ORIGINAL
GEOMETRICAL DIAPER DESIGNS,

ACCOMPANIED BY

AN ATTEMPT TO DEVELOPE AND ELUCIDATE THE TRUE PRINCIPLES OF

ORNAMENTAL DESIGN,

AS APPLIED TO THE

DECORATIVE ARTS.

BY

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AND "THE LAWS OF HARMONIOUS COLOURING, &c."

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AN ESSAY

ON

ORNAMENTAL DESIGN, &c

One of the most eminent Natural Philosophers of the present age,* in a late number of the Edinburgh Review,† has observed, that the publication of a series of diagrams upon the principles of linear harmony, with the diaper designs resulting from them, might be productive of much improvement in the Decorative Arts. For, as the carpets of rooms, geometrical pavements, and paper hangings, are all viewed by the spectator with various degrees of obliquity, it would be desirable to invent patterns which, though they might not be the most beautiful when seen directly, have the power of developing in succession a series of beautiful combinations, when viewed, as they must always be, at different obliquities.

A series of such designs will form the principal illustrations of the present publication, and, the Author trusts, they will be found useful in opening a new field of design, not only to the decorative artist, but to damask and shawl-weavers, calico-printers, stained-glass manufacturers, cabinet-makers, and those engaged in other branches of the useful and ornamental arts.

Hitherto our geometric diapers, if the term may be applied to this peculiar kind of ornament, have been copied from those of the ancients, without any attempt having been made to investigate or develope the principle upon which they were originally formed. Perhaps the most beautiful specimens of this class that have been handed down to us, are those of the Alhambra, and they have been used, in various manufactures, for so long a period, that they are now exhausted, and have become, from constant repetition, wherever they could be applied, too familiar to the eye, while, from being copied by the ignorant, they are often much deteriorated and deformed. Something new in this style of ornament is, therefore, required, and the Author trusts, that the present series of designs will supply the desideratum.

* Sir David Brewster. † October 1843, Art. II.

The total want of originality in our ornamental manufactures, seems to have been the cause of much loss to the country; for the French, by a different mode of procedure, have attained considerable excellence in the art of design, as applied to this branch of industry. Dr Ure, observes, that "the opinion generally entertained of the superiority of such French silks as are figured, and which depend for their beauty on tasteful arrangements, is no more a prejudice of mankind, than the feeling in favour of the works of Raphael and Titian. * * Taste is displayed both in the forms and grouping of the figures, and in the disposition of the colours."* The French style of ornamental design, although it may not reach the excellence ascribed to it by this author, has still originality to recommend it; and this superiority has not only operated in limiting the home consumption of our own ornamental manufactures, but has been the cause of their being superseded by those of the French in almost every foreign market.

All the works hitherto published in this country on ornamental design, have been, in their illustrations, merely copies from antique fragments of sculpture and from the examples given in foreign works on the same subject, and, as copies, therefore, they must be inferior to the originals from which they are taken. It has also been clearly proved, in a legislative investigation into the subject, that we copy, principally from the French designs, all our patterns applied to silk, cotton, and worsted manufactures. The designs accompanying the present attempt shall therefore be original, and that originality will be regulated by principles founded on the unerring laws of Nature. These principles the Essay itself shall gradually develope as it proceeds, with such explanatory examples in wood-cuts as may be required to elucidate them.

Ornamental design may be classed according to its mode of application, and its style may be varied agreeably to the principles about to be explained. But to arrange *styles* of ornament according to their origin in other nations and in other ages, and set them up as models, as has almost universally been the practice of those who have written upon the subject, is, to say the least of it, a tacit admission of the inferiority of the conceptive powers of the mind, in regard to ornamental art, in this country at the present period.

In all the arts there are first principles, and those principles are reciprocated in the perceptive faculty, or power, of the human mind. We find in all Nature's works the same principle uniformly operating in the production of beauty; and while each object is reproduced after its own kind, there exists an infinite variety amongst the individuals of each specific kind. Amongst those we are enabled, by perception, to select that which is most beautiful, and our power of doing so is regulated, in the first place, by the degree of perfection we possess in the physical construction of our organs of sense; in the second, by the degree in which our intuitive faculty of

* *Philosophy of Manufactures.*

perception reciprocates to the first principles of beauty; and, in the third, to the degree in which we have cultivated this faculty. The principles of this branch of art, therefore, being grounded in nature and universal reason, it must be as much under the influence of common sense as language itself; and, as before observed, its laws must be fixed and natural, and have a response in the mind of man.

There has been much said and written upon purity of style, and it may startle some to see it asserted, that this has had only one tendency, and that has been to retard the progress of the art of ornamental design in this country. But many of the kinds of ornament called styles being themselves impure, in so far as they are destitute of the first principles of beauty, a servile adherence to them is not only a very questionable kind of purity, but calculated to corrupt the taste, while it retards originality of conception.

If an ornamental designer were asked to imitate another in the same profession, he must either be conscious of his own inferiority, or feel his reputation compromised by the request. And the same may be said of any other profession where conception or originality of design is required, to constitute excellence. If a poet imitates the works of another poet, he thereby acknowledges his own inferiority; and so does the artist who copies the work (either ancient or modern) of another artist. But in neither case can the works copied constitute or supersede the laws or first principles of art. The greatest merit of all works of art, either in poetry, music, painting, or sculpture, consists in their being unlike the style of any that have preceded them; for there are no limits to the inventive powers of genius; and indeed it is only invention and originality that prove the possession of that divine gift. But the mode of proceeding in regard to tuition in the ornamental arts has, in this country, been of a very opposite character. What has hitherto been understood by purity of style, is nothing more than servility of copying, and if we were to inquire very closely into the origin of what are termed styles of ornament, we should find their claims to this distinction to rest on a foundation of a very slight and unsatisfactory kind.

The most beautiful of the architectural class of ornamental designs of antiquity have of course been handed down to us from the same people and the same era that have also supplied to us the most beautiful specimens of the arts of sculpture and architecture. And, but for the perishable nature of the materials, there can be little doubt but we might have owed to the same period and people not only the finest specimens of pictorial art, but those of that kind of design peculiar to manufactures and interior decoration.

When we take this in connexion with what we know of the poetry, the music, and, above all, the geometry of the same period, we can scarcely help feeling convinced that some fixed principles of taste and beauty were known and acknowledged amongst that extraordinary people at this period of their general refinement. And the more so, that the progress of natural philosophy in succeeding ages has proved, that there are ruling principles by which the sciences are in almost all cases identified with one another; and by which again the arts are identified with the sciences, and upon which they are reciprocally dependant. The same eminent natural philosopher, already quoted,* observes, "that the disposition to this species of exchange, and to introduce into the intellectual community the principles of free intercourse, is by no means general; but we are confident that art will not sufficiently develope her powers, nor science attain her most commanding position, till the practical knowledge of the one is taken in return for the sound deductions of the other;" and that "it is in the fine arts, principally, and in the speculations with which they are associated, that the controlling power of scientific truth has not exercised its legitimate influence. In discussing the principles of painting, sculpture, architecture, and landscape gardening, philosophers have renounced science as a guide, and even as an auxiliary; and a school has arisen whose speculations will brook no restraint, and whose decisions stand in opposition to the strongest convictions of our senses."†

A proper comprehension of art as a whole, and as it is connected with science, is therefore essential to right practice, even in that humble branch of it which forms the subject of this Essay; and upon no other foundation can a standard of just criticism be established. For that criticism which judges an ornamental design by other designs of the same description, without reference to the natural and scientific principles which ought to regulate the artist in the production of such works, concludes upon false premises. Were the proper mode of estimating works of decorative art adopted, those contracted and prejudiced views which take precedents alone as a guide, would soon give place to a correct understanding and appreciation of what is truly beautiful.

The names of the kinds of ornament called *styles* are numerous. We have the *Grotesque*, the *Arabesque*, the *Moorish* or *Moresque*, the *Persian*, the *Turkish* or *Byzantine*, the *Hindustanee*, the *Chinese*, the *Pompeian*, the *Elizabethan*, the *Louis Quatorze*, &c., some of which, no doubt, have what may be termed national characteristics, and they may, so far, whether good or bad, be admitted as styles, because they belong not merely to periods, but to nations. Yet in general they are not worthy of being held up as models of perfection, far less are they worthy of being made to supersede the necessity of studying the first principles of linear and chromatic beauty in our schools of design.

A style of ornament may legitimately be named after its originator, such as the "*Wateau*" *style*, which is probably of all comparatively modern styles the most original and most graceful; for, although it is grotesque, and may not have been established upon any known principles, yet it is the production of the intuitive good taste of an original genius.

* Sir David Brewster. † Edinburgh Review, Oct. 1843, art. II.

Some of the styles of ornament already enumerated, are, however, only characterized by the discordance of their parts, their grossness, or unmeaning profusion; and when we apply any known principle of harmony to their incongruous and absurd combinations, we are convinced of the degraded state of public taste which gave such productions even a temporary existence, and wonder how any attempt should have been made to revive them in a more enlightened era.

Strictly speaking, a mere ornament is something supplied by art, either to conceal what utility has rendered unpleasant to the perceptive faculty, or to enhance the effect of that which has been found to be otherwise tame and monotonous. Wherever, therefore, we observe an ornament, we may suspect a defect. Ornaments ought never to obtrude themselves upon the eye, but to appear as a necessary part of that which they are meant to embellish, like the graces introduced by the accomplished musician in the composition of a piece of music. Ornamental design in architecture ought to hold this situation, and it should always be in harmony with the subject it is intended to grace and adorn. Every ornament should have a purpose and a meaning, otherwise it becomes exuberant or superfluous; and an ornamental designer ought to be able to give a reason, based on the first principles of art, for the employment of every curved or straight line in his design.

There are two distinct classes of ornamental design. The one belongs exclusively to architecture, and the other conjointly to architecture and manufactures. All merely architectural ornaments are sculptured, and have specific styles, agreeing with that of the architecture in which they are applied. The three classical styles of architecture—the Doric, the Ionic, and the Corinthian—separately involve in their general proportions a certain modification of the first principles of beauty; and those principles seem to have been applied under the same modification in the ornaments belonging to each. The ornaments employed in architecture are in some cases employed to conceal defects, and in others, to soften the asperities of abrupt transitions from one kind of line to another. For instance, all mouldings are used to conceal necessary junctions, to soften angles, or to divide parts that would otherwise be out of proportion with the requisite vacuities in the composition. The capitals of columns, and other similar ornaments, soften the meeting of two opposite lines, and graduate the pressure on the top of the column. The ornaments introduced into friezes relieve the monotony of an accumulation of horizontal straight lines,—hence the division of this space by perpendicular triglyphs, sculptured figures, or foliated scroll-work.

The class of ornament that we have more particularly to treat of in this Essay, is that which may, however, in any kind of architectural subject, be applied to enrich those surfaces that have been necessarily left plain and monotonous, and used in every kind of manufacture, whether for an article of dress, or to cover the walls, the floor, or the furniture of an apartment.

Nature leaves nothing unadorned, and those of her works which are apparently the least embellished, are often found, upon being carefully studied, to develope, in the highest degree, the first principles of ornamental design, both in form and colour. For instance, the very common weed called the Dock (*Rumex crispus*), blends in its form the curved and the straight line, arranged in a manner not to be surpassed by the finest models of antiquity. Neither can there be pointed out in the arabesques of Raphael himself, a more beautiful blending of two harmonious colours than is displayed in the mode in which the red of the stalk is blended with the green of the leaves in this humble production of Nature. Thus Nature affords us an inexhaustible mine of knowledge in ornamental design, and no artificial attempt will be truly beautiful that has not its archetype in her works. Yet it appears as if this art were allowed to dwell in ancient ruins, while, by the investigation of the universal principles of beauty, we might lay solid foundations upon which to rear original and noble structures for her abode. Upon these universal or first principles of beauty, therefore, let us base such theoretic axioms as can alone constitute the science of ornamental design, seeing that it is only by such a mode of proceeding that we can ever expect to establish statutes in this art, capable of checking every species of fanaticism and false practice.

Architectural ornaments, it has been observed, belong to sculpture, and may therefore be fit subjects for the study of the modeller and carver; but to the manufacturer of carpets, damasks, calicoes, shawls, or hangings, the practice of copying them servilely is worse than useless; and their being employed as almost the only models of study in some of our drawing schools, has led to their misapplication in various instances. For example, in many of our carpets, we find a great deal of labour bestowed in attempts to give them the appearance of being composed of carved work, such as highly relieved rosettes, and foliated scrolls, deeply sunk pannelling, and many other attempts at a kind of deception, which, if successful, would convey any thing but a pleasing feeling to the mind. We might walk on the floor of an apartment with perfect safety, were it strewed with bouquets of flowers, although the inclination might be to step over them, instead of upon them; but to walk upon a piece of boldly relieved carved work, would neither be safe nor agreeable. Yet, to produce in the mind this feeling of insecurity and discomfort, would appear to be the sole aim of many designers of patterns for carpets. This is evidently the result of their education; for the production of a drawing in chalk which, by much laborious stippling, is made to represent the light and shadow of sculptured ornaments, is generally held up as the perfection of the art of ornamental design in our schools. But all this labour is useless, inasmuch as it does not assist the mind in its capabilities of appreciating in nature or art what is beautiful in form or colour. The outline is what constitutes the figure of the ornament, and the impression of beauty or deformity is conveyed to the understanding as effectually by this line, when it inscribes a plane figure, as when it surrounds a solid body; for no object in nature can depict any thing upon the retina but a plane figure; and it is only by experience that we become aware of any object having other dimensions than length and breadth. Hence, as every solid form is but the fluent of a plane figure, the eye, or rather the perceptive faculty through the eye, may be so far deceived by an imitation of light and shadow within the outline of such a figure, as to mistake it for a solid body, but never in regard to its configuration.

The combination of plane figures produced by lines is, therefore, susceptible of every modification of the harmony of form upon the eye, independently of light and shadow, and shall in this Essay be treated accordingly; neither is it necessary that an ornament should be an imitation of any natural object. To the student in ornamental design, as already observed, nature is no doubt an inexhaustible source of study, but it is enough for him to know the principle of combination which constitutes beauty to be able to produce it in his works; and to an investigation of this principle we shall now address ourselves.

The *true* in art is the *beautiful*, and the *false* is the *deformed* or *ugly*. As moral truth is to the conception, the concentration of all that is elevated in the human mind, so is beauty to the perceptive faculty a combination of the elements of the material world, upon the general principle of harmony, which comprehensive quality depends upon proportionate combination. Sir Isaac Newton endeavoured to show that the beauty resulting from harmonious combination was not confined alone to the musical scale, but that the light of the sun was composed of several colours, relating to one another upon a perfectly similar principle; and farther, that the planets, in their respective distances from the sun, and in their relative gravities, assimilated to the ratios which govern music. Attempts have since been made to show that the elements of beauty in the human figure may be reduced to a scale of parts, having also the relative proportions of musical intervals; but for want of a proper system of applying these ratios to form in the abstract, they have been reckoned fanciful and unsound. It would appear, however, that the idea of this principle exercising a controlling influence over all combinations throughout the great system of Nature is of remote antiquity, for the Chaldæan philosophers of the earliest ages taught that the chief image of celestial truth was harmony.

The mind of man certainly informs him that there exists, as a portion of its constitution, a faculty by which he contemplates with satisfaction and delight the beauty arising from order and proportion, by whatever means those ideas are excited, and however much they may be concealed in the apparent irregularity arising out of variety. The concurrence of these qualities produce in every case perfect harmony, and this concurrence is attained by certain modifications in the relative quantities of the elements by which any species of harmony is to be produced. The well investigated laws of acoustics, have shown that the modes in which sounds relate to one another in the production of harmony upon the ear are purely mathematical; and I have elsewhere shown, that these harmonic ratios, as they are termed in music, are equally applicable to that kind of harmony which addresses itself to the understanding through the eye, as also, that a scale of geometric figures can be generated within the circle, or any of its elliptical modifications, corresponding in every respect to the scale of musical notes.* The first principles of beauty are consequently the harmonic ratios, of which a description shall now be attempted.

OF THE HARMONIC RATIOS.

It is well known that the unit has no power of multiplication or division, while every other number has both those powers. The first multiple of the unite is 2. It is a submultiple of the numbers 4, 6, 8, &c., progressively, as 2, 3, 4; and it is the first even number. The number 3 is also simply a multiple of the unit, and is the first odd number; it is a submultiple of 6, 9, 12, &c., progressively, as 2, 3 4, and is composed of 1 and 2 added together.

The next multiple of 1, having no other aliquot parts, is 5—a similar compound of the first even and first odd numbers, 2 and 3. It is a submultiple of 10, &c. These three numbers 2, 3, and 5, are, therefore, the first three multiples of 1 that are multiples of no other number—consequently they are adapted to divide the elements of proportion into the primary harmonic ratios; and in this capacity will be shown equally to regulate the effects produced by external nature upon the senses of hearing and seeing. The number 5, although by it the third mode of division is performed, is of an intermediate character, and the middle may thus be said to be produced by a number which combines the first and last.

The primary or leading harmonic ratios produced by those modes of division, are 1 to 2, 2 to 3, 4 to 5, and the secondary ones, which complete the natural scale of musical notes, being 8 to 9, 3 to 4, 3 to 5, and 8 to 15, no new mode of division is required, 4, 8, 9, and 15, being multiples of 2, 3, and 5.

To arrange and proportion the combination of various forms by those ratios, in such a manner as to produce one or unity, ought on all occasions to be the aim of the artist in ornamental design; for every composition should manifest in all its parts a definite relation to a whole. This is the first condition of order, and consequently the primary cause of geometric beauty. But when the parts of a figure are perfectly homogeneous or identical, there can exist in it no principle of proportion productive of this

* "The Natural Principles and Analogy of the Harmony of Form;" and "Proportion, or the Geometric Principles of Beauty Analyzed."—W. Blackwood & Sons, London and Edinburgh.

effect, because its parts are throughout as 1 to 1, producing sameness. The circle, the square, and the equilateral triangle, as shall hereafter be shown, are figures of this description, and consequently want within themselves individually the first element of proportion—variety.

