COLOUR IN WOVEN DESIGN

COLOUR IN WOVEN DESIGN

BEING A TREATISE ON

THE SCIENCE AND TECHNOLOGY OF TEXTILE COLOURING

(WOOLLEN, WORSTED, COTTON AND SILK MATERIALS)

BY

ROBERTS BEAUMONT, M.Sc., M.I.Mech.E.

PROFESSOR OF TEXTILE INDUSTRIES, THE UNIVERSITY OF LEEDS;

AUTHOR OF

"FINISHING OF TEXTILE FABRICS," "WOOLLEN AND WORSTED CLOTH MANUFACTURE,"

"WOVEN FABRICS AT THE WORLD'S FAIR."

VICE-PRESIDENT OF THE JURY OF AWARD AT THE PARIS EXHIBITION, 1900;

INSPECTOR OF TEXTILE INSTITUTES; SOCIETY OF ARTS SILVER MEDALLIST;

HONORARY MEDALLIST OF THE CITY AND GUILDS OF LONDON INSTITUTE.

EDITOR OF

"THE JOURNAL OF THE LEEDS UNIVERSITY TEXTILE STUDENTS' ASSOCIATION"

WITH 39 COLOURED PLATES, CONTAINING 187 ILLUSTRATIONS AND 280 FIGURES IN THE TEXT

SECOND EDITION, REWRITTEN AND ENLARGED,
WITH NUMEROUS ADDITIONAL ORIGINAL ILLUSTRATIONS

WHITTAKER & CO.

2 WHITE HART STREET, PATERNOSTER SQUARE

LONDON, AND NEW YORK

1912

THIS NEW AND ENLARGED EDITION

IS DEDICATED TO THE MEMORY OF MY LATE FATHER

JOHN BEAUMONT,

PROFESSOR OF TEXTILE INDUSTRIES

THE YORKSHIRE COLLEGE, LEEDS,

1875–1889.

PREFACE TO FIRST EDITION.

THREE years ago the first edition of my work on *Woollen and Worsted Cloth Manufacture* appeared, and in the preface of the book I observed that should it be satisfactorily appreciated I would write other treatises on specific branches of textile designing and weaving.

Partially in fulfilment of this promise, and partially because I have frequently been requested by designers, manufacturers, and students who have attended my lectures on textile colouring at Leeds, Huddersfield, and other places, to prepare a text-book on the application of colours to woven fabrics, this volume has been written, which, to use the hackneyed prefatory phrase, *is intended to meet a long-felt want.*

Though there are several useful works on Colour—to wit, those of Chevreul, Rood, Benson, Hay, Field, Maxwell, and Guichard—dealing with its scientific phases, yet they can scarcely be said to lend that kind of help to the student of applied design that is needed; hence the necessity of this handbook, which is the first treatise published professing to treat exclusively of the colouring of woven styles.

During the last fifteen years various efforts have been made to teach textile designing and manufacturing systematically, and to specify the principles which underlie the origination of pattern in the loom: what to some extent was, previously, haphazard work, inasmuch as there were no schools for teaching textile technology, and those apprenticed in the mill were

generally allowed to glean information as best they could, has now become an exact science. Colouring, however, though practically of primary importance in design, has not been so efficiently taught as some branches of textile manufacturing. The object of this book is, therefore, to supply as far as possible a complete scheme of textile colouring, and to demonstrate the methods of applying fancy shades to all descriptions of woven manufactures.

Referring briefly to the plan of the book: In the early chapters the pigment and light theories of colour are expounded, and also the attributes and qualities of colours, and the laws of contrast and harmony. Subsequently, the technicalities characterizing woven colour combinations are analyzed *in extenso*.

As the initiatory method of introducing tints and shades into fabrics consists in blending raw materials of divers colours, the art of mixing to obtain artistic mingled compositions is at the outset fully considered. This part of the subject is possibly of the first importance to those engaged in designing fancy tweeds and kindred classes of woollen goods.

After having treated of the combination of shades in "blending," reference is made to the principles of developing simple patterns by amalgamating warp and weft yarns. The various kinds of stripe, check, mixture, and figured effects, and the tinting of all types of single, backed, and double cloths, of combination patterns, of fabrics figured in the warp, in the weft, and in both warp and weft, are all treated of at length. Woollen, worsted, cotton, and silk fabrics, and the specific styles of colouring applicable to each, have also obtained detailed notice.

Many of the patterns printed on the plates have been woven at the Yorkshire College under my supervision, and are now published for the first time; while the other figures, with the exception of a small number appearing in the *Textile Recorder*

in articles I have written for that journal, and which the Editor has kindly permitted me to use, have been specially prepared for this book. It need scarcely be observed that the coloured illustrations are unique, being exact representations of the woven textures.

I have pleasure in acknowledging my indebtedness to my publishers, who have done all in their power to meet my wishes in the execution of the plates of woven samples.

R. B.

PREFACE TO SECOND EDITION.

THIS Work has been rewritten and enlarged. Numerous original illustrations have been added in the text and also to the coloured plates, which should enhance its value to the Textile Colourist, whether Student or Expert.

A chapter has also been prepared on Colour Standardization, the scheme for which has been originated and developed in the Textile Industries Department of the Leeds University, under my supervision and in collaboration with Mr Thos. Hollis, Lecturer in Yarn Manufacture.

In reading the proof sheets, I acknowledge the help of Miss Clara Benton, of the Clothworkers' Museum of the University.

I am indebted to my Publishers for the regard and consideration they have had to my wishes in the preparation of the Book.

R. B.

UNIVERSITY OF LEEDS,
1911.

CONTENTS.

CHAPTER I.

THEORIES OF COLOUR.

CHAPTER II.

ATTRIBUTES OF COLOURS.

CHAPTER III.

CONTRAST AND HARMONY.

CHAPTER IV.

COLOUR STANDARDIZATION.

CHAPTER V.

MIXTURES.

CHAPTER VI.

ELEMENTS OF TEXTILE COLOURING—STRIPES.

CHAPTER VII.

CHECK PATTERNS.

CHAPTER VIII.

SIMPLE COLOURINGS.

CHAPTER XIII.

COLOURING OF DOUBLE WEAVES AND REVERSIBLES.

CHAPTER XIV.

FIGURED TEXTILES COLOURED IN THE WARP.

CHAPTER XV.

WEFT-COLOURED FIGURED FABRICS—CURL TEXTURES.

LIST OF COLOURED PLATES.

LIST OF FIGURES.

COLOUR EFFECTS IN COMPOUND WEAVE DESIGNS.

COLOURING OF SPOTTED DESIGNS.

TABLES.

COLOUR IN WOVEN DESIGN.

CHAPTER I.

THEORIES OF COLOUR.

1. Elements of Woven Pattern—2. Occurrence and Utility of Colour in Loom Productions—3. Treatment of Colour in Relation to Textiles—4. Methods of Using Colours in Textiles—5. Colour Phenomena—6. Analysis of Light—7. Utility of Prismatic Experiments—8. Schemes of Colouring—9. Primary Colours—10. Compound Colours—11. The Three Constants of Colour—12. Temperature of Colours.

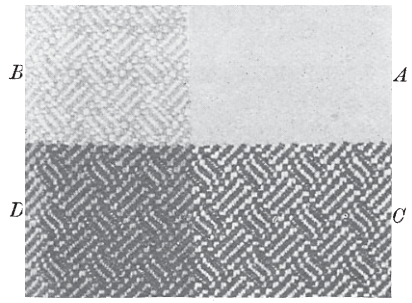
1. *Elements of Woven Pattern.*—Weave, compounds of form, and blending of colour are the three primary elements of textile design. They enter, either separately or in combination, into the many styles of loom effects. Weave relates specifically to the build or structure of the fabric, and is a necessary factor in any type of texture, whether plain, twilled, or ornamental in character. It is the scheme or plan of crossing the warp and weft yarns that forms or produces the fabric. Weave may give a compact texture subordinate in effect to other elements in the design; or, it may be the constructive and not the ornamental part of the pattern; yet in several woven specimens it possesses both these qualities. Fabrics of this description are not embellished with compounds of form or colour, and hence derive their design from the structural plan employed in the operation of weaving. Schemes of intertexture giving these results are devised in such a manner as to form, by interlacing warp and weft, an even fabric, decorated with a type of pattern consisting of minute effects in threads or yarns, and which may be subdued or decided in definition.

Fig. 1 is an elementary type of Weave design or Pattern. The weave used is fig. 1A. The sections are produced thus:—

A. White warp crossed with white weft.
B. Grey „ „ „ „
C. White „ „ black „
D. Grey „ „ „ „

Four degrees of definition of the design are present. The textural effect is clearly visible in section *A*, but increasingly distinct in sections *B*, *C*, and *D*, due to the improved or more

FIG. 1.



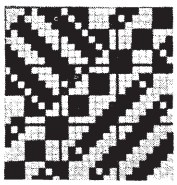


FIG. 1A.

pronounced contrasts of the shades of warp and weft combined.

Briefly considered, Weave has the following functions in textile design:—

(1) In the construction or build of the fabric.
(2) In the development of textural design (fig. 1).
(3) In the production of special and compound makes of fabrics.
(4) It is employed to accentuate or subdue in simple and decorative styles certain parts of the design—producing harmony of composition, whether due to blends of form, colour, or both.

Combinations of form have no relation whatever to the

structural arrangement of the fabric. The sphere of form in woven design is not constructive or utilitarian, but in the amplest sense ornamental. It is surface decoration obtained by amalgamating, on definite principles, linear and curvilinear lines: ornament, consisting of geometrical or floral features, is applied to such loom products as dress, mantle, and vesting fabrics; silk textures, including neckties, handkerchiefs, robes, and decorative styles; damasks, quiltings, tapestries, etc.; carpets, hand-woven or tufted (produced on the vertical loom and now made in Donegal and some parts of Scotland as well as in the East); velvet, or cut pile (Axminster type); looped or uncut pile (Brussels type); and Kidderminster and other plain-surface productions.

Colour, the third characteristic in design, is differently related to textile effects from Weave and Form. The special function of colour is to impart brightness of tone and improve the qualities of the design. There are many varieties of pattern in fabrics for wear, which possess freshness owing to the style and method of colouring practised. In the woven decorative arts, colour may be the main constituent of the design, or employed to develop its integral parts.

