happy to co-operate with Mr. Clay, in procuring such speci-
mens as they were able, and in that way to throw additional
light on the subject.

__AN ELUCIDATION OF THE GEOMETRICAL PRINCIPLES OF
GOTHIC ARCHITECTURE, PART II.,* BY WM. WALLEN,
ESQ., F.S.A., ARCHITECT, HUDDERSFIELD.

NORMAN ARCADES (EXTERNALLY.)

In resuming the subject of Gothic Architecture, I shall
first notice the intersecting and interlacing Arcades (so
frequent upon Norman buildings), as probably originating
the idea of the pointed arch, for I think little reliance is
to be placed upon the accidental form of the arch seen
upon the coins of Berengarius, King of Italy, or in the
Mosaics, previously to the tenth century; and I make this
remark the more pointedly, as the examples of windows in
York, Lincoln, and Beverley Minsters are complete pa-
rrallels to the Norman Arcades of Norwich Cathedral,
Saint John's Church, Devizes, and other examples: omit
the pierced lights in the former (which are of the thirteenth
century), complete the intercepted portions of the inter-
secting circles, and the examples are identically the same
in principle. (Compare Nos. 4 and 5, plate 1, with Nos.
6 and 7, plate 2.) The transition example, plate 3, No. 10,
clearly proves this.

With such proofs as these before us, I think there can
be little doubt that the intersecting Norman Arcade was
really the source from which the idea of the Pointed Arch
was derived; as in the examples of triple and multiple
windows, it is clear that the architects must have drawn
intersecting circles, in order to determine the degree of
acuteness or obtuseness observable in the lights. (See plate
2, Nos. 2, 6, 7 and 8.)

* Continued from page 314.
Euclid, in his first problem, describes an equilateral triangle upon a given straight line (plate 1, No. 1), and this is done by striking two intersecting circles, having their centres respectively at the ends of this straight line, such straight line being therefore the radius of the circles. The arcs of these circles inscribing the triangle are two limbs of a spherical equilateral triangle. This is generally considered as the actual form of the lancet arch. I am prepared to prove that it is not so, and that the spherical equilateral triangle is seldom used in lights of the thirteenth century: for this I now assign reasons.

Euclid treats simply of lines; but, as in architecture mouldings are introduced, the equilateralism is destroyed, and difficulty has thereby arisen in ascertaining which are the normal or principal lines. The plan I have adopted is this—to consider the outline formed by the light (or glazed part of a window) as the normal line, and the successful application of this plan induces the belief that it is the only correct one.

It is evident that, in a continued arcade, the inner line can never be a portion of a spherical equilateral triangle, where mouldings are introduced, excepting in the instance in which the mouldings form a mitre (i.e. the diagonal junction of the mouldings—(see plate 1, No. 2), because the diameter of the enclosing circle forms the bases of two equilateral triangles exactly. I am only acquainted with one example approaching to this form, a very early one, in Anselm's Tower, Canterbury Cathedral. (See plate 1, No. 2; also Britton's Canterbury Cathedral, plate 22.)

I now proceed to show the impossibility of the spherical equilateral triangle existing under any other circumstances, by a reference to the Norman arcade in Malmesbury Abbey, (plate 1, No. 3.) Here we find the arches formed by intersecting bands, (in the architecture of the thirteenth century,
label mouldings occupy the place of these bands); these bands lap over each other, so that the united or crossing band at the level of the springing is somewhat increased beyond the width of a single band. The width of these bands being taken out of the diameter of the enclosing circle, prevents the possibility of the pointed arches being otherwise than acute: let me remark that only two pointed arches are included under the enclosing semicircle. This semicircle is shown by a darker tint.

The next example is from Norwich Cathedral, and shows still more forcibly the correctness of my position. Here the width of two bands (nearly) is taken from the enclosing semicircle, so that the pointed arches are more acute than in the preceding example. (Plate 1, No. 4.)

The last example is from the Church of Saint John, Devizes. Here three pointed arches are included under the enclosing semicircle, leading to greater intricacy in the interlacing, and rendering the pointed arches extremely acute. (Plate 1, No. 5.) The properties of circles being alike, whatever their diameter, an useful key is here given to all the varieties of multiple windows having the same springing line.

I am not aware that these arcades have ever been viewed in a similar light to that in which they are now presented. They have been studied synthetically, but not analytically, (i.e. by considering the various forms obtained under one enclosing semicircle); and the important inferences which I shall hereafter draw from the peculiarities appertaining to these arcades, will, I humbly hope, induce others to direct their attention to the subject. It is clearly the duty of every architect (now that the study of Gothic Architecture has happily revived) to think for himself, to investigate for himself; to respect the opinions of his predecessors and his elders; but not to rest satisfied with an acquaintance with
the dogmas of any particular school. After all our investigations, we can merely re-discover the long hidden principles of those who have preceded us, and no re-discovery can be made, unless we strip the ornamental from the constructive parts of our Gothic buildings. As there must have existed principles for the production of those "mysteries of a human hand," the cathedrals and abbeys of Great Britain, it should be our highest aim to discover them, to reduce them to their original element (simplicity), and then to disseminate a knowledge of them as widely as possible. Much of the public taste depends upon architects; they themselves can never be duly appreciated, until they render themselves appreciable; and they can only become so, when the mystical cloak is thrown off, and the desire is exhibited on their part to diffuse that general love of architecture which is so desirable, and which is so richly merited by the science itself.—reserving to themselves, as they always will do, that more intense love, which none but the initiated can ever hope to enjoy. The public will favour architecture, and "when it does not suit it to be Gothic, it will be furiously Grecian."

Lancet Windows.

Windows, as the most important features in our Gothic structures, will next engage our attention. I shall separate them into single, double, and multiple windows; an arrangement which I am aware is quite novel, but which I think fully warranted, seeing that the arcs of the lights are not portions of separate circles, but of a series of intersecting circles.