The whole scale of elementary ratios are as follow:—

Consonances.	Dissonances, which are occasionally treated as consonances.	Dissonances.
1 to 2	5 to 7	4 to 7
2 ... 3	7 ... 10	7 ... 8
3 ... 4		8 ... 9
3 ... 5		9 ... 10
4 ... 5		8 ... 15
5 ... 6		15 ... 16
5 ... 8		

These ratios can be extended as 1 to 4, 1 to 8, &c., 2 to 6, 2 to 12, &c., in combined harmony; while in the harmony of succession, melody, or outline, the dissonances 8 to 9, 9 to 10, &c. become harmonious.

The application of this mathematical principle in the production of variety of musical composition is almost boundless, and a mode of applying it in the production of visible beauty shall now be shown. It will, however, be necessary, in the first place, to describe the elements upon which it is thus to operate.

OF LINES.

Although a point and a line, mathematically considered, are individually position without magnitude, and length without breadth, yet, in the arts, they are understood to have a physical existence, such as may be perceived through the eye, and thus convey to the mind a knowledge of where a figure ends, and the space that surrounds it commences, as also of the division of figures into parts.

There are only three kinds of lines used in producing forms, and they are—

the straight line, the crooked line, and the curved line.*

* As the crooked line is but a combination of two or more straight lines, it might be argued, that there are only two kinds of lines, the straight and the curved, and that they are correlative to silence and noise in acoustics, and white and black in chromatics, especially as a single straight line can enclose no figure; while the most comprehensive and capacious of figures—the circle—is produced by the homogeneous curve. Indeed, some assert that the circumference of a circle is but an infinite polygon, and that there is consequently none but straight lines, while others assert that Nature detests a straight line, and that every line is to a certain extent curved. These speculations, however, are worse than useless, for they not only misdirect the attention of the student, but bewilder him.

All varieties of form, however complex, all the similarity and dissimilarity that combine in the harmony of forms, are produced by these simple elements.

The straight line has three positions: it may be—

horizontal, vertical, or oblique.

The crooked line may be crooked in three different ways: it may produce—

a right angle, an acute angle, or an obtuse angle.

The curved line has also its varieties: it may be—

a portion of a circle, of an ellipse, or of a volute.

These are all the positive varieties of which the three kinds of lines are susceptible. The straight line, if not horizontal or perpendicular, must be oblique; for however near it may approach one or other of its two positive positions, so long as it is not in either of them, it remains oblique. There is only one positive angle, called the right angle because it arises out of the two positive positions of the straight line; for however near the other two angles may approach this in either direction, they still remain simply acute or obtuse angles. The curved line, in the same way, has only one positive curve, and that is when it forms a segment of a circle; for the two diameters of an ellipse may vary to any degree, but every segment of its circumference will form an elliptical curve; neither will any part of a volute be found to be circular or elliptical, and this curve may diverge in any degree from its centre, but its nature remains unaltered.

All ornamental designs are composed of inclosed spaces or figures, arising out of those modifications of the straight and the curved line, and those figures, as already observed, are reducible to an elementary series, corresponding in every respect to the natural scales of the elements of sound and colour.

OF GEOMETRICAL FIGURES.

Regular curvilinear figures must have either one or two points as a centre, and have no angles; and regular rectilinear figures must be composed of acute angles, right angles, obtuse angles, or an equal mixture of the acute and obtuse kinds. Amongst these geometrical figures there are three which are perfectly simple and homogeneous in the nature of their configuration, and are, in every other respect, quite analogous to the tonic, mediant, and dominant notes of the diatonic scale of the musician, and to the three primaries, blue, red, and yellow, of the colourist. These figures are the circle, the triangle, and the square, in the relative proportions in which they are given in figures 1, 2, 3.

Fig. 1.

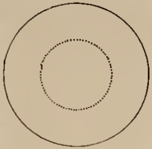


Fig. 2.

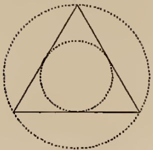
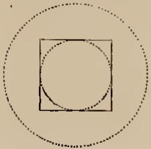


Fig. 3.



I have endeavoured to show in other works, that these figures, in such proportions, bear an analogy to the three primary parts of sound in the quantity of their circumference and perimeter. I have also demonstrated, that if two circles be produced from one centre point, having in their circumference the relative proportions of 1 to 2, as in figure 1, these two rectilinear figures, in the proportions in which I have given them, can be placed harmonically between two such circles, as shown by the dotted lines in figures 2 and 3.

The homogeneous simplicity of these figures consists, first, in the circle being the most perfect curve, and composed of one line drawn round one point, from which every portion is equidistant; secondly, in the equilateral triangle being composed of three sides, the smallest number possessed by any rectilinear figure, which sides are equal, and each of which, as well as each of its angles, are equidistant from one point; and thirdly, in the square being composed of four equal sides and four right angles, each side and each angle being also equidistant from one point, and the right angle itself being homogeneous.

Without referring to analogy, it might be shown that from their configuration, compared to the conformation of the eye, the effects of those particular forms upon that organ entitle them to hold the situation amongst other forms in which I have placed them. The pupil of the eye is circular; hence the rays, or pencils of light, which pass from external objects to the back of the inner chamber, or retina, are most easily transmitted when the object is circular. The circle is, therefore, not only geometrically the most simple of the homogeneous forms, but naturally so in reference to the organ by which it is perceived. The square is the next most consonant form to the eye, as its angles, although more in number, are less acute than those of the triangle, and are the exact mean between acuteness and obtusity. The triangle, of the three, is the figure which, from its being composed of acute angles and oblique lines, exercises the most powerful influence on that delicate organ.

It is well known in chromatics, that the primary colour, blue, exercises a softer influence on the eye than either of the other two, red and yellow; and this no doubt occurs from its being the most allied to darkness or black of the three, and hence associating more intimately with the colour of the retina itself. The colour that stands next to it as a primary in the solar spectrum, is red, which consequently holds the situation that the triangle does in my series of forms; and this colour is well known to affect the eye more forcibly than the yellow, which, in the natural series, is furthest removed from the blue; so that the more acute effect of the triangle upon the eye, although holding a medial situation, like that of the note E upon the ear, is quite in accordance with the analogy of acoustics and chromatics.

The scales by which harmony in sound and colour is produced, have, besides the three primary parts, other four of a secondary kind by which these are connected. So, to complete the scale of forms, it was necessary to adopt figures corresponding to these, as the 2d, 4th, 6th, and 7th notes in music do to the 1st, 3d, and 5th, and as the secondary colours, orange, green, purple, and neutral, do to the primaries, blue, red, and yellow. The figures I now adopt for this purpose are the rectangle, figure 4, the rhombus, figure 5, the ellipse, figure 6, and the hexagon, figure 7.

Fig. 4.

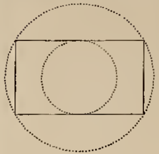


Fig. 5.

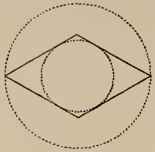


Fig. 6.

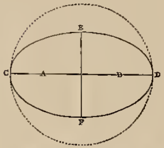


Fig. 7.

All these figures, except the ellipse, occur naturally from the intersections of two lines produced between two circles of the relative proportions already stated, and form, with the three primaries, a series embracing a representative of every variety of geometric figures, whether right-angled, acutely angled, obtusely angled, or curved. But before showing how this is performed, or giving a more ample definition of these figures, it will be requisite, in order to arrive at a proper comprehension of the subject, to show, in the first place, the manner in which angles are calculated.

OF ANGLES.

Rectilinear figures are named according to the kind and number of angles they contain. These angles are of three kinds, as already explained, and are geometrically regulated by the circle in this way:—Its circumference is divided into 360 equal parts, called degrees, figure 8,* which

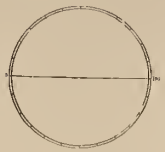
* At what period, or by whom, the circle was thus divided, I have not been able to learn; neither have I found, in such works as I have consulted upon the subject, any reason given for the choice of this particular mode of division. Being desirous to find a reason, I was led to investigate whether there existed in the number 360 any peculiarities that might have led to its adoption in preference to any other. This I find to be the case in the manner in which the first elementary numbers in harmonic proportion, 2, 3, and 5, are combined in producing it, as shown in the following analysis:—

2)360	3)360	5)360	2)72	3)45	5)40	2)8	3)9	5
2)180	3)120	72	2)36	3)15	8	2)4	3	
2) 90	40		2)18	5		2		
45			9					

degrees are again divided into 60th parts, called minutes; these, again, into 60 seconds, and these seconds into 60 thirds, and this subdivision may be carried on to any imaginable extent. The circle is divided into two equal parts by a line drawn through its centre, and cutting the circumference at each end, figure 9. This line is in geometry called a

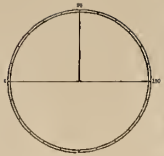
Fig. 8.

Fig. 9.



diameter, and when horizontally placed, is the base or groundwork from which all angles arise. The half of the circle is called a semicircle, and the half of the semicircle a quadrant. Any line drawn from the centre of this diameter to the circumference of the semicircle is a radius, and will divide it into two portions called arcs. If it cut the circumference in the centre, these arcs will be equal, and the angles formed with the diameter on each side of the radius will be right angles; and as these arcs contain 90 degrees

Fig. 10.



right angles are called angles of 90°, figure 10. But if the radius touch the circumference at any other point than the centre, two different angles are formed; one an acute angle, and the other an obtuse angle, because the one arc contains fewer, and the other more than 90°, as shewn in figures 11—12. Upon this division of the

Fig. 11.

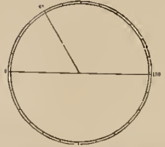
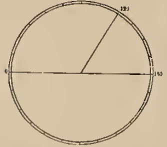


Fig. 12.

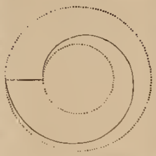


circumference of the circle depends the character of every straight line, as well as every rectilinear figure, and the explanation here given will make what follows regarding the nature of the primary figures, and the harmonic progression of forms, more easily understood by those who have not studied geometry.

OF CURVILINEAR FIGURES.

The circle itself, as already shown, is, in the parts that compose it, the most simple and homogeneous of all forms. Its secondary is the ellipse, also a perfect curve, because it is a line in all its parts equidistant from one or other of two points, and necessarily uniting its beginning and end at the same point. It is heterogeneous, for these points may be placed near or apart; but the figure described by their joint radii will still be an ellipse, however much it may resemble a circle from the closeness of its two centre points, or, on the other hand, a straight line from their separation. These points are called its *foci;* and if they remain in the same position while the line which forms the circumference is increased, the ellipses thus formed will continue in appearance to approach the proportions of the circle, but, although produced to infinity, can never form that particular figure. It has consequently two diameters, the longest of which is called the transverse diameter, and the shortest the conjugate diameter, as shown in figure 6, on which A B are the *foci,* C D the transverse diameter, and E F the conjugate diameter. It will be shown in another part, that although this figure can be produced in every variety of proportion, from the straight line to the circle; yet, as it possesses the most simple kind of variety of parts which constitute the first elements of proportion, there are certain rules for its formation which agree mathematically with the principles of geometric beauty, and which entitle the one here given to be termed *the* ellipse, in contradistinction to other varieties of the same figure. In this proportion it is also entitled to be the key of the secondary series of geometrical figures, and to produce within its circumference the rectilinear figures of that class. The only other curve that can produce a form or figure useful in the arts of design is the spiral: this curve, as well as that producing the circle and ellipse, is a real unmixed curve; and although it can form no figure of itself, is of much importance in the arts of ornamental design in producing the volute. It is a curved line, receding gradually from a focus or centre, figure 13. Its centre may be a point, a circular figure, or an ellipse, and these may be large or small, or its aberration may be in any degree; its direction still forms a spiral line, and the figure it produces when closed by another line, a volute. There are various other curved lines, which, although inapplicable in the arts of design, are of much importance in science. They are the cycloid, the parabola, the hyperbola, and others. But all these I look upon as compounds. For instance, the cycloid is the mixture of a straight line and a circle; for during the formation of the circle, by the revolution of a radius around its centre point circularly, that point is traversing a straight line. If the revolution were stopped, and the progress of the radius continued, the ends of the radius would produce two parallel lines. On the other hand, if the progress were stopped, and the revolution allowed to proceed, one end of the radius would describe a circle. But this curve cannot of itself enclose a space or produce a figure.

Fig. 13.



The parabola, in the same way, is the mixture of an elliptic curve and an angle; or, it may be termed, an ellipse formed upon a definite and two indefinite points, both acting at the same time upon the formation of the curve.

The hyperbola appears to be a circular curve, having also one definite and two indefinite points, which causes it to continue to approach the straight line with which it is associated, as the ellipse has been shown to recede from it.

OF QUADRILATERAL RECTANGULAR FIGURES.

The square is homogeneous in its parts, none of which can be altered without destroying its form. The parts are, as already stated, four straight lines of equal length equidistant from a centre, and uniting at their extremities in four right angles, which are likewise equidistant from the same centre, and being of 90° each, make up the full number 360 contained in the circumference of the circle. When a quadrilateral rectangle has two of its opposite sides longer than the other two, it is called an oblong or right-angled parallelogram; and every rectangle of this kind, from a perfect square to a straight line, is so, whatever may be the proportion between its length and breadth. In the proportion of this figure, therefore, there is the same latitude that exists in regard to the ellipse; and as geometricians have given no rules by which to distinguish *the* parallelogram or oblong from the innumerable series that lie between the square and the straight line, it is of importance to fix some rule for the formation of one whose proportions may entitle it to that distinction. This I shall attempt in its proper place, and here proceed with a definition of the other primary, and the figures that are allied to it.

OF TRIANGULAR FIGURES.

The equilateral triangle is the *proper* triangle; it is, like the other primary figures, homogeneous in its parts, being formed of three straight lines of equal length, equidistant from one point or centre, and by their union producing three acute angles, also equidistant from the same point. Like the square, it cannot be altered in any of its parts, without destroying its form and altering its character. Each of its angles are 60°, which together make 180°, being half the number contained in the circumference of the circle.

There are various other triangles, some of which have one right angle and two acute angles; others, one obtuse angle and two acute angles. But they cannot have less than two acute angles, or more than one right or obtuse angle; and, whatever their varieties in other respects may be, their three angles make up 180°. If two straight lines of the same length meet at an angle of 60°, whatever their length may be, a third straight line joining the other two ends will produce an equilateral triangle.

The equilateral triangle has for its secondary the rhombus, which may be termed a perfect mixture of the triangle and square. The ellipse is the secondary to the circle, by having two *foci*, while the circle has only one. The secondary to the square is removed from that figure by having two of its sides shortened, while the number of its angles and the direction of its sides are the same. But the rhombus is removed from the equilateral triangle by being two figures of the same kind placed together, which two triangles produce a quadrilateral figure. Two of its opposite angles are 60°, and the other two are 120°. It has, therefore, two acute and two obtuse angles, which, put together, are equal to four right angles. It is the only figure that can occur within the circle, having an equal number of acute and obtuse angles. It may be shortened until its angles be nearly right angles, or it may be lengthened until it approaches the straight line so closely that its figure cannot be distinguished, and it therefore possesses the peculiarities of the other secondary figures.

OF POLYGONS.

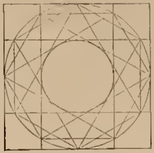
Although this term applies to all figures having more sides than one, yet those whose sides exceed four, are generally denominated polygons; and all regular rectilinear polygons of this kind are consequently obtusely angled. The hexagon has been adopted in the series as the representative of this class, from its being the first regular figure of the kind that occurs from the intersections of the dominant lines, as shall presently be shown. It is the figure that approaches nearest to the configuration of the circle of any rectilinear plane figure that can be joined together in any number by its sides. As regular polygons increase in the number of their sides, they can scarcely be distinguished from the circle.

OF THE GENESIS OF THE SERIES.

The five rectilinear figures, which, with the circle and ellipse, compose the whole series, are generated in their proper relative proportions, between two circles bearing to one another in circumference the ratio of 1 to 2, and in area that of 1 to 4. The perfect square is the dominant of the series of which the circle is the tonic; and between these two figures there exists a curious reciprocity in the division of the perimeter of the one, and the circumference of the other, into the harmonic parts that produce the series, which I shall here explain.

Let the perimeter of a square inscribing a circle be divided into sixteen equal parts, with lines drawn from those divisions at right angles across the area of the square; and it will be found that the circumference of the circle is thus divided into twelve equal parts. Let lines be drawn from the points at which the circumference of the circle is cut by the traversing lines to the points at which it is in contact with the perimeter of the square, and the whole series of rectilinear figures will thus be produced, figure 14.

Fig. 14.



These lines form right angles with the sides of the exterior square, angles of 30° with any radius that meets them from the centre of the circle, and angles of 60° with the lines drawn to the point of contact, and they inscribe the inner circle by a square having the ratio to the outer square of 1 to 2 in perimeter, and 1 to 4 in area.

If each of the four sides of any rectangle be divided in this manner—that is, into 4—the ellipse which it inscribes will be harmonically divided into four parts by the points of contact, each of which will be subdivided by parallel lines passing through the area of the oblong into three proportionate divisions; and by uniting the points of contact with the points of intersection, a series of rectilinear figures will be produced, inscribed by the ellipse, and leaving an area in their centre capable of containing another ellipse of precisely the same proportions and half the circumference of the first. This same process may be performed within any rectangle; and the proper angles, obtuse and acute, as well as the proper curve belonging to any rectangle, either vertically or horizontally, thus accurately determined, as shall afterwards be shown. But, in the next place, it will be requisite to give some account of the harmony of geometry, which may justly be termed the primary cause of beauty in every ornamental design.

OF THE HARMONY OF GEOMETRY.

The circle, as already shown, is geometrically divided into 360 degrees, &c.; and I shall endeavour to prove, that, in the division of those degrees by the harmonic ratios, the principle of geometric beauty or proportion lies.

In the first division by two, which determines the octaves in sound, the diameter of the circle or horizontal line—the base of all geometrical figures is produced. The second octave gives a radius perpendicular to it, producing the right angle of 90°; and the third, the angle of 45°, which is the diagonal of the primary square. We have thus the first elements of figure; and this division by two gives the first harmonic ratio. Figure 15.

The next harmonic division is by three; and when produced upon each

Fig. 15.

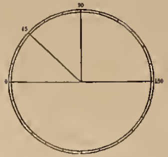
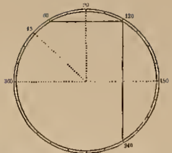


Fig. 16.



of those parts it falls upon the number 240°, 120°, and 60°, (Figure 16;) and the lines produced between the first and the second, and between the second and the third of these dominant divisions, are those which, being repeated from each twelfth division of the circle, will produce, by their intersections within it, the diagram which contains the whole series of rectilinear figures, and which has been already referred to. The remainder of those divisions will be better understood by what follows regarding rectangles.

