, NEAR LUCCA.
Survey in Elevation of the South Wall, Showing the Water-table as Following the Surface, the Cornice as Horizontal and the Heights of the Pilaster Capitals and Arches as Asymmetric. The Last Right-hand Arch is (feet) 1.60 Below the Level of the First Left-hand Arch.

Pisan district in the twelfth century, and because they prove, in conjunction with that fact, the existence of two distinct phases of intentional asymmetry. One of these phases is the acceptance of natural irregularity (viz., the sloping surfaces) as establishing the line of an architectural moulding, which might have been built with equal ease to the true horizontal. The allied, but distinct, fact is the departure from the normal horizontal in the lines of capitals and arches, which is proved to be intentional by the level cornices just above them.*

The building of the plinth course to the slope of the earth's surface is found in the Pisa Cathedral under still more remarkable conditions. The instance at Santa Maria del Guidice only appears more striking because the building is smaller. The actual variation from the normal horizontal line at Pisa is considerably greater when the two ends of the building are compared.

Between the northwest angle of the façade of the Pisa Cathedral and the southeast angle of the choir the earth's surface *slopes down (feet)* 3.02 *and the cathedral plinth course and pavement are built on this slope.*

On the other hand, the middle stringcourse slopes down 4.46 between the same points, or *one and a half feet more than the foundations,* while the second story roof line, above the stringcourse, is normal with the pavement and *slopes one and a half feet less than the stringcourse.*

In *The Architectural Record* article, Vol. VII, No. 3, which was devoted to the Leaning Tower and related phenomena in the cathedral, the only facts mentioned for the stringcourse are those which relate to the west sides of the tran-

FIG. 6.—PISA CATHEDRAL.
View of the Façade, North Wall and West Side of the North Transept. To Illustrate the Table of Levels for the Slopes of the Pavement and Stringcourse.

* See footnote at bottom on next page.

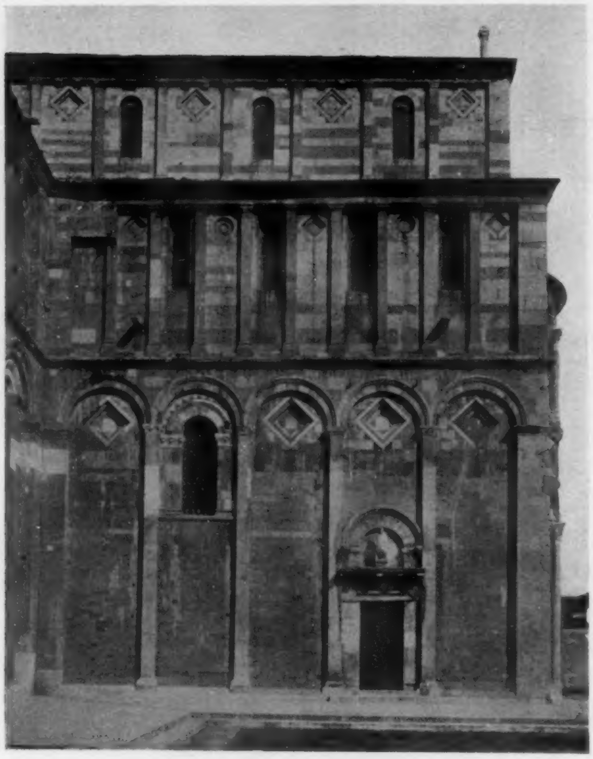

FIG. 7.—PISA CATHEDRAL.

South Transept, West Side. To Illustrate the Table of Levels for the Slopes of the Pavement and Stringcourse.

septs, to the north and south walls, and to the façade. The facts relating to the stringcourse which are described in the preceding article are confined to the north and south walls west of the transepts. The levels to the east, beyond the west sides of the transepts, have not been previously published, outside of the Edinburgh Catalogue (which, it will be remembered, is now in use for the Brooklyn exhibition).†

The middle stringcourse, east of the west sides of the transepts, *is parallel with the slope of the plinth course, both descending, in equal amount with the slope of the earth's surface, toward the southeast angle of the choir,* 2 feet 9 inches from the west side of the north transept (2.75) around to the point mentioned, and 1 foot 7½ inches (1.64) from the west side of the south transept to the same point.

On the other hand, the string of the west sides of the transepts is oblique, on both sides, *in direction opposed to the slope of the earth's surface* and of the corresponding pavement and plinth course. As compared with the pavement and plinth course, the measures for the string on the west sides of the transepts correspond on both sides, as regards departure from the line of the plinth course (about 5½ inches to a side, 0.45 north, 0.40 south); but this equality of measure is obtained by *different degrees of obliquity in the string, as regards the horizontal level.* The north transept plinth course, west side, slopes downward in northward direction with the earth's surface only 0.01. Consequently the corresponding string slopes up in northward direction 0.44. But on the corresponding side of the south transept, where the plinth course slopes down to the south 0.31, the string only rises to the south 0.09. Thus, as related to pavement and plinth course and earth's surface, the transept strings (west side), both slope in direction opposed to that of the plinth course, in equal amounts as regards the building and the effect on the eye, but in different amounts as regards the horizontal level; these differences corresponding to the differences of surface slope. This is an obvious proof of intentional design.

As for the north and south walls of the nave, the stringcourses both slope in the same direction as the earth's surface and the plinth course, but they both slope *nearly two feet more* (whereas beyond the west sides of the transepts they slope in equal amount), a correspondence of obliquities on opposite sides of the building which is again proof of intentional design; to say nothing of the fact that the obliquity is rectified in the second story by the cutting of masonry blocks in wedge fashion, just as the obliquity itself is obtained by the cutting of masonry blocks in wedge fashion as shown in the preceding article. Several photographs were there published which show details of this wedge-shaped masonry, both below and above the string.

We come now to the façade string, which slopes down to the south, in the same direction as the slope of the pavement and the earth's surface, but it slopes 0.30 less (plinth 0.86, string 0.56). It is certain that the façade was the last part of the church to be carried out, and it is evident that the slope of the string on the façade (0.56) represents the variation of level between the

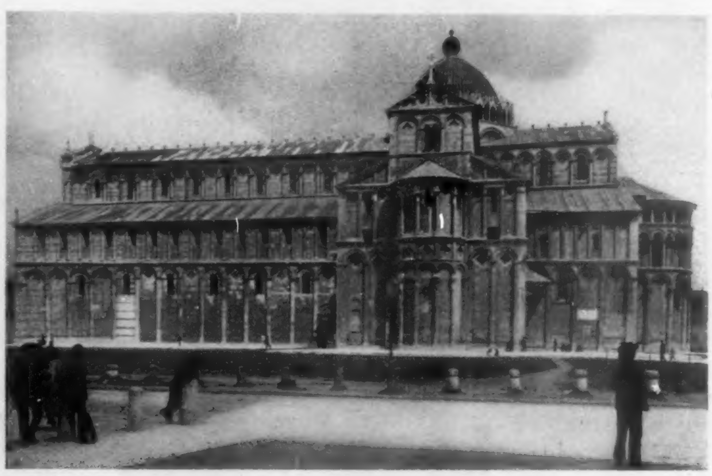

FIG. 8.—PISA CATHEDRAL.

