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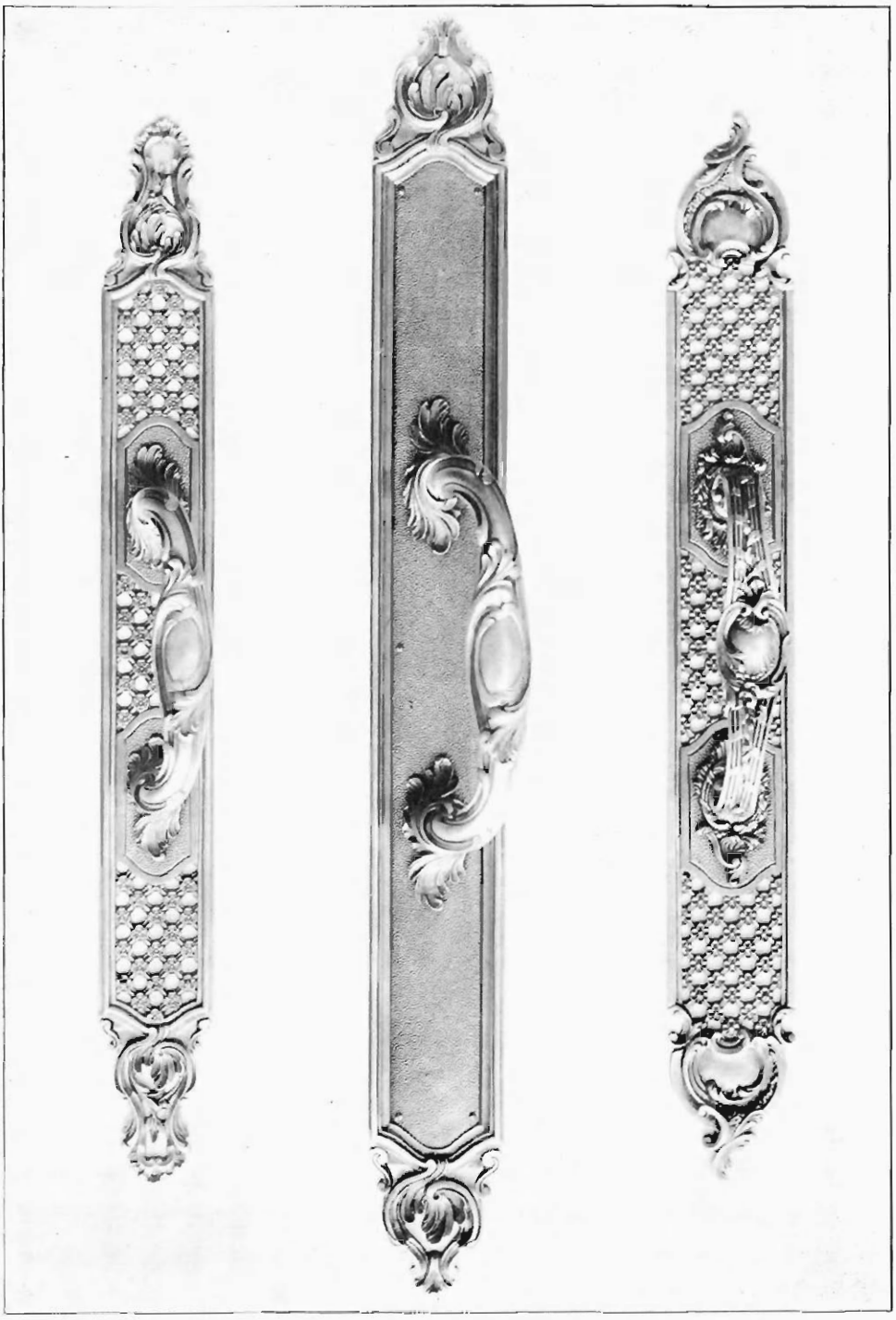

EXAMPLES OF MODERN FRENCH HARDWARE.

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ARCHITECTURAL REFINEMENTS IN FRENCH CATHEDRALS.

THIRD PAPER.*

Notre-Dame.

THE observations to be described in this paper and in its continuation in the January Number, were made mainly during the month of September, 1903. They are verified by photographs, in which the perpendiculars are represented by plumb-lines, and in which the dimensions are indicated by the inclusion of a surveyor's rod in the picture.

The entire number of negatives made in Notre-Dame to illustrate these observations was eighty-five. Sixty-three of these were interiors.

Of these photographs, forty-five have been enlarged to the dimensions of 25 in. by 35 in., or 18 in. by 22 in., and twenty-eight of them have the larger dimensions. They are now on public exhibition in the Brooklyn Museum. They are catalogued in a printed commentary, which has been published as a Museum Memoir.† In this Memoir, which appeared in April, 1904, the facts which are now to be described in a more categorical and more detailed manner were very briefly made public in print for the first time.

List of Illustrations.

Fig. 1 is a rough sketch of the north side of the nave of Notre-Dame, between the transept and the organ loft, showing arrangements which also appear on the south side. Figs. 2, 3 and 4 are photographic details relating to portions of this sketch, showing accurately the features which are exaggerated by it.

In the Brooklyn Museum exhibit there are fifteen photographs showing in greater detail the special facts which are in question in this limited number of illustrations, all but two of which are 2 ft. by 3 ft. each, inside measure.

Figs. 5 and 6 are reproductions of previously published surveys of the Pisa Cathedral, showing arrangements similar to those of Notre-Dame.

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*Continued from the November Number. The illustrations of these papers are from photographs of the Brooklyn Museum Series of 1903.

†Memoirs of Art and Archæology, No. 4: "Vertical Curves and other Architectural Refinements in the Gothic Cathedrals of Northern France and in early Byzantine Churches at Constantinople." (Macmillan.)