2. *Occurrence and Utility of Colour in Loom Productions.*—Colour is extensively used in woven design. It obtains, and is the prevailing element of the pattern, in all classes of fancy woollens, such as tweeds, flannels, and light textures, and thick figured rugs, wraps, and shawls. Whether the pattern be stripe, check, figure, or intermingled effect, it obtains its outline and detail from the method of colouring adopted. But colour is not confined to woollens; it is also an important factor in design produced in worsted, silk, cotton, jute, ramie, and other yarns. There is, in worsteds, a larger diversity of weave design than in woollen or carded-yarn textures; but, still, colour is very extensively employed to develop the effects due to weave and form, and also to impart a cheerful and lustrous appearance to the cloths. Patterns in dress fabrics, shirtings and blouses, made entirely of cotton, are frequently combinations of fancy shades; while, if the fabrics composed of silk and jute materials are considered, including—in silk—ties, handkerchiefs,

and various kinds of matelasses; and—in jute—simple carpets, mats, and coarse rugs, it will be discovered that the colour element of the design largely predominates. This brief summary of the textures, in which fancy shades are used, shows that colouring, and the combinations of colours, in all branches of woven products embellished with design, are the elements which give tone and character to the styles. Though the fabrics produced may be soft to the touch, substantially made, uniform in structure, and skilfully finished, yet a lack of brightness and harmony of colouring so powerfully detracts from the merit of the pattern, that these qualities, in themselves, are not sufficient to give the fabric an attractive appearance—particulars which demonstrate the importance of choice and tasteful colouring in designs produced in the loom. Evidently colour is of twofold utility in the development of woven effects; for it may, firstly, be the sole constituent of the pattern; and, secondly, a supplementary element which affords precision and beauty to the composition of the design.

3. *Treatment of Colour in Relation to Textiles.*—Though, to a considerable extent, the principles of colouring are similar in all types of decorative design—harmonious blending and contrasting combinations possessing like qualities in whatever materials they obtain—still there are several reasons why some of the recognized canons of the science of colour are inappropriate, if not inapplicable, when textiles are the media of development. Foremost of these reasons are the technical difficulties which arise in the employment of colour in woven pattern. There is not the same facility nor means for its application here, as in the treatment of ordinary surface decoration. The make of the fabric, and the principles of its structure, determine the system of distribution; while the general aspect of the entire body of colouring varies according to the nature of the materials employed. If the same colourings which appear harmonious, neatly toned, and cheerful in arrangement in a velvet pile carpet, were reproduced in a silk texture, many points of dissimilarity would be noticed in the general effect obtained, though the tint and hue of the shades combined, might be identically the same in the respective fabrics. Why is this? Are not the apparent

modifications in the colourings—for such they appear when thus compared—due, first, to the difference in the nature of the materials composing the textures; second, to the dissimilitude of their structural character; and, third, to the distinct principles of weaving practised in their production? The pile of the carpet —dense and compact — gives breadth, force, and richness to the colours; whereas the fine and clear texture of the silk imparts a more precise effect to the shades, causing the whole blend to possess an aspect which, while harmonious, lacks that mellow quality of bloom so characteristic of the pile production. It is clear, therefore, that colour in textiles requires to be studied as a special art. Its functions and effects in woven fabrics are so various and distinct from what they are in ordinary decorative work, that it can only be effectively treated when the nature of textile materials, and the diverse structures of the fabrics, are considered. In a word, there are not only recognized principles of woven design which have no place in purely ornamental art, but also schemes and laws of colouring which simply apply to the development of pattern in textile fabrics. Any exposition, therefore, of the theory and practice of colouring, to be useful to the textile technologist, must be given in relation to the varied technicalities of the weaver's craft.

4. *Methods of Using Colours in Textiles.*—Colour is not always applied to woven textures on the same system. The method of utilization depends upon the composition of the design to be woven, and on the structure of the cloth it is intended to produce. There are fabrics in which the colour element is so decided that the effect obtained is somewhat similar to the results noticed in ordinary surface decoration. Take, for example, silk textures of a ribbon class, in which, by skilful workmanship and exact sketching, any floral form may be developed with a delicacy of toning and correctness of delineation that cannot be improved upon, even though the crayon or the brush should be employed. But this is not a common, because not a useful, species of designing and colouring. Carpets and tapestry fabrics illustrate other principles of employing fancy shades. The structure of some types of carpets very materially affects the character of the colourings. In Brussels and tapestry, for instance, the loop or

pile of the carpet which forms its distinguishing feature, prevents that solidity and compactness of colouring noticeable in the silk ribbon or dress material. If the same design and blend of shades introduced into a Kidderminster or Scotch carpet were subsequently applied to a Brussels production, they would be entirely changed in appearance; for there is no common principle of intertexture in the respective carpets. In cotton, silk, woollen, and worsted textures, colour is found to have a different tone or cast in each fabric. Fancy colours in cottons, while decidedly smart and clear in effect, are comparatively non-lustrous, raw, and dull in toning.[1] Silk is distinguishable by brilliance of hue; woollen colourings have a unique depth and saturation of hue characteristic of the material employed in their manufacture; while worsted colourings are bright, definite, and smart in appearance.

These differences are due to the physical formation and properties of the several fibres and yarns. Thus, a filament of silk is almost transparent, and shines like a smooth glass rod when light falls upon it; that of wool is solid and opaque in the centre, but its exterior consists of a multitude of semi-transparent scales, which, when of large dimensions and uniformly arranged —as in the best qualities of Lincoln and Leicester wools— reflect light with a minimum amount of dispersion, and impart to the woven material a lustrous aspect. Cotton has no such partially transparent surface. Its downy structure absorbs light freely, while what is reflected is so broken up, that the colour resultant is impoverished in saturation and brightness. To clearly apprehend the degree to which the nature of the raw material is capable of changing the tone or character of colours, compare three plain woven textures of the same colour made of silk, wool, and cotton respectively. Lustre, brilliance, and richness are the features of the silk colouring. Though thus bright, it lacks that fulness and depth of hue which appertains to the wool production, the filaments of which closely compounded, and all tinted alike, possess a peculiar bloom and saturation of colouring not to be found either in the silk or cotton. The cotton texture is somewhat dull and flat in quality of

[1] Mercerized cottons possess some of the qualities of silk colourings.

hue, lacking the brightness of silk. Such is the importance of the relation of the material to the species of coloured effect produced in textiles, that it will require subsequent analysis.

The various methods of employing fancy shades in patterns obtained in the loom may be briefly summarized as follows:—

TABLE I.

METHODS OF APPLYING COLOUR TO TEXTILES.

I. In mixture cloths, for suitings, coatings, and costumes.

a. By combining or blending various colours of materials.
b. By combining several classes of twist threads.

II. In plain, twilled, mat, and fancy weave designs, for trouserings, coatings, suitings, dresses, costumes, flannels, shirtings, and fine textures.

a. By applying colour to the warp, forming stripes.
b. By applying colour to the weft, producing spotted patterns.
c. By applying colour to both warp and weft, giving checks and other styles.

III. In figured designs for dresses, mantlings, vestings, shawls, rugs, mauds, carpets, and tapestries.

a. By using one or several series of extra warp yarns.
b. By using one or several series of extra weft yarns.
c. By using one or several series of extra yarns in both warp and weft.

Each of these systems is capable of further subdivision; but, as here given, they represent the principles of colouring the general classes of woven designs.

5. *Colour Phenomena.*—Under ordinary conditions, light is essential to colour apprehension. Diversity of hue may be made evident to the mind by mechanical agitation of the optic nerves in a darkened room. Of course, such an experiment is only useful as showing the media by which colour sensations are rendered visible, or rather conveyed to the mind.

The colour of an object is determined by three things: the nature of light, the physical properties of the material on which

light falls, and the power of the observer's eye. These are obvious conditions. Change the light from brilliant daylight to gaslight, and a richly coloured fabric undergoes several modifications—the hues suffer in brightness and lose a measure of their co-relative value. Or, by using a mono-chromatic light (that from burning sodium is a compound of two yellow lights of similar quality in the spectrum[1]), coloured objects may be changed to a similar hue. That colour is affected by the nature of the material has been stated in reference to fibres of wool, cotton, and silk.

Incapacity to correctly distinguish the hues, tones, and tints

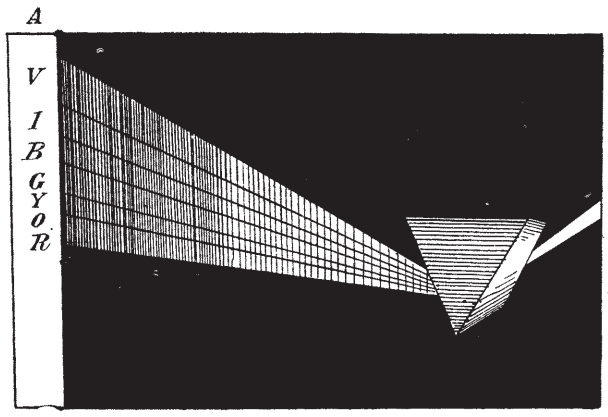


FIG. 2.

of colour is caused by some affection of the retina. Training and practice in the matching and blending of colours may enhance the acuteness of colour vision. The Gobelin tapestry-weaver will select, without hesitancy, from a bundle of bobbins of tints of material of the same hue or colour, the one he requires. Similarly, the carpet-weavers of Donegal — after a period of training — will unerringly manipulate a varied assortment of delicate colours.

"Light is due to waves — or other periodic disturbances, whose recurrence resembles that of waves—in the ether of space; and just as air-waves of a certain definite frequency of recurrence will induce in the ear the sensation of a sound of

[1] "Colour": *Chambers' Encyclopædia.*

a particular pitch, so will the impact of 'ether-waves' of a certain particular frequency induce in the eye a sensation of light of a particular colour."[1]

The extreme visible red in the spectrum is produced by 392 billions, and the extreme visible violet by 757 billions of waves per second. The table gives the wave frequency of the spectral colours:—

TABLE II.

WAVE FREQUENCY OF THE SPECTRAL COLOURS.