General View of the South Side. To illustrate the Table of Levels for the Slopes of the Pavement and Stringcourse.

*As to motive in the asymmetric arches, it may be easily explained, as, for instance, by the explanation of the asymmetric arches in the choir of St. John the Divine in New York, which is given by Mr. C. Grant LaFarge in his Scribner article on that cathedral (April, 1907, p. 400): *"It is with the desire to avoid to some extent the banal aspect of mechanical regularity that certain refinements are practised in the cathedral.* The choir arcades are not parallel but converge slightly; their springings are not level; the spacing of the arches of choir and ambulatory is unequal; the floor slants upwards to the east, and the great columns are unequally spaced."

†As regards the record, the levels are entered around the outer line of the ground plan which was drawn out in 1896, and which has been published in small dimensions. Under the term "publication" is understood here such analysis and description as follows.

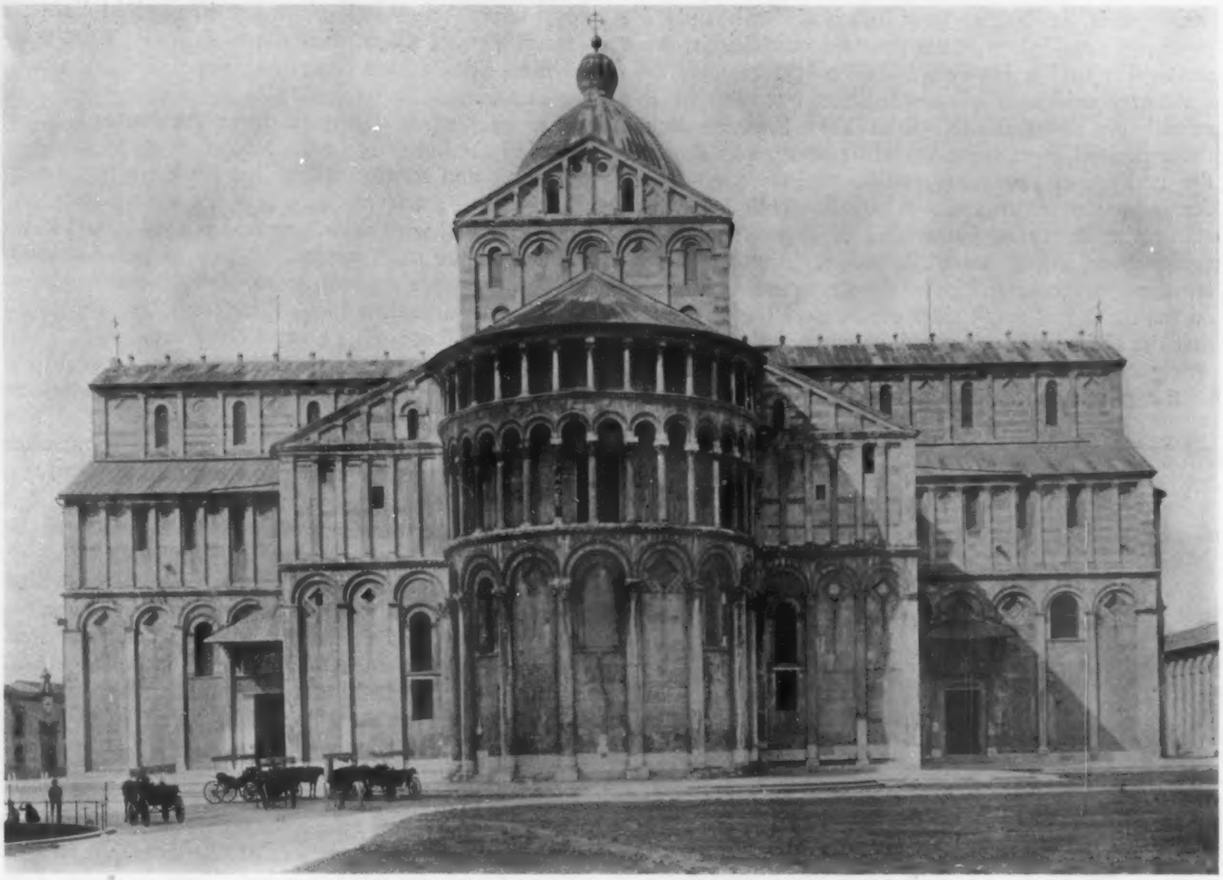

FIG. 9.—PISA CATHEDRAL.
The Choir in Parallel Perspective. To Illustrate the Table of Levels for the Slopes of the Pavement and Stringcourse.

west ends of the stringcourse on the side walls, each of which has been given a 2-foot slope as compared with the pavement.

In my last article it was mentioned that the south interior gallery is higher than the north interior gallery. The west gallery, which connects them, *rises* from north to south 0.24. It now appears that the façade string, on the exterior corresponding level and only removed from the west gallery by a few feet of masonry, *slopes down* from north to south. Each of these slopes thus proves that the other is not due to settlement, as they are in contrary directions.

It is evident that, although the façade string *actually* slopes down, it *rises* 0.30 *as compared with the pavement,* but it rises 0.65 as compared with the line of the arcade capitals which slopes down to the south 0.35 *more than the plinth course.* Here again it is, of course, impossible that a settlement could be greater at the capitals than at their bases, and another proof of intention thus appears.

Although the correspondences of slope on the north and south walls and on the west sides of the transepts vary from the kind of correspondence which is found beyond the west side of the transepts toward the choir, it appears that two different phases of correspondence exist, both of which argue unmistakable intention; one of *parallelism of slope* as between plinth and string east of those points, and one of agreement in the amount of departure of the string from the plinth, on two opposite sides of the church west of those points, and in two different cases. The former method accepts a natural obliquity as basis of an artificial obliquity; the latter method creates an artificial obliquity on the north and south walls and on the west sides of the transepts which, in the one case (west transept sides), opposes, and in the other (side walls) enormously increases, the natural slopes. These natural slopes are inconsiderable on the north and south sides of the nave (only 0.26 north, and 0.31 south, in the plinth, as against 2.09 and 2.15 in the corresponding strings).

The difference in the slopes of the strings on the north and south walls, west of the transepts, when the pavement and corresponding plinth course are taken as the normal line, *is only* 0.11 (1.83 north and 1.94 south) or 1¼ inches, and the difference on the west sides of the transepts, when the pavement and plinth are taken as the normal line, *is only* 0.05 (or ⅝ of an inch, 0.45 north and 0.40 south). These correspondences are much too close to be the result of accident.

To add to the perplexities of the possible sceptic as to constructive intention, the interior north gallery, to which the north middle stringcourse corresponds, is only 0.16 (2 inches) out of level when the two ends are compared (Fig. 3) of the last article; rise from west gallery 0.78, downward bend 0.93) and the interior south gallery, to which the south middle stringcourse corresponds, *is exactly level,* when the two ends are compared (see Fig. 2 of the preceding article, rise from west gallery 0.83, downward bend 0.83).