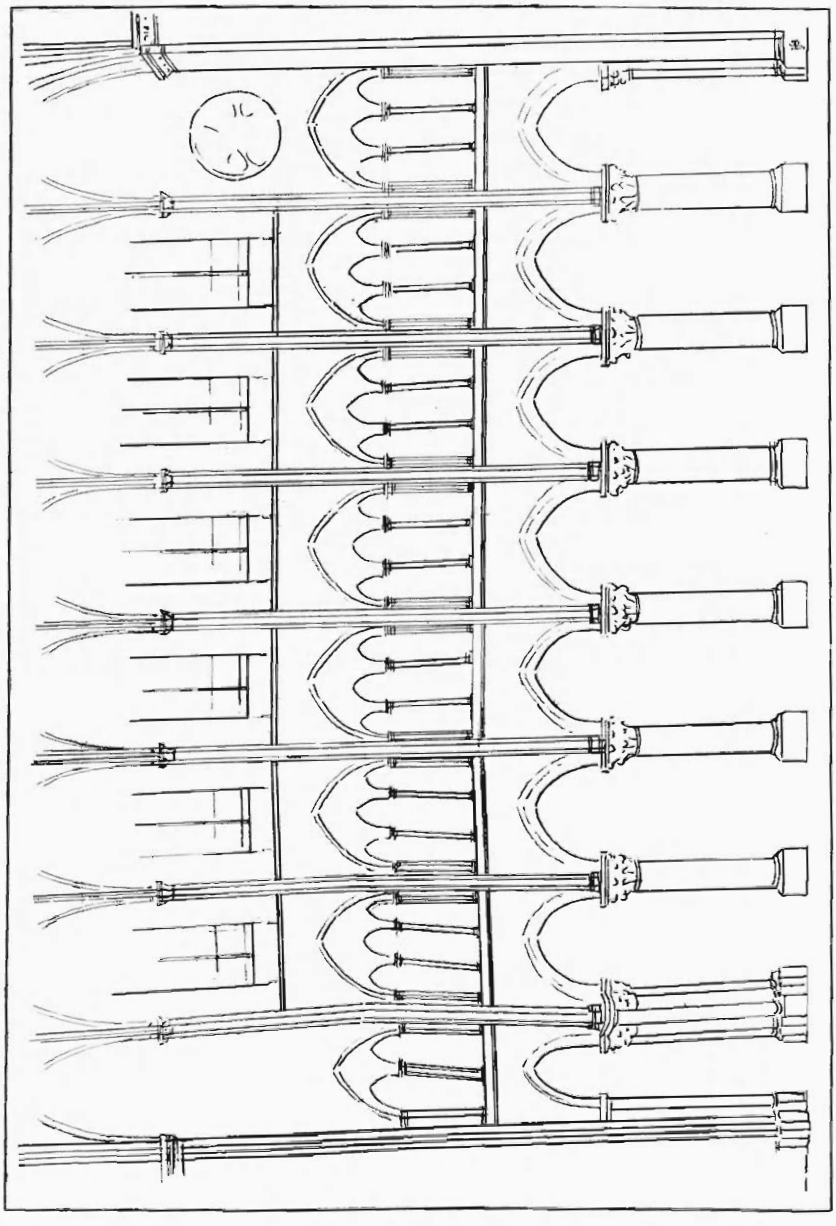

FIG. 1.—ELEVATION, IN EXAGGERATED DRAWING, OF THE NORTH SIDE OF NOTRE-DAME.

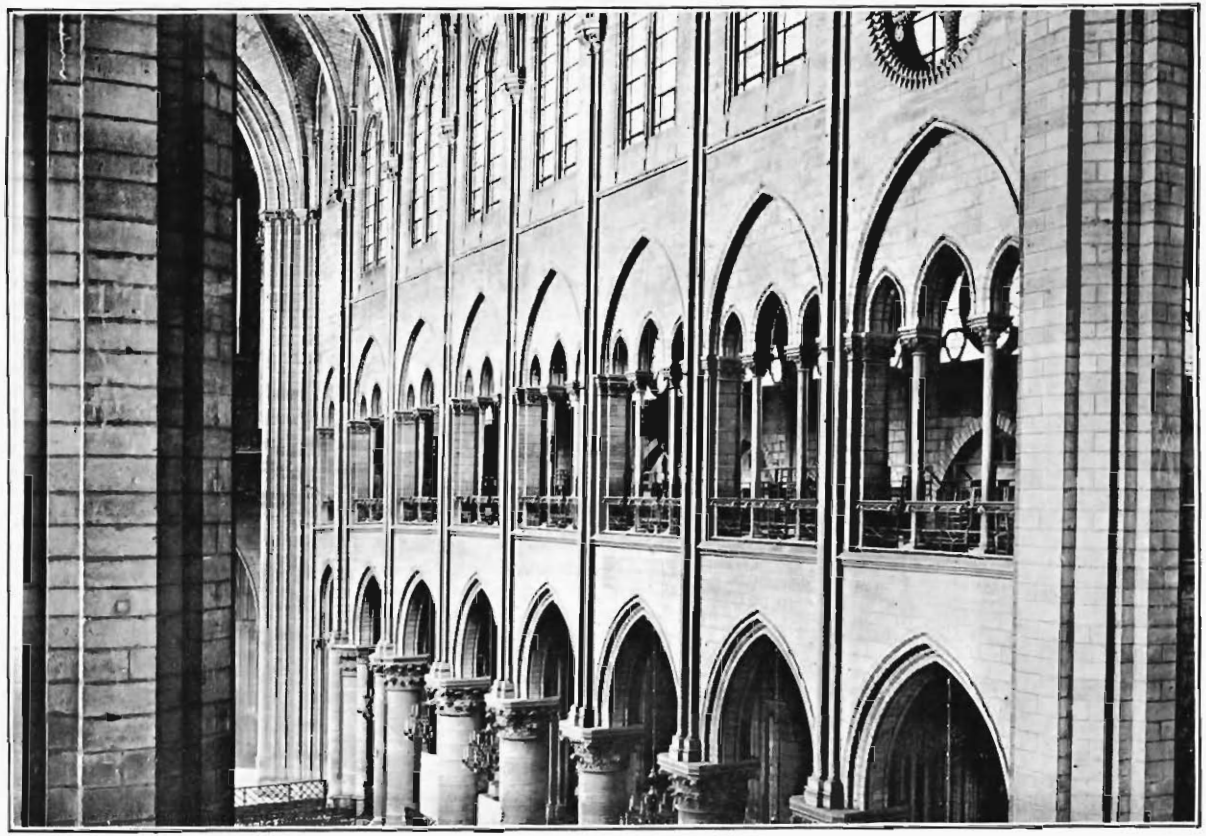

FIG. 2.—NOTRE-DAME. LEFT (NORTH) GALLERY. FROM THE CHOIR.