Red	492·4	billions	per second.
Orange red	484·1	„	„
Orange	503·3	„	„
Orange yellow	511·2	„	„
Yellow	517·5	„	„
Green	570	„	„
Blue	591·4	„	„
Cyan blue	606	„	„
Blue	635·2	„	„
Violet blue	685·8	„	„
Puce violet	740·5	„	„

As the frequency of the vibrations increases, or as they are diminished in length, the visible colours of the spectrum are produced. Just as the pitch of a musical instrument depends upon the celerity of the wave it produces, so the colour of an object is subjective to the length of the undulations transmitted. This analogy between the phenomena of sound and light has led some colourists to attempt a scheme of colours based upon similar laws to musical harmony.[2]

6. *Analysis of Light.* — When a pencil of sunlight passes through a prism horizontally fixed, as in fig. 2, it is decomposed, and produces on the screen the colour spectrum *A*, Plate I. In the intervals between each hue there is a gradation to which the colours are severally susceptive. Red passes, through a diversity of tinting, into orange, which graduates into yellow; and green, green

[1] Abney's *Colour Measurement and Mixture.*
[2] Wilkinson's *Harmonious Colouring.*

blue, blue, indigo, and violet occur in succession, all softly toning into each other. The purity and intensity of each colour will be observed.

A second and useful experiment may be made as follows:—Place a piece of black cardboard, about an inch wide and a few inches in length, on a white ground, and view it through the edge of a prism. If this experiment be correctly made, a result will be obtained corresponding to *B*, Plate I. The edge nearest the observer produces the violet, blue, and green side of the spectrum, while the opposite edge gives red, orange, yellow, and pale yellow—these two series of spectrum colours of distinct qualities being divided by a narrow band of black.

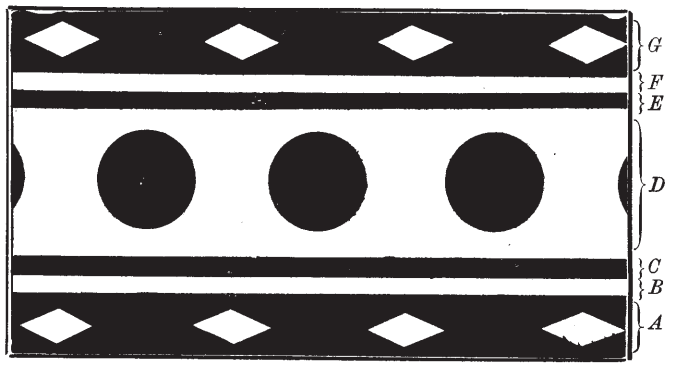


FIG. 3.

Coldness is the distinguishing characteristic of the violet side, and warmness that of the red side; in the upper portion of the spectrum are found the intense, ostentatious hues, while in the lower portion are the colours of a subdued, soft quality. Yellow and green are beautifully toned. The former passes from a yellowish orange into a pure, bright tint, which is softly shaded off into white. Green, on the front edge of the black line, is similarly graduated in hue, but as the band of this colour is not so broad as the yellow strip, its shadings are not so extensive; still, it imperceptibly changes from deep into pale green, and diminishes in intensity until it disappears in white light. One feature of this experiment will at once be observed, namely, the brilliance and richness of coloured lights, when compared with corresponding colours obtained by pigments or dye sub-

A B

Plate I

A = SPECTRUM
B = SPECTRUM RESULTANT FROM VIEWING A STRIP OF BLACK ON A WHITE SURFACE THROUGH A PRISM

stances. Bloom, depth, and purity of hue characterize the former; but however the latter are produced, they seem, in comparison, to be lacking in fulness, intensity, and brightness.[1]

7. *Utility of Prismatic Experiments.*—Experiments with the prism afford suggestive exercises in colour blending. Seeing that the results of these experiments are richer by far than those obtained by pigments, and always harmonious in tone, they are calculated to enhance appreciation for pure and lustrous colouring. For the purpose of successful manipulation of prismatic experiments, and of viewing in a suitable manner the effects that may, by this means, be produced, a piece of black velvet or cloth should be employed, and patterns cut out of white cardboard placed on it, and then the design thus arranged examined through the prism. The more ingenuity exercised in pattern origination, the more pleasing the combinations resultant. Fig. 3 illustrates the class of designs adapted for this work. Form and arrangement should be of the most elementary kind, and the whole pattern clear and pronounced, in order to allow of a complete development of the colours formed on the respective edges of the various figures. Intermingled, diminutive patterns give confused and indistinct effects. On the other hand, broad and large designs yield lustrous colourings, which the experimenter may feasibly dissect, and which teach principles in colour arrangement, harmony, and contrast, of utility in pattern production.

When the pattern in fig. 3 is viewed through the refractory angle of a prism at a distance of about two feet, and about three times larger than here sketched, it forms an interesting assortment of colourings and tinted effects. Any description of this experiment, however concise and clear, can only afford a vague idea of the real appearance of the pattern when prismatically examined. Still, to assist the reader to make the experiment accurately himself, a detailed analysis is given. Treating of the different sections of the patterns, the edge of band *A*, nearest the observer, should be considered first, which commences with pure green, running through blue, purple, deep violet, and crimson. The crimson results from the violet

[1] Paterson's *Science of Colour Mixing.*

rays of this edge blending with the intense red rays of the further edge of band *A*.

SMALL LINES *B* AND *C*. The former begins with crimson, which successively changes into scarlet, orange, and yellow, a small strip of white separating these colours from those of band *C*, which consists of various tints of green and orange.

DIAMOND FIGURES OF BAND *A*. The front edges of these are tinted with scarlet, orange, and yellow, and the opposite edges with various shades of green.

CIRCLES OF BAND *D*. First, as to the edges nearest the observer. These are coloured with emerald-green and grass-green. It will be noticed that the green in this section of the pattern is distinct from that produced by the front edge of band *A*, being, as stated, more grass- than sea-green. Its peculiar tint results from the orange rays of the upper edge of band *C* intermingling with the green rays of the circles. As the centres of the circles are approached, green is succeeded by blue, purple, and black. Second, as to the distant edges of the circles. At these points red, crimson, scarlet, and orange—the latter colour graduating imperceptibly into yellow—all occur. It is notable that the yellow hue is somewhat dingy, being adulterated with other colours. Compare it, for example, with the yellow resulting from the extreme edge of this diagram. Its dulness and impurity are due to certain colours intermingling with it. Thus, the space between the extreme edge of the circles and band *E* is so limited, that the yellow rays of the circular objects combine with the green rays of the latter, and, as a consequence, the yellow suffers in purity and luminosity.

BANDS *E*, *F*, AND THE FRONT EDGE OF *G*. These, very closely resembling strips *B*, *C*, and *A*, require no description.

EXTREME EDGE OF BAND *C*. Here the red side of the spectrum is seen in its intensity and lustre; it begins with deep red, which gradually verges into orange, and the latter into yellow.

This simple experiment demonstrates the value of prismatic results. All colourists should study shade combinations through these media. Analysis of the colourings obtained in this manner increases the acuteness of the faculty of discrimination of the brilliance and depth of hue of individual colours. Though,

in practice, the textile designer has to deal exclusively with pigments and dye substances, yet the intensity and beauty of the combinations resulting from the decomposition of light are so novel and suggestive, that all desirous of cultivating aptitude for harmonious colourings will be at pains to multiply experiments of this class, which afford a true conception of what constitutes harmony and contrast in colours.

That such compounds of spectrum colours have an application to textile design is evident from the specimens on Plate II., in which tints of the pure or prismatic colours are used in silk fabrics. The mode of distribution is irregular, but this is done for the purpose of subduing the strength of contrast which would be formed if the colours were used on the basis of the experiment described. Two fabrics are given as examples on Plate II. No. 1, a silk ribbon, is produced by weaving in a bold warp rep or cord weave, the colours being arranged in the warp to give the intermingled shaded effect. The weft is a thick, yellow cotton yarn, but, owing to the weave structure, does not show on either the face or underside of the texture. In the second example, No. 2, the colouring is due to printing the warp prior to weaving. It has a similar intermingled composition, but the colour contrasts are harsher in tone. Both examples show the utility of prismatic colours in their purity, or when slightly subdued by tinting.

8. *Schemes of Colouring.*—There are two important theories of colour—the Light Theory and the Pigment Theory. The former deals with the phenomena of colours, the attributes of light, and the laws which control the modification of the intensity, hue, and tone of colours. These varied phenomena are theoretically of value, but as they have few practical applications, the pigment theory of colouring is necessarily adopted in the applied arts, and deals with colour as an active element in decorative design. Every possible shade and hue of colour may be obtained by mixing red, yellow, and blue in variable proportions, and, of course, by toning and tinting with white and black. Mixtures of lights and pigments, however, do not give analogous results. Lambert[1]

[1] Atkinson's *Ganot's Physics*; Tyndall's *Fragments of Science.*

is credited with being the first to discover and prove that the colours due to these two causes were rarely identical, and frequently widely dissimilar. His method of doing this consisted in using two coloured wafers, *A* and *B* (fig. 4), which were placed on a black surface, and a piece of ordinary glass, *g*, fixed vertically. It was found that when blue and yellow were thus simultaneously seen, the rays reflected by them did not, when co-mingled, give green, but a whitish-coloured sensation. This fact was also subsequently elaborated by Helmholtz, who pushed his inquiries into the spectrum itself, and, by blending the lights, obtained valuable results. Blue-green, when mixed with red, instead of giving a brownish or greenish grey, as with pigments, was found, like ultramarine blue and yellow, to also constitute white light. With pigments, a mixture of chrome yellow and ultramarine blue, in variable quantities, forms different tints of green. Microscopic examination of this compound does not reveal the separate particles of yellow and blue pigments, but simply the greenish hue. The real and obvious distinction between spectrum and pigment combinations is that the former are additions, while the latter are subtractions. Knowing this, it will at once be evident that the colours obtained by these two methods cannot coincide.

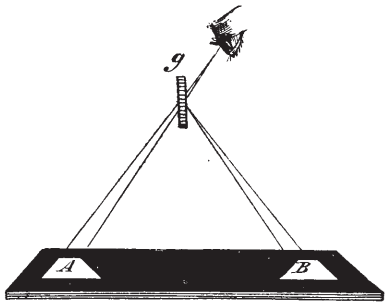


FIG. 4.

The following are some of the results of combining coloured lights and pigments respectively:—

TABLE III.

COMPOUNDS OF COLOURED LIGHTS.

Red + green = yellow. Should the green be slightly bluish = white.

2 red + green = orange.

Green + blue = sea-green.

2 green + blue = greenish sea-green.