The examples of single windows (Nos. 6, 7, 8, 9, 10 and 11, plate 1) clearly show that the spherical equilateral triangle was not the form invariably adopted. (Many of the examples are omitted in the plate.) The examples 10 and 11, from Chichester and Beverley Cathedrals, owe their acuteness to the circumstance of their being parts of a composition:
thus, in the case of Beverley, the arc forming the light is a portion of a circle, whose diameter is equal to one-fourth the width of the transept, the centre being the side of the buttress. (See also plate 2, No. 10, centres a b.) The example from Chichester Cathedral owes its great acute-ness to the same circumstance; and I feel persuaded that wherever there exists a deviation from the customary form of the light, that deviation can only be accounted for by considering the window as part of a composition, and not as an individual feature of the building.

DOUBLE LANCET WINDOWS.

Here are ten examples of double windows, some of which are necessarily omitted on the plates. I shall only notice three of the most interesting. That from the nave of Lincoln Cathedral (plate 1, No. 13) presents two windows included between two principal and one subsidiary buttress. The arcs forming the lights are struck from centres occurring at the sides of the principal buttresses, (see ax, xb), and the whole is proved to be a composition, by the fact that the arcades or recesses filled in next the windows (to give relief), have their heads struck from the same centres. (See the concentric circles turned.) Another example from the transept of York Minster (plate 1, No. 14) has the arcs of the lights struck from the side of the smaller buttress. (See xx on the diagram.) Arcades are also introduced in this example as before, and also on the face of the larger buttress, the heads of which are struck from the same centre as the windows, (the diagram is too small to show this.) In another example from the south transept of York (No. 17), we find the centre to be the centre of the adjoining buttress. (See x on the diagram.)

TRIPLE WINDOWS.

Various examples of triple windows have the same springing line for the three lights; but the most interesting
are those in which the central windows rise above the side ones. The windows of the Temple Church, London, are remarkably beautiful, and are thus arranged. (See plate 2, No. 1.) The central light is equilateral, the circles being completed and a vertical line drawn through the points of intersection, and two circles of equal diameter being drawn touching this straight line (and also the primary circles), the arcs of the side lights are found; and the centres of these last circles are also the centres of the mullions between the lights. An isosceles triangle being formed, whose base is the distance between the centres of the mullions, the sides of the triangle produced cut the sides of the side lights at the level of the sill. No arrangement could be more beautiful than this—none could be more scientific!

I must request especial attention to the principles upon which the two next examples are formed, as they are perfect parallels to the Norman arcades. No. 6 (plate 2) is from the south transept of York Cathedral; (the clerestory windows, or those over the great arches separating the nave and side aisles.) This example consists of three lights and two pointed recesses; the whole of which are formed by a series of intersecting circles. The label mouldings are so many bands crossing each other, but intercepted in execution: a reference to plate 1, Nos. 3 and 4, will prove the Norman arcades and these pointed windows to be formed upon the same principles, as in both instances we find two pointed arches under one enclosing semicircle. It is impossible to judge of the effect of these windows stripped of their ornamental accessories; but I would mention that the pointed recesses or arcades, on the side of the three lights, are portions of circles of the same radius as the lights, (the arcades have no deeply receding jambs), and that great variety is thereby given in the “chiaroscuro.” remove the dotted lines from this example, and no one would detect
the identity of principle upon which both the Gothic lights
and Norman arcades are formed.

The next example is from the same cathedral, and
exhibits the normal lines of the clerestory windows to the
north transept. Here three acutely pointed lights are
formed under one enclosing semicircle. (Plate 2, No. 7.)
This triple window is identical with the Norman arcade
of St. John’s, Devizes. (See No. 5, plate 1.) “The Five
Sisters,” of York, (No. 2, plate 2), are formed upon the
same principle; also, “the Seven Sisters,” of Lincoln Ca­
thedral, (No. 8, plate 2); but in these examples, three and
four lights are enclosed under one semicircle.

How frequently have the various degrees of obtuse­
ness or acuteness of Lancet lights been referred to as
proofs of the whim and caprice actuating the minds of the
designers of our Cathedrals! How immediately is the
caviller silenced by the resolution of these exquisite ex­
amples into their simple and elementary lines! If such
taste and judgment be discoverable in the mere normal
lines, can we be surprised at the emotions which arise
in our breasts, when contemplating the appropriate and
beautiful decorations under which these lines are con­
cealed?

The next example is a very beautiful one from Salisbury
Cathedral. (Plate 2, No. 3). Two intersecting circles,
forming the central window, determine the distance of the
buttresses; and two other circles of equal diameter, struck
from the centres of the buttresses, find the arcs of the four
side windows, and render it difficult to decide whether this
example should be considered as a triple or quintuple window.

**MULTIPLE LANCET WINDOWS.**

Nos. 2 and 8 (plate 2), the former “the Five Sisters of
York,” and the latter “the Seven Sisters of Lincoln
Cathedral,” prove a constant recurrence to the inter-
secting principle, and are, as before mentioned, multiple windows: thus disproving Rickman's assertion, that "they "are separate windows, having their heads formed from "individual centres."—(Attempt, p. 58, Fourth Edition.)

No description can be given of the singular examples from the gables of Salisbury Cathedral, (Nos. 4 and 5, plate 2). I shall, therefore, only remark, that they present the same evidences of design, and attention to geometric principles.

No. 15, plate 1, presents one method of forming the "vesica piscis," (fully explained in a former paper,) the name of a window having a symbolical representation of Christ, under the figure of a fish. This form was held in peculiar reverence by the early Christians, and occurs in the old Church of Romsey, Hampshire; St. Leonard's, Stamford; and in Salisbury and Beverley Minsters; and I have recently met with a curious example, (with perpendicular tracery) in Kirkstall Abbey; it is in the south transept, but at such a height as to be inaccessible. The vesica piscis also occurs in the upper part of the Norman front of the Cathedral at Angoulême, in France.