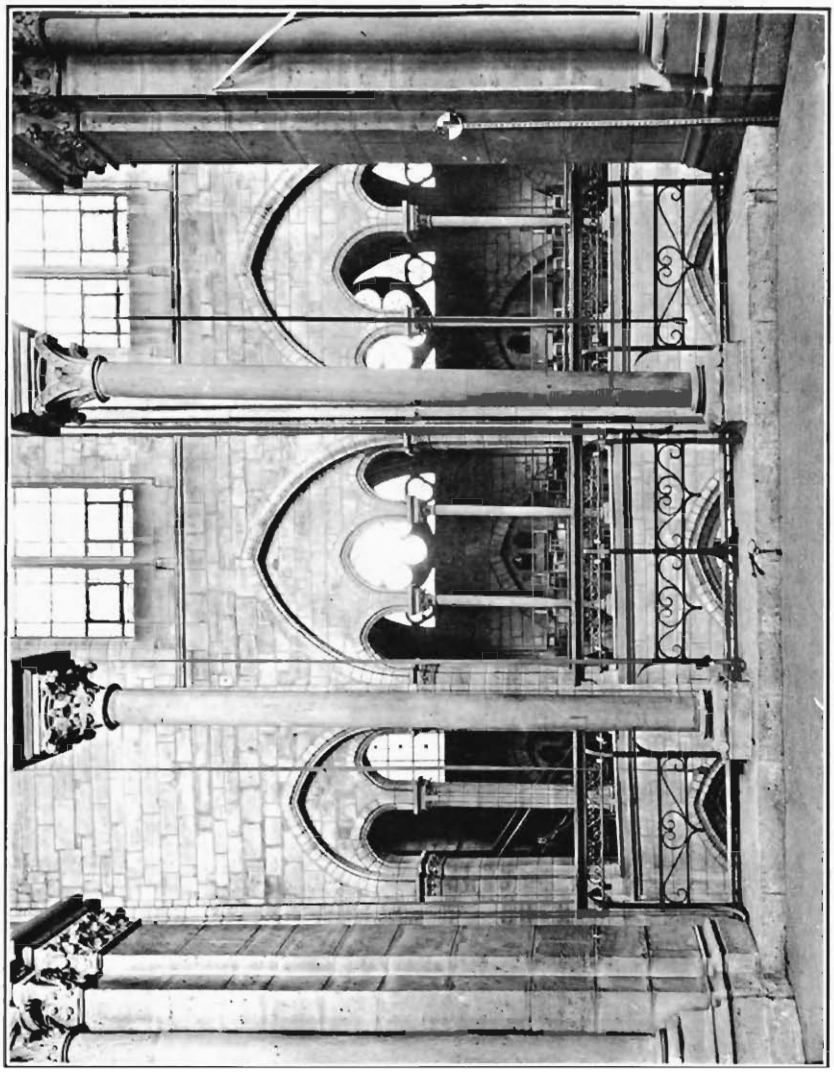

FIG. 3.—SOUTH GALLERY, NOTRE-DAME. SEVENTH BAY, COUNTING FROM THE TRANSEPT.

The Gallery Bends in Elevation.

We will first devote attention to the gallery bends in elevation, one of which is roughly shown in Fig. 1 and accurately shown in Fig. 2. This bend is found in both galleries in the same relative position, and having the same general character, with measurements which are practically identical. In Fig. 3 its rise is shown for three bays of the (farther) north side and for one bay of the (near) south side. Fig. 4 also shows the rise of the parapet for one bay of the (near) south side, next the organ loft.

In this picture the cutting and fitting of the masonry, by which the rise is effected, can also be seen quite clearly on the farther side of the nave. In the Brooklyn enlargement from the same negative, and in other enlargements, the cutting and fitting of each individual block of masonry are shown with the greatest clearness.

The amount of the gallery bends in elevation in Notre-Dame was tested by level, in the south gallery. In the north gallery the stationary benches, which have been placed there for use on ceremonial occasions, made the use of a level impossible, and the measurement was taken by plumbing to the pavement below at three points; viz., at the bend, and at the two extremities of the gallery. As I did not take the level of the pavement below, the measurement for the north gallery bend must be considered as an approximation, but the best which is possible at present.

According to these measurements, the north gallery parapet rises 0.95 (or 11¼ inches) in the first three bays, counting from the organ loft. From that point it bends abruptly to an approximate level, but rises .08 in the remaining five bays (assuming the pavement below to be accurately level).

By level, the south gallery parapet rises 0.85 (or 10¼ inches) in the first three bays, and falls 0.28, toward the transept, in the remaining five bays. The gallery floors correspond to the parapets in general change of level.

On the north side the capitals of the triforium, and the window-sills of the triforium, follow the same bend, but I cannot observe it in the sills of the clerestory windows or in the string-course under them.

On the south side the bend is repeated in the line of capitals of the triforium, in the triforium window-sills, in the sills of the clerestory windows and in the string-course under them. The bend in this clerestory string-course and in the line of window-sills in the clerestory has been entered by our artist in the rough sketch, Fig. 1, in order to economize cuts; although it is really found on the other side of the church.

The verification of the facts stated regarding the clerestory win-

dows on the south side, and for the corresponding string-course, may be accomplished by a trip to Brooklyn, where the visitor will find, not only a 2 by 3 ft. counterpart to Fig. 2, for the south side, but also a 2 by 3 ft. detail for the bend in the string-course of the south clerestory wall (No. 94 of the Catalogue).

The bends described are wholly invisible from the pavement of Notre-Dame. From this position they are discounted insensibly into the ordinary effects of perspective. That they very much add to these effects is beyond dispute. In the galleries of Notre-Dame the bends are also easily overlooked, and here again they are naturally discounted into optical effects.

No. 75 of the Brooklyn Museum exhibit illustrates the tendency of the eye to discount these deflections. When the picture is viewed in the normal position one does not notice any change of direction in the line of sills of the triforium windows. If the picture is turned sideways, and the line of window-sills is sighted by holding the view in a diagonal position, the very pronounced bend is easily seen.

That these deflections are not due to accidental movement of the masonry may be gathered from the inspection of the enlargements in Brooklyn, which show the cutting and fitting of the masonry, all the blocks of which, under the parapets, can be individually seen in the photographs. That they are not due to masonry movements may farther be gathered from their close uniformity on the two opposite sides of the church and from the mentioned fact that they are found in a series of repetitions, including on the south side the clerestory string-course and the alignment of the window-sills.

Even in the half-tone prints of this article (Figs. 3 and 4), the individual blocks of masonry may be fairly well distinguished. In the numerous enlarged details of the Brooklyn Museum exhibit, the great magnitude of the pictures and the sharp definition of their details furnish an opportunity to trace the entire process of the construction of these bends, not only beneath the parapets, but also in the clerestory walls, up to the height of the vaulting-shaft capitals; including about one-half the height of the clerestory windows.

Nothing similar to these gallery bends has been noticed in other French cathedrals as far as visited.*

Their exact counterparts, as regards system, occur at Pisa.

Fig. 5 represents a survey, made under my direction in 1895, of the north gallery in the Pisa Cathedral. The north parapet rises from the façade 0.78 for the first three bays. It falls 0.93 toward the transept in the next seven bays.

*A complete list of these cathedrals will be found in Museum Memoir No. 4.