Rectangles only differ from one another in their proportion—that is, the ratio that their length bears to their breadth. This proportion is determined by one measurement, which is the diagonal. The difference between the various kinds of angles has been already explained. It has been shown that the angle of 90° is the right angle; and that all the angles having more degrees are obtuse, and that those having less are acute. The diagonal, by which the proportion of a rectangle is determined, is a line drawn from the vertex of one of its angles to that which is opposite, and every such diagonal must form two acute angles—the square being the only figure of this kind in which these angles are the same, namely, 45°. This angle is therefore to the angle of 90°, as 1 to 2, and they consequently are in the harmonic ratio of octaves. As no diagonal of a rectangle can be an obtuse angle, all variety of this peculiar line must be found within the quadrant.

The oblong is simply a modification of the square, and this modification is regulated by the number of degrees in the angle of the diagonal, which, when the oblong is placed vertically, must exceed 45°; and, when horizontally placed, must be under that number. If, therefore, a series of these diagonals be produced by a harmonic division of the degrees that occur upon a quadrant—that is, by 2, by 3, and by 5—the rectangles formed upon them must bear a harmonious relation to one another.

The rectangle is the dominant figure in every series, and the diagonal of the homogeneous one (45°), arises from the division of the quadrant by 2. The second division by 3, gives the vertical diagonal of the first oblong, 60°, and relates to the right angle as 2 to 3; and the third division by 5, gives the vertical diagonal of the second oblong, 72°, which is in the relative proportion to the right angle of 4 to 5.

Fig. 17.

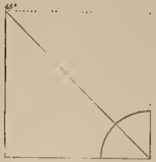


Fig. 18.

Fig. 19.

The square being homogeneous, has only one proper position, in which its diagonal is always 45°; the other two rectangles being heterogeneous, have two, a vertical and an horizontal. Their vertical diagonals, as shown above, are respectively 60° and 72°. Their horizontal diagonals are therefore 30° and 18°. The first of these latter numbers, 30°, is relatively to its vertical number, 60°, as 1 to 2, and is consequently in the ratio of an octave; and being relatively to 45° as 2 to 3, it is in the harmonic ratio of a fifth, or dominant to that diagonal. Its relation to the tonic, 90°, is that of a musical twelfth, being as 1 to 3.

The second number, 18°, is relatively to its own vertical number, 72°, as a fifteenth or double octave, being as 1 to 4. It is to the tonic, 90°, as a seventeenth, being relatively to it as 1 to 5; and is the third degree to the diagonal, 22° 30′, to which it relates, as 4 to 5.

It has been shewn elsewhere,* that the three leading harmonics, agreeably to the established laws of acoustics, are produced by portions of the monochord relating proportionally to one another, in the first instance, or within an octave, as 1 to 2, 2 to 3, and 4 to 5, and are called the 8th, 5th, and 3d degrees of the diatonic scale. But that when the portions of the monochord are as 1 to 2, 1 to 3, and 1 to 5, the harmonics of an 8th, a 12th, and a 17th, are produced. This is, therefore, precisely the case in regard to the formation of these three rectangles. The angles of their diagonals, in the first instance, relate to the right angle as 1 to 2, 2 to 3, and 4 to 5. But when the horizontal, instead of the vertical diagonal, is employed in the construction of the two latter figures, the three will be found to relate to the right angle as 1 to 2, 1 to 3, and 1 to 5. The harmonic ratios are therefore in this instance quite analogous.

I have already shown that if each side of a square be divided into four equal parts, and lines drawn from those parts at right angles across the area of the square, these lines will cut the circumference of an inscribed circle into twelve equal parts, and by uniting those intersections, the first series of figures is produced. Now this same reciprocity exists between an oblong rectangle and its inscribed ellipse, the latter being harmonically divided by the same process, and the intersections united in the same way, a secondary series of figures will be generated, and the process may thus be continued harmonically to any imaginable extent. Figures 20 and 21.

Fig. 20.

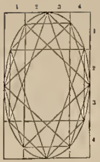
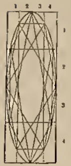


Fig. 21.



When Plato endeavoured to explain the nature of the atomic construction of the elements of the material world, he did so by saying, that when the Deity began to adorn the universe, " He first of all figured with forms and numbers, fire and earth, water and air," and proceeds to show that, as every body possesses profundity—as every depth comprehends the nature of a plane—and as the rectitude of the base of a plane is composed from triangles, those figures must constitute the first principle in the construction of the elements. He then enumerates three triangles as being remarkable for their beauty, and describes them as that which forms the half of the square, and is isosceles; a scalene triangle, such as forms the half of an equilateral; and another scalene triangle, which he describes as having its longer side trebly greater in power than the shortest. Now these are the identical triangles that arise out of the division of the quadrant by two, by three, and by five, as shown in figures 17, 18, and 19, and that produce

* " Proportion, or the Geometric Principle of Beauty Analyzed," where this part of the subject is treated at length.

when joined two and two, the dominant rectangles, namely, the square, the oblong, and the secondary oblong.

I now presume that I have pointed out amongst the infinite multitude of geometrical figures that exist, such a series as may be truly termed the elements of Form, and that these elements correspond in their number, and in their relative effects upon the sense to which they are addressed, with the elements of colour and of sound, inasmuch as their combinations are capable of producing every variety of beauty arising from geometrical symmetry or proportion. I have likewise shown that these elements are the result of a demonstrable and certain process, namely, the application of the harmonic ratios of numbers to the division of a circle. Farther, I have just shown that the series thus produced, proceeds from primary to secondary, and from secondary to tertiary, agreeably to the Platonic theory of the atomic form of the elements.

In doing all this, however, I have only made one step in the elucidation of my subject, and that is, the production of an alphabet for ornamental design, or rather a gamut of visible harmony.

It may be requisite here to state, that this gamut has been before the public for upwards of two years, and although probably not investigated adequately to the importance of such a step in the arts of design, yet the attempt thus to establish fixed principles for geometric proportion and harmony, has met in some high quarters with an approval so flattering, as to induce me to treat it as in some measure authenticated, and now to attempt its application in the art of ornamental design.

When the teacher of language exhibits to his pupil the alphabet, he endeavours to make him acquainted with the nature of the letters, and their relative effect upon one another, in order that he may comprehend the mode of their combination in the simple words which form the first lessons in reading. In like manner the teacher of music, when he lays the gamut or scale of seven musical notes before his pupil, explains to him that he must not only be able to sound them upon an instrument, but also to understand the relative effects that they have upon one another, when combined in harmony, or when arranged in succession or melody. This he does likewise by the most simple passages, knowing well that the more intricate and difficult can only be understood after long and assiduous study. But when this apparently simple matter is accomplished, either as regards the alphabet or gamut, a permanent and secure foundation is laid, for any degree of knowledge in these respective branches of education, that may be consistent with the talents and opportunities of the pupil. And it is perfectly understood that the letters of the alphabet, and notes of the gamut, are capable, when properly used, of producing an infinite variety of beautiful effects, intellectual and æsthetical.

My object in this Essay is to carry the pupil in ornamental art as far in that peculiar branch of education, as the teacher of language has carried his pupil when he has enabled him to spell, and probably to construct a very simple sentence; or as the teacher in music, when he has enabled the tyro in that art to understand the nature of a chord. This degree of instruction may not only enable latent talent to develope itself, but, if generally disseminated as a branch of polite education, would be the means of enabling the public to appreciate the harmony which addresses itself to the eye in forms and figures as accurately as they do that which is addressed to the ear in the skilful compositions of the accomplished musician.

On this subject an elegant writer justly remarks:—" Were every man a judge and appreciator of beauty, then indeed might we expect forms of loveliness and grace to pervade the regions of domestic and every-day life, to replace in our streets the expensive ugliness of our street decoration—in our homes the vulgarities of ornamental deformity—and in our churches the distortion and anomalies of meretricious decoration.*

The various modes of combining the elementary series of geometrical figures in the production of visible melody and harmony shall now be explained. In doing so, however, it will be requisite for me to remind the reader, that I am not attempting an elucidation of any kind or style of ornament in particular, but of principles which ought to regulate all compositions of lines and figures, in order to make them ornamental or pleasing to the eye, considering every ornament as a plane surface, because it is only as such that it is depicted on the retina of that organ.

Every figure, viewed in this way, is supposed to be surrounded by a line, technically called its outline, and when two figures are placed in contact with each other, or so joined as to overlap, their outlines enter into combination, forming various continuous curved, angled, or mixed lines, which are pleasing or otherwise, according to the modes in which they unite, and the forms they thus produce.

Lines, like notes in music, must, in their combinations, if contrasted at all, be so by proper intervals, or distinct differences. While in their combinations in melody or succession, they may change by smaller degrees like a chromatic passage in musical composition.

Geometrical figures of the same kind and size combine with each other, that is, circles with circles, squares with squares, &c., and produce new figures and lines. Such figures and lines have to each other a degree of similarity that distinguish them as a class. So also may figures of a dissimilar kind be united in harmony, producing other figures useful in ornamental art. I shall commence the illustration of this part of my subject with the circle.

OF COMBINATIONS OF THE CIRCULAR CURVE.

The circle is the primary, most comprehensive, and most perfect of

* Athenæum, No. 815, p. 541.

PLATE 1.

Fig 1

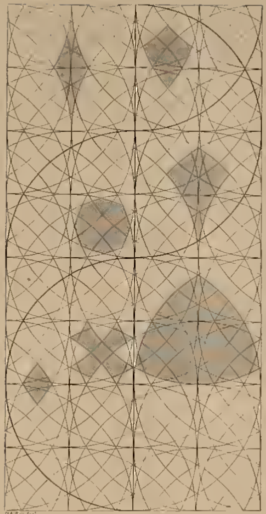
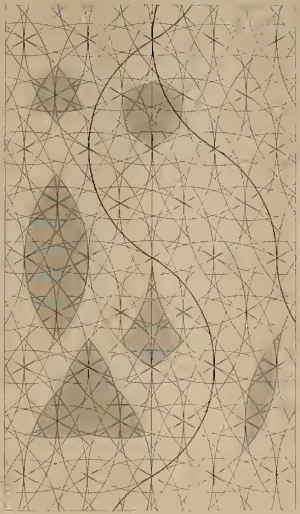


Fig 2



Fig

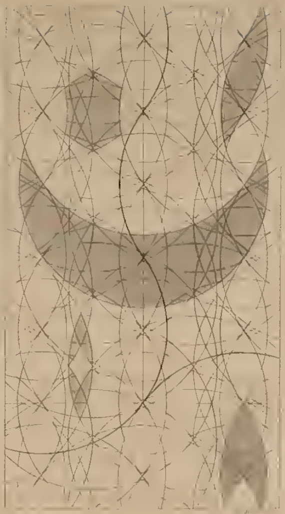
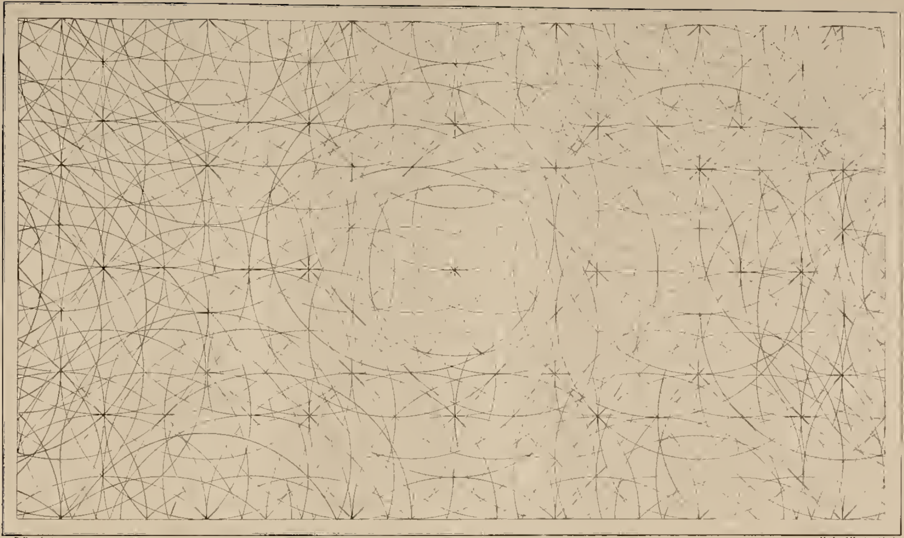


PLATE 2



D. R. Hay, Inv.t

Maclure & Macdonald Lith.

curvilinear figures; it is remarkable for its perfect unity and symmetry, and its modes of combination give rise to lines and figures of great beauty; but it wants within itself that peculiar constituent of beauty—variety. By the external mode of combining circles, the most simple kind of waved or serpentine line is formed, as also several of the figures in Gothic tracery, and by the internal mode all other figures of the same kind are produced. The points of union in arcs of circles forming waved lines, must be in the same straight line, and they must be equal parts of circles formed by the same radius. A series of those lines are given in Plate 1* of the illustrations. In figure 1, will be found that arising from the union of two semicircles, as also from arcs of a fourth. In figure 2, those produced by arcs of a third, and a sixth; and in figure 3, those produced by arcs of a fifth, and of two-fifths. This division of the circle by the harmonic numbers 2, 3, and 5, seems to produce all the distinctive varieties of what may be termed the homogeneous waved line. In this plate by combining a number of circles of the same radius upon this harmonic principle, various characteristic figures are produced, a few of which are pointed out by being shaded.

Circles, although of the same size, will, when properly combined, give rise to a great variety of figure, of which one example is given in Plate 2.

* The Plates now commence a new series, being illustrative of the Essay, and are therefore differently numbered from those of the diaper designs.

In this diagram, the diaper designs numbered XXIV., XXV., and XXXII., will be found, besides many others of a similar character, all equally remarkable for originality and symmetry.

The circular curve is uniformly employed in Gothic tracery, and in such works circles of various sizes are often combined, giving rise to many beautiful figures and devices in this branch of ornamental design. But as many excellent and elaborate works have already been, and are now publishing, on the subject of Gothic ornaments, I do not consider it requisite to give any examples here of this mode of combination, and shall therefore proceed to the secondary curvilinear figure.

OF COMBINATIONS OF THE ELLIPTIC CURVE.

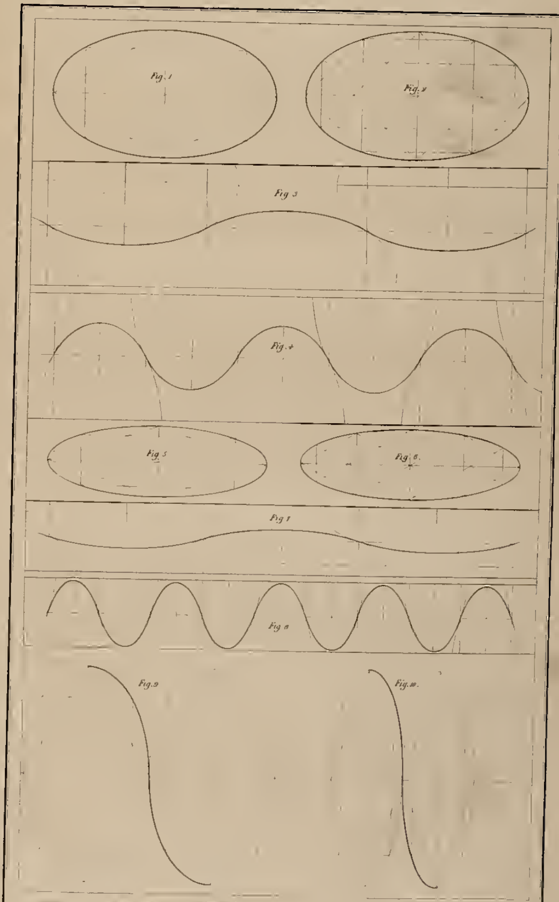
The ellipse of all geometrical figures is the most beautiful, and most useful in the arts of design. As just observed, the circle, although remarkable for unity and symmetry, wants within itself that essential constituent of beauty, variety. This the ellipse possesses in an eminent degree. Its outline being formed by two radii, one of which is continually decreasing, while the other is increasing, it imperceptibly varies from an oblate to an acute curve. The variety of proportion amongst individual figures of this kind is very great, extending from the circle down to the straight line; hence the necessity of fixing on two as primary and secondary of the class. (See *ante* figs. 20 and 21).

The waved or serpentine lines produced by the combinations of this figure, while they possess the most perfect mathematical uniformity, are at the same time rendered truly beautiful, by partaking of the variety already alluded to. These lines prevail in the contour of the most pleasing scenery, composed of hill and valley—they form the characteristic figures of many of the most beautiful productions of nature in the animal and vegetable kingdoms, and are a leading feature in the finest specimens of the ornamental designs of the ancients.

Although I have somewhat systematised the waved line of the circular curve, yet, from its homogeneous nature, equal arcs of any size, from a semicircle downwards, may be joined together in its production; but it is not so with that of the elliptic curve; this line must be subjected to a systematic division in forming continuous flowing lines, as exemplified in Plate 3.

In a former part of this Essay I promised to show that the ellipse, the proportions of which arise out of the harmonic division of the circle already explained, is entitled to be termed the primary of its class, or in contradistinction to all other figures of the same kind, *the ellipse*. Perhaps I cannot more clearly do this than by showing its intimate connexion with the two primary rectilinear figures—the equilateral triangle and homogeneous square. Plate 3, figure 1, exhibits it inscribing two equilateral triangles united by one of their sides, and thus dividing its circumference into four equal arcs. Those two triangles so joined also form the rhomb of the series. When thus divided the four arcs are similar, but when divided by the angles of an oblong, formed by the union of two halves of an equilateral triangle united by their longest sides, the arcs are of two different kinds, oblate and acute. Those two modes of dividing the circumference of the ellipse into four, unite in dividing it harmonically into eight. Thus the same figure which divides the circumference of the circle harmonically into three or six arcs, divides the ellipse, as above shown, harmonically into four or eight. Figure 2 of the same plate, exhibits the connexion of the ellipse with the homogeneous square, two of which, when united by one of their angles, divide the circumference of the ellipse into six arcs, at the same time forming within its circumference another square, whose area is equal to that of both the other two. Again, it will be observed, on examining this figure, that a right-angled isosceles triangle, or half of a square, divides this ellipse harmonically into three arcs, and consequently two of these divide it into six arcs. These divisions occurring exactly between those already made by the angles of the two smaller squares, divide the circumference harmonically into twelve parts. Thus we find that the harmonious division of the ellipse by three and by four, reproduces the two homogeneous rectilinear figures by an inverted process, the division by three producing the square, and the division by four the equilateral triangle. Those who wish to in-

PLATE 3.