The last example of windows (plate 1, No. 16) is the very curious one in the gable of the south transept of York Minster. I have now shown, for the first time, the normal lines by which the form is obtained. A simple equilateral triangle, subdivided on each of its sides into three parts, gives the base of so many separate triangles, from which spherical equilateral triangles are readily obtained. The notched appearance in the outline is produced by the central triangle on each side being again subdivided into two smaller spherical triangles. In the diagram merely the outline is referred to, but it is not difficult to imagine the beauty of a decorated window of this form, with its tracery filled in to the six primary spherical triangles.
EXTERNAL AND INTERNAL ARCHED RECESSES, ARCADES, OR NICHES.

These arcades are frequently found in the interior of our cathedrals and larger churches. A very interesting series of Norman character may be seen in the chapter-house of Worcester Cathedral; and of transition examples I may notice the arcades to the circular part of the Temple Church, London. These arcades, externally, give great relief, as may be observed in Lincoln Cathedral, where they are of the Early English style. In York and Beverley Cathedrals, the clerestory is thus enriched, and a very interesting example occurs in the clerestory of Darlington Church, Durham. Arcades of decorated character are to be found in York Cathedral, and also on the exterior of the tower of Darlington Church, and on the chapel on the bridge, Wakefield; but the examples are almost infinite. In the perpendicular style these arcades may be said to be supplied by panelling.

My present object, however, is to point out the forms of the heads of Early English arcades. In the chapter-house of Lincoln Cathedral, they partake of the same character as the multiple windows, (three arches being included under one large semi-circle—see Britton's 5th vol.,) as also do many other examples having simply the lancet or pointed head. It will only be necessary to notice a few examples with trefoiled heads, in order to show their dependance upon geometry. These examples are sufficiently alike in principle to show that these arcades may be correctly classified; and yet so different in contour, as to give a clear idea of the infinite variety of which they are susceptible, by a very slight alteration of the geometrical lines.

The first example is from Stone Church, Kent, (see plate 3, No. 4,) and is unequally foiled. The base or springing line being divided into two parts, two circles are struck of equal diameter, and from the tangential point as a centre, a third circle of the same diameter. The diameter of the last
circles being taken as a base line, and lines drawn from its extremities through the intersections of the circles, an equilateral triangle is produced. By bisecting the radii of the two outer circles, and from these points, as the diameter, striking a fourth circle, the intersection of this last circle with the sides of the triangle, gives the centres of the upper limbs of the trefoil head, which it will be perceived approaches very nearly to a portion of a single circle. The lines of the label moulding over this trefoiled arcade are also struck from the centres of the two outer circles first-mentioned, so that by reference to the diagram, it will be seen that every point arising from the various intersections is of practical utility. Having measured this example myself, I can vouch for its correctness; and I would mention, that the mouldings of this arcade, which have an excellent effect, are produced by strictly geometrical forms of a very complicated character, (but which could not be reduced to the size of the plate.)

The next example is from York Cathedral, (plate 3, No. 7.) Here, by a slight variation, the head becomes equally foiled. The base line at the springing, is the diameter of a circle, and by striking two other circles of equal radius, from the extremities of the diameter, and forming two spherical equilateral triangles, the lower limbs are obtained: the points of intersection of these circles give the base of a third equilateral triangle, and are the centres from which the upper limbs are struck; so that the inscribed line of this niche or arcade is an equilateral triangle exactly.

The third example is from Lincoln Cathedral, (No. 6, plate 3,) which, although very different in appearance from that of Stone Church, differs only in one respect, viz., that the apex of the equilateral triangle is a centre from which both limbs of the upper foil are formed.

The fourth example is by far the most interesting; it is from Kirkstall Abbey, (No. 5, plate 3.) Had I not actually
measured it myself, I should have been somewhat doubtful of the correctness of the diagram. This is a most excellent example, now fast falling to decay. It cannot be described, but it will be seen that it (curiously enough) includes the very same lines as those in the diagrams, showing the identity of principle in the plans of York, Lichfield, and Salisbury Cathedrals, (plate 3, Nos. 1, 2, 3,) and also those by which the window termed "vesica piscis" (plate 1, No. 15) is produced. The whole of these arcades display the use of geometry; and a careful attention in taking the admeasurements of others, would doubtless give rise to a very simple mode of classification, as to the variety of forms which the heads may be made to assume.

**BUTTRESSES, FLYING BUTTRESSES, AND VAULTING.**

I have already remarked, that the thick walls of Norman and Saxon buildings were capable of resisting the slight thrust of the vaulting, and that therefore the Norman buttress is merely a thin slab of masonry, introduced on the face of the wall for the purpose of giving relief by the light and shade which it creates, (this may be seen in Kirkstall Abbey, &c.) The projecting buttress arose from *necessity* so soon as the cathedrals were acutely vaulted; and connected with these buttresses are found some of the most beautiful ornamental accessories of the pointed style, such as pinnacles, niches, canopies, &c.

With respect to the caps of early English buttresses, which are triangular on the face, certain rules appear to have been observed, which have, I think, hitherto escaped notice. I find, both from actual measurement, and the examination of engraved geometrical drawings of acknowledged accuracy, that the side of the buttress-cap, if continued, *generally* cuts either the angle or the centre of the window-sills: two or three illustrations may suffice as corroborative of the fact—(some are omitted in the plate.)
In plate 1, No. 13, we have two principal, and one subsidiary buttress; the line of the cap of each, when produced, cuts the angle of the sills. This example is from Lincoln Cathedral. Again, in the example from York Cathedral, No. 14, we find the same circumstance occur; and again in No. 17, also from York Cathedral. In Beverley Minster transept, plate 2, No. 10, the line of the buttress-cap, A, produced, cuts the centre of the central window sill, and the line of the pinnacle, B, produced, cuts the sill at the same point.