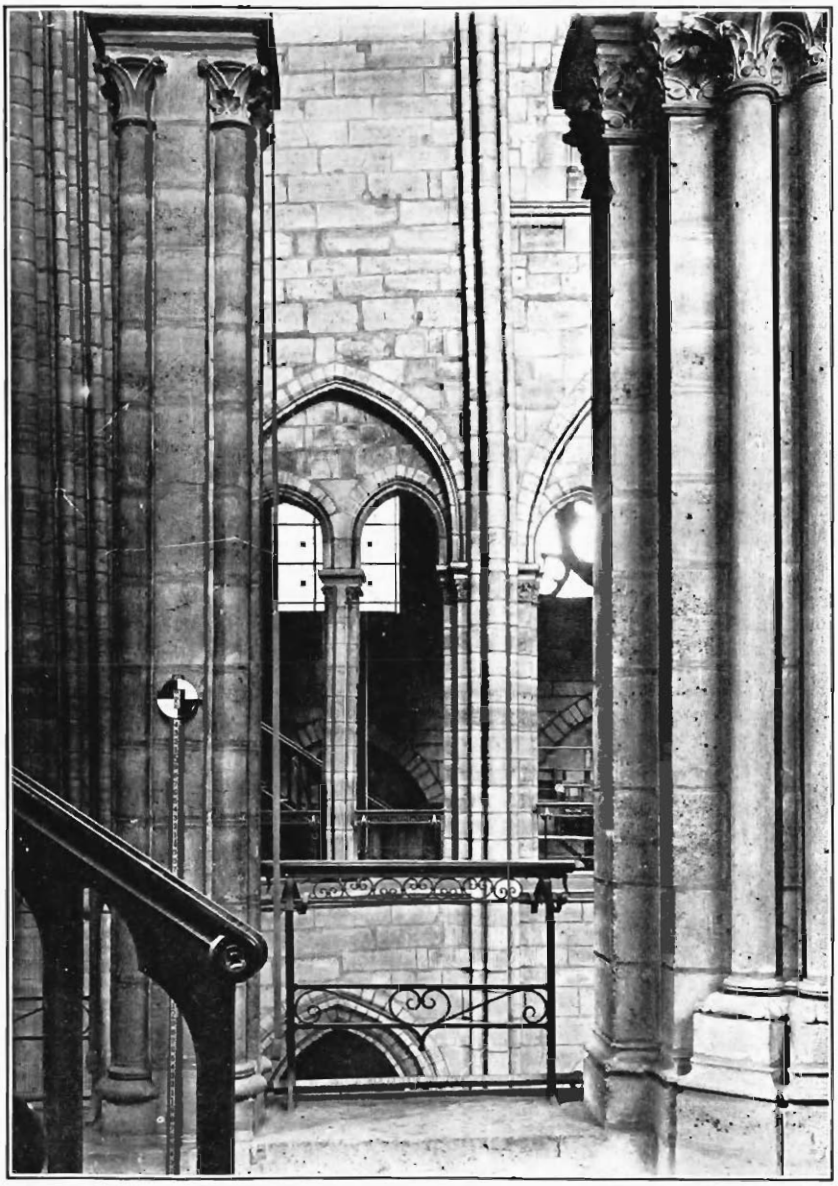

FIG. 4.—SOUTH GALLERY, NOTRE-DAME. EIGHTH BAY, COUNTING FROM THE TRANSEPT.

Fig. 6 is a survey of the south gallery at Pisa. The south parapet rises from the façade 0.83, for the first three bays. It falls 0.83, toward the transept, in the next seven bays. The Pisa bends were originally published in my paper on "Constructive Asymmetry in Mediæval Italian Churches," in the Architectural Record for March, 1897, Vol. VI., No. 3. They have been verified as constructive by Signor Annibale Messerini, engineering architect in charge of the cathedral in 1901, and his certificate has been published.*

The Triforium Columns.

We will now return to Fig. 1, in order to observe a second feature which is indicated in its exaggerated drawing; viz., that on both sides of the church the triforium columns (as distinct from the triforium piers, which are connected with the vaulting-shafts) lean together toward a common point, which is the apex of the bend.

For the first three bays, on both sides of the church (counting from the organ gallery), the triforium columns lean east (to the right). For the remaining five bays, on both sides of the church, these columns lean west (to the left).

On the other hand (see Fig. 1), the piers and vaulting-shafts lean uniformly west (to the left) from transept to façade; but they make a concession to the opposing leans of the triforium columns in the first two bays, as far as the corresponding height is concerned, and beginning lower down. They compromise, so to speak, with the opposing lean, and then return to their own system.

This compromise bend, which is found on both sides of the church (but which is most strongly defined on the north side), is roughly shown in Fig. 1. It is accurately shown in Fig. 4. In Fig. 3 we see the columns, from which plumb-lines are suspended, leaning east (to the right), and we see the vaulting-shafts, across the nave, leaning west (to the left). In Fig. 4, the westward pitch of the great pier next the organ loft is well shown on the extreme left, and in the centre of the picture we note the return bend of the vaulting-shaft to the left (westward), in the clerestory wall; whereas, for the height of the triforium arcade its inclination westward (only 0.03 in 10½ ft.) does not contrast abruptly with that of

*Architectural Record; Vol. XII., No. 6, Nov., 1902; Am. Journal of Archæology, New Series, Vol. VI., No. 2; Museum Memoirs, No. 1.

The irregular heights of the columns in the nave are due to their heterogeneous origin; but, although the columns of the galleries are also of irregular size, the gallery piers have been systematically constructed in varying heights, which form a bend on the south side and a gradually descending line on the north side. For the farther encouragement of sceptics, it may be added that the string-courses on the exterior sides of the Pisa Cathedral, which correspond to the general level of these gallery parapets, do not bend at all. They fall at an even rate from the façade toward the transept, to the extent of 2 ft. This proves that the interior deflections were not caused by some change of plan during construction, such as the lengthening of the church might have involved.

the adjacent column, leaning east 0.14 ft. Lower down and beginning at the base of the pier the westward lean is very pronounced; at the rate of 0.37 in 20 ft.; and this is also the rate of pitch above the triforium arcade (the view of the pier and vaulting-shaft from the pavement up to the parapet is shown by No. 97 of the Brooklyn exhibit).

In Brooklyn there is a series of photographs similar to Fig. 3, each 2 ft. by 3 ft. in size, one for each individual bay of the south gallery, looking through it to the vaulting-shafts and bays of the opposite side of the church. There are also four enlargements, looking from the north side to the south side of the church, showing that the facts are uniform for both sides, as regards the vaulting-shafts.

It appears, from the compromise bend in the vaulting-shafts, which would otherwise conflict too distinctly in their westward inclination with the eastward leans of the triforium columns, that two distinct lateral systems of optical or asymmetrical arrangement have been employed in the nave of Notre-Dame, which had to be harmonized in this manner, in order to avoid an abrupt contrast of vertical lines, leaning in opposite directions, in the bays next the organ loft.

It also seems evident that the inclinations of the triforium columns towards the apex of the bends are connected with the system of these bends, and it may be presumed that the inclinations were intended to accent and develop their effect, as seen from the level of the pavement below.

Vaulting-Shafts of the Nave.