D. R. Hay inv.

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vestigate these peculiarities farther, will find the subject treated more comprehensively in my works on Form and Proportion.*

Figures 3, 4, 7, and 8, exhibit the only mode in which an ellipse can be united to produce by arcs of a fourth part a continuous symmetrical waved line. And the sixth portions that lie parallel to the transverse and conjugate diameters are the only others that, according to these divisions, will so unite.

The secondary ellipse has also its peculiarities, which, independently of the mode in which it is generated, are equally remarkable. It is divided into four equal arcs by two of the triangles arising out of the division of the quadrant by five, united together by their shortest sides upon the conjugate diameter of the ellipse, and these divisions are each subdivided into two by an oblong formed of two halves of a similar triangle, united by their longest sides.—See figure 5. Figure 6 shows it divided into six arcs by four equilateral triangles; the angle of 60° acting upon it in precisely the same way as the angle of 90° acted upon the primary ellipse, and the angle of 36° in the same way as the angle of 60° did on the same figure.

These coincidences are simply as follow: The figure arising from the division of the circle by three, gives the binary division to the first ellipse, while the figure arising from the division of the circle by four, gives the ternary division to the same figure. The figure arising from the division of the circle by five, gives the binary division to the second ellipse, while the figure arising from the division of the circle by three, produces a resolution of the whole by a ternary division of the second ellipse. Therefore, I consider them the second and third of the elementary curvilinear figures, and their establishment as such is a matter of some practical importance in the arts of design, as I shall now endeavour to show.

Figures 9 and 10 are waved lines, which being perfect in themselves, cannot by their repetition upon the same straight line, be continued harmoniously, yet they are the most beautiful of their class, embodying, as they do, all the variety of the ellipses by which they are produced.

This peculiar curve, as already observed, seems to prevail in the outline of all objects in nature that we esteem the most beautiful. In the vegetable kingdom, it is particularly conspicuous in the leaves of plants, and in every kind of foliage; while its prevalence as a constituent of beauty in the Animal Kingdom is equally remarkable.

Plate 4, exhibits a few of the systematic modes of combining the first and second ellipses, by which figures are produced typical of what are generally acknowledged to be beautiful in the forms of leaves of plants, and petals of flowers.

Figure 1 is composed of two of the first ellipses united at their ends

* Published by Messrs Blackwood and Sons, Pall Mall, London, and 45 George Street, Edinburgh.

upon an angle of 45°. Figure 2, of two of the same upon an angle of 60°, and figure 3, of two of the same upon an angle of 72°. Figures 4, 5, and 6, are produced by two similar ellipses, united at their centres upon angles of 72°, 60°, and 45°. Figures 7, 8, 9, 10, 11, 12, are similar combinations of the second ellipse. Figures 13, 14, 15, 16, and 17, are harmonious combinations of other portions of these ellipses, showing, that by varying the mode of union, an endless number of other figures of this kind might be produced.

Plate 5, figure 1, is an outline of the principal muscles of the human leg, carefully drawn from Albinus's work,* and on looking at this figure, it will be observed that every line in the configuration of these muscles forms an arc of the second ellipse. The student who will take the trouble of a farther investigation of this part of the subject, will find the same curve pervading not only the outline of the other muscles of the human body, but that of the bones themselves. The lower limb has been selected as an example, in preference to any other part, because it exhibits the largest and best developed class of muscles.

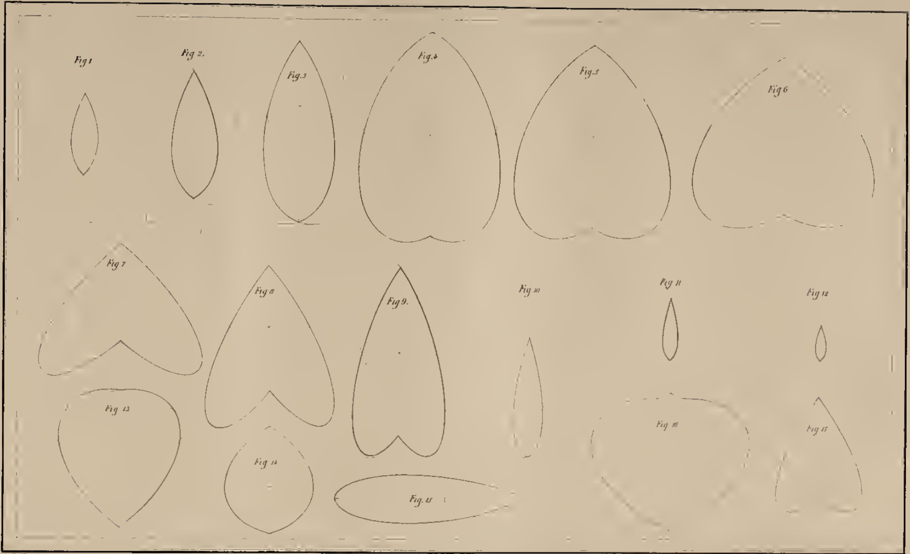
The other examples on this plate have been selected at random from Sir William Jardine's Naturalist's Library. The horse subjected to the elliptical outline in figure 2, is copied from Plate VIII., vol. xii. of that work, and is called Bonaparte's Arab; I adopted it as apparently the most perfect outline of that animal in the volume. The birds, figures 3 and 4, are the cuckoo and blackbird; and the fishes, figures 5 and 6, a salmon and turbot, and are given as familiar instances, simply to show the universal prevalence of this curve in the configuration of the lower class of inhabitants of the earth, the air, and the waters. It may here be observed, however, that the more perfectly these correspond in their general outline to a harmonious combination of the circumference of the ellipse, the more are they generally esteemed beautiful specimens of their respective kinds. This is exemplified in the striking contrast between figures 5 and 6.

These facts are of much importance to the artist, whatever branch he professes, and I therefore consider this part of the subject eminently deserving of his attention, since it points to an apparent governing principle of beauty which it would be well to study closely and assiduously.

We also find throughout Nature two opposite principles in operation in the production of visible beauty, namely, uniformity and variety, and these must consequently, to a certain extent, co-exist in every beautiful object. In ornamental design especially, there can be no real beauty without uniformity amidst variety. A decorative ornamental design is seldom employed but as the part of some whole, especially the diaper, which is the most simple of all, and only employed, as already observed, to enrich surfaces that might otherwise be tame and monotonous blanks. In this respect the diaper cor-

* Tables of the Skeleton and Muscles of the Human Body. By Bernard Seigefield Albinus. Edinburgh, 1777.

PLATE 4



D R Hay inv

PLATE 5

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responds to the minutiæ of Nature—every moss-grown stone, the apparently bare trunks of trees, the surfaces of individual leaves—are all found upon examination, to be decorated and enriched with delicate and beautiful combinations, in which the variety appears infinite. When we examine the higher and more apparent mathematical beauties of inanimate Nature, we find a general uniformity amongst the leaves of the same species of plants, as well as between the opposite sides of the same leaf; even the trunks and the branches of trees, when devoid of foliage, proclaim, by their uniform similarity of configuration, the class to which they individually belong. Yet there co-exists with this an endless variety amongst the individuals of every species, both as to form and colour, so that the combined grandeur and beauty of the forest, of the garden, and of the field, may be said to arise from a compound ratio of uniformity and variety.

Principles similar to what I am endeavouring to elucidate, have been insisted on by most lecturers and writers on high art, but I am not aware that any attempts to systematise them have been made. Flaxman seems to have felt that a ruling principle of harmony existed in forms in regard to the curved line especially, for the only example he gives in his excellent lectures on Sculpture, is in reference to it. He says—" One simple instance only shall be given of opposition, and another of harmony, in lines and quantities; two equal curves set with either their convex or concave faces to each other produce opposition; but unite two curves of different size and segment, they will produce that harmonious line termed graceful, in the human figure." This is a facsimile of the example—

" Opposition)(()

Harmony ∫: ½."

Now, " *two curves of different size and segment*" is not a very intelligible definition. There can be no doubt of this great artist's mind being naturally imbued with every principle of beauty, therefore what he here meant must have been such a line as may be produced by two quadrants of an ellipse, as given in Plate III. figures 9 and 10. Hogarth's " Line of Beauty," of the application of which he has left us so many splendid examples in his works, is evidently the same combination of the elliptic curve; and it was probably from his " Analysis of Beauty" that Flaxman took his example of harmony. But Hogarth's work is merely an assemblage of examples in Nature and Art of the beauty of the waved line, and of the deformity arising from its absence in artistical compositions, especially in reference to the human figure. The only approximation he makes to the laying down of a general principle, is contained in the following sentence: " The way of composing pleasing forms, is to be accomplished by making choice of variety of lines, as to their shapes and dimensions; and then again, by varying their situations with each other by all the different ways that can be conceived." This is but a loose principle of linear harmony, and could be tolerated only in connexion with such excellent examples as he has collected and exhibited in the two plates which accompany his "Analysis."

Having given examples of the prevalence of the elliptic curve, in what are esteemed the most beautiful forms in Nature, and likewise shown that, although apparently unacquainted with its precise geometric character, Hogarth and Flaxman adopted it as the line of beauty and grace in the high arts of painting and sculpture, I shall now attempt to show the mode in which it may elevate by its application the humble art of ornamental design.

Plate 6. figures 1, 2, 3, 4, and 5, are examples of the most palpable and simple mode of such an application of this curve. The body of figure 1, it will be observed, is simply produced by the combination of two ellipses upon an angle of 45°, with other two upon a horizontal line, forming the neck. Figure 2 is a similar combination upon an angle of 60°. The body of figure 3 is a similar combination upon an angle of 72°, the neck being formed of other two ellipses, united to these upon an angle of 18°. To these are added other two ellipses, united at one of their foci upon the same angle as the body. Figure 4 is produced by two ellipses united at one of their ends upon an angle of 81°, the neck being formed by other two upon an angle of 18°. Figure 5 is formed upon an angle of 45°, with a neck upon an angle of 15°. It may be as well here to remind the reader that, with a view to simplicity, I calculate all angles within the quadrant, that is, I imagine a vertical line raised upon a horizontal base, and from each end of the horizontal line I calculate upwards.

Figure 2 of Plate 7, is the same as figure 1 of Plate 6., with this difference, that the curve of the neck intersects that of the body, instead of touching it externally. Figure 1 is two ellipses joined together at the end of their conjugate diameters, which are upon angles of 36°; their transverse diameters being consequently upon angles of 54°. The neck is formed of two ellipses upon angles of 60°.

Figure 3, notwithstanding its small dimensions, is a composition arising out of the union of four arcs of ellipses of the same size and proportions used in producing the preceding seven. The faint lines upon it, as well as upon all the elliptical examples, will show clearly the mode of combination.

These eight outlines are not copied from ancient vases, but are simply the result of a systematic combination of the elliptic curve. I mention this, because they thus produce figures typical of all that we know of those much admired productions of the ancient Grecians.

The almost infinite variety that might be produced by this means in the form of every kind of domestic utensil, as well as ornamental vases, may give some interest to this portion of my Essay; the more especially, as we sometimes find in periodical works dedicated to art, the most shapeless, grotesque, and absurd productions of this kind exhibited in woodcuts, and accompanied with eulogiums upon their beauty, evidently written by persons

PLATE 6.

Fig 1

Fig 2

Fig 3

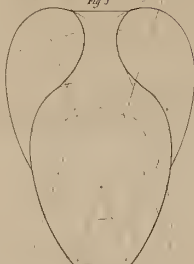

Fig 4

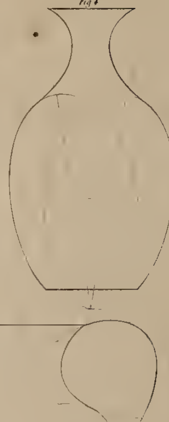

Fig 5.

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PLATE 7

Fig 1

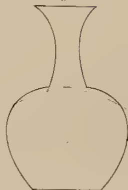

Fig 2

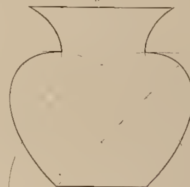

Fig 3

Fig 4

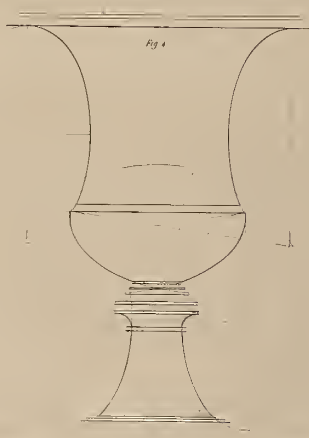

PLATE 6

D R Hay Inv^t

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as ignorant of what is truly beautiful, as the potter who produced the specimen, and consequently calculated to mislead the public taste.

Plate 7. figure 4, is an outline of a Grecian vase of Parian marble, and of the finest workmanship, in the collection at the Villa Albani near Rome. This I carefully traced from Tatham's Etchings,* and applied my elliptical rule to it, and the result, as shown upon the figure, is a proof that the Grecians at the period of their highest refinement, applied the elliptical curve in a manner similar to that which I am attempting to elucidate. But, indeed, I have scarcely ever met with any specimens of such works that did not exhibit an intimate knowledge and systematic application of the geometric principle of beauty, as well as of the elliptic curve. That this curve is a principal constituent of beauty in outline, there can be no doubt, and from investigations which I may at some future time submit to the public, I am led to believe that the curve which has been found to pervade every part of the outline of the Parthenon at Athens, even to the entasis of the column, is of this nature.

Plate 8. is a general combination of this figure, and in the diagram thus formed, will be found the outlines of the diapers XIX., XX., XXI., XXII., XXVI., XXVII., and XXXIII., as well as many others, which I leave to the student to find out by his own ingenuity.

* Etchings representing the best examples of Grecian and Roman Architectural Ornament, &c. By C. Tatham. London, 1826.

OF COMBINATIONS OF THE STRAIGHT LINE.

Figures composed of straight outlines are of comparatively rare occurrence in Nature, except in the crystallization of salts, acids, some minerals, in the stems of some plants, and occasionally in the trunks of trees. The whole system of geometry, however, depends upon the straight line; and there can be no perfect composition of artistical configuration without a straight line entering into it, either in an understood or apparent manner. For instance, the bend of every joint in the human frame, notwithstanding the curvature of its outline, must be upon an axis of straight lines, which form an angle at a point between the ends of the bones; a regularly waved line must be concave and convex in the same straight line; and the ellipse itself owes its beauty to the circumstance of having a straight line for its centre, which, when of the proper relative proportions, imparts to it that perfect ratio of uniformity and variety already explained.

Figures composed of straight lines may be so formed as to possess in their configuration that uniformity amidst variety that constitutes geometric beauty, even when confined to rectangles; and thus may a monotonous form be converted into an ornamental design. This I shall attempt to illustrate by a series of examples, commencing by exhibiting some errors which, though not uncommon in practice, are sufficiently palpable when pointed out.

Let us take, for example, the front of an edifice forming a horizontally placed rectangle, and suppose it to be put down in a situation where the upper or sky-line appeared tame and monotonous from its not entering into harmonious combination with any other set of objects. Suppose that an attempt was therefore made to render it less so, but that this attempt was restricted to the projection of other three rectangles. Now, let perfect uniformity be applied to this mode of improving the outline, and we have figure 1, Plate 9. This is probably the first idea that would occur to an untutored mind, but that inherent mathematical principle by which external objects operate æsthetically upon the understanding, detects the want of the constituent of beauty, variety, while the disproportion of the height of the additional rectangles is palpable and offensive. They are therefore, as in figure 2, reduced to a proportionate height, while the uniformity remains in every line but that which gave the disproportion just alluded to. The next attempt would naturally be to impart variety to these rectangles, and to the spaces between them, and supposing that with this view they were divided harmonically with different lengths, while in order to combine uniformity with this variety, they were left all of the same height, as in figure 3. This variety has, however, produced relative disproportion amongst these projections, for the centre one, from its increased length, appears too low. It would at first sight appear, that to make it higher than the other two would destroy the requisite uniformity, and so it would were the height not increased by the infusion of another kind of uniformity in place of that which is destroyed. The uniformity thus imparted must be in the diagonal of these projected rectangles, as shewn in figure 4, where these diagonals will each be found to be upon an angle of 10°. Here we have at last in this simple example proportionate variety in the lengths of the various parts, combined with perfect mathematical uniformity in the diagonals of the projections, which uniformity adds the proportionate variety to their height; the former thus lying concealed as in many beautiful objects in nature, while the variety is apparent to the most casual observer. In this last figure the division of the lengths is changed from that of figure 3, being now in the ratios of 1, 3, 6, and 8, instead of 1, 2, and 4.