Similar instances occur in Salisbury, Norwich, and other Cathedrals, in buttress-caps of the thirteenth century. The reason is, obviously, to give a pyramidal form to these features, the great object of attainment in the works of the middle ages, in which the impartial critic will find nothing arising from whim—nothing from mere fancy or caprice, but everything exhibiting the exercise of mature judgment and correct taste. The flying buttresses, or "arcs boutants," are, however, of much greater importance, and must be considered in connection with vaulting, from the introduction of which they naturally and necessarily arose.

VAULTING AND FLYING BUTTRESSES.

N.B. The letters of reference on the plan and section correspond.

I have selected the vaulting of the nave of Salisbury Cathedral, on account of its simplicity. In many of our cathedrals, &c., the main rib is found to assume an undulating form, as in the case of the vault of the chapel of King's College, Cambridge, which "has been rather a subject of wonder than inquiry. The vault of this chapel is divided into parts, called severies, each severy subtending an oblong, consequently the curves of the inverted quadrants intersect each other before the quadrant of the circle is completed, whence the intersections form an undulating ridge or orbit. In an early investigation of vaulting, this
"was attributed to error and defective workmanship, but it has since been the cause of solid content and admiration."

No such undulation occurs in the main rib of Salisbury, but the circumstance has been referred to as a matter of interest in connection with the subject before us.

The main rib of the vaulting is shown in plate 3, No. 8, the lines A B C, converging to the point D, are the subsidiary ribs forming the groins, and dying into the pendant D, which is attached to the wall E E, (this is the clerestory wall E, on the section over the columns F, which separate the nave from the aisles.) It is against this wall E that the thrust of the vaulting is directed, and concentrated on the point D: this thrust would necessarily drive out the wall, were it not carried forward by the flying buttress G over the aisle roofs, and made to die into the wall buttress H.

The principle of the vaulting, and the use of the flying buttress, may be rendered more familiar by a very homely illustration. Let us presume that the several converging lines A B C are the ribs of an umbrella, the point D the point at which the snick or pin is introduced. Now so long as this pin remains fixed, the umbrella is expanded; the moment it is forced in by the hand, the umbrella collapses. I have simply introduced this illustration as a popular one, but must admit that the thrust of the vaults is in a different direction, which can only be withstood by corresponding resilience, and this is afforded by the flying and wall buttresses.

In order more clearly to understand the effective character of the flying buttress, as a medium of communicating the thrust from the vaulting to the wall buttress, let us refer to the annexed diagram.
Suppose $IK$ to be a beam originally in a state of rest, against the wall $KL$. When the beam is moved between the planes $IL$, $KL$, so that the lower end $I$ slides along the plane $IL$, and the upper end $K$ down the plane $KL$, the centre of gravity will describe a portion of a circle, (the centre of gravity being in the middle between the two ends of the beam); and this may be proved *mechanically* by the use of a small paste-board model.

Now upon reference to the section of Salisbury Cathedral, it will be found that the curve of the soffite (or intrados of the arch) of the flying buttress, is regulated by the angle at which the buttress is placed against the wall $E$, and that it is a portion of a circle; also that the thrust of the vaulting at $NO$ is carried forward by means of the flying buttress $G$, into the wall buttress $H$. That is, the direction of the centre of gravity is the same as the curve of the flying buttress, so that neither the wall $E$ nor the buttress $H$ is distressed. From the point $P$ the wall buttress is wholly inactive, and the laws of gravitation are left to act unrestrainedly in a downward course *within* the body of the buttress.

We thus see that the extreme tenuity of the flying buttress does not militate against the effective performance of the
duties assigned to it, and that the architect of the *miscalled* dark ages effected his object with the same apparent playfulness, but with the same unerring certainty as the Mexican hunter displays, when, singling out from the herd the devoted bull, he throws his "lasso" around his head for a few seconds, and then hurls the fatal cord with never-failing precision, and brings his victim to the ground!

Having thus briefly brought under notice some of the most important features of our Gothic structures, and I hope clearly proved their dependence upon geometry, I shall, in conclusion, make some remarks upon the ornamental accessories of the style.

Unlike its sister-arts of sculpture and painting, architecture addresses the judgment and not the passions. It is true that the reasoning faculty is called into exercise by means of the outward sense of sight, and that taste in architecture is inseparable from the pleasures of imagination; nevertheless, the aid of the imagination is called for lastly, so that the attributes of taste, as defined by Burke, are simply reversed in order.

It will be perceived, that in the illustrations of the two papers read before this Society, the diagrams have simply displayed the skeleton of Gothic architecture, and are without the charms of colouring, or the ornamental accessories. If they have excited any interest, it must have arisen from the proofs which they afford, that the style is not devoid of scientific principle, which has been denied it by so many of the early writers upon the subject. But some may be ready to exclaim, that Gothic architecture was the work of monkish times, and *must*, therefore, be barbarous. Let it not, however, be forgotten, that the term Gothic is a misnomer; that it arose with Evelyn*—was taken up by Sir C. Wren, and that

* "A certain licentious manner of building called *modern* or *Gothic.*"—*Evelyn's Account of Architects and Architecture.*
the revilers of the style are only those who from prejudice have been disinclined, or from ignorance unable, to investigate its real principles. In the twelfth century, the learning which had characterised the centuries immediately preceding the Crusades, and had gradually dwindled away, was in the course of revival; the ray of light which first gleamed in the east, had diffused itself over the whole of Europe; and in the reign of Henry the Second (1154–1189) our language assumed a new character. "The English language was, in fact, then formed. A style of architecture founded upon the Saxon and Norman (but differing from both) was, if not invented, at least practised extensively in England, and by English artists."* Amidst surrounding ignorance and barbarism, the inmates of our monasteries devoted their lives to the service of religion, the preservation of literature, and the cultivation of the fine arts, whose bland and genial influence became apparent among the higher orders of society.