TABLE III.—*continued.*

Blue + red = purple.
2 blue + red = violet.
Red + green + blue = white.
2 red + green + blue = white + red, or pale red.
2 red + 2 green + blue = white + yellow, or pale yellow.
Red + 2 green + 2 blue = white + sea-green, or pale sea-green.
2 red + green + 2 blue = white + purple, or pale purple.

TABLE IV.

COLOURS RESULTING FROM COMBINING PIGMENTS.

Primaries.	Secondaries.	Tertiaries.
Red + yellow	= orange.	2 R + Y + B, or O + P = russet.
Yellow + blue	= green.	2 Y + R + B, or O + G = citron or greenish olive.
Blue + red	= purple.	2 B + R + Y, or G + P = olive.

9. *Primary Colours.*—Writers on the pigment theory are all agreed as to the selection of the simple colours; but scientists have, in treating of this subject, chosen several sets of hues as primaries. Young and Helmholtz take red, green, and violet; vermilion, emerald-green, and ultramarine blue are selected by Maxwell. When the subject of colour is considered with a view to its practical application to the arts, it is needful to base all combinations on the scheme elucidated by Chevreul, Hey, Field, and others — that red, blue, and yellow (Plate III., Nos. 1, 2, and 3) are primary colours, and all others the resultants of mixing them in variable quantities. For technical purposes, it is therefore only feasible to deal with colour as it changes, according to the pigments combined; hence red, yellow, and blue will be regarded as primaries, because, when mixed with each other and with black and white, every possible shade of colour may be obtained.

10. *Compound Colours.*—These are of two classes—secondaries and tertiaries. The secondaries — green, orange, and purple (Plate III., Nos. 4, 5, and 6)—are composed of two primaries, while the tertiaries—russet, citron, and olive (Plate III., Nos. 7, 8, and 9)—are composed of two secondaries. Orange

and purple produce russet or reddish brown; orange and green produce citron or greenish olive; and green and purple, olive. On reducing these shades to their simple elements, it is found that they are each composed of three primaries, with one predominating and giving tone to the colour. Russet, for instance, contains a double portion of red, for red is a constituent of both the orange and purple which enter into its composition; citron contains a double portion of yellow, and olive a double portion of blue.

The hue or tone of a compound colour is determined by the proportionate quantities of the primaries combined in its production. For example, to procure a bluish green, blue must be the predominating and yellow the subordinate colour; while, on the other hand, to obtain a yellowish green, yellow would be the predominating and blue the subordinate colour. Reddish or yellowish orange is got by increasing the red or yellow constituents of this colour; and bluish or reddish purple, by increasing the blue or red components of this secondary. This affords some idea of how colours are modified and multiplied. Taking the three secondaries and subjecting them to similar treatment, a diversity of shades will be found to result. Russet (Plate III., No. 7) is composed of two parts red, one part yellow, and one part blue. It will be obvious that by varying these proportions another series of hues will result. By increasing the red constituent, the warmth of the colour is intensified; by increasing the yellow, the reddish tone is neutralized; while an increase of the blue would add to its depth and saturation. Similar results are obtained by modifying the constituents of the other primaries. Thus citron—composed of two parts yellow, one part blue, and one part red—may be changed to a yellowish, bluish, or brownish citron, according to the quantity of yellow, blue, or red used. Olive, which consists of two parts blue, one part red, and one part yellow, varies from a deep olive-green, brownish olive, to a yellowish olive-green, as the blue, red, and yellow constituents are increased.

The tertiary shades are the most useful colours employed in textile design. They are generally used for the ground of

the fabric, while the secondaries and primaries are utilized in enhancing the brightness of the pattern.

11. *The Three Constants of Colour.*—The three constants of colour are, *purity*, *luminosity*, and *hue*. If a piece of paper is painted vermilion and placed across the red end of the spectrum, it will be seen to be deficient in purity. Emerald-green and ultramarine blue papers, when compared with their respective sections of the spectrum, are found to be similarly defective. By mixing white light with the colours of the spectrum they may be so adulterated as to correspond with, or match, those obtained by the use of pigments. Artificial colours are never perfectly pure—they always contain some measure of foreign element, which can only be correctly determined by bringing them in contact with the colours of the spectrum. The second constant, *Luminosity* or *Intensity*, depends on the degree of light a colour reflects. Yellow, orange, and red represent the most luminous, and green, blue, and violet the least luminous end of the spectrum. It will be evident that it is possible to have two or more colours of the same degree of purity, but of different degrees of brightness. Two scarlets might both contain the same proportionate quantities of colour and of white light, and yet be dissimilar, simply on account of one being more intense in hue than the other. To match the two colours, the more luminous one would require to be exposed to a dull light, or the less luminous to a bright light. The third constant, *Hue*, is that special property which is caused by a definite refrangibility of light, producing the colour proper. Green and red may be exactly of the same purity and brightness, but they are different in hue, each being produced by a distinct refrangibility of rays.

12. *Temperature of Colours.* — The temperature of the spectrum colours is not uniform. It augments from violet to red. Herschel, by exposing thermometers to the several tints of the solar spectrum, determined the temperature of each colour, and proved that, proceeding from the most refracted or violet end of the spectrum to the least refracted or red end, there is a successive increase of heat. Besides luminous rays, the sun emits a mass of invisible but potent calorific rays. Herschel, pushing

his thermometers beyond the visible red and violet rays, discovered the presence in the spectrum of ultra red rays of intense heat, and ultra violet rays of a less heat. The solar spectrum may therefore be described as consisting of three distinct sections: First, of the ultra and invisible red rays; second, of the luminous rays, red, orange, yellow, green, blue, and violet; and third, of the ultra and invisible violet rays. Though it is thus evident that each spectral colour has a different temperature, yet it cannot be assumed on this basis that a red fabric will possess a greater degree of heat than a blue fabric composed of the same materials; because all rays penetrating a coloured body are not luminous, and yet, whether luminous or non-luminous, they possess properties of heat. Were the rays absorbed by a coloured surface only luminous, then it would be possible, by estimating the measure of absorption, to determine the colour temperature. But the bulk of radiation from any luminous body consists of invisible calorific rays, regarding which colour teaches absolutely nothing. A fact that has to be taken into consideration is, that a body may be highly susceptible to one class of rays, but insusceptible to other classes. As it is generally known that black garments are more effective retainers of solar heat than white garments, it may be pointed out why this is the case. White clothes absorb the invisible rays, but reflect the luminous rays which constitute solar light. Black or dark clothes, on the other hand, not only retain the dark rays which penetrate them, but also the visible rays; and hence they are that degree warmer than white fabrics of the same structure and material, as the difference in the influx of temperature due to the absorption of luminous as well as invisible rays. Tyndall explains that if a white cloth were spread over the snow, it would even act as a shield to the latter instead of assisting it to thaw. Snow, which is ice in a powdered form, absorbs the dark rays with greater avidity than a white fabric; and, as both the particles of snow and the threads of the texture reflect the luminous rays poured upon them, the snow would melt sooner without the cloth than with it. Indeed it would be found that in a short time the cloth would occupy quite a prominence —the snow not covered by it thawing more rapidly than that

over which it is spread. Should a black fabric of similar material be next placed on sunned snow, it would produce the very opposite results. Absorbing the luminous as well as the dark rays, it retains more of the sun's heat than the snow, which rapidly melts under it; while the surrounding and uncovered snow remains comparatively unthawed and icy. Both the white texture and the snow are powerless as regards the luminous rays emitted by the sun; the myriads of fibres composing the former receive no warmth from them, nor can the ice-like atoms of the latter be melted by them. They, in a word, can only be changed by the dark rays. As to the black-surfaced texture, there are different conditions to be taken into account. It is both an absorbent of the invisible and of the luminous rays, consequently dark materials not only attract but retain more of the sun's heat than light materials. More than this cannot be stated with certainty about the warmth-yielding qualities of woven textures of various colours.

CHAPTER II.

ATTRIBUTES OF COLOURS.

13. Utility of a Knowledge of the Qualities of Colours—14. Qualifications of the Textile Colourist—15. Functions of Pure Colours in Design—16. Red: its Characteristics—17. Methods of Modifying Colours—18. Derivatives of Red: their Qualities and their Province in Textiles—19. Blue: its Properties and Uses—20. Derivatives of Blue and their Application to Woven Textures—21. Shades and Tints of Blue mixed with Shaded and Tinted Reds and Yellows—22. Methods of obtaining Well-balanced Colourings—23. Uses of Blue in Twist Yarns—24. Points in the Application of Blue and Red to Textiles Summarized—25. Attributes of Yellow—26. Province of Yellow in Woven Fabrics—27. Derivatives of Yellow—28. Secondary Colours—29. Green: its Attributes and Derivatives—30. Tints of Green—31. Orange: its Shades and Tints—32. Purple.

13. *Utility of a Knowledge of the Qualities of Colours.*—In order to apply colours artistically to woven fabrics, one must be conversant with the attributes of the tints, tones, and hues of colour the technologist uses in his work. More is requisite than a mere acquaintance with the technical details which lie at the basis of the construction of useful and decorative fabrics: this knowledge must be supplemented by practice and training in the blending of pure and other shades, and in the origination of novel schemes of colouring. Exact knowledge of the quality and application of colours, and of the laws which determine harmony of colouring, is indispensable to the successful textile designer. The pattern originator must display in his work a reliable conception of the province of colour in woven style; this is as essential as it is to the manufacturer to have regard to the chemical composition, physical structure, and clothing qualities of the materials used. As in blending wools and other fibres, the nature and properties of each are taken into account, so in colouring woven manufactures, the attributes of the several

shades and the method of arrangement require to be carefully considered.

14. *Qualifications of the Textile Colourist.*—One of the primary qualifications of a colourist is natural aptitude for his work. To "feel" or appreciate harmony and contrast of colour, the eye of the observer must convey to the mind an accurate impression of the *ensemble* of shades visible. Two things are requisite—intuitive and acquired taste for colouring, combined with practice in textile designing. Yet these are insufficient. They may enable one to judge of the purity of colours, or of the degree in tone between two or more hues; but this faculty for matching of colours, or of colour discrimination, however acute, does not constitute that sense for harmony of colouring which would make it a transgression of nature for a designer to originate incongruous colour compounds. Another quality is needful. It may be said to be practically, if not wholly, an intuitive talent, for it may be displayed in the work of those who possess but slender knowledge of the laws and theories of colour. There must be taste or genius for colouring. Such is the perfection in which some designers have this natural faculty for colour blending and application, that they are a law in themselves. Natural talent is the source of inspiration. This faculty is invariably the better for culture. As a capacity for music may be developed by training, so a power for colouring may be augmented by studying harmony and contrast, and the general principles of the science as they relate to the development of patterns in the loom; consequently, though culture may not create that acuteness of conception exercised by those who have an intuitive bent for harmonious assortments of hues, yet it may result in producing a passable, if not a proficient colourist, and is, moreover, calculated to direct even the naturally talented to a judicious selection and use of materials.