The combined harmony of rectangles differs from that of their union in outline, in so far as they are then supposed to be inscribed in a general outline with which they must harmonise, and within which they must be in harmony amongst themselves. Such combinations are the rectangular openings in the façade of a building; the pannelling of the ceiling, walls, doors, or window-shutters of an apartment. These may all be made to form ornamental designs, by attention to the harmony of their diagonals relatively to one another, as well as to the spaces that surround them; or they may turn out, as they often do, heterogeneous and discordant mixtures of this particular figure. In plate 10, I have given a harmonious combination of ho-

PLATE 9

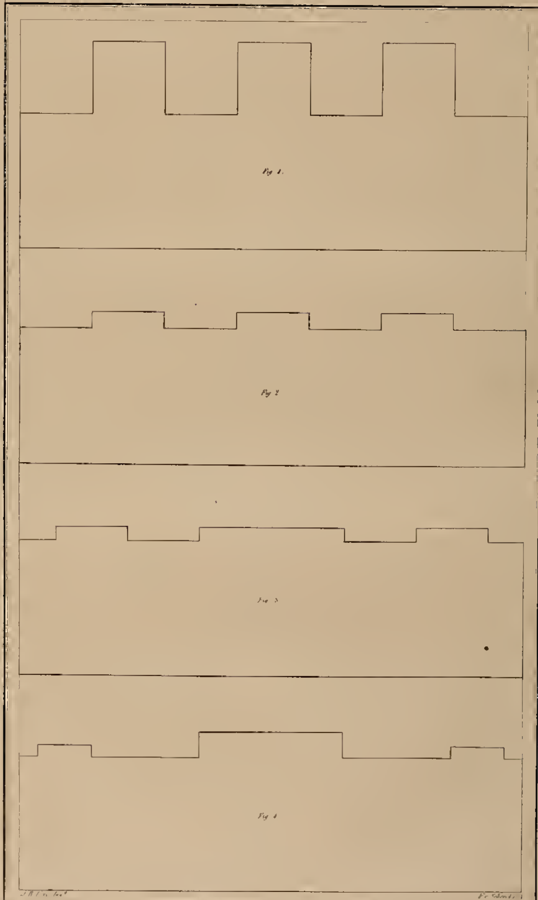

PLATE X

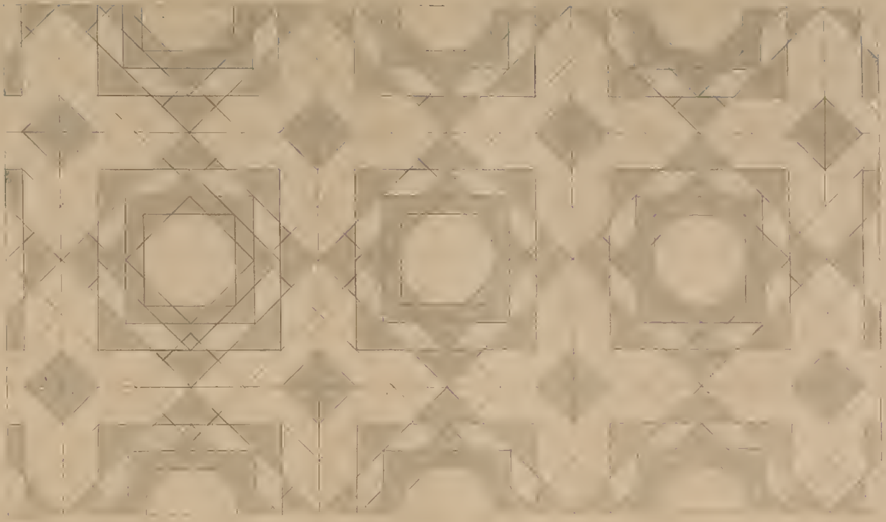

PLATE II.

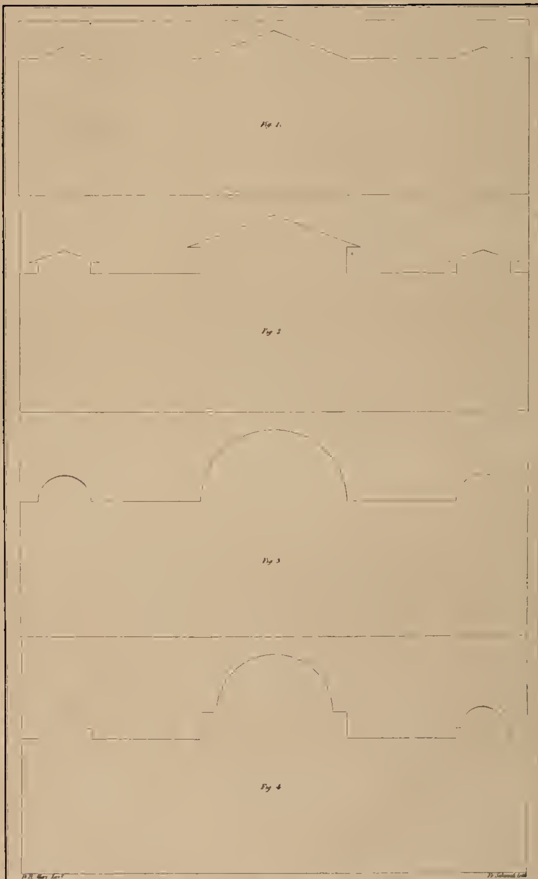

PLATE XII

PLATE XIII.

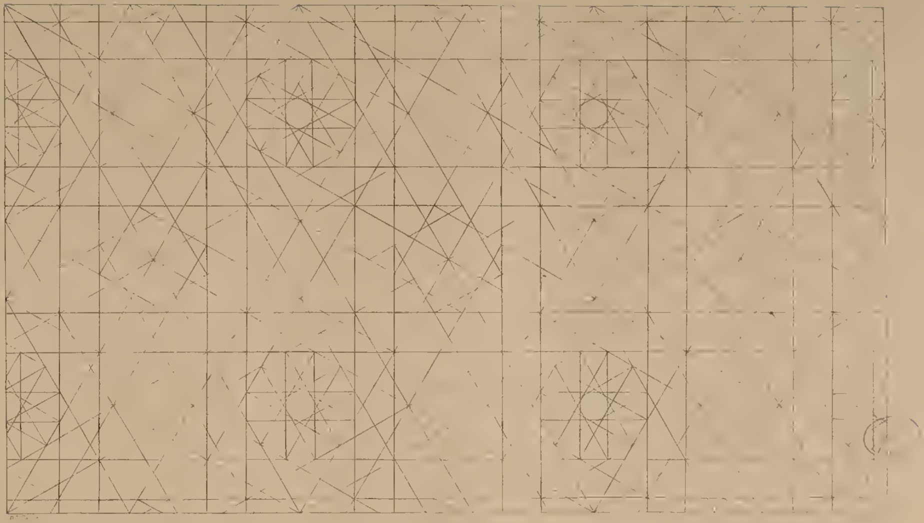

PLATE 14

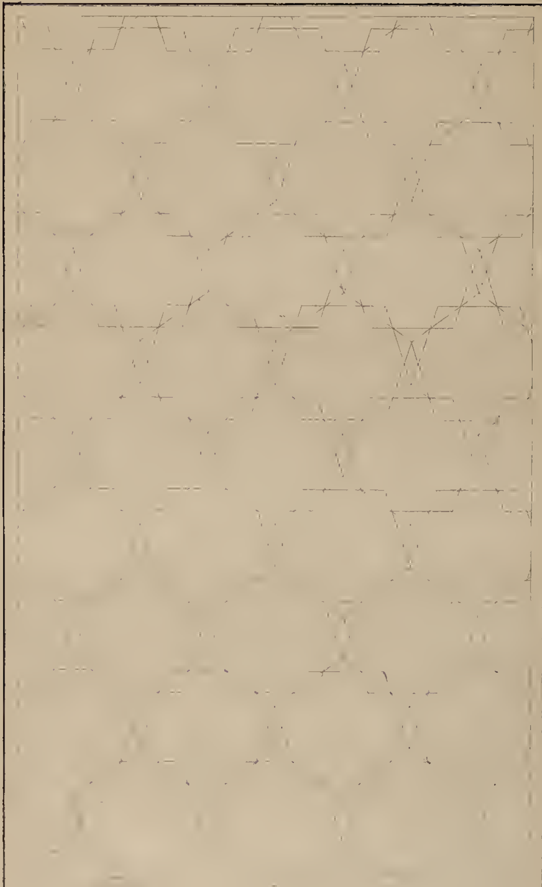

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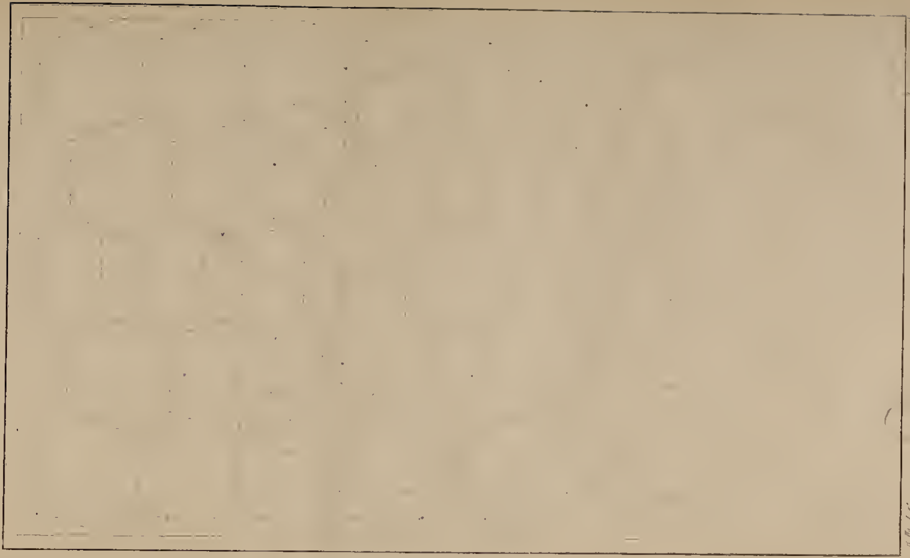
PLATE 15



mogeneous squares. The largest has a perimeter of fourteen inches, within which are placed other two with areas in the ratio to it of 1 to 2. Within these again are placed other two, having each a ratio to the first of 1 to 4 in area, and 1 to 2 in perimeter. From the intermediate squares being joined at their angles, instead of the outer ones, a species of variety is given, arising from the excess in the ratio of their perimeter relatively to that of their area. The arrangement of rectangles of various proportions is, however, a more complex kind of ornamental design, as shall afterwards be shown.

The combinations of straight lines forming acute and obtuse angles follow the same principle in their arrangement, as just explained in regard to the rectangle. Whatever may be the variety of size amongst angular projections, arising from the same straight line in a composition, there ought to be uniformity in the degrees of the angle, as shown in Plate 11. fig. 1. This is more apparent when combined with the proportionate rectangles, fig. 2. It is the same with acute as with obtuse angular projections in this respect. They must be of the same angle when arranged upon the same straight line, for the harmony depends as much upon the imaginary figure generated between two forms placed together, as upon the forms themselves; thus two projecting triangular figures of different degrees of angle, when placed upon the same straight line, generate the discordant figure of an irregular trapezium, by an imaginary line between them parallel to the base.

In Plate 12, I have given a combination of the equilateral triangle upon the principle already explained in regard to that of the homogeneous rectangle.

Plate 13 exhibits a much more difficult combination than any yet given. It is that of the two primary rectilinear figures—the square and the equilateral triangle, the same lines producing arrangements of those very dissimilar forms, as exemplified in those that surround the dodecagon upon this diagram. The various figures that arise out of this combination will afford some scope for the ingenuity of the student.

There yet remains one figure to be noticed, namely, the pentagon. It results from the division of the circle by five, and probably ought to hold in the general series the situation in which I have placed the hexagon; but I preferred the latter figure for the reasons already given. This figure is productive of much beauty when properly arranged, of which the diagrams, Plates 14 and 15 are examples; the former showing its rectilinear mode, and the latter its circular mode of combination. It has, like all other geometrical plane figures, peculiarities connected with solids; but these are apart from the subject of this essay.

My object being to elicit and explain the true principle of beauty in forms and figures, though but with reference to what has been considered a humble department of art, I must continue to appeal to the highest authorities; for the same principle that guides the hand of the professor of high art in his attempts to produce beauty, ought also to guide that of the humble mechanic, who would impart a similar quality to his works, as the same moral principle governs alike the actions of the prince and the peasant. I shall therefore first attempt to ascertain to what principle we may attribute the symmetrical beauty universally admitted to exist in some objects, commencing with the highest authority in nature, the human figure.

OF THE GEOMETRIC PRINCIPLE OF BEAUTY AS EXEMPLIFIED IN THE HUMAN FIGURE.

Vitruvius, amongst other vague ideas regarding the practice of the ancient Grecians in architecture, supposes the proportion of their temples to have been deduced from those of the human body. This supposition is very natural, inasmuch as the human figure is the most truly beautiful work of creation, and the Grecian temple the most scientific specimen of art. But a little investigation will show us that this quality was more likely to have been imparted to the works of the ancient Grecians, through the knowledge of a universal mathematical principle of harmony inherent in the human mind, producing a response to every developement of its laws presented to the senses, whether in sound, form, or colour. Of the developement of this principle, in geometric proportion, the human figure is the highest example in nature, and the Grecian temple the most perfect in art. The variety that pervades all nature is apparent to every one, but the extent of the uniformity that constitutes the beauty of this variety is only ascertained by close observation of its general laws, and by a careful investigation of particular productions. By such means the natural philosopher has been enabled to classify and arrange the objects of his study. By such means also, the relations of the various parts of the universe, and the constituent parts of the chemical combinations throughout nature, have been ascertained. It is precisely so in æsthetical science with regard to configuration. When any object is presented to the eye, its variety is at once apparent, and to a perfect organ and quick perception, its beauty also, if it possess any. But the manner in which the uniformity that constitutes beauty is imparted to this variety, can be perceived only through a knowledge of that governing mathematical law of harmony and proportion, already noticed. The human figure owes much of its beauty to variety, but when we examine carefully the relative proportions of its parts, it will be found that in the most perfect specimens the uniformity is in the ratio of the variety; and farther, that this uniformity amidst variety is produced by the same harmonic ratios that regulate the laws of acoustics and chromatics; but to proceed to the proof.

Let the whole length of a perfect skeleton be divided into 90 parts, the first grand division is from the sole of the foot to the *os pubis*, and it contains 45 of those parts (the ratio to the whole of 1 to 2). The second from the same to the fifth or last *vertebra* of the loins, 60 parts (ratio 2 to 3). The third from the same to the upper bone of the *ster-*

num or breast bone, 72 parts (ratio 4 to 5). From the same to the bottom of the lower *mandible* or jaw-bone 78¾ parts (ratio 7 to 8). From the same to the top of the same bone, 80 parts (ratio 8 to 9). From the same to the top of the *os ileum* or flank bone, 54 parts (ratio 3 to 5). From the same to the bottom of the *os sacrum* or great bone of the spine, 48 parts (ratio 8 to 15). From the crown of the head to the bottom of the *patella* or knee bone, 67½ parts (ratio 3 to 4). From the crown of the head to the bottom of the first *vertebra* of the back, and from the top of the *os sacrum* or great bone, of the spine, to the *atlas* or uppermost *vertebra* of the neck, are each 30 parts (ratio 1 to 3). From the bottom of the *os pubis* to that of the *patella*, and from the bottom of the *patella* to the sole of the foot, each 22½ parts (ratio 1 to 4). From the crown of the head to the bottom of the first bone of the *sternum*, from the *os pubis* to the first *vertebra* of the back, from the *clavicle* to the lowest rib, and from the top of the *humerus* or large bone of the arm to its junction with the *ulna* and *radius*, each 18 parts (ratio 1 to 5). From the *os pubis* to the top of the fifth or last *vertebra* of the loins, and from the crown of the head to the twelfth or last *vertebra* of the back, are each 15 parts (ratio 1 to 6). The fore-arm, from where the *ulna* and *radius* join the *humerus* to their union with the lunar bones of the wrist, is about 13 parts (ratio 1 to 7). The length of the facial surface from the crown of the head to the point of the chin, the length of the sternum or breast bone, and the vertical length of the *pelvis* are each 11¼ parts (ratio 1 to 8). The *cranium* from its highest point to where it joins the *atlas*, is 7½ parts (ratio 1 to 12).

The parts of the human body are no less remarkable for the harmony of their subdivisions. In the arm the *radius* and *ulna* are to the *humerus* in the ratio of 2 to 3. The hand, from the wrist bone to the point of the longest finger, is to the whole length of the arm (hand included) in the ratio of 1 to 4. The length of the foot is to the length of the leg, taken from the sole of the foot to the head of the thigh bone, in the ratio of 1 to 4. The division of the human countenance into the harmonic ratios is equally worthy of notice in this place. On the transverse diameter, from the crown of the head to the centre of the eye, is in the ratio of 1 to 2 of the whole length. From the same to the point of the nose, 3 to 4; and to the mouth, 5 to 6. From the point of the chin to the mouth, 1 to 6; to the nose, 1 to 4; to the centre of the eye, 1 to 2; and to the setting on of the hair, 5 to 6. Upon the conjugate diameter, the eye, the width of the nose and the mouth are as 1 to 5. But these ratios of the countenance I have given in detail, and with illustrations in another work.* Every minutiæ of the human figure is full of this species of harmony. The eye itself in its division into the parts by which its extraordinary functions are performed, displays it in an eminent degree, as I have already endeavoured to show.†

* "Laws of Harmonic Colouring," 5th edit. W. Orr & Co. London.

† "Proportion or the Geometric Principle of Beauty Analysed." Blackwoods, Lond. & Ed.

The ratios in the human body are in the order of their simplicity as follow:— Ratios.		These Ratios in the pulsations of the atmosphere, produced by similar divisions of the monochord, are called,
1 to 2	....	An octave.
1 ... 3	....	A twelfth.
1 ... 4	....	... fifteenth or second octave.
2 ... 3	....	... fifth.
1 ... 5	....	... seventeenth.
1 ... 6	....	... nineteenth.
3 ... 4	....	... fourth.
1 ... 7	....	
3 ... 5	....	... sixth.
1 ... 8	....	... twenty-second or third octave.
4 ... 5	....	... third.
5 ... 6	....	... third minor.
1 ... 12	....	... twenty-sixth.
6 ... 7	....	
8 ... 9	....	... major tone or second.
8 ... 15	....	... seventh.

To some this may appear a rather unnecessary digression, but believing that in investigations of this kind, where first principles are traced to the highest works of the Deity, the student in ornamental design will take a deep and profitable interest, I shall follow it up with a few farther remarks.

At first sight it may appear strange, that there should be fixed rules for the beauty of what nature produces in such infinite variety. But it is well known in art that there is a standard of perfection for the proportions of the human figure, rarely if ever found in any individual, and that the statues of ancient Greece display an approximation to this standard hitherto unattained in any other similar works of art. This, I believe, is what is understood by the *beau ideal* of the ancients. Sir Joshua Reynolds and many other writers on art, suppose that it was attained by selecting parts from various models in nature, and combining them in one individual; and this has been almost uniformly recommended to the student in art, as the best mode of arriving at the same degree of perfection. Such a mode of combination is, however, not only very difficult and uncertain in its results, but unnatural. Beauty is the truth of art, and, like moral truth, it is embodied in one universal governing principle. This principle ought to be familiar to the artist, and according to the amount of intuitive genius he may possess, will it appear in his works, as the moral principle of integrity produces the greatest effects when combined with high talent, and a wide sphere of action.