The westward leans of the vaulting-shafts, including the piers, from the pavement up, which are slightly exaggerated in Fig. 1, are a separate affair, and belong to a distinct system, because they are uniform in the direction of their inclination, from transept to façade. As a tentative suggestion regarding the purpose of this arrangement, it may be noticed that its optical effect, in the direction from the main entrance to the choir, would be to increase the appearance of the widening which is described in the November paper. It would, therefore, be a plausible, tentative explanation that, over and beyond the slight actual widening in the clerestory of the nave, this expedient had been employed as preferable to a more pronounced actual widening, which might have been considered as going beyond the limits of constructive safety. It is a possible objection to this suggestion that there would be an inverse result in the opposite direction, but there are many mediæval churches in which perspective illusions have been arranged in the

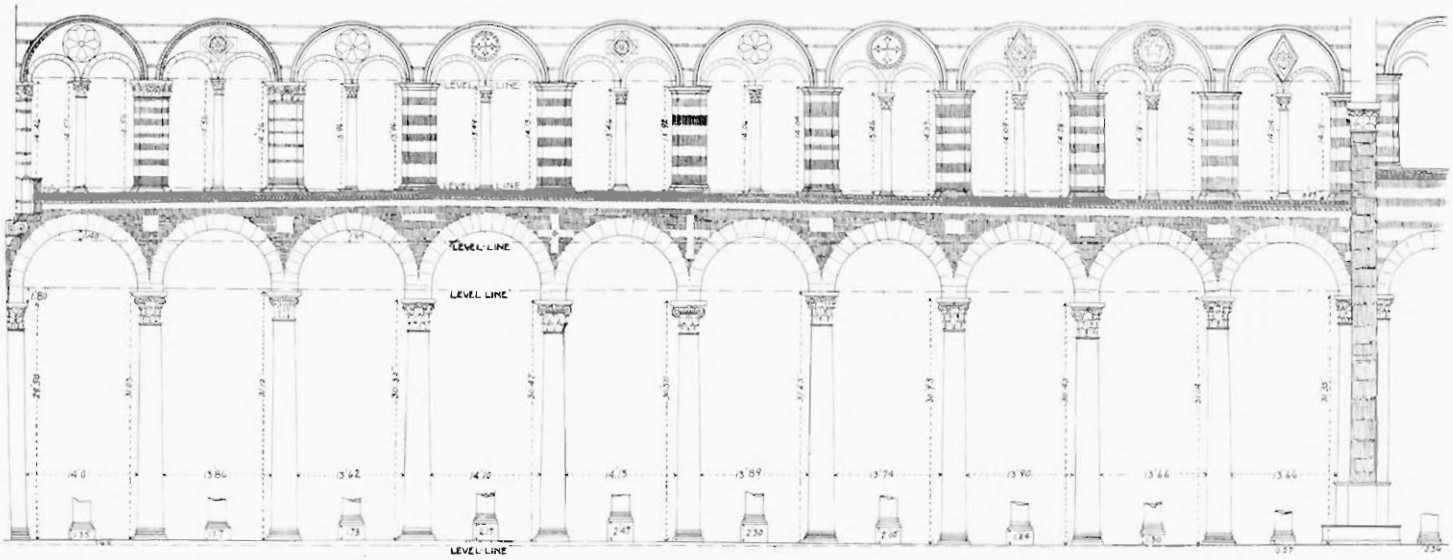

FIG. 5.—PISA CATHEDRAL. SURVEY OF THE NORTH GALLERY BEND IN ELEVATION.

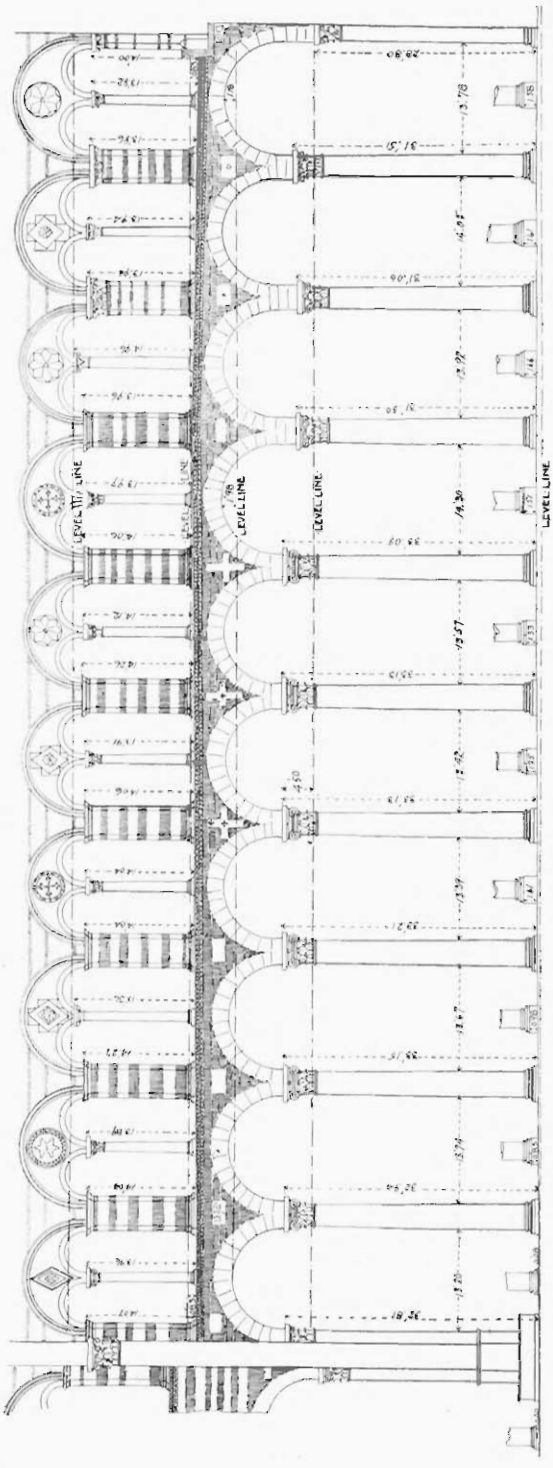

FIG. 6.—PISA CATHEDRAL. SURVEY OF THE SOUTH GALLERY BEND IN ELEVATION.

direction from entrance to choir, which work inversely in the opposite direction. In a Catholic church the eyes of the worshipper and very often those of the spectator are mainly turned toward the choir. Effects from the direction of the main entrance, or during worship, may have been considered the most important.

For the moment the facts appear to be more interesting and curious than any possible theory about them can be, and the essential fact is, at present, that this very remarkable asymmetric construction exists in Notre-Dame.

Plumb Measurements for the Triforium Columns.

The plumb-lines which are seen in Figs. 3 and 4 were actually broad tapes, because this width was considered desirable, as a means to their prominence in the photograph. For the measurements which follow, a light cord (10½ ft. in length) and a heavy plumb-bob were used. The object of quoting these measurements is to exhibit that uniformity of arrangement which demonstrates the existence of a definite and carefully conceived plan, whatever that plan may have been.

In the following list of plumb measurements they are quoted by bays, counting the "first" bay as the one nearest the transept and the "eighth" bay as the one next the organ loft. In this list only the triforium columns are mentioned, two for each bay; the piers of the triforium, which are connected with the vaulting-shafts, being omitted. These uniformly lean west, according to measurements which have been published in Museum Memoir No. 4.

Plumbs for the Triforium Columns.