Among evidences of constructive intention in this remarkable series of obliquities have been mentioned those derived from the numerous photographs showing the cutting of the masonry blocks in wedge-shaped forms on the north and south walls (both below and above the string). These are, of course, conclusive evidences as to original construction. Another demonstration that the obliquities of the string are constructive on the north and south sides of the nave lies in the fact that the obliquity is recovered, or corrected, between the string and the second story roof line, which is normal to the plinth course and pavement. This fact is not

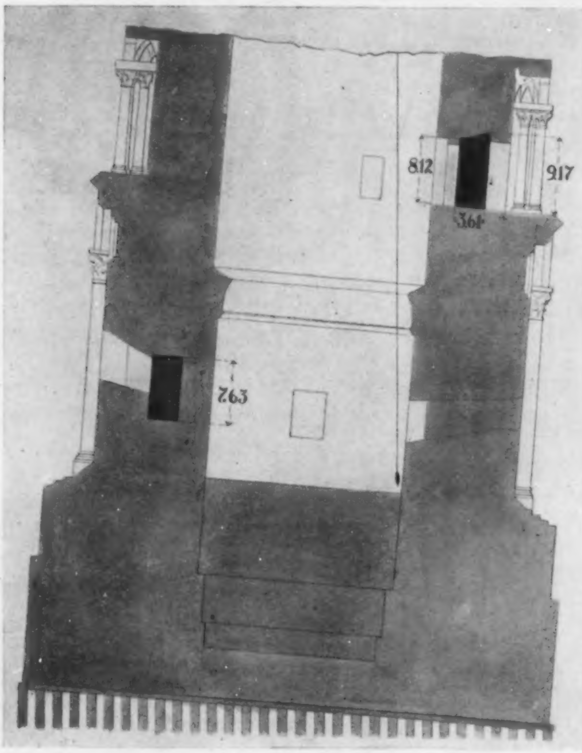

FIG. 10.—SECTION OF THE FIRST STORY OF THE LEANING TOWER.

Showing the Downward Tip of the Stairway Ceiling Toward the Inner Wall, at the Point of Greatest Inclination on the South Side of the Tower.

only established for the north wall by Fig. 5 of the preceding article (taken in parallel perspective), on which a compass test may be applied, but it is also established by the measures of Taylor and Cresy (1829) which only figure 3 inches difference in the height of the second story roof line above the pavement, as between the east and west ends of the church. Their elevation also represents and figures the measures for the whole obliquity of the string as between the east and west sides of the church, although it omits to show that this obliquity, as compared with the pavement, is confined to the nave, and although it also fails to show that the foundations slope downward 3 feet from west to east. Professor Simpson is in error in supposing that Taylor and Cresy have given measurements for "curves."* These obliquities are in straight lines, although there is a bend with slight increase in the slope, on both sides of the church, at the fifth arcade from the façade.

An interesting departure from the method of recovering the obliquity in the second story, as found on the north and south walls of the nave, appears on the west sides of the transepts, where the second story roof line is parallel with the string on both sides, and is out of level to the same extent. It thus slopes downward toward the nave on both sides of the church. It has already been mentioned that these slopes are opposed in direction to those of the earth's surface.

It is rather singular that the first levels ever published for the foundations of the Pisa Cathedral are those of the Brooklyn Museum survey. The total amount of slope now published for the foundations (3.02) must be as surprising to the world at large as it was to Mr. McKecknie and myself.

A study of the distribution of the slopes will probably explain the habitual oversights of their existence or total amount, which certainly appears rather astonishing when this total is made known. For instance, the southward slope of the base of the façade is quite imperceptible to the eye (0.86 or 10¼ inches). At all events I was personally very much astonished to learn of it from the levels. The table which follows here illustrates the distribution of the slopes. It is drawn up in two divisions. One division gives the facts continuously, first for the pavement and then for the string. The second division unites the levels of the pavement and string for each portion of the church and also figures the results for the observer, who naturally accepts the pavement of the church as the normal horizontal line.

TABULATED SUMMARY OF LEVELS FROM THE NORTH-WEST TO THE SOUTH-EAST OPPOSING ANGLES OF THE CATHEDRAL.

The pavement falls, on the north side of the entire building and east side of the choir (the measures begin at the north-west angle):

North wall	0.26
West side, north transept	0.01
North side, north transept	0.87
North transept, east angle to choir	1.05
East side of choir	0.83
Total fall	3.02

The pavement falls, on the façade and south side of the entire building (the measures begin at the north-west angle):

Main façade	0.86
South wall	0.21
West side, south transept	0.31
South side, south transept	0.63
South transept, east angle to choir	1.01
Total fall	3.02

The stringcourse (levels in the same order for the north side of the entire building and east side of the choir):

Falls, north wall	2.09
Risers, west side, north transept	0.44
Falls, north side, north transept	1.16
Falls, north transept, east angle to choir	0.49
Falls, east side of choir	1.16
Total fall	4.46

The stringcourse (levels in the same order for the façade and south side of the entire building):

History of Architectural Development, vol. II, p. 178. The foundation of this error may be an inadvertent and incorrect use of the word "curve" as relating to the string of the north wall in Arch. Rec. Vol. VII, No. 3, p. 268.

Falls, façade	0.56
Falls, south wall	2.15
Rises, west side, south transept	0.09
Falls, south side, south transept	0.63
Falls, south transept, east angle to choir	1.21
Total fall	4.46

COMPARISON OF LEVELS FOR EACH PORTION OF THE CHURCH AND RESULTING OBLIQUITIES OF CONSTRUCTION AS DISTINCT FROM OBLIQUITIES OF LEVEL.

FAÇADE.

Pavement slopes down to south	0.86
String slopes down to south	0.56
String rises as compared with pavement	0.30

NORTH WALL.

Pavement slopes down to east	0.26
String slopes down to east	2.09
String falls as compared with pavement	1.83

SOUTH WALL.

Pavement slopes down to east	0.21
String slopes down to east	2.15
String falls as compared with pavement	1.94

Variation in the obliquity of the strings on north and south sides of the nave, when compared with the pavement, 0.11.

NORTH TRANSEPT. WEST SIDE.

Pavement slopes down to north	0.01
String slopes up to north	0.44
Obliquity of the string as related to pavement	0.45

SOUTH TRANSEPT. WEST SIDE.

Pavement slopes down to south	0.31
String slopes up to north	0.09
Obliquity of the string as related to pavement	0.40

Variation in obliquity of the strings on the west sides of the transepts, when compared with the pavement, 0.05.

NORTH TRANSEPT. NORTH SIDE.

Pavement slopes down to east	0.87
String slopes down to east	1.16
Builder's error, excess downward on string	0.29

NORTH TRANSEPT, EAST ANGLE TO NORTH-EAST CHOIR ANGLE.

Pavement slopes down	1.05
String slopes down	0.49
Builder's apparent error of underestimate in lowering string	0.56
Builder's real error of underestimate in lowering string*	0.27

EAST SIDE OF CHOIR.

Pavement slopes down to south	0.83
String slopes down to south	1.16
Builder's apparent error of excess in lowering string	0.33
Builder's real error in excess of lowering string**	0.06

SOUTH TRANSEPT. SOUTH SIDE.

Pavement slopes down to east	0.63
String slopes down to east	0.63
Builder's error	0.00

SOUTH TRANSEPT, SOUTH-EAST ANGLE TO SOUTH-EAST ANGLE CHOIR.