Now, it is well known, that in the operation of the moral principle of truth in producing rectitude of conduct in mankind, there exists as much variety as there does in the human countenance; but no one would assume from this, that there existed no standard of excellence, even although that standard may never have been attained by any individual. Copying parts from various figures, in order to produce a perfect whole, is in art what imitating the good actions of other individuals, without any governing principle, would be in morals. I shall now proceed to inquire into the operation of this geometric principle of beauty in what may be justly considered the highest authority in art.

OF THE GEOMETRIC PRINCIPLE OF BEAUTY, AS EXEMPLIFIED IN THE PORTICO OF THE PARTHENON.

The proportions of this portico have for many ages excited the admiration of mankind, and are still referred to as the most perfect example of this kind of beauty known in architecture. It is therefore a subject of some interest to inquire into the nature of those proportions, and especially to ascertain how far they are governed by the same principle of ratio just exemplified in the human figure. The two subjects are quite dissimilar in their general contour, there being no conceivable likeness between a Grecian portico and a human figure. But the beauty of their proportions are traceable to a similar principle differently applied. In the human figure it has been shown that the proportions consist in the division of an imaginary or mathematical straight line passing through the centre of the leading bones in the skeleton; and in the portico the operation of the same principle of harmonic ratio, will be seen upon the imaginary line called the diagonal in each of those rectangles which, combined together, form what may be fairly termed its skeleton, as shown on Plate 16. But it is not in the various lengths of these diagonal lines that we are to look for the developement of the harmonic ratios, but to the degrees of the angle they form with the longest side of each rectangle, which of course, when vertically placed, must be above, and when horizontally placed, below 45°; and the following is the result.

The entire portico, from the extreme of the base of the outer columns to the upper point or apex of the pediment is inscribed in a rectangle, the diagonal of which is 30°, bearing to the angle of 45°, the ratio of 2 to 3, and to the angle of 90°, that of 1 to 3.

The angle of the pediment itself is 15°, bearing to the diagonal of the inscribing rectangle the ratio of 1 to 2; to the angle of 45°, that of 1 to 3; and to the angle of 90°, that of 1 to 6.

The diagonal of the rectangle under the pediment inscribing the columns with their architrave and frieze is 22° 30′, bearing to the diagonal of the inscribing rectangle, the ratio of 3 to 4; to the angle 45°, that of 1 to 2; and to the angle 90°, that of 1 to 4.

The diagonal of the rectangle inscribing the columns is 18°, bearing to the diagonal of the inscribing rectangle, the ratio of 3 to 5; to the angle of 45°, that of 2 to 5; and to the angle of 90°, that of 1 to 5.

The diagonal of the rectangle inscribing the architrave and frieze is 5° 37′ 30″, bearing to the diagonal of the inscribing rectangle, the ratio of 3 to 16; to the angle of 45°, that of 1 to 8; and to the angle of 90°, that of 1 to 16.

The rectangles of the six centre columns, which I have taken at their mean diameter, have each a diagonal of 80°, bearing to the angle of 90°, the ratio of 8 to 9; and the five intercolumniations between these have each a diagonal of 75°, bearing to those of the columns, the ratio of 15 to 16, and to the angle of 90°, that of 5 to 6.

The rectangles of the two outer columns and their intercolumniations have diagonals of 78° 45′, being to the right angle in the ratio of 7 to 8.

The two outer columns, with their intercolumniations, are necessarily out of harmony with those that lie between them, for the ratio of 78° 45′ is to 80° as 23 to 24, and that of 78° 45′ to 75° as 63 to 62, ratios too far removed from the primary elements to have a harmonious relation. But the circumstance of these outer columns being of greater diameter than the other six, is well known to have arisen from a knowledge of the fact, that any upright object placed between us and the sky will appear more slender than when placed against a background in shade. As these outer columns of the portico were so situated, while the other six could only be viewed against the inner portion of the building, it became requisite to increase their diameter, the discord being neutralised by this optical illusion.

From the same cause that a solid body appears more slender than it really is when viewed against the light, an open space seen between two solid bodies appears wider; and this assists in harmonising the two outer intercolumniations.

The harmonic ratios of the Parthenon are in the order of their simplicity as follow:— Ratios of	Names of those ratios when applied to the vibrations produced by the division of the monochord.
1 to 2	An octave.
1 ... 3	A twelfth.
1 ... 4	... fifteenth or second octave.
2 ... 3	... fifth.
1 ... 5	... seventeenth.
1 ... 6	... nineteenth.
2 ... 5	... tenth.
3 ... 4	... fourth.
3 ... 5	... sixth.
1 ... 8	... twenty-second or third octave.
5 ... 6	... minor third.
1 ... 16	... twenty-ninth or fourth octave.
8 ... 9	... major second or tone.
3 ... 16	An eighteenth.
15 ... 16	A semitone or minor second.

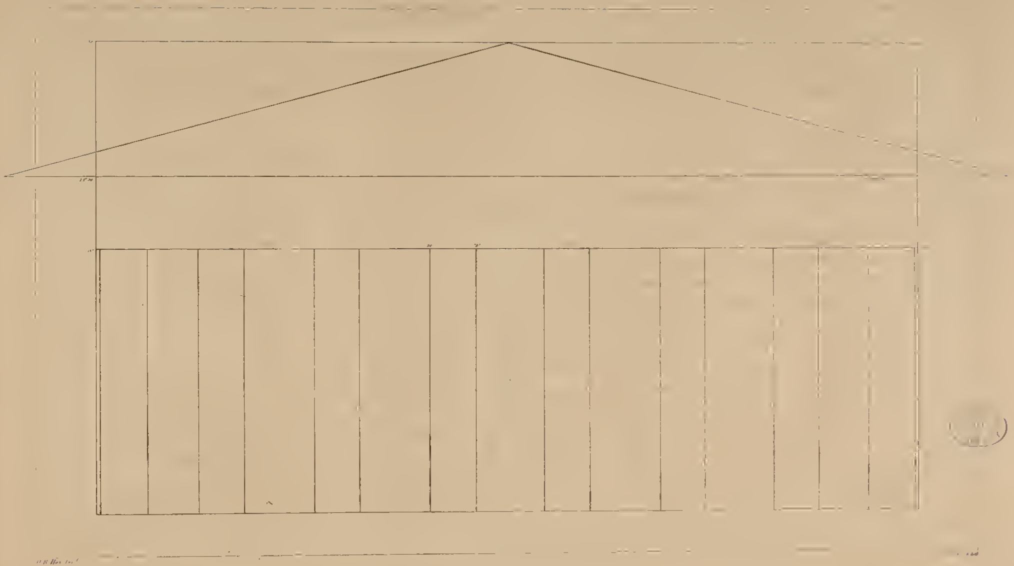
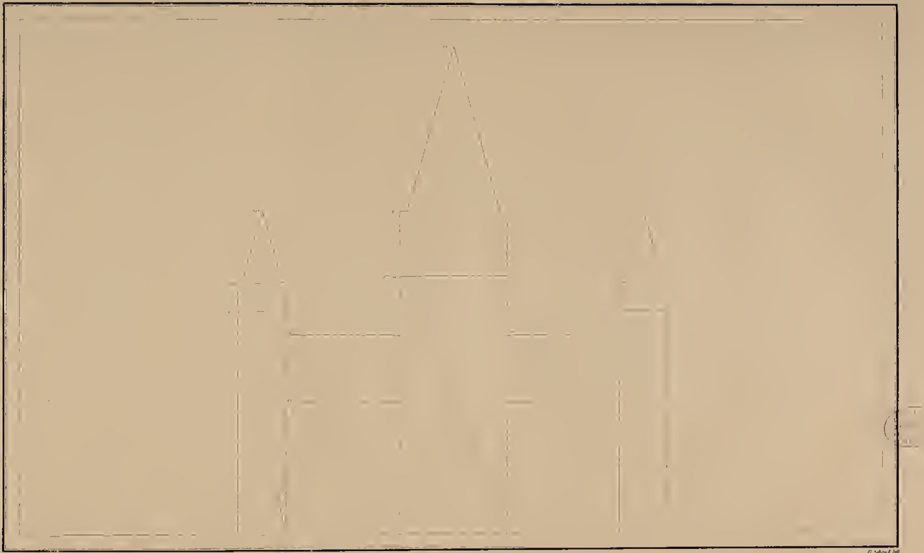


PLATE 17



R. A. Hay Inv.t

P. Schraag Lith

It may here be interesting to see what effect the harmonic ratios thus found to exist in the Parthenon, will have when applied to a vertical composition. Plate 17. exhibits such an arrangement, which might probably act as the geometric skeleton of a Gothic structure, thus affording in the requisite subdivisions of these elementary parts into doors, windows, buttresses, &c. ample latitude for the introduction of harmonious accompaniments to this general outline. The following are the angles of these diagonals with their relation to those of the Parthenon.

Parthenon, Plate 16.			Plate 17 with its ratios to 90°.		
15°	horizontal	corresponds to	75°	vertical	5 to 6
18°	....	....	72°	....	4 ... 5
22° 30′	....	....	67° 30′	....	3 ... 4
30°	....	....	60°	....	2 ... 3
80°	vertical	....	80°	....	8 ... 0
75°	....	....	75°	....	5 ... 6
78° 45′	....	....	78° 45′	....	7 ... 8

The ratios in the portico of the Parthenon are agreeable to the dimensions of the elevation in Stewart's Athens, as given in Plate VI. of that work. But as the angle of the pediment in Plates VI., VII., and XV. all differ, I adopted that of the latter, as being the most likely to be correct, because the pediment is there given by itself.

OF COMBINATIONS OF THE CURVED AND THE STRAIGHT LINE.

Hitherto the combinations of figures and lines treated of in this Essay, have been confined to those of a similar kind, that is, curvilinear with curvilinear, and rectilinear with rectilinear figures. It now remains to be shown how those two kinds of lines, and the figures resulting from them, may be harmoniously united in ornamental design.

The rules by which each of those classes of lines and figures have been shown to combine amongst themselves individually, must be observed in their union with one another. It has been shown that two curved lines can only meet each other harmoniously in the same straight line; so, to unite a straight line with a curved line in successive harmony, they ought also to be made to meet each other in the same manner. This mode of combination ought to be observed in the forms of all apertures in solid surfaces, which are intended to be rendered ornamental by means of the combination of those two kinds of lines. No doubt an ornamental appearance is often attempted to be given in such cases by placing horizontally upon vertical lines, a smaller arc of a circle than its half, but the effect is discordant, and such a mode of combination need never be resorted to, while the elliptic curve upon its transverse diameter, whatever its proportion may be, will, when placed horizontally upon vertical lines, meet them harmoniously.

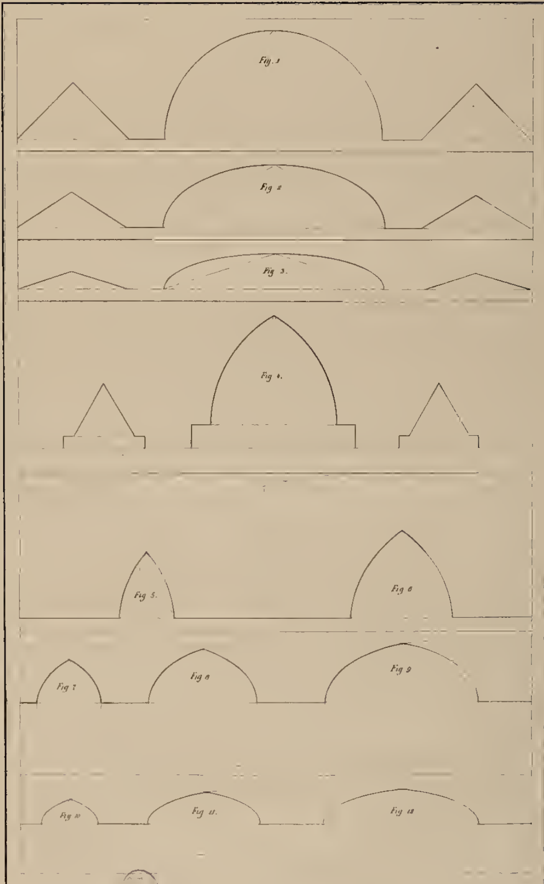
In like manner, curvilinear figures, when projected from a straight line, in order to produce perfect harmony of opposition or contrast in the outline of any object, ought to meet the straight line at right-angles, and here likewise all projections under a semicircle ought to be elliptic. When, on the other hand, the curvilinear figure exceeds a semicircle in height, it must be formed of two smaller arcs, either of the circle or ellipse, and consequently have an angle, its summit being pointed. This necessity seems to arise from the nature of the elliptic curve preventing its being used vertically in the formation of any such figures. The principal cause of this is evidently its exuberance of curvature towards the extremity of the transverse diameter; but it would exceed the limits, and be apart from the object of this Essay, to enter upon the discussion of this point here, and I therefore beg the student in the meantime to take it for granted.

On Plate 11. figure 3, is placed three semicircles of harmonic relative proportions, and at harmonic intervals, upon a straight line; yet the curves are not proportionate in comparative quantity to the straight line. This defect is at once removed by adding to the composition those three harmonic rectangles, given in Plate 10. figure 4, the nature of which has been already explained. Figure 4, Plate 11, exhibits this proportionate combination of the straight and the curved line with the right angle; and this figure is worthy of some attention from the student. He will in it observe that the projected semicircles necessarily follow a law which always proportions their height to their length; for their radii are to them what the diagonals are to the rectangles upon which these semicircles are placed. These are proportions arising from necessity, because the figure is formed by the motion of the line which gives them; and the proportions of the rectangle may be naturally deduced from these, because the diagonal is the only single line within that figure that can regulate its proportions.

Triangular figures, when arranged upon the same base with curvilinear figures, ought to be in exact proportion to these in their configuration, whatever their relative sizes may be. The mode of doing this is exhibited in Plate 18. figures 1, 2, and 3. When the angle of an isosceles triangle exceeds 45°, the curvilinear figures to be associated with it as a projection from the same line, or even in the same composition, must also be angled, for the reasons just stated in regard to the exuberance in the curve of the semi-ellipse produced upon the conjugate diameter. Arcs of a circle have been hitherto employed in such cases, of which those of a sixth of the whole circumference produce the most beautiful figure. Such an angled curvilinear figure has exactly the proportions of the semi-ellipse already referred to' without the exuberance towards its apex, and it consequently associates with the equilateral triangle.

Figures of this kind, however, would be improved in the ratio of the

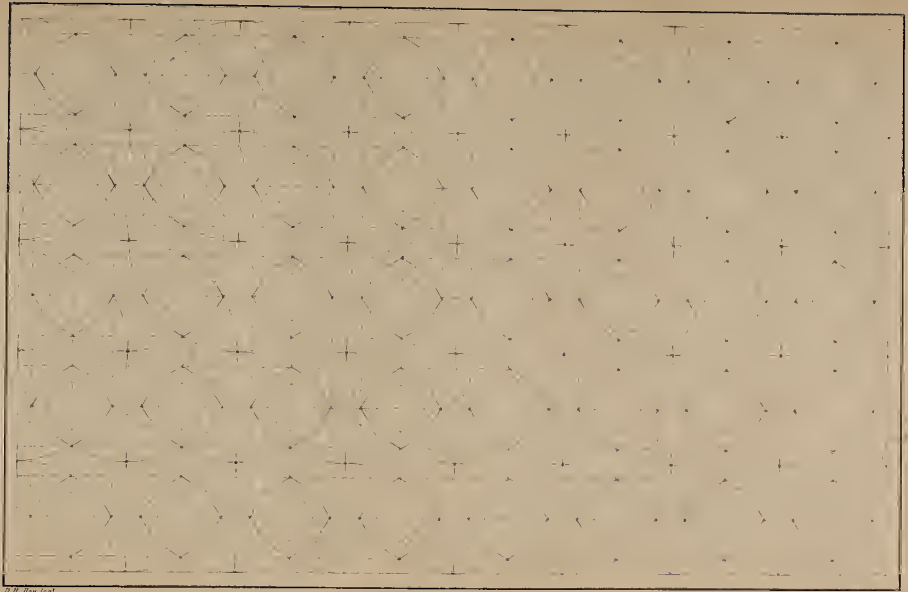
PLATE III.



D. R. Hay, Inv.

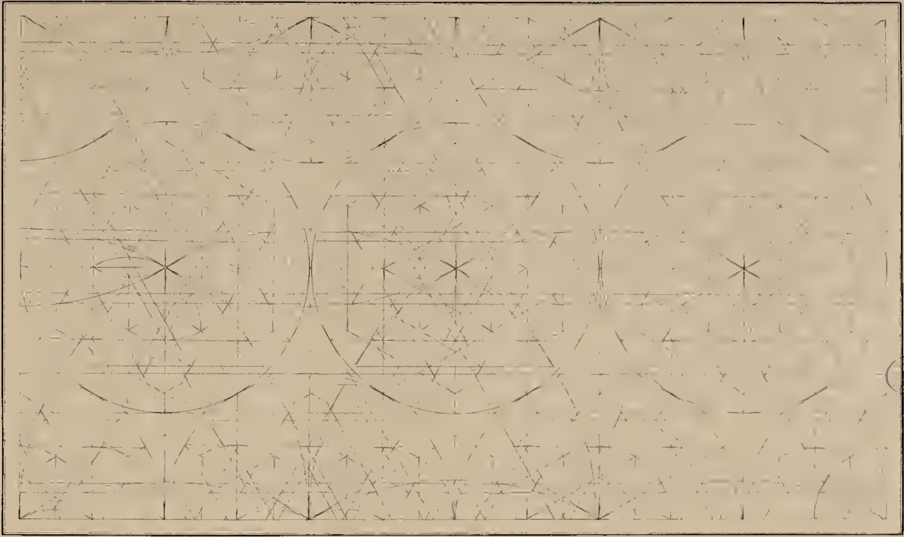
Schenck & Macdonald, Lith.