North Gallery.		South Gallery.
.05W	1st Bay	.03W
.10W	....	.04W
.10W	2nd Bay	.07W
.12W	....	.14W
.06W	3d Bay	.14W
.11W	....	.15W
.06W	4th Bay	.13W
.07W	....	.13W
.04W	5th Bay	.13W
.05W	....	.11W
.04E	6th Bay	.20E
.00	....	.03E
.18E	7th Bay	.25E
.24E	....	.12E
.14E	8th Bay	.10E

It is understood that the facts represented by these measurements are shown in an easily visible and rough approximation in Fig. 1, and that they are accurately shown for two bays, viz., the

eighth and seventh, by Fig. 3 and Fig. 4. It is also to be understood that the facts are accurately shown for every individual bay by photographs, of size 2 by 3 feet, in the Brooklyn Museum.

It is evident that the correspondences in the direction of these leans, and in their change of direction, on the two sides of the church, as related to the apex of the bend on both sides of the church, is such as to make the suggestion of accident or carelessness too improbable for consideration. To argue this point would be to insult the intelligence of the reader.

As regards the suggestion of acidental masonry movement I ought, however, to remember that such theories are occasionally held by persons who evidently have not grasped all the facts which are involved in the given problem. Let such persons understand here what is the problem which *their* theory of the unlimited plasticity of cathedral masonry has to grapple with. In the "sixth," "seventh" and "eighth" bays all the columns lean east, but in these same bays all the piers lean west (individual measurements for the piers in Memoir No. 4) and this holds of both sides of the church. For instance, the column of the eighth bay, north gallery, which is mentioned in the list as leaning east 0.14 in 10½ ft., is only 3½ ft. distant from a pier which leans west 0.20 in 10½ ft.

Thus we are led in the next place to describe more carefully the westward leans of the gallery piers and of the vaulting-shafts of which they are portions.

Westward Leans of the Vaulting-Shafts.

The vaulting-shafts of Notre-Dame are best shown in their general relation to the architecture of the church by Fig. 2. In this cathedral they rest on the capitals of the piers and rise from them to the ribs of the vaulting. Their westward leans are also found in the piers, and are, therefore, continuous from pavement to vaulting, as roughly shown by Fig. 1.

The piers of the nave, as distinct from the vaulting-shafts, will presently be considered, but, for the moment, our attention may be devoted to the vaulting-shafts alone, and for the reason that their arrangement carries with it its own proof of constructive intention. Masonry is neither putty nor india-rubber, and the vaulting-shafts, as distinct from the piers below them, are, for large portions of their length, fixtures in a wall, on the surface of which they are simulative and decorative supports, which are not exposed to any east and west (lateral) movement. It therefore follows that eighteen of them (nine on each side of the church) could not all lean in one direction in lines rising from the pier capitals to the vaulting, except by a constructive intention which must have had a fixed purpose of some kind or other.

The question, for the moment, is therefore—do these vaulting-shafts actually lean as they are asserted to lean, and as they are represented to lean, in exaggerated drawing, by Fig. 1?

The answer is furnished in the Brooklyn Museum by eleven photographs, in which the facts can be tested by plumb-lines; nine of these photographs being 2 by 3 feet in dimension. Of these photographs two are shown in the inconspicuous size which is necessary for the page illustrations of this article, by Figs. 3 and 4. In these two pictures the leans of the vaulting-shafts on the south side of the nave are to be tested by the plumb-lines which are hung from the columns in the foreground. Note, among others, the great vaulting-shaft on the extreme left of Fig. 4.

The total amount of the westward leans for piers and vaulting-shafts near the transept and in the center of the nave would appear to be only about 6 or 8 inches (minimum estimate), but it must be remembered that in optical appearance this would add considerably to the widening effect of the nave, when looking toward the choir. Near the entrance the pitch of the inclination increases greatly, especially in the great piers next the organ loft (as shown in Figs. 1, 3, 4). These belong to the tower constructions, and facts of so remarkable a character are here in question that a separate and special account of them must be given in the following article. In this following paper it will be shown that the lower façade leans forward by construction and that the buttresses of the tower constructions follow this lean and then curve to the perpendicular, so that the towers themselves are perpendicular. It will then appear that the leans, which have just been mentioned, of the great piers at the organ loft, which also curve toward the perpendicular, are parallel with those of the exterior tower constructions, of which they form the interior angle supports.

As plumbed from the pavement the piers in question lean 0.44 in 20 ft. As plumbed in the gallery they lean respectively (south) 0.14, and (north) 0.20, in a height of 10½ ft. That the entire amount of lean is about 18 inches is apparent from the following considerations, although these piers have not been plumbed for the entire height and this would not be an easy matter. The height from bases to capitals is close to 80 ft. The pitch is visibly uniform, aside from a curve toward the perpendicular near the top. Since the lean averages about 0.20 in 10 ft., as tested both in the gallery and from the pavement, it appears that 18 inches is a conservative estimate for the entire amount.

Aside from the demonstrations to be offered in the next paper that the leans and bends of the facade and towers cannot be accounted for by settlement, it now remains to be shown that settle-

ment cannot account for the leans of the piers of the tower constructions.

If these piers went over by a settlement of the west front, it was before the weight of the towers was placed upon them, for the towers are perpendicular. Pending publication of the next paper this fact may be verified by inspection of the photographs in Brooklyn. An inspection of the masonry of the clerestory walls will, show, however, that no settlement has occurred. This inspection is verified by photographs in which every block of masonry can be separately studied. If the piers went over 18 inches, there must have been fissures to the amount of 18 inches and the subsequent repairs by which these fissures were filled in would appear in the walls. No such repairs are to be found. On the contrary the intact construction by which the masonry was inclined downward in parallel courses, with the slope at right angles to the leaning piers, can even be studied in the small dimensions of Fig. 3. Note the downward slope of the course of masonry which runs directly over the two triforium arcades on the right in Fig. 3. It may then be suggested that a settlement began at the fourth bay. There are three separate proofs that it did not.

(a) In Fig. 3 a magnifying glass will show more clearly, what can fairly well be seen by the naked eye, that the course of masonry under the fillet which marks the clerestory window sills is cut in gradually narrowing width so as to level and equalize the slope below. In the large photograph of the Brooklyn exhibit which corresponds to Fig. 3, this fact is conspicuous. In the large photograph of the Brooklyn exhibit which joins with Fig. 3 (No. 88), the construction by which all the masonry courses are brought to a level is clearly visible. Similar constructive arrangements of the masonry can be studied in the Brooklyn photographs of the south clerestory walls (Nos. 92-95), with the difference that on this side the fillet is bent constructively. According to the slopes of the masonry courses on both sides of the church, if a settlement took place at all it must have begun at the fourth bay from the organ loft (fifth from the transept), and at this point therefore the greatest fissures must have been filled in. But exactly at this point is found the evidence for the deliberate construction of a bend in the masonry courses.

(b) If the piers of the tower constructions went over by a settlement beginning at the fourth (gallery) bay and indicated by the bend in the gallery parapet (Figs. 1, 2, 3) then the capitals of the nave piers would repeat this bend. On the contrary they are level (Fig. 2).