Pavement slopes down	1.01
String slopes down	1.21
Builder's error	0.20

NOTE ON THE BUILDERS' ERRORS.

If the order of building reversed the order of arrangement here followed, which is probable, for it is most likely that the entire sequence of construction was from east to west, the comparisons of real and apparent error would make the corrections in the opposite direction. In that case, in considering the east and north-east sides, the first error, 0.33, was compensated by 0.56 in reverse direction, which was 0.23 too much. The next apparent error of 0.29 in again reversed direction would make the real error 0.06 on the north side, north transept. It is evident that all minor errors could be easily corrected when it came to joining the two west ends of the north and south strings, for here it would be only a question of stretching a cord between the two points.

*Because correcting to amount of 0.29 the previous error in the opposite direction, viz., the one made at north transept, north side.

**Because variation otherwise corrects error of 0.27 in opposite direction at north transept, northeast angle to northeast choir angle.

There are two interesting features about the acceptance of the surface slope in the construction of the eastern parts of the Pisa Cathedral, beyond the west sides of the transepts. One is the considerable actual amount of departure from the horizontal. The other is the wholly inconspicuous result, as regards detection by the eye. We can only repeat what was said in another connection in my first article, that no horizontal lines appear to the eye to be horizontal excepting those which are viewed in strictly parallel perspective. No eye is searching for this point at which the lines ought to appear horizontal in parallel perspective. Consequently, obliquity is the normal and practically perpetual fact of all visual appearance. The eye is used to it and accepts it as normal, even when artificially produced.

However inconspicuous in result these departures from the true level may be, there was certainly a great deal of boldness and daring in the procedure, considered from the standpoint of architectural construction. A pronounced independence of formalism, a strong preference for picturesque asymmetry are visibly demonstrated by these levels.* It is my own conviction that the straightforward and bold acceptance of the irregularities incident to the use of heterogeneous material, which appears so widely in the details of this cathedral, and notably in the columns of the nave, is simply a more familiar phase of the spirit shown in building to the slope. Another illustration of this spirit is found in the careful avoidance of monotonous regularity in the masonry stripes (of white and dark green marble), a trait which is shown in all parts of the cathedral, both interior and exterior. The unfortunate results of geometrical regularity in this particular are shown at Siena and at Orvieto—not to speak of S. Miniato at Florence or of the Florence Cathedral.

That many asymmetries of the cathedral represent a dislike of architectural formalism and monotony which finds its most pronounced and most visibly eccentric expression in the Leaning Tower, which is of considerably later date, has always been my belief. This idea was advanced in the early Scribner article and in the article of the *Architectural Record,* Vol. VII, No. 3. but the argument of that article was based on analogy and it expressly mentioned that no new evidence, directly relating to the tower, was made known by it. This is also true of my article on *Leaning Towers,* which was written at the request of the lamented Russell Sturgis for his *Dictionary of Architecture.* It did not contain any new or original direct evidence. This direct evidence was subsequently obtained, however, in 1901. Aside from the Edinburgh Catalogue, the survey section which presents it is now made public for the first time. The measurements in the spiral stairway, which this section illustrates, were made after the date of Signor Annibale Messerini's certificate, which appeared in the last paper, and I had no opportunity to bring them to his notice, before leaving Pisa.

In a sympathetic review of the Edinburgh Exhibi-

*A somewhat analogous case is found at Pompeii, where: "In the street of the Silversmiths, the masonry and mouldings incline almost imperceptibly with the slope of the street." See article *Optical Correction and Refinement* in the *Dictionary of Architecture,* published by the Architectural Publication Society, printed by Thomas Richards, London, Vol. VI, p. 17.

tion, which appeared September, 22, 1905, the editor of the (London) *Building News and Engineering Journal* said that these measurements "prove that the tower was built as it now stands."

There seems to be no doubt on this point and the editor of the (London) *Builder* has recently announced a similar belief,* although in such a way as to do injustice to my views as to the explanation or reason for the construction.

The passage in the *Builder* is as follows and appears in a review of Prof. Simpson's *History of Architectural Development:* "We are little disposed to believe generally in the speculations of Mr. Goodyear, who sees in every dropped arch and wall out of plumb an 'architectural refinement,' but in this case we think he is right and that the building of the tower in this way was a piece of bravado, and would have the consent of the authorities as giving a sort of celebrity to the locality—as it has actually assisted in doing. Indeed, the mere fact of leaning towers being also built at Bologna, Este, and elsewhere seems conclusive on this point; they could not all be accidental. Of course, Mr. Goodyear's idea that the lean was slightly modified half-way up to 'give an entasis to the outline' (an entasis on one side only!) is ridiculous; the obvious fact is that the builders began to get a little nervous about it as they got higher, and did not like to overhang so much."

The development of a myth is nicely illustrated here. It will be widely believed in England, and it will naturally be believed by architectural editors in the United States who exchange with the *Builder,* that I have announced a theory which appears quite as ridiculous to me as it does to the Editor of that journal. The quotation marks naturally appear to indicate a passage from my publications, but no such passage nor anything like it can be found in them. The passage about giving an "entasis to the outline" is a quotation from Prof. Simpson, not from me, and here again two other stages of myth making are illustrated. Prof. Simpson has misunderstood my explanation of the curving line in the Pisa tower (which curves toward the perpendicular). In describing my explanation, which he misunderstood, he has used a word "entasis" which I have never employed in speaking of the Leaning Tower, but he has used it in a sense which is distinctly authorized, as applying to a single curving line, as distinct from the lines of a column.**

My own opinion, however, agrees with that of the *Builder,* that the curve toward the perpendicular was intended to diminish the inclination and to make the tower more secure, and this opinion would only differ to the effect that this curve was contemplated in the original plan. This is the point which appears to explain Prof. Simpson's misunderstanding.

It may be added that Professor Simpson has agreed with my views in several particulars and that where he has differed from them, as in the case of the tower, it has been with the greatest courtesy of expression.

The following anecdote may serve to illustrate how far myths and legends may develop in such matters. On the day after my arrival in Brooklyn from Edinburgh, in 1905, a New York morning newspaper printed this announcement:* "Mr. Goodyear reiterated yesterday the interview cabled recently to the effect that the famous Leaning Tower of Pisa does not really lean."

It is hardly necessary to say that an interview which was never given was not "reiterated." As a matter of fact, no interview had been given on any subject whatever and, naturally, no such interview had ever been cabled, although there had been some cabled notices of the Edinburgh Exhibition. There was certainly also no malicious intent in the paragraph. This may, however, again illustrate the point which appears from the *Builder's* notice, that in circles remote from those who really know something about the matter, there have developed some impressions, of mythical character and tendencies, about this research. Among these mythical impressions may be included the *Builder's* idea that "Mr. Goodyear sees in every dropped arch and wall out of plumb an architectural refinement."

Although the measurements of the sections (Figs. 10, 11) appear to be conclusive for the question of purpose, they simply verify the statements published by Ranieri Grassi in 1837.** The only difference is that Grassi did not offer measurements in verification of his general statements about the spiral stairway.