15. *Functions of Pure Colours in Design.*—Before treating of the attributes of the primary and secondary colours, namely, red, blue, yellow, green, orange, and purple, it may be useful to allude to the application of these colours to the various types of woven decoration. Some designers so rarely use such hues, unless tempered with either white or black, that they seem to

entertain an idea that they can only be made to yield strong and harsh contrasts. Certainly this is likely to occur if they are not combined with due regard to intensity and quantity of hue, the methods of distributing the several colours, and the relative effect they have on each other in the woven fabric. Bright colours should always be applied to textures for the purpose of imparting tone and character of pattern. Though, generally, they do not form the groundwork of the style, yet they should give additional lustre to the design. What such hues are in decorative and pictorial art, they are also in loom productions when skilfully employed.

Showy styles in which the primaries or bright colours are present, result more from the system of combination practised than from excessive brightness. The Indian shawl—or the Paisley imitation—and the Turkey or Persian carpet, not infrequently consist of designs composed of the most brilliant shades producible in the dye vat. In the former, in addition to a play on certain figures, which are generally unique in arrangement and ingeniously grouped, there is a depth and fulness of tinting that seems to possess all but a permanent freshness. As to the Eastern carpet, it contains a large diversity of colours, and mostly of a bright tone, but still the general effect is pleasing and cheerful. To what are the congruity of tone and richness of colouring due in these textures? This law is observed in their composition: the quantity of each colour used, depends entirely on the position it occupies in the pattern and on its intensity and quality; while the several shades are so blended that when the carpet or shawl is viewed in its entirety the whole is harmonious in result. This is the general effect sought after in tweeds and all classes of fancy fabrics. If scarlet, blue, green, crimson, or orange were applied to a woven design, —though decidedly stronger in hue than the shades forming the bulk of the fabric—while tingeing the pattern with a freshness of tone, they should not be allowed to unduly attract the eye. The use of twist yarns very largely facilitates the production of congruous combinations, in which bright colours play a prominent part in the composition of the pattern. By employing these threads, the colours may be broken up, in which form they

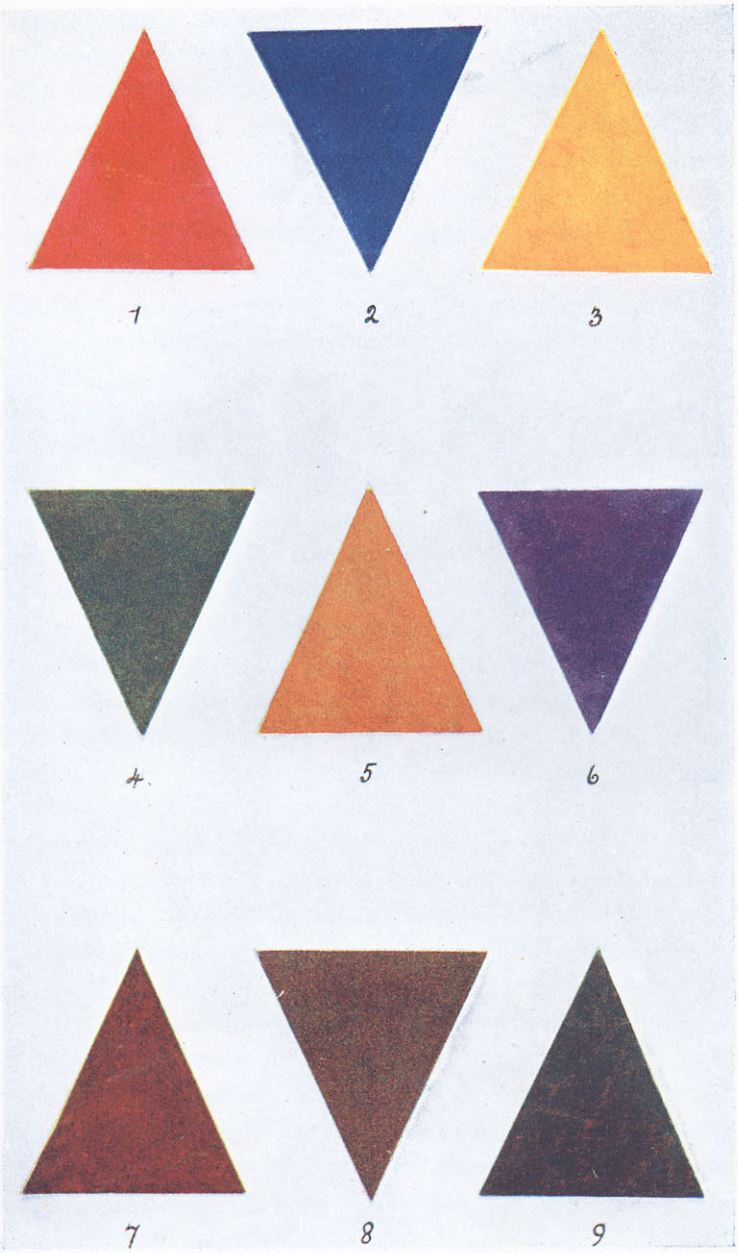


Plate III

PRIMARY, SECONDARY AND TERTIARY COLOURS

do not produce that continuity of effect which necessarily results from the use of self-coloured yarns. Success in effective colouring with pure hues lies, however, in a proper distribution of the shades combined, incongruity of effect being as largely due to defective balancing of colour as to injudicious and distasteful combinations; in a word, there is as much dependent on the arrangement, as on the selection and blending of shades in pattern origination.

In addition to thus acting as the brightening elements in woven design, these colours are also used in some classes of textures as ground shades. For instance, they are the principal colours employed in dress fabrics of a Scotch tartan class, certain kinds of shawls, silk neckties, handkerchiefs, and wraps; but generally, in worsted and woollen textures they are used sparingly, and for giving lustre to a sombre mixture of colours. Pure colours have therefore two distinct functions in textile patterns: first, they constitute a kind of supplementary colouring which imparts lustre and intensity of hue to the style to which they are applied; and, second, they may be the principal colours comprised in the design.

16. *Red: its Characteristics.*—Red (No. 1, Plate III.) is designated a simple or primary colour in both the light and pigment theories of colouring. Of all hues it is the most showy, brilliant, and gorgeous. Intense red is so powerful that when used in large quantities it neutralizes the effect of adjacent hues. On this account, its distribution in textiles should always be accomplished in accordance with the depth of the other colours entering into the style; that is to say, its intensity, as well as its quantity, must be varied in the same proportion as the general colouring of the pattern is diminished or augmented in tone. An otherwise satisfactorily coloured pattern may be destroyed by using a red too potent in hue, or by using this colour too profusely. Yet red is decidedly one of the most useful colours at the command of the decorative designer and the textile producer. Whether employed as a pure, or as an adulterated colour, it is of extensive utility in textile designing. When judiciously applied, it adds brightness and cheerfulness to woven effects. Its true sphere in textiles is to impart freshness. Red

in these compositions is the brightening or toning hue. In applying red tints to worsted and woollen fabrics, they should seldom occur in patches or in continuous lines of a check arrangement, but they should be more or less intermittent in effect.[1] It should be borne in mind that in these fabrics it is not loudness or showiness, but neatness of style, that is sought after, yet the quality of brightness must not be lacking. In the form of twist yarns, reds and scarlets may be made to produce exactly the general toning required. This mode of applying this colour is particularly well adapted to textures of a cheviot and tweed description. Worsteds require different treatment. One method of introducing reds into these fabrics consists in using silk yarns, and simply bringing them on to the surface to form a bright spot or minute line of colour. In silk, cotton, and some kinds of linen textures, this primary is used in larger quantities, and more liberally displayed in patterns composed of these materials, than in the ordinary run of woollen and worsted fabrics.

Being such a potent and bright colour, it is of utility in the blending process of manufacturing, when several shades of materials are combined to produce a mixture yarn. Some mixtures or blends of this class contain scarlet wools, which, in whatever form they occur, give tone and quality to the combination of which they form a part. A variety of tints and shades results from mixing red in different quantities with black or white, and also an extensive range of hues from combining it with other colours. Still, pure red is not so liberally used in textile work as its derivatives: thus, it unites with yellow and blue in the production of orange and purple. Should a small quantity of yellow be added to red, it gives scarlet, while the addition of a small quantity of blue produces crimson. The richness and luminosity of the scarlet are determined by the proportion of yellow added; and the depth of the crimson by the amount of blue entering the mixtures. Both in scarlets and crimsons, a considerable diversity of hues is obtainable. Before either of these colours is pro-

[1] Tartans are special forms of checks in the colouring of which this principle is not observed.

duced, red undergoes a series of gradations of hue. In the rose, there is displayed to perfection the various modifications in tint and shade of which this colour is susceptive. Scarlets, crimsons, maroons, russets, and browns are all hues employed by the weaver that obtain their prevailing tint from this primary.

17. *Methods of Modifying Colours.*—All pure colours, such as red, blue, yellow, orange, green, and purple, may be subjected to three kinds of modification: first, they may be darkened in *tone*; second, lightened in *tint*; and third, changed in hue. If, for example, black is mixed with red in various proportions, it produces *tones* or *shades* of this colour, while an admixture of white with red yields different *tints* of red. To alter the hue, it is necessary to blend it with some other colour, such as blue, when various shades of full-toned crimsons result. In blending, and also in the arrangement of colours in the warp and weft of the woven fabric, the phenomena underlying the changes producible in the tone and tint of a colour have to be taken into consideration. Black and red wools when scribbled together give a dark brown or reddish-brown mixture, according to the quantities of the respective shades entering into the combination; on the other hand, if white and red wools are blended, a mixture of a pinkish character is obtained. Hence it is clear that the same principles which determine the alteration in the shade, tint, or hue of a colour when pigments are combined, also regulate the results due to mixing several colours of textile fibres.