(c) If the piers of the tower constructions went over by a settle-

ment beginning at the bend of the fourth (gallery) bay, then the pavement and the bases of the piers would slope down to the west to an amount corresponding to the amount of the bend. That this is not the case is shown by the plumb to the pavement from the north gallery.

Before abandoning the subject of the downward slopes of the masonry courses in the "sixth," "seventh" and "eighth" bays (next the organ loft) it should be noted that these slopes and that of the gallery parapet all meet the lines of the great piers leaning west, at a right angle (see Fig. 3). It is this arrangement which makes it difficult to detect or estimate their leans. The bend at the fourth bay is easily overlooked because it is an obliquity which corresponds to the ordinary facts of vision. But if the bend and the slope are not realized by the eye then the leaning piers, which are normal in relation to them, must also escape detection. The north and south walls of the Pisa Cathedral have similar bends in their masonry, with similar relation to the lean of the lower portion of the Pisa façade, and it may not be amiss to remind the reader that the demonstration which has been accepted by the expert in charge of the Pisa Cathedral, and other experts, in Italy, for the constructive lean of the Pisa façade is closely analogous to that which is now offered for the piers of the tower constructions in Notre-Dame.

An Answer to Criticisms of the "Builder."

In his issue of Aug. 13th, the Editor of the London "Builder" has made some adverse criticism on my article in the August Number, and has quoted Peterborough Cathedral as an instance showing that a vaulting may spread 2 ft. without collapsing. He says: "At Peterborough, as we all know, the piers have moved more than 2 ft. out of perpendicular, but the vault did not actually fall in, although it was in a very precarious state before the recent restoration."

"As the nave of Peterborough is not vaulted, and never was, Mr. Statham's instance appears to be poorly chosen, and especially so when we consider Mr. G. L. Pearson's Report on the West Front of Peterborough Cathedral, which he repaired.

We extract the following passage from Mr. Pearson's report:*

"Careful plumbing has determined that the detached clustered columns [of the west front], with the part up to the string-course above them, lean out to the extent of fully 2 ft., and that the three gable-ends have an inclination in the same direction of about 6 in.

*Quoted from the American Architect of June 29, 1895; as copied from the Building News.

Upon looking for the effect of such a divergence from the perpendicular of these pillars upon the work inside the arcade, *one is surprised to see how little there is to indicate that such a great movement has taken place, for, instead of huge gaps in the groining* [of the entrance porch] *which one would have expected to see, there are only—so far as can be discerned from the ground—some slight openings in the cells.* Coupling this fact with the fact that the three gables lean over at a less angle than the pillars below them, and that some of the work in connection with these gables inside the roof is nearly perpendicular, I am disposed to think that the pillars began to settle and lean outward at a very early period, even perhaps before the gables were erected, *and certainly before the groining of the arcade was put in.*"

It thus appears that the instance invoked by Mr. Statham is misleading and worthless, and that it is the opinion of the expert who knows most about the matter that the vaulting of the porch is later than the leaning piers. (The passages in italics are thus marked by me.)

We will now put a hypothetical case. Supposing that I were to lay before Mr. Pearson the measurements and photographs which have been made of the leaning and bending façades of Notre-Dame and Pisa and other similar façades. Supposing that in the light of these observations and of his own, as just quoted, he should determine that the bending façade of Peterborough had been purposely so constructed, and supposing that he should put himself on record to that effect—would it be honest and fair of Mr. Statham to suppress that fact in debating the question as to whether the façade of Peterborough had been purposely so constructed. This is an exact parallel to what the Editor of the "Builder" has actually done in the case of the Church of St. Quentin. Knowing that M. Benard, the architect who was in charge of the repairs of that church for 36 years, is on record as having considered the widening of that church to be constructive, Mr. Statham has deliberately suppressed that fact, in order to make more probable his own hypothetical explanation, manufactured at a distance from the building and without personal examination of the construction in the light of the facts which I have published.

The controversy of Mr. Statham against the existence of a constructive widening system in the vertical lines of mediæval churches, which I have announced for some fifty churches in Italy, France and at Constantinople, moves from the trivial fact that there are tie-rods in the vaulting at St. Quentin. According to my present memory, assisted by many photographs, out of the fifty odd churches which have been found to exhibit the widening, there are only two which exhibit tie-rods, viz., at St. Quentin and in S.

Lorenzo at Vicenza. If these cases of widening were proven to be accidental, it would not affect the great number of other churches which have no tie-rods; least of all the notable case of S. Mark's at Venice, as verified by an expert's certificate, the existence of which Mr. Statham is also careful not to mention, although it was known to him.

The matter of the tie-rods at St. Quentin's is trivial in itself, but, as treated by the "Builder," it denotes an error of logic which is not wholly confined to its Editor. It is significant of certain methods of architectural restorers and of certain prepossessions in the matter of repairs, which have been universal in the last three centuries.

Since the time when the tradition regarding the widening system was lost, in the decay of Gothic architecture and in the Renaissance reaction against the Gothic, it has been natural that all the ordinary and inevitable signs of decay and weakness in mediæval churches should be connected with that supposed evidence of decay which was found in the leaning verticals, wherever these have existed and were taken note of. These have naturally been considered as accidental, and have consequently appeared to be the cause of all other disorders.

In the next place, it is manifest that no vaulted building is exempt from the disrupting tendencies of thrust, and it is equally manifest that buildings originally constructed with spreading verticals are not thereby guaranteed against the ordinary effects and results of these disrupting tendencies. Hence, whenever an original constructive widening has been accented and increased by accidental causes, it has been natural that the actually accidental effect should be considered as indicating the one and only explanation and cause of the entire supposed deformation.

Tie-rods, therefore, prove absolutely nothing in a contention that given deformations were wholly accidental. They may show simply that the restorer mistook constructive arrangements for accidental deformations, or they may show that constructive divergences have accidentally increased to a dangerous extent, or they may show that other accidental deformations have been attributed to the wrong cause—viz., to a constructive widening.

Thus I differ radically with Mr. Statham when he says of me: "If he had found evidence that they [the tie-rods] were ancient, it would have made short work with his theory."

If the church of St. Quentin was built with diverging piers (as held by M. Benard), does that argue that the building was guaranteed from the consequences of careless building or from the disintegration occasioned by vaulting thrust? By no means. Tie-rods might have been called for, at any date, from a time imme-

diately following the erection of the building down to the present year. The original divergence might have been accented and increased by thrust to a point which made the tie-rods necessary. A very few inches of accidental movement would be sufficient to make this advisable. Even if the vaulting had fallen in, it would not prove that there was not originally a constructive divergence. In fact, such a divergence, if carelessly constructed, or of too great a spread, might cause exactly such a catastrophe.