It appears to be an elementary proposition that this spiral stairway would not gradually, and alternately, rise and lower in height, without explanation or purpose. Since the greatest height of the stairway and least weight of the walls, in the first four stories, is always on the overhanging side and since the lowest height of the stairway and greatest weight of the walls, in the first four stories, is on the side opposed to the overhang, the conclusion seems inevitable that the motive of this construction was to increase the weight of masonry on the side opposed to the overhang and to diminish this weight on the side of the overhang. This motive could only be supposed to exist in the case of an intentionally constructed inclination. As this system of construction begins at the entrance doorway it could not be ascribed to a system of rectification after, or during, settlement, such as has been suggested, but wholly without reason or authority, to explain the vertical bending line of the tower.

Vasari's wholly gratuitous conjecture, offered four hundred years after the tower was begun, that settlement had occurred, is the only authority for the widely quoted modern statement to that effect. Vasari presumed that the settlement happened "before the tower had reached half its height," and thus only mentions one settlement, apparently because the bend toward the perpendicular is especially marked above the fourth story (note measures for the rectification after Fig. 11). The expansion of this legend, so as to include a successive series of separate settlements, beginning at the first story and repeated at each individual story higher up, is a purely modern invention, suggested by the fact that every story, above the first, shows a slight rectification toward the perpendicular. A detailed account of these imaginary settlements has been given, for instance, by Mothes, in his *Baukunst des Mittelalters in Italien.*

An interesting feature of the published sections is the

*April 17, 1909.
**See "Entasis," in the *Dictionary of Architecture,* published by the Architectural Publication Society, Thomas Richards, London.

*See *The Morning Telegraph,* Oct. 2nd, 1905.
***Descrizione di Pisa e suoi Contorni,* Vol. II, pp. 97-109.

inward and downward dip of the ceiling of the stairway on the side of the overhang, at the height of the first story, which throws the weight above toward the inner wall (Fig. 10). This was also mentioned by Grassi but without the measurements now offered. There is no other part of the stairway in which such a dip occurs and here it begins and ends gradually. In this, and other respects, the measurements speak for themselves.

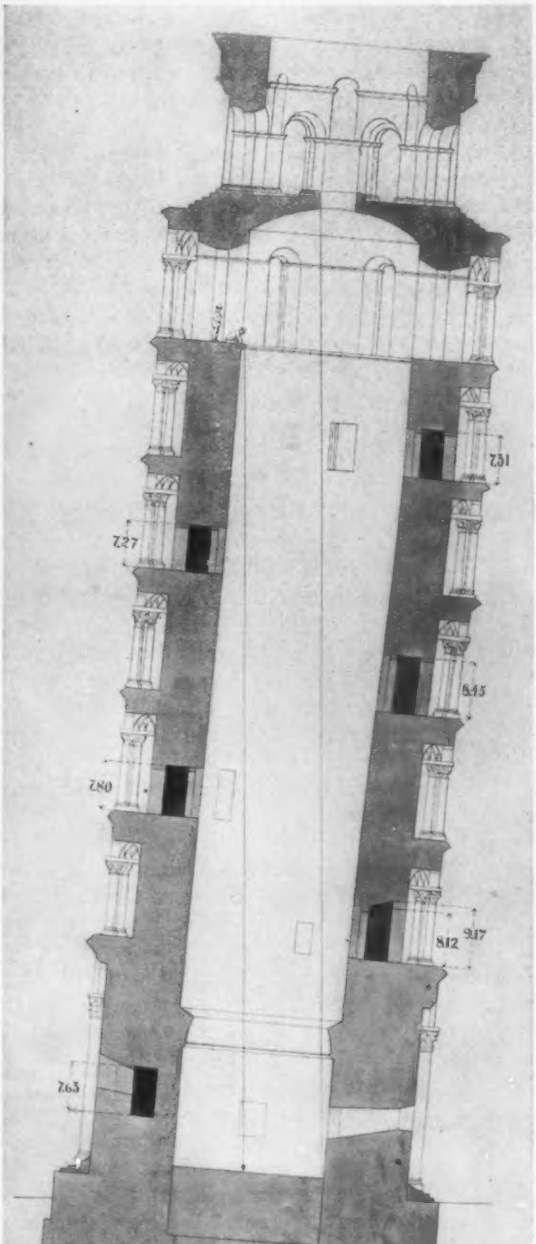

FIG. 11.—SECTION OF THE LEANING TOWER OF PISA.

Fig. 11 is supplemented by Fig. 10 for the first story.

The entrance to the spiral stairway, on the left of the entrance door, is midway between the north and south sides of the tower, the latter being the overhanging side. At the entrance, the stairway (3.80 wide) has a height of 7.94 feet. The height then decreases gradually to the 13th step on the north side (which is opposite the center of the overhanging south side) to the amount of 0.31, or about 4 inches. At this point the height is 7.63. The ceiling of the stairway now rises gradually to the 46th step, which corresponds to the center of the overhanging north side, near the level of the platform of the first gallery. Here the height of the stairway ceiling is 8.12 from the step on the upper side, and 9.17 on the lower side, in a width of 3.61. The step inclines with the lean and dips down 0.34. Thus at the given point (the 46th step) the south side of the stairway is 1.05 higher than the north side *in a width of only* 3.61. The south side of the ceiling at this point is thus 0.71 (or 8½ inches) above the level of the north side of the same step. In order to continue the comparison for the height of the stairway we now take the average or central measure of the stairway at the 46th step (adding the measures on opposite sides of the step and taking the half). Thus, at the 46th step, the average height there being 8.645, we find the stairway *to be a foot higher* than at the 13th step, where the height is 7.63. If we now follow the rising spiral stairway to the north side, it gradually lowers in height to the amount of 10 inches (0.84), to the 79th step, opposite the center of the overhanging south side, where the height is 7.80. As the spiral stairway turns in its rise toward the overhanging side it gradually increases in height 8 inches (0.65) to the 115th step, at the center of the overhanging side, where the height is 8.45. In the next half turn, toward the north side, the height again lowers, 14 inches (1.18), to a height of 7.27. (There is an intermediate variation between these points, half way to the 4th gallery and fifth story, culminating at the center of the east side in a rise of 18 inches. There is no obvious explanation for this change, and it is the only one which breaks with the general rule up to the given point.) The stairway continues to the next central point on the overhanging south side without any appreciable variation in height (7.31 as against 7.27) and the stairway ends before another half turn is completed. The various alternating changes in the height of the stairway, up to the fourth story (third gallery) inclusive, can all be explained on the theory of an intentional inclination of the Tower and are otherwise incomprehensible. To these facts must be added the significant one of the inward downward tilt of the ceiling on the overhanging side of the first story (Fig. 10). When the delicate masonry arrangements are considered by which these variations of height and level are gradually and insensibly obtained, no explanation appears possible excepting that an intentional inclination of the tower had been planned.