"ingenuas didicisse fideliter artes
Emollit mores, nec sinit esse feros."—Ovid.

It is not necessary for us to lay claim to pointed architecture as peculiarly our own; but the style having varied in every country, in its minuter features, in correspondence with the character of its inhabitants, we may proudly refer to England as that country in which the union of the sublime and beautiful has been fully carried out. In the time of Henry the Second, when the pointed style arose, Normandy was in our possession, and this Duchy contained Caen, Rouen, Bayeux, Abbeville, and other cities and towns in which the early pointed style was carried to great perfection. Anjou, Maine, Bretagne, and Guienne, were also held in fief of Lewis, King

* It has been recently discovered by means of some long-hidden records, that nearly the whole of the beautiful memorial crosses of Queen Eleanor, the beloved wife of Edward the First, were the work of Englishmen: they have hitherto been ascribed to foreign artists.—See Gentleman's Magazine, 1841.
of France, by the sons of Henry the Second, so that we cannot be surprised at the remarkable similarity in the details of Norman and English structures at this period. It has been already noticed (p. 297) that the pointed style advanced more rapidly and with more distinctive features in England, and those parts of France bordering upon it, than in any other country.

Those who would uphold the superiority of the continental cathedrals (at the present time) over those of Great Britain, seem entirely to forget one point,—that the impression made upon the mind by the former is heightened to a great degree by their accessories. Connected with a religion gorgeous in all its apparelings,—uninjured by the hands of the destroyer,—filled with paintings attractive to the eye, and by congregations whose garb is exceedingly picturesque from the variety of its colouring, and heightened in its effect by the southern sun, what a contrast does the continental structure present to our own minster, in which on every side we perceive the effect of the puritan spoliator or the modern Alaric, and in which, although

"The storied windows richly dight
Casting their dim religious light,"

may to a certain extent instil into the mind the feeling of devotion; yet that feeling has little else to give rise to its intensity, than the bold shadows cast by the deeply recessed moulding, and the awe-inspiring grandeur of the edifice itself, which is the impress of its sacredness, and declares, in silent but eloquent language, that this is none other than the house of God!

In the works of the middle ages the most refined taste is apparent even in the minutest ornament, while the greatest science is displayed in the general arrangement. The architects of these structures were able, in the emphatic language of our great philosopher, Dr. Johnson, "to comprehend the
vast and attend to the minute.” In the decorations we find luxuriance without affected display, and delicacy and repose far removed from repulsive simplicity.

By those who would ascribe “the substitution of pointed arches and enormous buttresses to ignorance of mathematical science,” we may expect to find the appropriate ornaments of the pointed style designated as consisting of “fantastical capitals and whimsically-shaped windows, the mere offspring of innovation.” Sir James Hall has laboured hard to prove that the decorated tracery of the fourteenth century was the result of observation upon the platting of wickerwork, but we can obtain as gently-flowing lines by the aid of geometry, (by the interception of portions of these lines,) as by the compulsory bending of the willow.

I have dwelt at some length upon the subject of windows, as they betoken, in a peculiar manner, the various phases of the pointed style. The following may be received as a popular description of the variations made. It has been my endeavour to show the probability of the multiple Lancet window arising from the intersection of the semicircular Norman arcades. The Early English window may be said to include the Lancet, although the reverse is not the case; just as the fifth problem of Euclid includes the first problem, although the first does not include the fifth.

The two-light window appears to me to have arisen in the following manner. Two lancet windows being placed in juxta-position, and a circle introduced immediately over the jamb, (merely for the purpose of relief,) the simple inclusion of these three distinct features under one label moulding, formed the whole into a composition, and the lights being pierced, a new form of window was produced. This is, I think, evident on the west front of Salisbury Cathedral, (and also the Painted Chamber, Westminster,) where we find in the gable the lights and quatrefoils all pierced, but distinct from
each other, and again the whole pierced and included under a label. This form of window is Early English or geometric decorated, the mouldings touching, but not blending with each other. Very fine examples are found in Tintern Abbey, Monmouthshire, Stone Church, Kent, and Durham and Lincoln Cathedrals, &c.

The transition from the geometric to the flowing Decorated style of window, appears to have arisen from the interception of a portion of the geometric forms; it is the peculiarity of this style, that the inscribed line of the window is an equilateral triangle. Even the gorgeous west window of York Minster may be resolved, without much difficulty, into severe geometrical forms. I cannot adduce a more remarkable instance of the concealment of these forms under the most playful tracery, than that exhibited in the windows of Little Maplestead Church, Essex. They consist of two lights trefoiled, with ogee quatrefoils over the same. The whole of the lines are perfectly meandering, (if the expression may be allowed,) and yet the centres by which they are struck occur at the angles of a regular hexagon!

The Perpendicular form of window evidently arose gradually and imperceptibly from those of Decorated character. The arch being now four-centred, and two of the centres being below the springing, the curve of the arch became depressed; some portion of the geometrical tracery was necessarily excluded, and short perpendicular tracery was introduced to supply the vacant space; and at length the arch becoming more and more depressed, the former subsidiary straight lines became the principal ones, and the curved lines were used merely as of secondary importance. This depression of the arch, thrusting the whole of the ornament into a confined space, gave an ungainly appearance to the windows, and transoms were introduced to give stability to the mullions, and for the more equal distribution of the ornaments.
This leads me to offer a few remarks upon the principles apparently regulating the mouldings of the pointed style, which, however varied, are all reducible to elementary forms.

In referring to the transition style, we find that the circular arch was not suddenly abolished, nor were its analogous mouldings and details. In the work of Bishop Remigius, in Lincoln Cathedral, the ornaments are all strictly geometrical. The distinctive character of Norman mouldings on the plan is this, that the lines are at right angles to each other, with chamfers at an angle of 45°, the circular columns or mouldings being attached.