Mr. Statham's entire sentence, of which a portion has just been quoted, does him no great credit: "If he had found evidence that they were ancient it would have made short work with his theory, and he has apparently not tried to get any evidence." Mr. Statham knew, when he wrote that sentence, that I had taken pains to ascertain the opinion of the expert who had the best general knowledge of the history of the church and of its present condition. I had published this opinion in the very article which he was endeavoring to discredit by this trick of suppression. I have the highest French authority for stating that it was M. Benard who first brought to the attention of students the celebrated mediæval architectural sketch-book of Villard de Honnecourt, and that M. Benard was an expert of the most reliable character.

The same disposition to mislead his readers is apparent in Mr. Statham's suppression of the opinions of Italian experts. The one man, who by virtue of lifelong acquaintance with the history of St. Mark's at Venice, and his own literary contributions to that history, and by virtue of his own lifelong contact with the repairs of the church of which he was then in charge, was best qualified to pass an expert opinion on that church, in 1901, was Commendatore Pietro Saccardo. St. Mark's is a much more important church than that of St. Quentin. It has consequently been much more carefully measured and published by me, and has been made the subject of a special monograph. Saccardo's official approval of these observations has also been published. All this was known to Mr. Statham, and all this is carefully ignored in order to make good his own personal idea about the widening refinement.

His personal idea is that to build a church with outward bending or curving verticals is "one of the most clumsy, useless and stupid things that could possibly have been done." It would have been an awkward fact for this thesis if his readers should know that the finest church in Italy has been officially credited by the architect in charge with having this construction. Consequently that fact is carefully suppressed.

The "Builder's" argument is otherwise to the effect that "the widening of the piers at the upper portion would have the effect, not of increasing, but of diminishing the apparent height of the

building, and this at a time when the French architects were vying with each other in the endeavor to increase height. The whole notion is too preposterous to do anything but laugh at."

The "Builder" appears not to be familiar with Viollet-le-Duc's proofs, recently quoted with approval by M. Choisy, that the architects of twelfth and thirteenth century Gothic strove to keep down the height of their buildings, and that their great height is due to compelling constructive causes (contrary to the usual idea and preconceived opinion).*

I have shown the widening refinement to be originally Byzantine and Romanesque (that is to say, it was first designed for churches of comparatively low proportions), and I have shown that it disappeared during the late Gothic and soon after the really exaggerated heights came into Gothic vogue. However, a glance at Fig. 4 for the Amiens nave in the November Number of the Architectural Record seems to give the best answer to the objection of the "Builder." For the sake of the gracefully bending lines and the more open and airy effect of the upper nave, for the sake of eliminating that frightful rigidity and coldness which the taste of the "Builder" and the temperament of Mr. Statham have grown not only to tolerate but to consider as a necessary standard of perfection, the architects of Amiens may have been willing to sacrifice a little of the effect of height, and they did well, in my opinion, to do as they did.

There are, however, very few of us who estimate the height of a lofty nave by twisting the neck so that we look directly upward. In so far as the eye takes in the height of a building naturally, and without wrenching of the neck; in so far, that is, as the comparative width between the same piers at the pavement and at the capitals, is estimated at some distance from the standpoint of the observer, in so far such a perspective convergence of lines as holds for a plane surface near the level of the eye, is very materially diminished. Our impressions of height in interiors are not determined by converging lines to anything like the extent which holds of impressions of length or distance on a plane surface. The proof of this is that photographs taken with the camera slanting upward appear freakish and unnatural. This shows that we are so accustomed to discount convergence in rising lines that we do not recognize it in a photograph, although shown as we actually see it. On the other hand, convergence of lines on a plane surface, as shown by a camera, has no abnormal appearance.

Estimates of height in lofty interiors are naturally made by the eye in a normal or not too inconvenient position, looking toward

*Dictionnaire III., pp. 187, 197. Choisy, Histoire de l'Architecture, II., p. 413.

the depth of the building, and contrasting with the entire height as seen *there*, the objects near the pavement. These are again related by the eye to the average height of the human body. In estimating the height of interiors, the height of the human body is the natural norm, and the objects on the plane surface which are related to this norm, in their turn become standards of height.* The easiest position for the head of the observer is the position in which an estimate of height is most easily and most naturally made, and in this position the more distant objects on the plane surface are related to the height as visible at the same distance. Therefore, in the perpendicular direction converging lines have very little to do with our estimates of height, either in exteriors or interiors, and the builders of the Middle Age were by no means "clumsy" or "stupid" in slightly opening out their vertical lines in interiors.

It is we who are too clumsy to appreciate their delicate art, and too stupid to admit that it existed.

As the entire art of the Middle Ages was experimental, it is natural that some buildings should have more widening than others, and that some should have too much. Sta. Maria della Pieve, at Arezzo, and the church of St. Quentin may be open to this criticism, but it is the extreme cases which make the best photographic illustrations, and furnish the easiest demonstrations in so novel a topic. The truth is, that at St. Quentin the nave is seen from the entrance (and also in photographs from the entrance), through the arches of a very low vaulting, which supports the organ loft. The lines of these arches curve over against the curving piers so as very much to exaggerate their apparent leans by this optically illusive contrast. This effect was, of course, not foreseen by the mediæval architect.

Meantime, the Editor of the "Builder," having come round to the admission that perspective illusions were practised by mediæval builders, may possibly condescend to notice the fact that the only extant systematic publications on the subject are those which I have made. This fact he has carefully suppressed in his recent admission of the existence of mediæval perspective illusions, although several caustic and slighting notices appeared in the "Builder" during the publication of the series of articles in which the existence of these illusions was demonstrated in the Architectural Record. My first announcement that "perspective illusion was practised on a most extensive scale throughout Italy and the whole of Europe in the Middle Ages" was made in 1874† in the words above quoted.

The publication in which this announcement was made was the

*It is well known that St. Peter's appears larger when filled with people. It is also well known that the over-enlargement of details like the cherubs of Bernini's fonts, which are seven feet high, has diminished its effect of size.

†Scribner's Monthly, August, 1874, p. 440.

first publication ever devoted to this subject. Aside from the confusion of ideas on the physiology of vision in interiors which afflicts the Editor of the "Builder," he has failed to reflect that, as I have done more than anyone else to insist on the existence of perspective illusions in mediæval architecture, I may be safely trusted not to antagonize the results of my own observations. He wholly fails to notice that such observations have been made by me.

It farther appears that the Editor of the "Builder" has discovered "a certain condescension in foreigners" (and *this time* the foreigners are Americans) in regard to English Gothic. He suggests that I should "condescend" to study English Gothic, in order to discover further aberrations of the class which he claims are non-existent anywhere, with the illy-concealed purpose of "wiping up the floor" with me, after I have fallen into the trap which he has so discreetly baited at Salisbury. I have seen the piers at Salisbury, and, so far, have not mentioned them in any publication on constructive widening.

Mr. Arthur Hill, F. R. I. B. A., of Cork, has, however, discovered, measured, and photographed a constructive widening of the nave piers in St. John's at Chester, and it may be, at some future day, that I shall mention other English or British instances.

Wm. H. Goodyear.

(To be continued.)