The first four stories of the tower were built in about 16 years and by a single architect, 1170-1186. The fifth story (fourth gallery) was not begun until 1233, and we may thus explain the absence of the system described, in the final turns of the stairway, by the change of builders, by the stability of the construction as apparent in intervening years, by the fact that the rectifications toward the perpendicular were not only continued, but were much increased, and by the supposition that these increased rectifications were considered to sufficiently ensure the safety of the construction. Thus the rectification (which makes the columns higher on the leaning side) which is:

M. 0.03 in the first gallery
M. 0.04 in the second gallery } (Bonanus, A.D. 1170-1186.)
M. 0.07 in the third gallery

Increases to:

M. 0.15 in the fourth gallery (A.D. 1233, Benenato).
M. 0.08 in the fifth gallery (A.D. 1286, Wilhelm Von Innspruch).

M. 0.22 in the sixth gallery (A.D. 1350, Tomasso da Pisa.)

Above this gallery there are farther rectifications in the steps supporting the bell chamber, of M. 0.30, and in the height of the bell chamber, of M. 0.14. See Mothes (II, p. 736-8), who assumes a separate settlement for each individual rectification, without the slightest proof or indication that any settlement has ever occurred and solely on the ground that the tower curves toward the perpendicular with the measures quoted.

SNAPSHOT DRAWING FOR ENGINEERS AND ARCHITECTS

Mr. T. R. Ablett, founder and art director of the Royal Drawing Society, at a recent meeting during the International Exhibition, at London, read an interesting paper entitled "Snapshot Drawing for Engineers and Architects." In the course of his remarks he said it has come to the knowledge of the Council of the Royal Drawing Society that in various branches of technical drawing, such as that of practical mapping, botany, zoology, geology, war, surgery, architecture, engineering and other constructional drawing, students with undeveloped pictorial imagination have extreme difficulty in realizing the natural pictorial aspect of the objects represented by such technical delineation. The Council has therefore made special efforts to develop practical imagination through the realization of the natural pictorial aspect at first solely as "The Art of Childhood," for the veriest baby delights in it, and later as a necessary auxiliary to other kinds of drawing which are not as readily invented by the young people themselves. To facilitate the early acquirement of all kinds of drawing the Council has made their scope and relationship clearer by lay or popular definition, analysis, explanation, and also by reproductions.

General Definition of Drawing.—Drawing is the process of producing by human efforts certain markings of a descriptive nature to serve as records and convey information in connection with pictorial, mathematical, diagrammatic and decorative work.

Analysis of Drawing.—1. The most important branches:—Pictorial drawing represents the appearance of objects observed by means of converging rays of light; mathematical drawing represents the imaginary observation of objects by parallel rays of light. The latter describes the facts of the three dimensions in connection with practical, plane and solid geometry as dealt with in the mathematics and other branches of general education, and which forms the basis of constructional drawing as used by engineers, architects and many other workers. It is by working these together judiciously that the precious gift of practical imagination is developed. 2. Subsidiary branches.—Subsidiary branches are found in diagrammatic and decorative drawing.

The Unbiassed Observer.—Practical imagination develops well in such unbiassed observers as are assisted in their early efforts without being interfered with.

The born artist is an unbiassed observer reflecting his environment by self-invented delineation according to the measure of his intelligence, and every intelligent child with good, serviceable eyes is to this extent a born artist. A picture is the embodiment in form and color of an idea formed in the mind of the artist from, and based on, his observation of nature. The more realistic a picture, the more useful for scientific purposes, and realism is founded on the most expert use of the eye as an optical instrument. This self-invented delineation by the unbiassed observer is called common-sense drawing, and is the method of becoming expert by experiment.

Reproductions of the "snapshot drawings" by young unbiassed observers were shown by lantern-slides of sheaves, umbrella, human nature study, value of structure to the artist, animal machinery, man's machinery, Achill Island.

The youthful unbiassed observer, judiciously handled, comes early to skill in pictorial drawing, and he first makes acquaintance with mathematical drawing in connection with geography. In general education all sorts of plans have been tried to found the mathematical drawing of geography on its pictorial appreciation, which through early neglect is generally found very rudimentary in the young as well as the teacher.

It is well known that the youth of the country, especially the boys, have a passion for the study of engines, steamships and other forms of machinery. The Royal Drawing Society desires engineers to help the Society in giving them correct information about these machines, so that those who come to be the engineers of the future may have that most useful of all faculties, "practical imagination."

An eminent engineer lately said that when any draughtsman had a difficulty in his drawing office he was told to draw the look or perspective view of the object, and this generally got over the trouble.—*Architect and Contract Reporter.*

A RECENT LEGAL DECISION

Liability of Contractor's Surety

Where by the contract an owner was required to make certain payments to a building contractor upon the certificate of the engineers as the work progressed, reserving 15 per cent of the amount of each certificate until the work was fully performed, the fact that the owner made excessive payments to the contractor at the request of the surety or the contractor's bond is not such a violation of the contract as will discharge the surety on the contractor's subsequently abandoning the contract. By his request and consent the surety was estopped from insisting that such payment was a violation of the contract.—Hellman vs. Farrelly (Supreme Court, Appellate Division, First Department) 116 New York Supplement, 809.

Specifications to a building contract provided that the price of changes required by the owner must be agreed upon before the changes were put into execution. The bond provided that the owner and the contractor might make additions, etc., without notice to the surety. The materials found when excavations for footings were made required heavier foundations than the contract called for and the street line would not permit a right-angled parallelogram as the contract provided. The contractor and owner agreed that the foundation should be made heavier and that the building should be a rhomboid instead of a parallelogram. It was held that the price of such changes did not have to be fixed by agreement in writing before they were made and that the stipulation in the specifications did not refer to that kind of changes, but to such changes as the owner might compel the contractor to make; and that the surety was not released—Hax-Smith Furniture Co. vs. Toll, 133 Missouri Appeals, 404.

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APPARENTLY realizing the difficulty, if not impossibility, of passing impartial judgment on the merits of his own productions, and being solicitous that his fame as a painter should not, in after years, suffer by the existence of unworthy pictures, an artist recently made the novel provision in his will, that all canvases left by him should be censored after his death, and any found to reflect no credit on his artistic ability, destroyed. The same concern as to future fame is suggested by the analogous case of a poet, who, during his last illness, caused to be burned all of his unpublished manuscripts, numbering a score or more. Apparently he preferred his reputation to rest upon what the world knew of his genius before death, rather than to trust to its being augmented by the publication of any posthumous volumes.

IN both of these instances, commendable efforts have been made to safeguard a reputation gained by a life spent in earnest study and painstaking work. There may, however, properly be some question raised as to whether the methods adopted will prove effectual. Under ordinary conditions it would seem that the "pot boilers" and other indifferent productions would speedily pass from the control of their authors. Otherwise they would fail to relieve the need that it might be assumed inspired them. If this is true it becomes apparent that the artist's concern for his reputation was manifested rather too late in life. Again, if the least meritorious pieces of work did indeed remain within the jurisdiction of the artist, it would appear little short of remarkable that so simple a means of increasing his "average" had not been more generally adopted heretofore. But, after all, perhaps, the important thing and the one worthy of thoughtful attention, is the fact that the artist's desire to protect or enhance his fame, in years to come, was sufficiently strong to prompt the destruction, if need be, of any of the children of his brain which might be considered defective, or concerning the reception of which by the world after his death there could be any question. It reveals the attribute of the human mind that has produced the world's greatest monuments in science, in war and in art. How strong the desire to be remembered! To do something that will live through the ages to come. No sacrifice is too great that promises to shield one from oblivion. Indifferent work certainly cannot, and the artist and the poet approaching dissolution realized wherein greatness lay and did what still remained within their power to do toward gaining immortality for their achievements. The same desire to do something that will live after him probably constitutes one of the architect's strongest incentives to great work. And it behooves him to consider carefully his conceptions before committing them to enduring masonry. For in his latter days he can scarcely destroy the evidences of his lapses, or perhaps necessities, of earlier life with the ease of a poet burning his manuscripts, or a painter appointing a jury to remove from the light of day his inferior canvases.