Strictly speaking, white and black cannot be designated colours, being merely representative of the principles of light and darkness, and acting, in the multiplication of shades and tints, as the great modifiers of colour. Such is their province in the *rôle* of colour production. In design, they are indispensable in mellowing certain combinations of hues, and in giving precision and clearness to specific sections of a pattern. As ground shades they are also useful. Light colours appear bright and distinct on black surfaces; while deep colours, such as blues, purples, and reds, appear intense and clear on white materials. So that by a proper use of these shades it is possible, in the first place, by the process of mixing them with bright colours, to produce a variety of hues; and, in the

second place, by introducing them into the warp and weft of the pattern, to impart smartness and lustre to the colours employed.

18. *Derivatives of Red: their Qualities and their Province in Textiles.* – By the derivatives of a colour, are signified those shades and tints which result from mixing it with various quantities of white or black. Those obtained from red are both numerous and important, being specially useful in the production of woven effects. They comprise both ground and fancy hues. First, in the category of the derivatives of this primary, are those shades produced by toning it with black. A few typical specimens of these are given in Nos. 1, 2, and 3, Plate IV. The brightest shade (No. 3) is compounded of three parts of red and of one part of black; the medium shade (No. 2) of equal quantities of red and black; while in the dark brown (No. 1) black preponderates, the proportions being one part of red to three parts of black. Such shades of brown may be used as ground colours, but the two latter are the most appropriate for this purpose. Shade 3 is, however, frequently employed with good results in dress fabrics for the foundation of the texture. Some excellent colourings ensue from their combination. The two extremes—Shades 1 and 3—when employed in the same style give a softly toned pattern. A less pronounced contrast ensues from a compound of Shades 1 and 2, or Shades 2 and 3. In combinations of this kind, there should usually be a larger quantity of one colour element than another. Another method of combining these shades consists in introducing the three into one pattern. For example, if twelve threads of Shade 1, eight threads of Shade 2, and four threads of Shade 3, were woven together and checked over in the weft by a similar arrangement of yarns, a neat design would be obtained. It might be changed by taking four threads of Shade 1 instead of twelve, and twelve threads of Shade 3 instead of four. In the former style the dark brown would preponderate, but in the latter the light brown, the quantity of the medium hue being the same in each instance. These illustrations demonstrate the utility of these shades and the systems on which they are amalgamated in pattern construction.

The tints Nos. 4, 5, and 6, on Plate IV., are characterized by brilliance and intensity of tone, making them adapted for imparting lustre and richness to design. Like the colour from which they obtain their specific tint, they are ostentatious and potent in effect. While the shades given in Nos. 1, 2, and 3 are all darker in tone than the original red, these tints are lighter on account of the entrance of white into their composition. Thus they are made up as follows:—

Tint 4, Plate IV.—1 part of red and 3 parts of white.
Tint 5, „ „ —2 parts of red and 2 parts of white.
Tint 6, „ „ —3 parts of red and 1 part of white.

Bright tints of this kind are extensively used in figured weaving, as in the manufacture of vestings, silk neckties, dress fabrics, and trimmings. Sometimes in the latter description of textures they form the pattern proper. In the ordinary run of woollen and worsted cloths they are, however, only sparingly employed, and that in the form of twist yarns. Amongst the varieties of twists which can be produced by combining two or more of these shades and tints of red, the following are selected as suggestive illustrations:—

I.—One thread of Shade 1 twisted with one thread of Tint 4, Plate IV.
II.—One thread of Shade 1 twisted with one thread of Tint 6, Plate IV.
III.—One thread of Shade 2 twisted with one thread of Tint 5, Plate IV.
IV.—One thread of Shade 3 twisted with one thread of Tint 4, Plate IV.
V.—One thread of Shade 1; one thread of Shade 3; and one thread of Tint 4, Plate IV., twisted together.

Each of these compound yarns, in worsted, woollen, or cotton materials, is capable, when judiciously applied, of contributing to the quality of woven pattern.

Another section of manufacturing in which these derivatives are employed is in the blending process, or in the production of fancy mixture yarns.

19. *Blue: its Properties and Uses.*—Blue (No. 2, Plate III.) is

one of the most valuable colours used by textile designers. In dark shades it is utilized for the ground of patterns; in medium shades it is employed for mellowing and toning purposes; while bright blues convey freshness and force of colouring; so that this primary has three distinct functions in textile designing. In each of these, it will be indicated what its properties are as a colour, and the relation it sustains to other shades with which it may be combined.

Unlike red, which is decidedly a warm colour, the quality of blue is cold and retiring: this distinguishes it from yellow, orange, and red, which produce a sensation of warmth. Resembling violet and purple, it is indistinct and neutral in a declining light, but strong and brilliant in a bright light; hence, when applied to light grounds, it is not only pronounced in hue, but is quite distinct from other shades, while on a dark or black surface it is both mellow and lustrous in effect.

Its property of "coldness" renders it a useful shade for subduing the redness of tone of some colourings; for it in some degree neutralizes the warm hue of the browns, maroons, russets, or other shades forming the pattern in which red is prevalent. This does not, however, indicate that red and blue harmonize; on the contrary, whenever these two colours are associated in large quantities, the resultant composition is somewhat incongruous; but that when combined with browns and russet olives, or shades in which the red tint is assimilated by the quantity of black they contain, blue can be made to yield excellent coloured effects. Pure blue, like pure red, is not so largely used as its derivatives, still it has a place in textile designing. This is principally as a fancy yarn, when it gives freshness and bloom to the pattern. It is also employed as a ground colour in the manufacture of fine silk fabrics, and as the figuring colour in certain makes of fancy worsteds.

20. *Derivatives of Blue and their Application to Woven Textures.*—If blue is mixed with black, shades of an indigo character result; but, if mixed with white, peacock blues, lavenders, and pale blues are formed. Some few examples in both these types of derivatives may be considered. From the series of dark or shaded blues three examples have been selected,

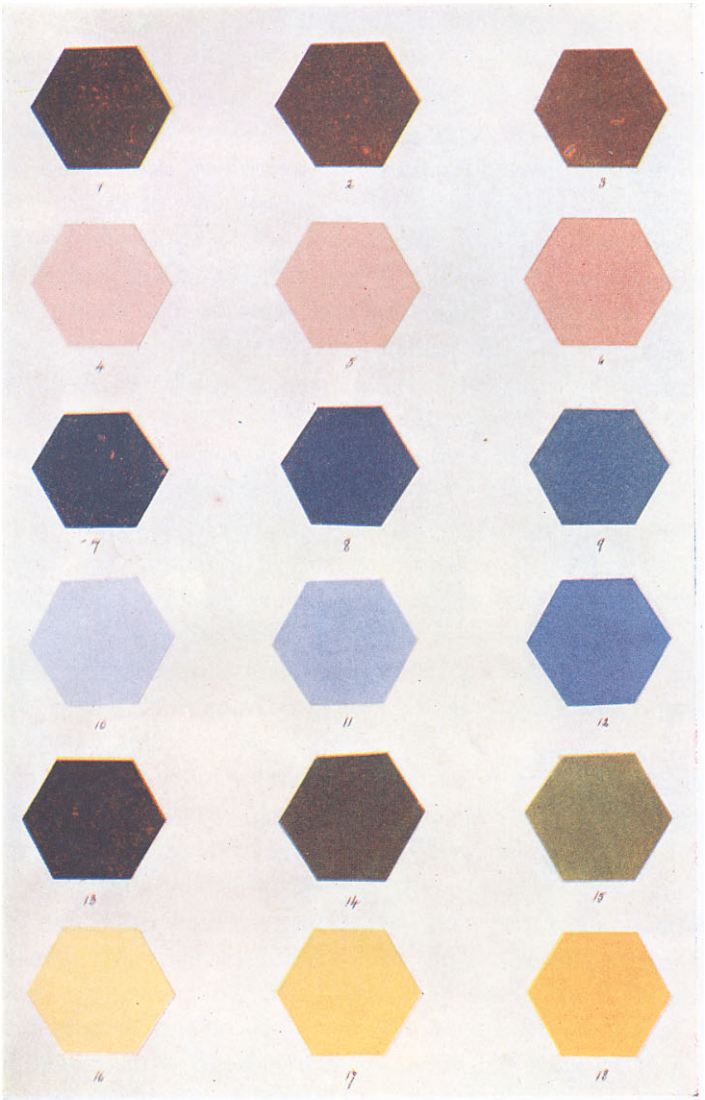


Plate IV

TONES AND TINTS OF THE "PRIMARIES"

1, 2, 3. Tones of Red
7, 8, 9. .. .. Blue
13, 14, 15. .. .. Yellow

4, 5, 6. Tints of Red
10, 11, 12. .. .. Blue
16, 17, 18. .. .. Yellow

namely, those in Nos. 7, 8, and 9, Plate IV. The first consists of one part blue and three parts black; the second (No. 8) of two parts blue and two parts black; and the third (No. 9) of three parts blue and one part black. Shade 1 (indigo) is a useful colour for piece-dye goods, as well as for the grounds of fancy fabrics. By studying this method of mixing, it will be observed how a pure and intense colour may be gradually darkened in shade, or —if white is added—gradually lightened in tint, until it closely resembles black or white, as the case may be. This system of varying the tone of a colour makes it feasible, by a proper assortment of hues, to produce stripes or checks in light or dark shades. Take, for example, the three blues given in Nos. 7, 8, and 9 on this Plate. If these are put together thus: eight threads of Shade 7, eight threads of Shade 8, and eight threads of Shade 9, a shaded blue check will result, which in worsted, woollen, or cotton yarns gives a satisfactory pattern. Let the warp thus arranged be crossed with similar quantities of the respective shades, and checks of the several blues will be formed in the fabric. This plan of colouring produces checks of equal proportions of the different shades; but, if needful, these might be easily got in various dimensions, say, for instance, the darkest check about three-quarters of an inch in size, and the remaining two checks half an inch.