The Early English mouldings (in transitu) present much of this character, but when the style had become perfected, we find the mouldings, however complicated, forming gracefully undulating lines. The columns or roll mouldings, when attached, consist of portions of two intersecting circles; and when straight faces occur, they have small hollows, with chamfered angles, to afford relief and keep up the characteristic lightness of the style. But a continuity of flowing lines would produce sameness, and "pall on the senses like a twice-told tale." The architects of this period, therefore, introduced occasionally, on the face of the column, a square fillet slightly projecting, but giving decision to the chiaroscuro.

The Decorated mouldings are not unlike those of the Early English style, but straight portions and bold quadrant hollows are frequently met with, (especially in door jambs.) Small reeded mouldings also occur, and the fillet on the face of the column, and the doubling of the roll moulding, is retained.

In Perpendicular mouldings the most prominent and distinguishing marks are bold hollows, sometimes circular, but more frequently elliptical; double reverse ogees are also very common.

In painting, the eye is charmed by appropriate colour, no
less than by the management of the light and shade; by the latter, apparent prominence or distance is given, as may be required; and it has been observed by an ancient author—(Theages Pythagoricus apud Stobæum)—"That the contour of the illuminated part of a figure should be blended with and lost in the shade, since on this depends animation, tenderness, and similitude to truth."

Sculpture frequently calls painting to its aid, as may be observed in the monochromatic and polychromatic works of the ancients, no less than those of the middle ages.

But by what means, it may be asked, does Architecture produce those thrilling sensations of awe which we experience in the contemplation of our sublime cathedrals? Simply by the effect of light and shade.

Longinus, in his work on the "Sublime," observes, that "if we place in parallel lines, on the same plane, a bright and an obscure tone of colouring, the former springs forward, and appears much nearer the eye." Now, in Norman buildings the recession of the mouldings produces this very effect; but the mouldings being placed at right angles, however multiplied, a degree of harshness and severity in the shadows is the result—not to say, a great degree of sameness.

The superiority of the Gothic over the circular arch, in the projection of shadows, is thus beautifully explained by Mr. Kerrick:—"In the archivolt of a semicircular arch, all the mouldings, however diversified and rich, will still be all concentric semicircles, (see plate 1, No. 18), all exactly similar to the arch itself; but in pointed arches it is not so. Every moulding on the face of the arch is concentric with its arch, but not similar to it; (see plate 1, No. 19); no two are alike; they are respectively composed of different portions of a circle, and each is a different arch, (the internal being pointed, the external
"nearly circular"; the eye feels the pleasure it is naturally "formed to receive from the continued diversity, though "very few, perhaps scarcely any, of the spectators are at "the same time at all conscious of the cause." I may also add, that the greatest diversity is observable in the plans of Norman and pointed clustered pillars; of the former, some very interesting specimens occur in the nave of Kirkstall Abbey (transition); of the latter, I will only mention those in Darlington Church, Durham; in the north aisle, the first pillars are clustered, the second cylindrical, the third octagonal, and the fourth a plain cylinder; in the south aisle, the first and third are clustered, and the second and fourth octagonal.

Mr. Kerrick's observations as to the variety given in the light and shade by Gothic arch mouldings may perhaps be better understood by reference to plate 3, No. 4. The upper foils of the trefoiled head of the arcade are struck from two centres so close to each other as to render the foils almost portion of one and the same circle; if arcs of circles of less radius were struck, the foil would become exceedingly acute. We may readily imagine, that if from the centres of diagram No. 19, plate 1, two very large circles were struck, they would appear almost as a semicircle formed from one centre, —in the same manner as from the immeasurable distance of the stars in the firmament, (but reversing the position), they appear contiguous to each other, although probably millions of miles asunder, and the suns of separate systems equally important with our own.

The great advantage of Gothic Architecture over the Circular style, in the projection of shadows, is very evident in the mouldings of the thirteenth century, as their graceful contours allow the "liquid light" to melt imperceptibly into the shade: nay, more than this—a constant recurrence of the same regular forms, such as are perceived in Norman
mouldings, creates a monotony; whereas the *half tone* of shadow produced by the ever-varying forms of Gothic mouldings present infinite variety and attractiveness to the eye of the artist and the man of refined taste.*

It must be evident from the preceding observations, that varied talent and knowledge are required in the reparation of our cathedrals and collegiate and parish churches; a general acquaintance with the peculiarities of the various styles of Gothic Architecture is not sufficient; it must be conjoined with deep antiquarian feeling, and an intimate knowledge of all the historical circumstances which have given rise to these variations. A modern Gothic church, although far from faultless, may escape the censure of the critic, from a knowledge of the parsimonious spirit of the founders, although the neglect of perfect synchronism is without excuse.

But the existence of anachronism, as exhibited in the different styles in our ancient churches, may be regarded as among their chief beauties; these varieties lead the mind into a delightful train of reflection, connected with the history of the several periods in which they were introduced, and of the county in which the structures themselves are situated.

All these churches necessarily require reparation from

* "We cannot but admire the consummate skill manifested by Gothic architects in the conduct of their mouldings,—their curvatures are sometimes abrupt, and sometimes gentle and easy, according to the degree of light that is impinged upon them. If a number of small members occur together, appearing as mere expletives, it is where they were certain to have the necessary effect of softening the violence of a powerful shadow, or, in other words, of producing those beautiful *reflecting* tints, apparently so much valued in the combinations of mouldings by the Grecian architects. In those situations where the composition required it, and in the convexities where great effect was called for, they are thrown either partially into shadow by a sharp fillet or some part of their curvature, or entirely so by a bold separating torus advancing before them."—*Cooper's Tintern Abbey.*
time to time. I am not speaking of general repairs, but such as apply to the restoration of a single window, a door­way, or other individual feature.