THAT the present general contract system under which a considerable part of construction work is carried on, is far from ideal as ordinarily conducted becomes more apparent day by day. The question has received the thoughtful consideration of many architects in recent years, and reference was made to it in a committee report or paper submitted to the Convention of the American Institute of Architects in 1908. From such pronouncements as have been made on the subject it appears that there is a growing feeling among architects that better control, and as a consequence better work and more satisfactory service can be obtained by adopting the plan of conducting an average building operation under separate contracts. Such a course necessarily adds greatly to the architect's work, and in a measure to his responsibility. Where under the general contract system he is concerned only with the financial standing and responsibility of one man, he is required to ascertain the resources and general qualifications of each separate contractor in the case of separate contracts. Moreover the friction and disputes between contractors as to responsibility for errors or cause of delay must fall to the architect for adjustment where no general contractor is at hand upon whom the burden can be laid. Perhaps, after all, the trouble has generally been due rather to an unfortunate choice of men rather than with the system under which the work has been done. A competent general contractor with ample facilities and equipment, in full sympathy and co-operation with the architect, is a factor of such strength and importance that it would seem unwise to discard him as an institution, if only occasional instances of dissatisfaction arise, which may possibly be ascribed to lack of discrimination in selection, or other causes, for which the system could scarcely be held responsible.

THE HUDSON-FULTON CELEBRATION AND THE METROPOLITAN MUSEUM OF ART

The few out-of-town visitors who confined their attention to the attractions of the recent Hudson-Fulton Celebration in this city to the sights to be seen out of doors, day and night, and failed to visit the Metropolitan Museum of Art, missed one of the most important features of an important week.

The specially arranged exhibition of Dutch and American Art, opened on September 20th, and is to remain intact until November 1st. A writer in the New York *Tribune,* referring to this exhibition, states: "No such resplendent show has hitherto been made in this country, and in all probability it will be many years before anything like it is organized again. Canvasses of old Dutch Masters, men like Rembrandt and Franz Hals, Vermeer and DeHoogh, priceless examples of the best periods of Dutch Art, and which have been jealously guarded by the owners, were generously loaned for this event.

This exhibition, grouped in galleries set apart for the purpose, was visited throughout the celebration by many thousands, representing every class and condition of life. And, now that the pageants of the day and night parades have ceased, the attendance at this remarkable exhibition has increased in place of diminishing. The student who likes to linger for careful study and comparison, finds himself jostled and disturbed, so great is the throng that constantly moves through this gallery.

Men whose association with Art matters has numbered many years, when met together, comment with much enthusiasm on this large attendance, and comparing it with the few who not more than twenty years ago would take the time to attend an exhibition like this, see a growing appreciation for Art and all it means in our daily lives and feel that the fruition of their labors is at hand.

ILLUSTRATIONS

House Near Radnor, Pa. Messrs. Cope & Stewardson, Architects

A little more than ten years ago this firm designed a country house which was erected under their supervision near Philadelphia for the owner of the house now the subject of illustration. It was a simple enough Colonial house, to begin with, but after a year or two changes were made and space added here and there year by year until a fairly interesting group resulted. In the course of time when it was found necessary to erect a new house in another location, there were introduced into the new some of the features of the old which might have had a somewhat different character, had they not been, in fact, additions to the original scheme rather than part of it.

The house stands out white at the head of a sloping garden designed by Messrs. Zantzinger & Borie, and while it has a fair sized piece of woodland on one hand and some isolated trees about it, a few years growth to the recent planting will be of great advantage in the general effect.

The site is amongst the rolling and partly wooded country to be seen all around Philadelphia and the property is large enough to give the owner control of practically all in his immediate vicinity.

The walls are of local stone dashed over with mortar and white washed. All wood work painted white and the roof of split shingles in graded courses.

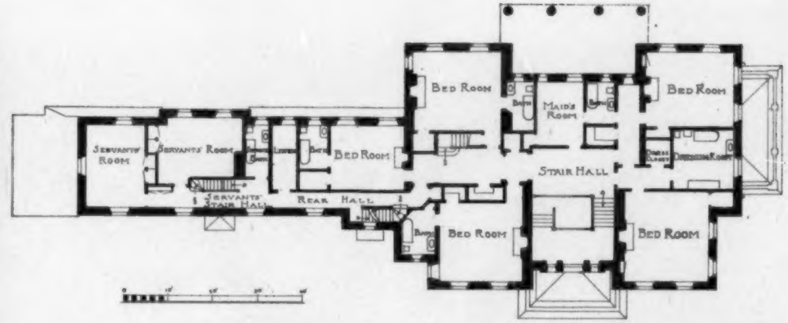
The columns at the west entrance were salvaged from a recently destroyed building of some historical interest in Philadelphia. The same is true of the mantelpiece and door heads, etc., in the dining room which it may be seen from the photographs are extremely rich in decoration.

Some of the work is as yet unfinished—the ceiling and dado in the reception room are prepared for wainscoting which is not yet in place.

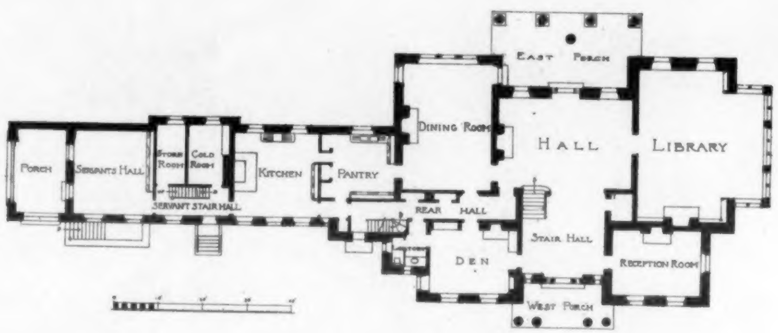
A COUNTRY HOUSE
NEAR RADNOR, PA.