A few of the principal tints of blue, got by mixing this primary with white, in the same proportions as the shades just described were produced by mixing it with black, are Nos. 10, 11, and 12, Plate IV. The white has given them a softened and mellowed tone, having neutralized that forcible and striking attribute which characterizes pure blue. On comparing them with the original colour from which they result (No. 2, Plate III.), the degree to which white subdues and mellows bright hues with which it is blended will be evident. Tints of this class are used in various ways in designing. Some styles in silk handkerchiefs are producible by the exact depth of hues seen in the illustration — these weights of colours forming congruous and evenly-balanced patterns. They are also largely employed in cotton textures. One example of this type of combination is given in No. 1, on Plate VII. This is a sketch

of a fabric made of cotton yarns. The warp is light blue—Tint 10, Plate IV.—and the weft a deeper blue, or Tint 12. The neatness of this colouring is due to the soft contrast between the tints of the warp and weft yarns.

21. *Shades and Tints of Blue mixed with Shaded and Tinted Red and Yellow.*—In the styles in which blue is employed for ground purposes, indigo shades are invariably used. Blue, however, is not a foundation colour that admits of much diversity of tinting. To succeed in its application to the grounds of patterns, a good range of browns, olives, and greys is important. With shades of the olive class it gives the most marked contrasts. This is due to yellow being the prevailing tint of this compound hue. But it also mingles harmoniously with certain tints of grey and brown. Patterns in which these shades are arranged as in Tables V. and VI., in woollen, worsted, cotton, or silk yarns, illustrate the methods of combining blue effectively with different shades and tints of red and yellow. In Table I. the combinations of shades are included; but in Table II. will be found the tints of red, blue, and yellow. The colours are given in groups of six threads, and would, providing the arrangements appended were carried out in the weft, produce a series of clearly developed check effects.

Table V.

Compounds of Shades or Tones of Colour.

(*a*) *Shades of Blue and Red* (*Plate IV.*).

Ex. 1. Dark shades.

Black preponderating.

6 threads of dark blue (Shade 7).
6 „ „ brown (Shade 1).

Ex. 2. Medium shades.

Black and Blue, and Black and Red equally mixed.

6 threads of medium blue (Shade 8).
6 „ „ brown (Shade 2).

TABLE V.—*continued.*

Ex. 3. Lightish shades.

Blue and Red preponderating.

6 threads of toned blue (Shade 9).
6 „ light brown (Shade 3).

(*b*) *Shades of Blue and Yellow* (*Plate IV.*).

Ex. 1. Dark shades.

Black preponderating.

6 threads of dark blue (Shade 7).
6 „ „ olive (Shade 13).

Ex. 2. Medium shades.

Black and Blue, and Black and Yellow equally mixed.

6 threads of medium blue (Shade 8).
6 „ „ olive (Shade 14).

Ex. 3. Lightish shades.

Blue and Yellow preponderating.

6 threads of toned blue (Shade 9).
6 „ „ olive (Shade 15).

TABLE VI.

COMPOUNDS OF TINTS OF COLOUR.

(*a*) *Tints of Blue and Red* (*Plate IV.*).

Ex. 1. Very light tints.

White preponderating.

6 threads of pale lavender (Tint 10).
6 „ „ salmon (Tint 4).

Ex. 2. Light tints.

Blue and White, and Red and White equally mixed.

6 threads of lavender (Tint 11).
6 „ bright salmon (Tint 5).

Ex. 3. Deep tints.

Blue and Red preponderating.

6 threads of tinted blue (Tint 12).
6 „ „ red (Tint 6).

TABLE VI.—*continued.*

(*b*) *Tints of Blue and Yellow* (*Plate IV.*).

Ex. 1. Very light tints.

White preponderating.

6 threads of very pale yellow (Tint 16).
6 „ pale lavender (Tint 10).

Ex. 2. Light tints.

Blue and White, and Yellow and White equally mixed.

6 threads of lavender (Tint 11).
6 „ pale yellow (Tint 17).

Ex. 3. Deep tints.

Blue and Yellow predominating.

6 threads of tinted blue (Tint 12).
6 „ „ yellow (Tint 18).

22. *Methods of Obtaining Well-balanced Colourings.*—From these Tables it will be evident that if the shade of blue is modified, that of the combining colour is also changed. Unless this rule is adhered to, the arrangement adopted will give incongruous results. Only a certain depth of blue harmonizes with a corresponding depth of brown and olive; if one predominates over the other, the colouring becomes deficient and displeasing to the eye. For example, if Shades 1 and 9 and Tints 4 and 12 were blended, the result would not be so mellow as if Shades 1 and 7 and Tints 4 and 10, as in the Tables, were combined. The reason for this is that, in the first instance, a shade of red in which black preponderates is used with a shade of blue in which blue preponderates; while, in the second instance, a tint of red in which white preponderates is associated with a tint of blue in which blue preponderates; whereas, to produce a perfect balance of colour—that is, providing the quantities of the respective colours are equal—it is necessary for the shades or tints combined to contain exactly the same quantities of black and white, as in the combinations of Shades 1 and 7, and Tints 4 and 10 of Plate IV.

In no combination given in Tables V. and VI. is there a lack of harmony; indeed, considering the principle on which they

have been obtained, this is almost impossible. Thus, take Ex. 1 in Table V. Here, dark shades of blue and brown are associated. In both colours black preponderates; that is to say, the former is composed of three parts of black and two parts of blue, and the latter of three parts of black and two parts of red. Providing the primaries blue and red (Nos. 1 and 2, Plate III.) harmonize, these shades, which are their derivatives, will also mix well together. A test to which they can be submitted is to view them side by side. If slips of these shades are thus combined, they do not appear incongruous and harsh in tone, but possess a soft and mellow aspect, and in this consists the true characteristics of harmonious colourings. As the tints are worked out on the same system as the shades, they form useful compounds. In order that this important element of congruous colour effects may be clearly understood, let Ex. 1 of Table VI. be also briefly examined. Such a combination can only yield an agreeable pattern. Whether these tints are blended in the wool or in the yarn, the resulting mixture is satisfactory. This arises from the weight or depth of colour of the respective tints being identical; in other terms, the intensity of the tinted red is precisely the same as that of the tinted blue. In dress stuffs, tennis flannels, fabrics for trimmings, silks, and extreme fancy textures, this blend of tints is invariably pleasing. Equally harmonious results may be arrived at by combining tinted red (No. 4) with tinted yellow (No. 16), or tinted blue (No. 10, Plate IV.) with tinted yellow. In each of these compounds, delicacy of tint and mellowness of hue are the prevailing qualities.

23. *Uses of Blue in Twist Yarns.*—Having now treated of blue as a ground colour, and also as a shade for blending with other hues to tone down a style or subdue its coloured aspect, it only remains to indicate its utility as a colour for twist yarns. It is a valuable shade for this purpose. As it is a bright but not a showy colour, it is particularly suitable for fancy two- or three-ply yarns. Twists in which red, yellow, or orange are used, have a tendency to overpower the general colouring of the pattern in which they appear, but this is not the case in fancy yarns in which blue is the principal colour. Such twists, while impart-

ing lustre and freshness to the design, in no wise detract from its beauty of colouring, though that may be of a comparatively subdued character. The following are a few examples in two-ply yarns in which blue threads are employed: black and blue; white and blue; brown (No. 1) and tinted blue (No. 10); dark blue (No. 7) and tinted red (No. 4); blue and yellow; dark blue and shaded red (No. 3, Plate IV.); and medium blue and white.

24. *Points in the Application of Blue and Red to Textiles Summarized.*—The analyses which have been made of the use of blue and red in woven designs, have demonstrated that, whenever primary colours are applied to textile fabrics in their purity and natural intensity, it is in comparatively small quantities. Brilliance of hue causes the application of primaries in large patches to textile surfaces to be undesirable. In dress fabrics, bright blue, red, and yellow have an important place. Mantlings, shawls, wraps, and travelling rugs also provide scope for a liberal use of these shades; but in treating designs with colour for fabrics of the coating and trousering class, subdued and indefinite shades prove the most useful. Red and blue are valuable to impart tone and newness of character to the style. The groundwork of the pattern should first have attention—the intensity and strength of the bright colours depending on the mode of application. Should the ground colouring of a pattern be strong and harsh, the addition of green or blue will, in some cases, give it a mellow quality; or should it lack brightness, then red, orange, or yellow, if applied in small quantities and properly distributed, will relieve the heaviness of the colouring and impart the requisite freshness of aspect. Success in the use of pure colours is determined by the quantities in which they occur, and by the nature of the shades with which they are associated. Bright red, however sparingly employed, if applied to a mixture of brown or russet shades, cannot but form an incongruous colouring; but if applied to an assortment of shades in which soft-tinted blues and greens are conspicuous, both harmony and contrast of composition would result.

25. *Attributes of Yellow.*—This colour (No. 3, Plate III.) is generally understood to be emblematical of purity and brightness.