PLATE 19



D R Hay Invt

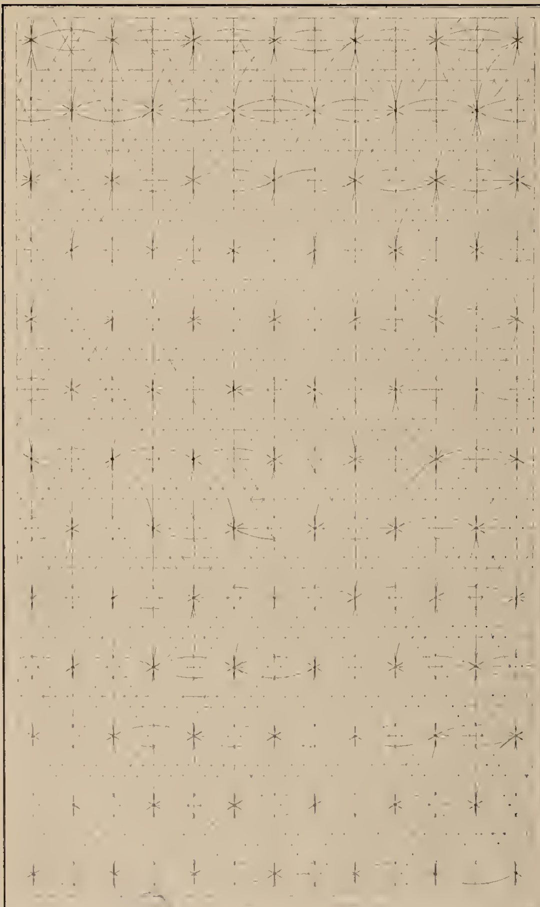
PLATE 20



D. R. Hay inv.

Maclure & Macdonald lith

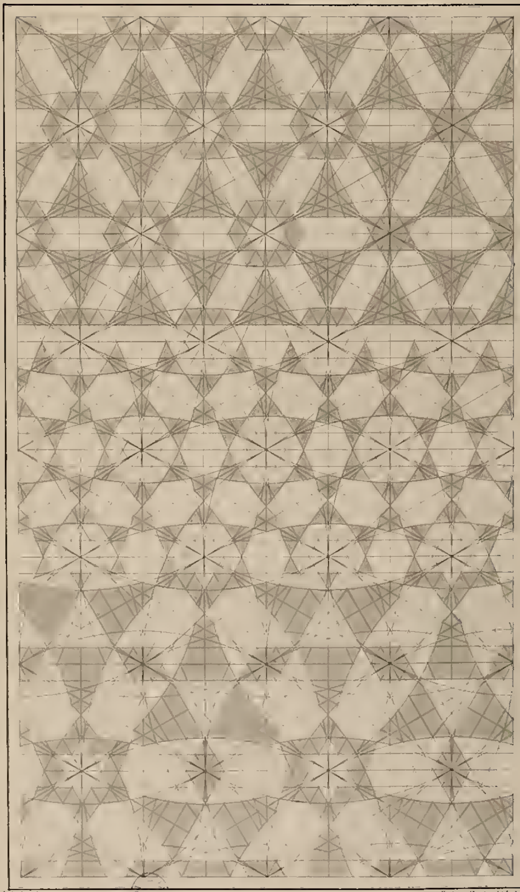
PLATE 21



D R Hay fec.

Maclure & Macdonald l.

PLATE 22.



D R Hay Inv. Maclure & Macdonald Lith.

increased variety imparted to them by a diminution of their curvature as they approach their apex. Figure 4 is excelled in beauty by figure 6, because its curve being elliptic, it has that variety amidst uniformity that constitutes the true principle of beauty already explained. This figure will, therefore, whether vertical or horizontal, be always more beautiful when formed by arcs of the ellipse united upon its transverse diameter, than by arcs of circles, as exemplified in figures 5 to 12. To produce similar figures in architecture, it is not unusual, I am aware, to unite in one line arcs of circles of different radii; but combinations of this kind are unnatural and inharmonious. There may be in the constructive portion of the science of that art, substantial reasons for using in all pointed arches arcs of the circular curve in preference to those of the elliptic curve, and if there really be such reasons, the true principle of beauty must, in this particular instance, continue to be sacrificed to utility.

In Plates 19, 20, and 21, are given diagrams of various combinations of the straight and the circularly curved line. In Plate 19, will be found the outlines of the diapers numbered XXIX. and XXX; in Plate 20, the outlines of I., III., IV., VI., VII. VIII., IX., XII., and XIII; and in Plate 21, the outlines of II., V., X., XI., XIV., XV., XVI., XVII., XVIII., XXIII., XXVIII., and XXXI. Many other designs of this kind can be taken from these diagrams, and they may thus afford profitable amusement to the student. Plate 22, is another combination of the straight and curved line, upon which three geometric diapers are marked, in order to show the mode of producing this peculiar kind of ornament.

In Nature we often find the straight and the curved line beautifully associated, especially in the manner in which the branches of some plants leave their parent stems. But it is not consistent with the infinite variety that pervades all her works that there should be mathematical exactness in every case, or that there should be an equality of beauty amongst individual objects of any class of combinations; it is enough that the general or governing principle appears to operate, while the extent of its influence is continually varying. A knowledge of the modes in which this principle operates upon the perceptive faculty, forms the true science of æsthetics. The results of a proper study of this science, are a just appreciation of what is most beautiful amidst the variety of Nature, and a correct judgment as to works of art, while it assists the artist not only in selecting objects of study, but in imparting beauty to his works. At the same time, it must be acknowledged, that no absolute perfection can be attained in productions of art, because, as before observed, although the mathematical principle that governs æsthetics, like the principle of truth that governs morals, be perfect in itself, as emanating from the Deity, yet its operation in art is applied through an imperfect medium. So that our attempts in this way, as in moral rectitude, will be after all but humble approximations to perfection. It will therefore be in the ratio of the general diffusion of a knowledge of their first principles that we will be able properly to appreciate and practise the arts of design.

ON THE DECORATIVE ORNAMENTS OF ANCIENT GREECE.

We find in the decorative ornaments of ancient Greece, the same chaste beauty that pervades its statuary and architecture, and this is evidently not imparted to those works by any servile copying, even of any of Nature's productions, but by the application of a mathematical principle, which enabled its artists to every case to treat form in the abstract; or, if I may use the term in this humble Essay, in a philosophical manner. Indeed, I believe it probable, that the learned have found the philosophy, as well as the poetry of the same period, displaying an equal adherence to high governing principles, uncontrolled by dogmas and precedents, and thereby forming the closest approximations to perfection, combined with the greatest simplicity, ever exhibited in the intellectual efforts of the human mind.

Many remnants of the decorative ornaments of ancient Greece have survived the ravages of time, the dilapidations of hostile invasion, and no less destructive effects of ages of barbarous possession of the country. These remnants are now carefully preserved in many public and private collections throughout Europe, and have been carefully copied by travellers, the accuracy of whose artistical labours may be fairly depended upon. Amongst the most prominent of these enterprising artists are Tatham, Kinnard, and Donaldson, from whose works I have copied the examples in Plate 23. Figures 1 and 2, are from Tatham's work. The first is from an antique fragment of a Grecian frieze in the Villa Albani near Rome, and represents one of the most beautiful specimens of this peculiar style of decorative ornament that I have met with. The second is half of the side of a seat of Parian marble in a chapel near Rome.

Figure 3, is from the Supplement to Stewart's Athens, by Mr Kinnard. It is the top of a sepulchral marble, inscribed to the memory of an Attic citizen, of a town at a defile of Mount Parnes, of great importance during the Peloponnesian war. It is remarkable from its contour being formed of two arcs of an ellipse, and for the characteristic elegance of the ornament which it inscribes.

Figures 4 and 5 are the only two curvilinear ornaments of the Parthenon. The first being one of the ornamental apices termed antefixæ, anciently placed over the horizontal cornices, and the second is upon the soffit of the cornice.

Figure 6 is from Mr T. L. Donaldson's supplement to Stewart's Athens, and appears to be the production of a later period than any of the other specimens given. In it there appears less accuracy of style, with more exuberance of fancy, and it may be taken as an example of one of the first steps from that severity that distinguishes the more classical specimens of attic ornament, to the more florid style that succeeded it.

PLATE 43

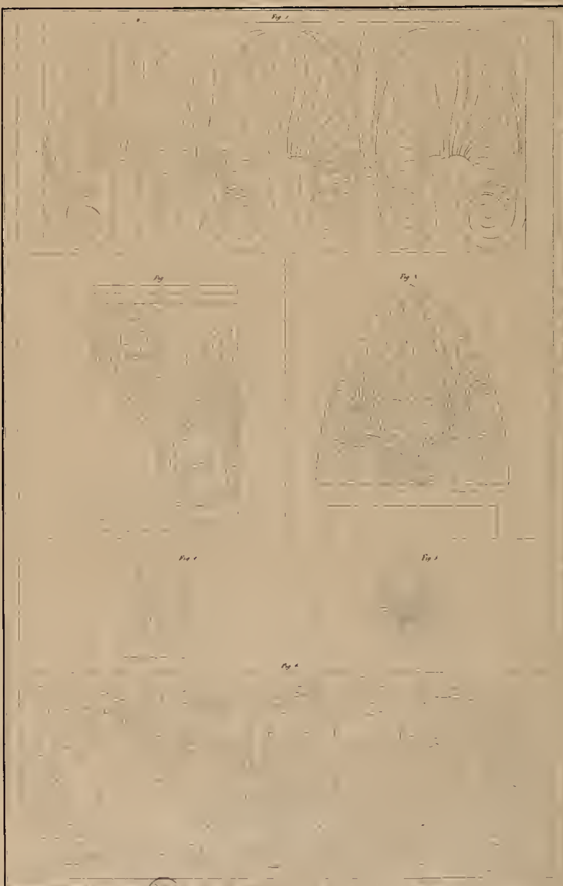
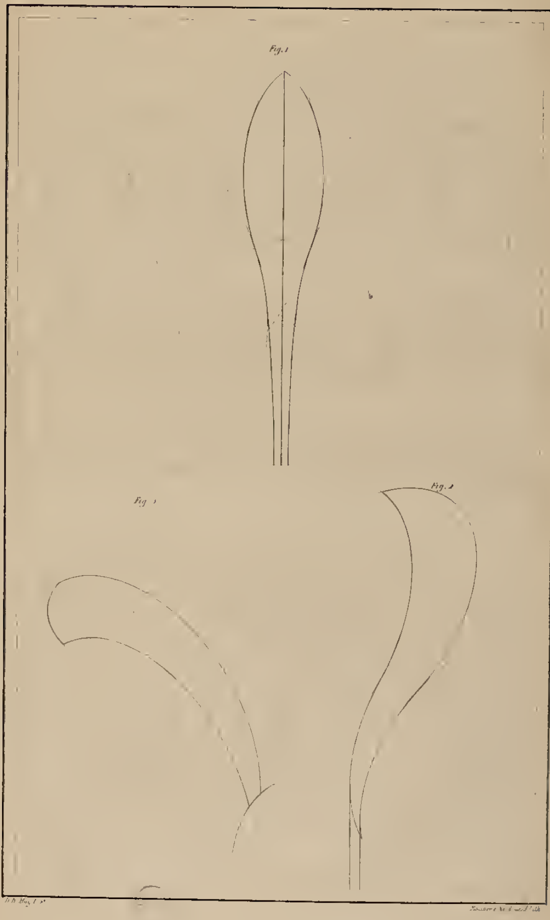


PLATE 24



These examples are selected as giving fair specimens of the general characteristics of this classical style of decorative ornamental design. And it will be observed, that amongst them the peculiar figure generally called a "Honeysuckle ornament," holds a prominent place; upon the beauty of which figure it would be a waste of words to expatiate. I agree with Mr Kinnard in believing that it was no direct imitation of that plant, neither do I conceive that it has any particular prototype in nature, but is simply the result of the application of the same general principle attempted to be developed in this Essay, upon which form may be treated abstractly in the production of beauty. To those who wish to gain a learned, historical, and critical knowledge of this peculiar style of ornament, apart from the application of this æsthetical principle, I would recommend the perusal of the two excellent Essays of Kinnard and Donaldson, my object here being simply to develope the existence of such a principle in its construction.

In Plate 24, ocular demonstration is given of the fact, that the beauty of this figure arises from its being the combination of the elliptic curve with a straight line. Figure 1 is the centre part of one of those ornaments, figure 2 one of the side parts, and figure 3, one of the parts of the antefixæ of the Parthenon.

From these figures it will be seen, that a complete ornament of this kind has as its centre a straight line, from which diverges on each side elliptic curves, becoming gradually more acute, until they reach on either side the outer line of the spiral curve that proceeds from a circular point. We have, therefore, in this single ornament, the two most beautifully varying curves, proceeding from the two primary mathematical figures, the point and the straight line, so associated that they proceed from the one until they are resolved into the other.

In geometry there are many varieties of the spiral curve, with rules for their formation. But the most beautiful, and that which is most useful in ornamental design, is what is called the spiral of Archimedes. It is so called from his demonstration of its nature, by which it is proved that if the arc of a circle be divided into any number of equal parts, and radii drawn from the centre to these points, the spiral line commencing at the end of one of those radii, where it proceeds from the centre point of the circle, and ending at its other extremity, will divide all the intermediate radii in arithmetical progression of 1, 2, 3, &c. of similar parts, as it recedes from the centre. But the simple mode of producing this line is, by unwinding a thread from a cylinder with a pencil at its end, by which the curve will be accurately described. Its beauty is somewhat like that of the ellipse, depending upon the uniformity of its variety, which property it receives from a continual and uniform increase of its radii.

This curve, associated with the waved line, is a leading feature in all foliated ornaments, many beautiful examples of which, taken from fragments of ancient sculpture, will be found in the works just alluded to. But these seem generally to belong to the Italian style of ornamental design, in which it would appear the elliptic curve fell into disuse even in the contour of mouldings, and other architectural adornments.

The decorative ornament of ancient Greece may therefore, with perfect propriety be termed "a style," as it embodies a principle of pure geometric beauty, for which there existed in art no precedent, and which unfortunately has been lost to succeeding ages. To copy the fragments that still exist of this pure style, without inquiring into the principle upon which its beauty depends, has been too long the practice in our schools of design, and the futility of such a practice is exemplified in the total want of originality, combined with classic beauty, that still prevails in this as well as in other countries.

ON THE DECORATIVE WORKS OF RAPHAEL.

What are erroneously termed the "arabesques" of Raphael, are perhaps the most beautiful series of painted decorative ornaments now in existence. But "arabesques" they are not. The "arabesque," or moresque," species of ornament, is that particular kind of diaper design, whether painted or carved, applied to the enrichment of flat surfaces, and is composed of combinations either of geometrical figures, or of the representation of objects in inanimate nature.

But the decorative works of Raphael in the Loggie of the Vatican take a much wider range of art. They embrace allegorical subjects of the highest class, expressed by exquisite delineations of the human figure, varied by every age, and every grade, all equally expressive of the sentiment they are intended to inspire, despite the fanciful and even grotesque situations in which they are generally placed. These works embody also the most beautifully ornamental combinations of the lower grades of animate nature, and are no less remarkable for their graceful embodiment of her foliated productions. In these latter, the scientific combinations of the straight with the spirally curved line are most conspicuous, while the geometric division of the various parts are generally harmonious and accurate. These are the natural results of such a genius as that of Raphael; but whether from his having allowed his fancy at times to run riot, or from his assistants having been allowed in some cases to exercise their own peculiar fancies, there are chimeras and absurdities introduced, which cause these great works to bear an analogy to the more correct works of the ancient Grecians, similar to that which some of the poems of Byron bear to those of Homer.

The student in ornamental design should therefore be cautious in his selection of objects of study from the works even of this great artist. And I consider this caution the more requisite, from having repeatedly seen those objectionable parts selected for imitation in what is usually misnamed an "ornamental design."

ON THE MOST SIMPLE MODE OF ATTAINING THE POWER OF GRAPHIC DEFINITION.

An experience of thirty years in such matters has convinced me that a much more accurate idea can be given of the configuration of an object, by a few tolerably correct lines, in five minutes, than it would take in ordinary cases half an hour to describe. I would therefore recommend to the employer who wishes to express his ideas of form distinctly, as well as to the artist who is to put such ideas into execution, that, in addition to the attainment of a knowledge of principles, they should each acquire the power of thus expressing themselves. Such a facility is as useful to the nobleman as to the artizan, for it often happens that the style of language in which they individually attempt to explain their ideas of such matters to each other, is to a certain extent, reciprocally unintelligible, while the import of a few geometric lines could at once be comprehended, and an understanding brought about which words might fail to establish.

The mode by which this facility may be attained is more simple than is generally supposed; indeed, so much so, that it might be taught to children along with the alphabet. It is as follows:

Let a large black painted board be provided, upon which the drawing with white chalk of circles, equilateral triangles, squares, ovals, rhombs, oblongs, and hexagons should be separately practised on as large a scale as the length of the arm will allow, and with no more separate motions than there are angles in the figure. This must be performed with as little motion of the body as possible, and without any guide to the hand but the eye. Let this practice be continued till each of the above figures can be so produced with a tolerable degree of accuracy, when the practice may be changed to the production of the various waved lines of the circle and ellipse, their combinations with the straight line, and lastly the spiral. A degree of accuracy of hand and eye will thus be secured, which will not only infuse itself in a striking manner into every more minute production, but must be a surer means of developing latent talent, than that generally employed in our schools of design, namely, of setting boys to copy, on a small scale, what they do not understand, like so many humble transcribers of ancient manuscripts.

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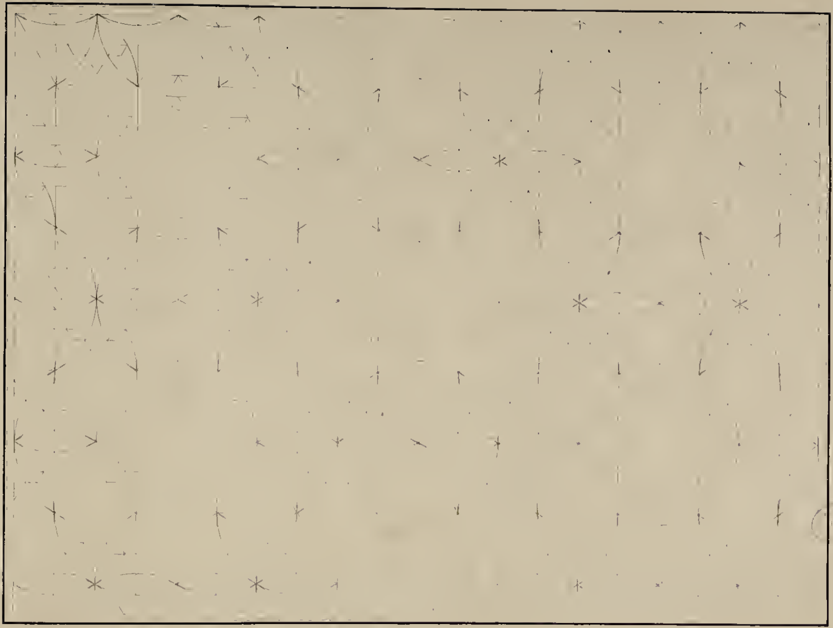
31 EAST ROSE LANE.