MESSRS. COPE & STEWARDSON
ARCHITECTS

GARDEN DESIGNED BY MESSRS. ZANTZINGER & BORIE



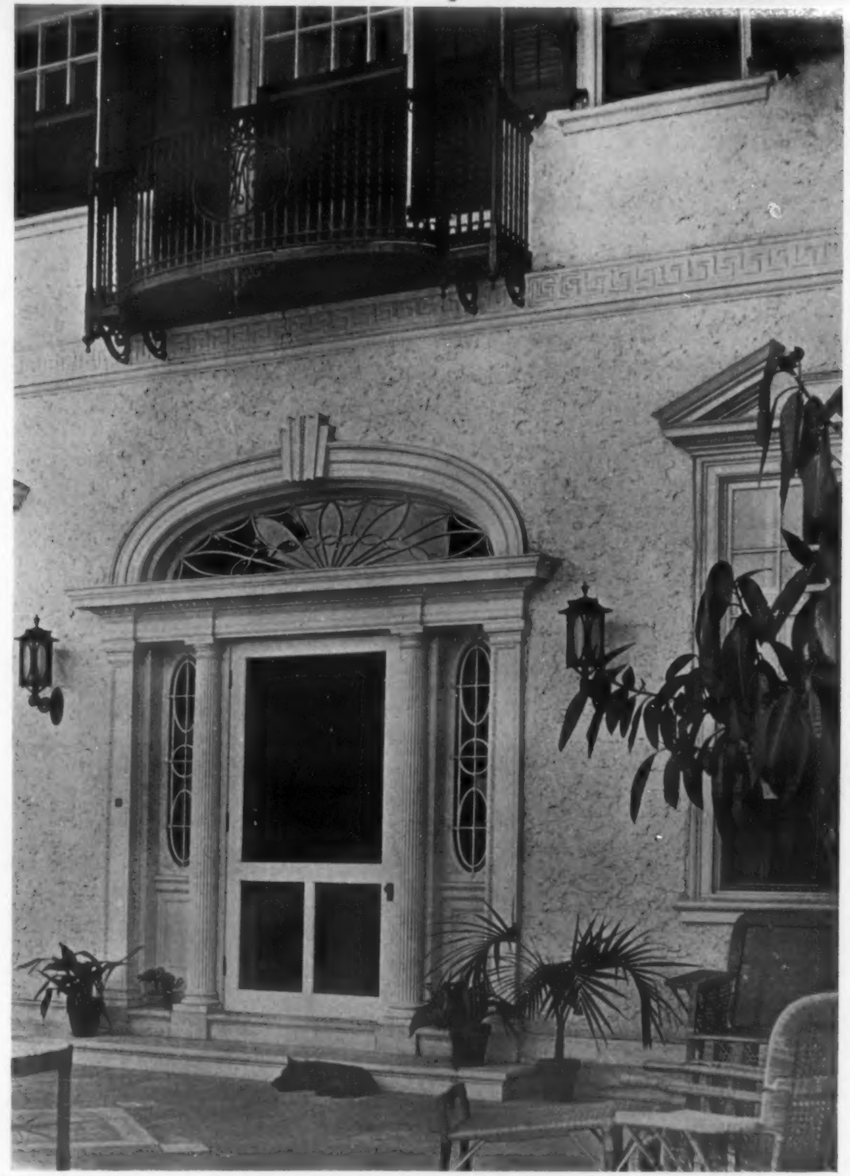
SECOND FLOOR PLAN



FIRST FLOOR PLAN

A COUNTRY HOUSE
NEAR RADNOR, PA.

MESSRS. COPE & STEWARDSON
ARCHITECTS



A COUNTRY HOUSE
NEAR RADNOR, PA.

MESSRS. COPE & STEWARDSON
ARCHITECTS

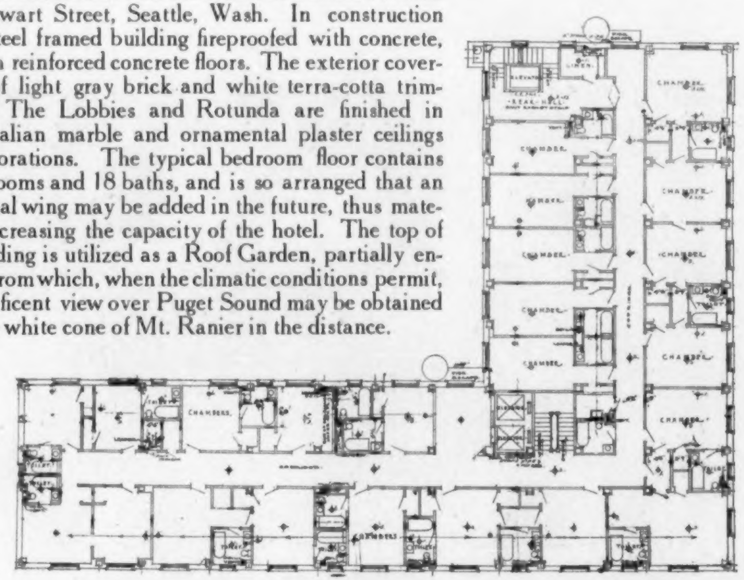
A COUNTRY HOUSE
NEAR RADNOR, PA.

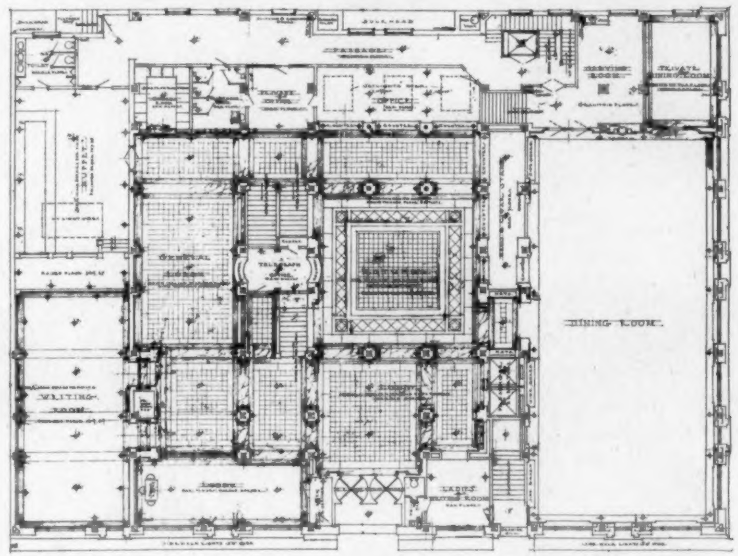
MESSRS. COPE & STEWARDSON
ARCHITECTS

SUPERINTENDENT'S HOUSE
NORWICH, CONN., STATE HOSPITAL FOR INSANE

MESSRS. CUDWORTH & WOODWORTH
ARCHITECTS

This hotel is located on the corner of Second Avenue and Stewart Street, Seattle, Wash. In construction it is a steel framed building fireproofed with concrete, and with reinforced concrete floors. The exterior covering is of light gray brick and white terra-cotta trimmings. The Lobbies and Rotunda are finished in white Italian marble and ornamental plaster ceilings and decorations. The typical bedroom floor contains 23 bedrooms and 18 baths, and is so arranged that an additional wing may be added in the future, thus materially increasing the capacity of the hotel. The top of the building is utilized as a Roof Garden, partially enclosed, from which, when the climatic conditions permit, a magnificent view over Puget Sound may be obtained with the white cone of Mt. Ranier in the distance.





THE NEW WASHINGTON HOTEL
SEATTLE, WASHINGTON

MESSRS. EAMES & YOUNG
ARCHITECTS

MAIN DINING ROOM

THE NEW WASHINGTON HOTEL
SEATTLE, WASHINGTON

MESSRS. EAMES & YOUNG
ARCHITECTS

ROOKWOOD "ALASKA" MANTEL IN LOBBY

VIEW IN ROTUNDA

THE NEW WASHINGTON HOTEL
SEATTLE, WASHINGTON

MESSRS. EAMES & YOUNG
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