Generally speaking, the matter is left to the church­warden, and his grand object being the attachment of his name to some conspicuous part of the church, denoting the year in which the structure was repaired and beautified under his superintendence—he proceeds boldly to his work. The ruined Gothic window is removed, the jambs are repaired, and the spruce modern sash supplies its place, as in the clerestory of Calverley Church, near Bradford. The grotesque heads, serving anciently for the reception of the brackets to the hammer beams of the roof (long since destroyed), having been relieved of their weight, and appearing to his eye somewhat ghastly and unmeaning, are coloured "au naturel" by the village painter, and at once look smilingly and contented, or the reverse, as they may happen to have been carved by the original sculptor, out­rivaling in some cases the facial distortions of "Tim Bobbin." This may be seen in Bluntisham Church, Hunts. The clerestory walls are painted to imitate stone, the joints (which the mason always endeavours to conceal) being clearly denoted by strong black lines, the painter receiving an extra allowance per yard superficial for the additional labour incurred, as in the recent beautifying (in 1841) of the Gothic church of Saint Paul's, Huddersfield. In some cases, however, the painter hits upon still further improve­ment, and by varying the colour and setting out the stones like a chess-board, he imitates to the life a laminated surface on the stone, such as would cause the rejection of the original on account of its unfitness for use, while the horizontal joints are run on continuously, no arch joints being shown, so that the masonry seems as though about to fall upon one's head.
This may be seen in Almondbury Church, near Huddersfield. The masonry externally, instead of being jointed with Roman cement, is repaired in plaster, and then the joints are defined by a broad line of 1\frac{1}{2} inch wide, as at Elland church, near Halifax. The clustered pillars of the nave receive the assistance of the plasterer, and alternate streaks of yellow, black and white, are introduced to distinguish the various mouldings, destroying the effect of light and shade, and thereby giving to the whole an appearance as pert and spruce as the creditable domicile of some tidy village school-mistress. This may be observed in Lincoln and Bristol Cathedrals, Saint Cross Church, Winchester, and Londesborough Church, East Riding of Yorkshire. Is a sounding board thought requisite? the village carpenter supplies one with Roman pediments on each side, as at the beautiful little church at Lockwood, near Huddersfield. Is the ancient altar screen mutilated? some “pseudo antiquary” is called in, and after carefully looking at the details, and poring over “Batty Langley’s Gothic,” a sketch is produced, from which a piece of half-inch board is quaintly cut into crockets, and placed horizontally upon the old screen, uniting but not assimilating with it. This has recently been effected at Almondbury Church, and also at Hartishead Church, near Huddersfield; and these abortions are considered to be decided proofs of talent in the designers!

How different was the feeling in former days! If a church required re-pewding, it was done in the style of Gothic then prevalent, and became an historical incident in connection with the structure. In such a case, we can excuse the harmless vanity displayed by the official persons, in leaving their names to posterity. Thus, in the screen of Methley Church, near Pontefract, we have the donor and the churchwardens immortalized with their work:—
And in good conscience we only wish that our modern improvers had proceeded thus: the donor's name, the cost of the work, the date of its execution, and the names of the churchwardens, all recorded in five lines!

But, to show to what an extent these ill-judged "beautifyings" are sometimes carried, it is not many years since "a churchwarden of Saint Stephens, Norwich, commenced his reign by cleaning and painting the church, and at the close of his labours, he rested his eye fretfully upon a picture of the Last Supper. 'Boy,' said he to the painter, 'I should consider myself wanting in duty and veneration, did I suffer this church to be cleaned, and our Saviour sitting before a dirty table-cloth: take your brush and paint it white directly!' A few days after this mutilation was discovered by the Rector, who sent it, with tears in his eyes, to an artist, to be restored to its pristine state."—Elms's Arts and Artists.

At a period such as the present, when a strong feeling is exhibited by the clergy of our venerable establishment in favour of the proper reparation of the structures under their care, the notice of these instances of Vandalism (most of which I have seen) may not seem misplaced.

If the windows of a church, whether Norman, Early English, Decorated or Perpendicular, have fallen to decay, and modern sashes be introduced, the whole character of the structure is destroyed; whereas the expenditure of a few pounds, from a feeling of con amore on the part of the clergyman and a few parishioners, (if you will, upon the voluntary system), would in a few years restore the muti-
lated or defective parts. The Church at Ranby, Lincolnshire, has been recently much improved by the insertion of Norman windows. The Early English Church, at Eynesford, in Kent, has been rendered perfect by the restoration of the chancel windows, and still further by the insertion of painted glass, chronologically correct in design. Littleborough Church, Notts, has also been partially restored. The Old Chapel at Flixborough, Lincolnshire, has had a doorway inserted, of character corresponding with the period of its erection; and several churches in the Isle of Wight have received judicious improvements and restorations.

I might instance many other churches which are at this time being restored to their original beauty, by the insertion of windows, doorways, &c., and in some cases by the removal of the inserted perpendicular tracery from Norman and early English windows. In such cases, the surveillance of an architect, however desirable, is not absolutely necessary; but I am persuaded (judging from my own feelings), no architect of the Gothic school would feel otherwise than delighted in affording his advice and opinion without charge, when the required restoration is trifling; or with the mere payment of travelling expenses, when a personal visit may become necessary. A hint from a practical architect may save much—a suggestion from the mere amateur may mislead, and will generally be attended with unnecessary outlay. No professional man will withhold his aid in the attempt to stem the torrent of innovation and bad taste which has already in too many instances swept away from our parish churches every vestige of by-gone days: the rubble walls, the storied brass, and the parish register being all that remains to bespeak connection with the past!