I.

R. Hay Inv^t

[illegible] & Macdonald sc.

II.



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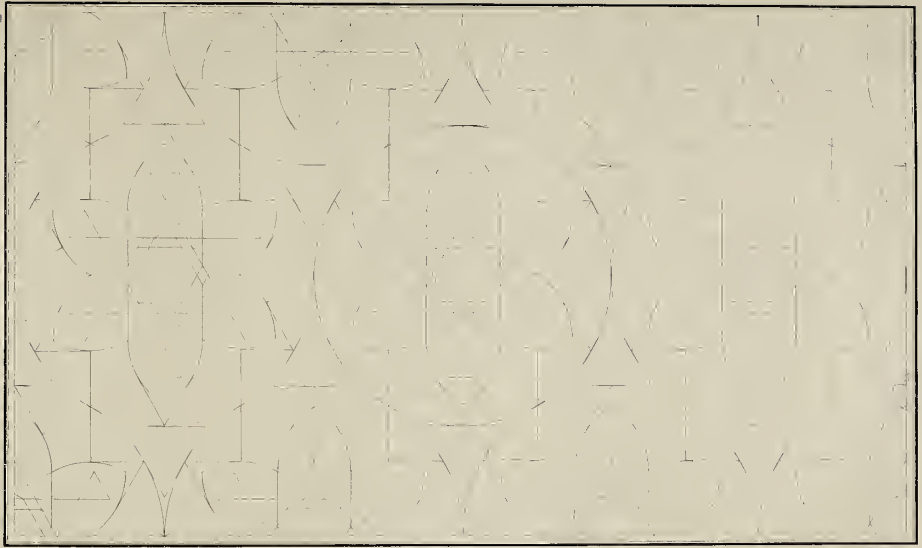

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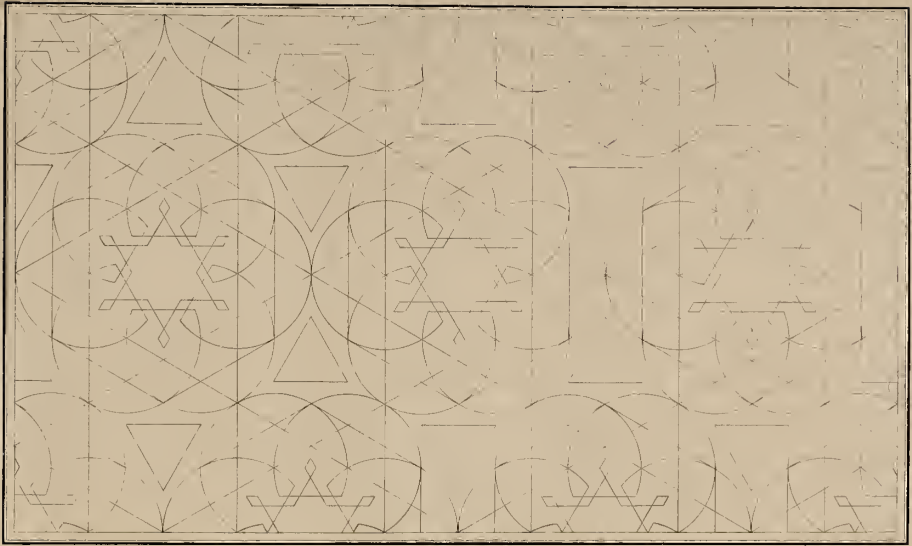

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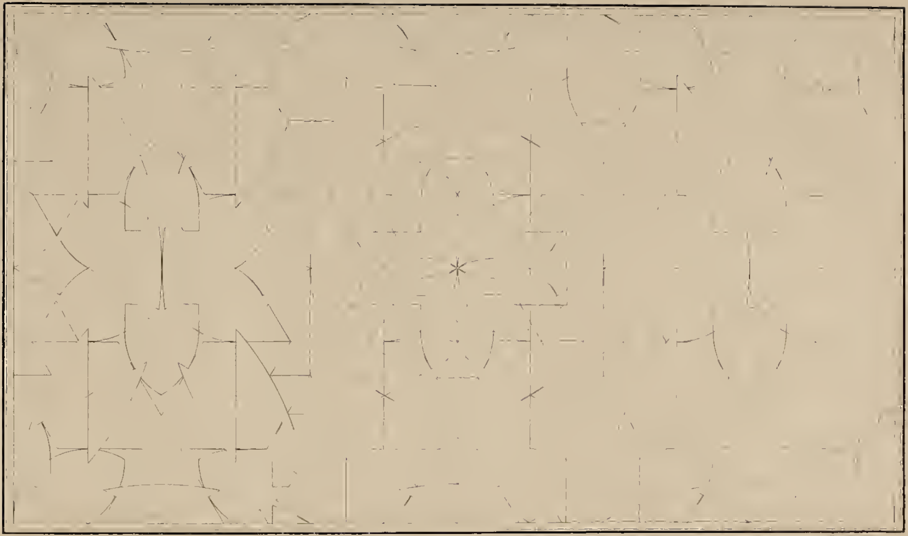

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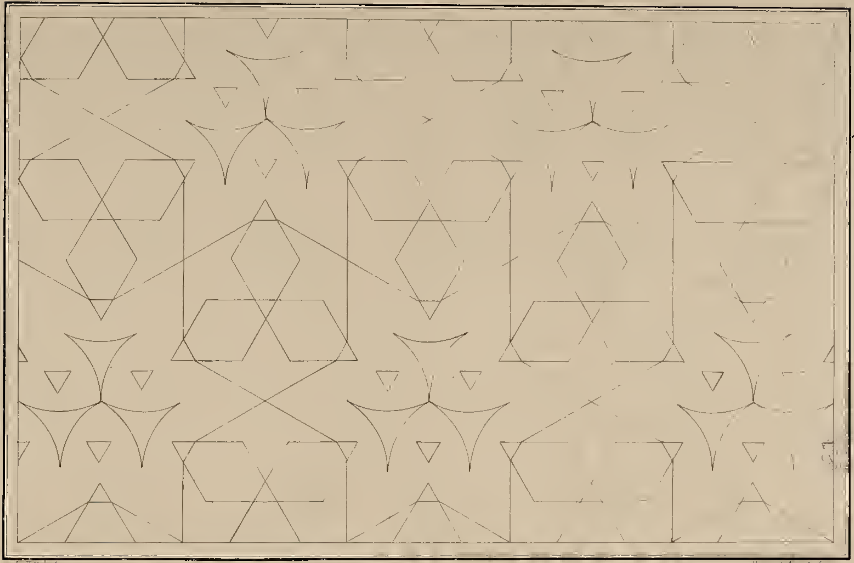

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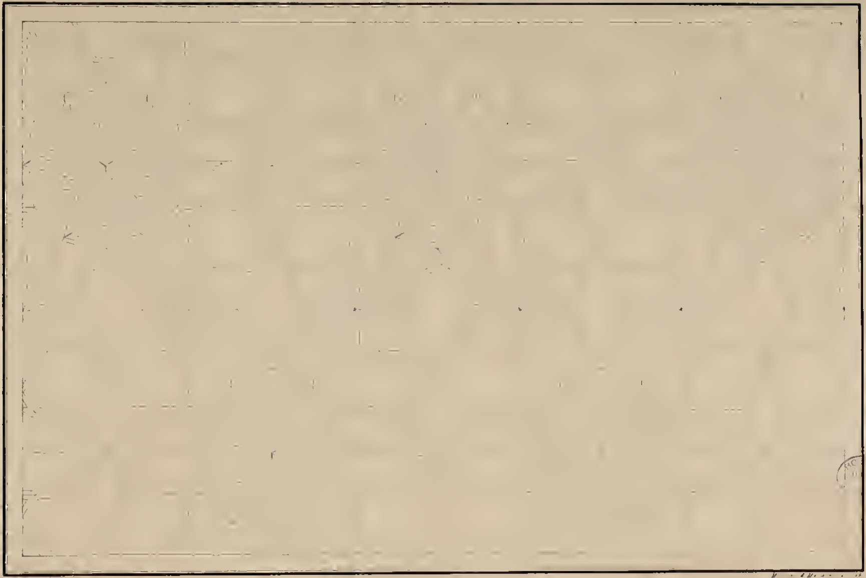
XIX.

XXI.

Nº XXIII.



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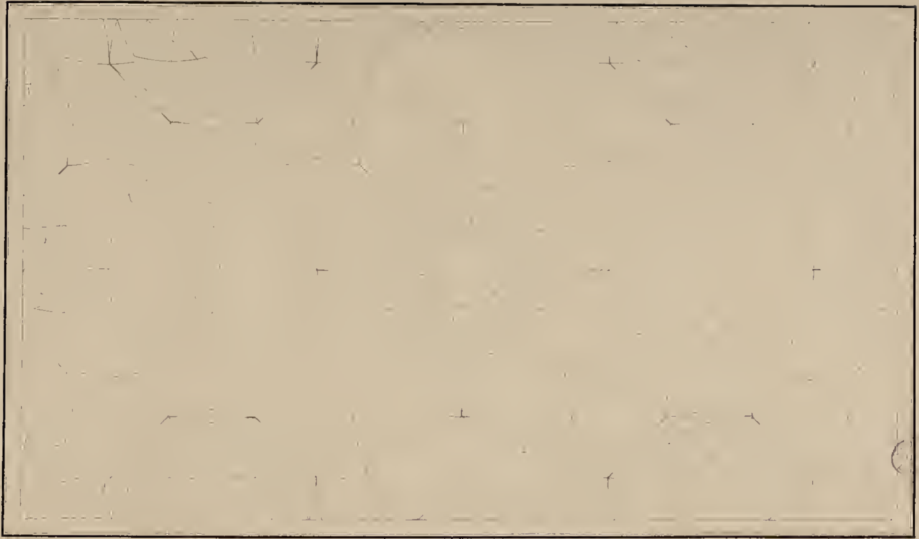

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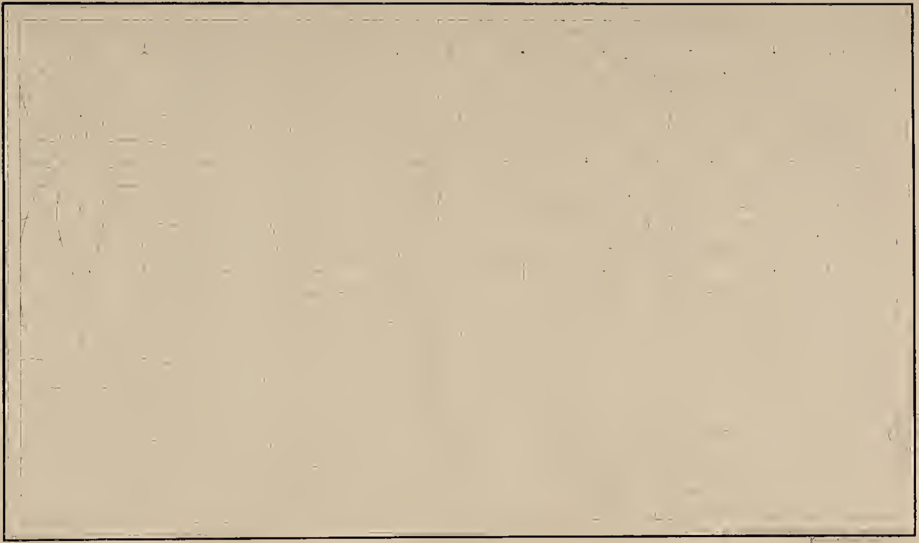

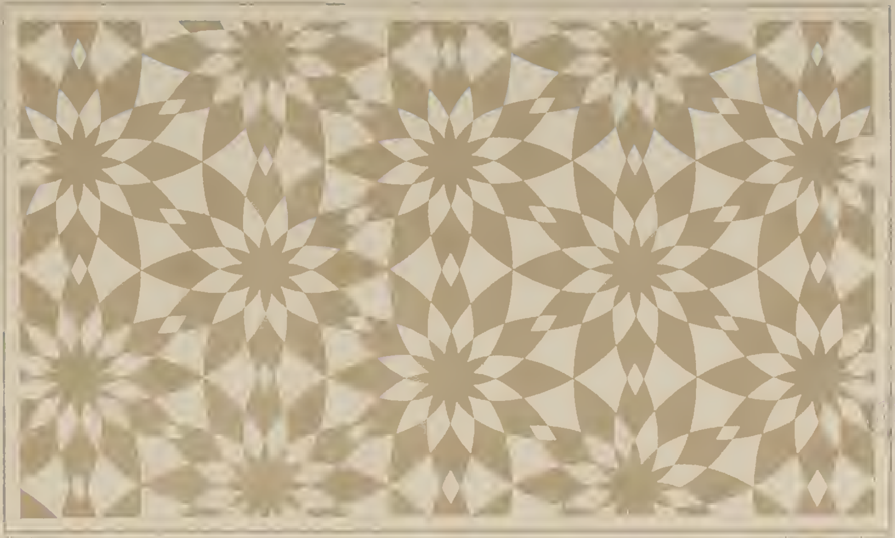

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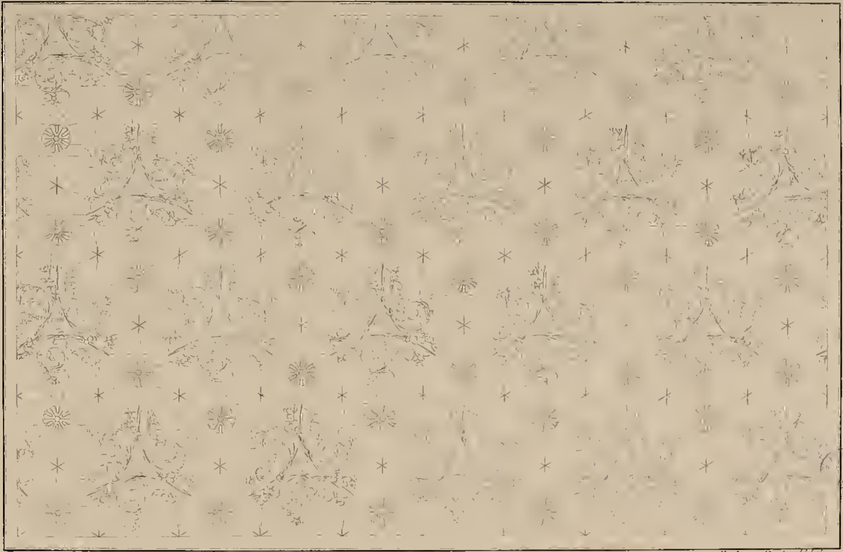

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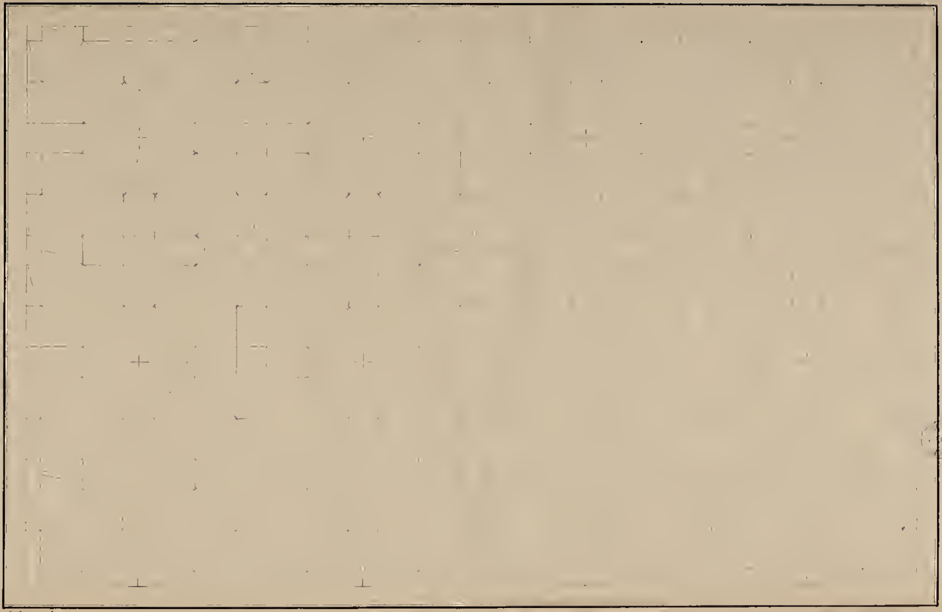

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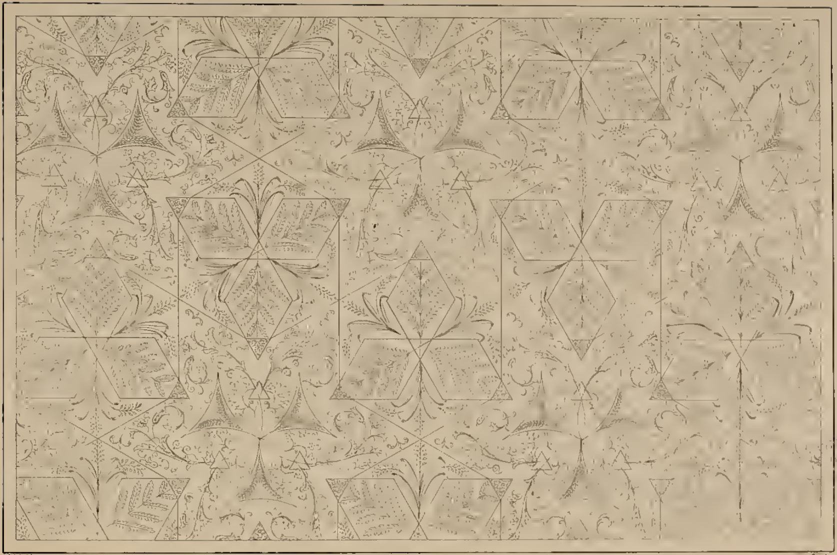

XXXII.