But how frequently is the font, used for the sacrament of baptism, thrown aside as lumber among the rubbish in the tower, as at Halstead Church, Essex, (a beautiful speci-
men), desecrated by being used as a cistern to “an old lumbering pump,” as at Hammersmith, or otherwise unceremoniously rejected from the house of God. Fonts are historically interesting, apart from their consecrated use; for I hesitate not to say, that if any Saxon architecture exists, it is to be found in our crypts, and not unfrequently the ancient font was retained when the Norman structure was raised upon the foundations of the decayed Saxon church; there could be no motive for its destruction, but the highest, the holiest motives for its preservation. The font of Saint Martin’s, Canterbury, that of Little Maplestead, Essex, and again that of St. Clement’s, Southampton, are decidedly earlier than the buildings themselves; the first and last buildings have much of Norman character, and we learn from Doomsday Book that a church existed at Maplestead when William the Conqueror’s survey took place, although the present church is the second, if not the third, erected upon the same site. I cannot, therefore, look lightly upon the circumstance of the font at Adel being removed to the church yard, while its place is supplied by an Italian marble font of Roman character, in style at variance with that of the church, and its introduction apparently uncalled for: at all events, the Norman font was once part of the consecrated furniture of the church, and this alone should cause its restitution within its walls, although it may not be re-used.

The following excellent remarks by Archdeacon Hare, in his charge to the Archdeaconry of Lewes, Sussex, cannot be too widely promulgated:—

“Your duty (says he, in addressing the churchwardens) is to take care that the house of God in your parish shall be such as befits the worship of God. You ought to feel that it is a noble charge to take care of that house. It ought to be your ambition, your glory, the wish of your
"hearts, to see that house pure, and perfect, and beautiful; to repair whatever injury it has sustained; to restore it to its ancient integrity. The house of God belongs to every inhabitant in your parishes—to the poor as much as to the rich; it belongs to each one of you more entirely, more lastingly, more unfailingly, than any other property can—to you and to your children's children. You will, perhaps, complain of the difficulty of raising church-rates, and the dissensions which they breed; but works of this kind, which belong to the decoration of the church, may well be executed by voluntary subscription; only take care that you yourselves are among the chief subscribers. Do not talk of expense; make a beginning at least; restore one window this year; let your successors restore another next year. When the good work is once entered upon, the desire of going on will increase rapidly; for you will take more and more interest in that which hitherto you scarcely thought about; your eyes will open to discern the beauties of your churches; your hearts will open to rejoice in them. In making alterations, however, care should be taken, on the one hand, that they accord with the general style of the architecture, and, on the other hand, that they be suited to the great end and idea of the building."

Shall we, as Protestants, be indifferent to the maintenance and reparation of our parish churches? Can we possibly feel lukewarmness upon the subject? If so, we may find aid proceeding from another and a very equivocal quarter. Yes, from the Roman Catholic laity, under the impression or at least the hope, that, at no very distant period, these venerable structures (for whose retention, for the use of a purified church, a Ridley and a Cranmer have suffered martyrdom,) will again be placed under the custody of the hierarchy and priesthood of Rome. The following extract
from the *Dublin Review* (May, 1841) may well cause us to reflect deeply upon this subject:

"By the parish churches (says Mr. Pugin, a Roman Catholic architect), the faith of our nation is to be sustained and nourished; the parish church gives, in fact, the history of the adjacent county. If the English Catholics avail themselves of this feeling of attachment to the old parish church, which exists among the great body of the people, wonderful good may be produced; but if they neglect the means they are bound to employ to turn this feeling to the restoration of the old faith, then it will be found extremely inimical to the revival of our religion!"

Far be it from me to gainsay the motives expressed in this extract, but I breathe the fervent hope that Protestant feeling will render it unnecessary to receive aid from such a quarter; tendered as it must be from those who are so inimical to our old faith, handed down to us from the apostles, and whose author and finisher is Christ himself.

If we admire the Architecture of our ancient edifices, it is our duty to restore them to their pristine beauty, where decayed by time, or injured by adventitious circumstances; and as the feeling of ignorance is frequently the precursor of a desire to obtain knowledge, so may an enthusiastic feeling in favour of Gothic architecture, and of the preservation of the structures in which it is enshrined, be imbibed by a practical acquaintance with the glaring innovations which have arisen from the permitted exercise of a Vandal taste.

"Our village carpenters and masons have too long conspired with ignorant churchwardens, in converting our fine old churches into dens of ugliness and confusion." If Canova felt and declared that "it would be sacrilege in him or any other man to presume to touch the works of Phidias with his chisel"—is it not more improper that the restoration of our Gothic structures should be any longer left to those
who are, in most cases, utterly ignorant of even the merest rudiments of the style in which they have been erected?

Mr. West next read the following paper:—

ON THE DATA FOR A COMPARISON BETWEEN THE HEAT YIELDED BY COKE AND BY COAL.—BY WILLIAM WEST, ESQ., OF LEEDS.

I know, and I acknowledge all due weight to, the feeling which leads practical men to think very lightly of calculations which are not put to the proof by experiments, especially if they appear in any degree contrary to their own real or supposed experience on the great scale. Yet two good purposes may be answered by such calculations: since our processes and our machinery are all attended and interfered with by circumstances diminishing the calculated effects, our mechanical powers, by friction or atmospheric resistance, our chemical, by the need of time, or an excess of some elements for ensuring combination with the saturating quantity, our modes of applying heat, to radiation, and escape in various other ways—if we can show what the greatest possible amount of effect is which can be produced, we may prevent fruitless endeavours to exceed that amount. On the other hand, if we show that the effects produced fall below what calculation shows to be possible, by a quantity much greater than the ordinary defects of our proceedings in other cases prove to be unavoidable, we may prompt or encourage endeavours to reduce to a moderate standard these defects, and may furnish hints to others for new or improved applications of Science to the Arts. Such were the reflections which occurred to me when the well known opinion that coke equals, or very nearly equals, in its power as fuel, the coal from