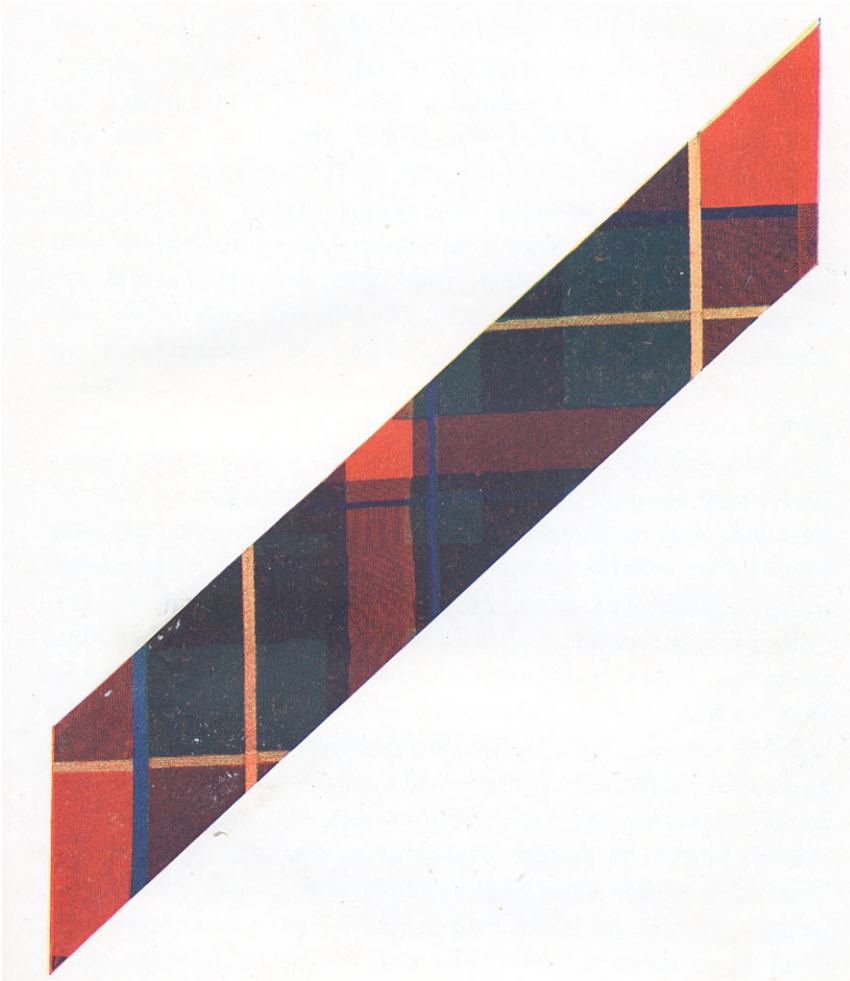


Plate V

PLAID IN WHICH YELLOW IS THE BRIGHT OVER CHECKING COLOUR

It is the most luminous tint in the spectrum. Purple is its complementary and contrasting hue. Intense yellow—rich, bright, and cheerful—has the same relation to light or whiteness as blue has to darkness. It lacks the lustrous quality of red and the retiring, mellow characteristic of blue, but possesses vividness and lustre. Luminosity and brilliance of hue limit its application to textile design; yet it has a sphere which no other colour can occupy. Thus, in patterns in which white yarns and light or delicate shades are employed, it is one of the most important fancy colours it is possible to introduce into the fabric. Mingled with such shades, it loses a degree of that prominence and individuality of tint which characterizes it when applied to patterns possessing dark and sombre grounds.

Another quality of this primary is vividness—no colour being comparable with it in this sense. Orange possesses this attribute, but not so largely as positive yellow. Its characteristic freshness, but comparative lightness of hue, imparts to it a clear and decided tone on black or dark surfaces. Hence it is found that when yellow is blended with light and medium greys and lavenders, its property of lustre suffers in intensity; whereas, if it is applied to dark blue, dark brown, or black materials, its vivid attributes are forcibly distinguished. When these modifications, which this and other bright colours undergo according to the qualities of the several shades with which they may be combined, are clearly understood, the possible effect of their application to any pre-arranged scheme of ground colours may be estimated. Obviously there are three factors to be carefully considered when employing primary hues: first, the nature of the contrast resultant when the colours are placed on light materials; second, on medium-toned grounds; and third, on textures composed of dark yarns. Yellow is somewhat lessened in distinctiveness on the first, but improves in intensity on the dark grounds, being only slightly changed when arranged side by side with shades of a medium depth.

26. *Province of Yellow in Woven Fabrics.*—Pure yellow is but sparingly used in textile designing. In tweeds and worsteds it is combined, to a limited extent, with other shades in the con-

struction of fancy twist and mixture yarns. It is the principal colour in the following two- and three-ply yarns: black and yellow; blue and yellow; indigo blue and yellow; dark grey and yellow; black, purple, and yellow; black, medium grey, and yellow; and black, red, and yellow. When used in this form it may add lustre and freshness to an otherwise sombre style. It possibly gives the best results in tweeds, where the fibrous nature of the texture helps to minimize its excessive brightness. Yellow is also applied as a self-coloured yarn to certain styles of check patterns for woollen travelling mauds, shawls, and rugs. An example of a plaid pattern of this description is given in Plate V. There are contrasts of dark green and red, dark green and blue, black and red, and also yellow as an intermediate colour between green and red, and as a checking colour on the black. Yellow is thus used for two purposes: first, as a divisible hue, contrasting with the green, and harmonizing with the red; and second, as the strongest contrast possible on the black. It gives what may be termed the chief checking lines to the plaid, and produces freshness and lustre in the style. These lines are of sufficient width considering the brightness and vividness of the colour, which are two qualities to be taken into account when using colours in combination with other bright shades.

27. *Derivatives of Yellow.*—These are both numerous and important. When blended with blue, as previously explained, hues of green are formed, comprising myrtle green, sea green, emerald green, and grass green, all of which vary in tint according to the intensity of the bluish and yellowish elements entering into their composition. Yellow with red, on the other hand, yields an assortment of scarlet and orange hues. Yellow with white gives delicate tints of a straw, lemon, and primrose class (see Nos. 16, 17, and 18, Plate IV.); while with black it forms many shades of an olive character, such as those supplied in Nos. 13, 14, and 15 on the same Plate. If it should be mixed with grey, it produces various tints of drab; so that this primary is a very useful colour for blending with other hues in the production of compound shades.

28. *Secondary Colours.*—The attributes and functions of the

primaries in textiles have now been defined. The secondaries—colours resulting from mixing two primaries—possess quite distinct properties from the hues of which they are composed. Compared with the primaries red, yellow, and blue, they lack intensity and strength of hue. Still, they are potent colours, and, as a consequence, only produce harmonious combinations when judiciously employed. As a rule, the stronger and the more intense a colour, the greater the skill required in its application to pattern or design. To use the secondaries in large quantities with success, some practice in textile colouring is essential.

Of these compound shades, orange is the most ostentatious, being tinged with red; purple possesses depth and fulness of hue; and green is suggestive of freshness. Each colour is largely used in woven manufactures, the methods of application depending on the type of the texture. In silk ribbons and neckties, they are used as pure colours, and are also applied to cotton and flannel shirting styles, linen vestings, and fancy worsted shawls; but when employed in the ordinary types of woollens and worsteds, they are somewhat subdued by mixing with white or black, or they may form one of the threads in a fancy twist yarn. The qualities of each colour will be considered separately.

29. *Green: its Attributes and Derivatives.*—This is a useful secondary colour. In the Light Theory of Colouring, it is a primary hue; but it is already understood that, according to the Pigment Theory, green is not a simple, but a compound colour resulting from the admixture of the pigment yellow with the pigment blue. Greens may also be obtained by the same process in the dye vat. Thus the texture or material may primarily be treated with the blue colouring matter, such as indigo, and subsequently with the yellow dye-ware, such as weld or old fustic.

In Nature, green is the most extensively distributed colour, but in the decorative arts, unless modified, it has not a wide application. As a colour it combines the qualities of its component hues—blue and yellow—for it is at once fresh, bright, and cheerful. When associated with the various shades and

tints of red, harmonious and contrasting combinations ensue. Amongst the shades used in textiles derived from this secondary, are myrtle greens, olive greens, slate greens, and dark greens. Colours of this description are useful in textile work.

The spectrum green is only applied to extreme fancies, and then chiefly as an extra, spotting, or figuring yarn; in tweeds and worsteds, however, it forms an appropriately coloured yarn for twisting with other threads of such shades as will neutralize a degree of its intensity and lustre. In fact, green is one of the most useful colours for twisting purposes employed in textile designing: such twists as black and green, scarlet and green, and white and green illustrating its utility in the production of fancy yarns for tweeds.

Derivatives of green, due to its admixture with black, comprise a fair diversity of medium and dark shades which are employed as ground colours, and also for piece-dye textures. Three examples in such shades are Nos. 1, 2, and 3, Plate VI. In the first, black is the preponderating element, but in the third, green is the prevailing hue. With the red browns given in Nos. 1, 2, and 3 on Plate IV., they form perfect contrasts. The most pleasing combinations are those in which the greenish derivatives are blended in equal quantities with the reddish browns as follows: dark green (No. 1, Plate VI.) with dark brown (No. 1, Plate IV.); medium green (No. 2, Plate VI.) with medium brown (No. 2, Plate IV.); and toned green (No. 3, Plate VI.) with light brown (No. 3, Plate IV.). An endless variety of striped and checked patterns in woollen, worsted, and cotton materials is got by combining these shades on the lines just indicated. Some excellent ground twists result from combining dark brown (No. 1, Plate IV.) and toned green (No. 3, Plate VI.); dark green (No. 1, Plate VI.) and light brown (No 3, Plate IV.); and medium green (No. 2, Plate VI.) and medium brown (No. 2, Plate IV.).

30. *Tints of Green.*—The admixture of green with white results in the formation of tints of pea-green. (See Nos. 4, 5, and 6, Plate VI.) These blend harmoniously with the tinted reds given on Plate IV. For example, the pea-green, No. 4, Plate VI., when blended with the whitish pink, No. 4 of Plate IV.,

the pale green, No. 5, Plate VI., with the rose colour, No. 5, Plate IV., and the tinted green, No. 6, Plate VI., with the tinted red, No. 6, Plate IV., all form satisfactory contrasts. As the tints of the respective couplets perfectly balance, being of the exact depth of hue, they constitute mellow and choice combinations. Though these tints are not extensively employed in fancy woollen and worsted fabrics, still there are some classes of these textures in which they are used for ground purposes. One illustration of this kind is pattern No. 2 on Plate VII. The twilled ground of the fabric is a similar tint to No. 4, Plate VI., while the spotting yarns are two-ply, namely, tan and white, and crimson and white twists. The white feature of the colouring serves a twofold purpose: first, it neutralizes and subdues the intensity of the crimson and tan threads; and, second, it imparts precision to the mottled figuring.

31. *Orange: its Shades and Tints.*—Next to red, orange (No. 5, Plate III.) is the most intense, showy, and potent colour. It is closely allied to both red and yellow, of which hues it is composed. Orange is more luminous, but less intense than pure red, and is warmer, but not so bright in hue as yellow. Its potency of hue causes it to suffer little impoverishment either in lustre or intensity from juxtaposition with certain shades. With colours of a reddish or yellowish hue, it undergoes the most marked degree of modification; with blues and greens, and also with their derivatives, its quality is not perceptibly diminished. Whether distributed on dark or light surfaces, it stands out with lustre and freshness, and hence is one of the most appropriate colours for imparting brightness, or for giving to any combination of shades, lacking these qualities, a rich appearance.

Shades of orange (Nos. 7, 8, and 9, Plate VI.) are designated brownish olives, possessing warmer attributes than the shades derived from yellow, but wanting that strength and richness of hue characterizing the russet browns resulting from mixing red with black. As ground colours they are of utility to the textile colourist. With shades of green they form complementary combinations, as the following examples illustrate:—

I. Dark brownish olive (No. 7) with dark green (No 1, Plate VI.).

II. Medium brownish olive (No. 8) with toned green (No. 2, Plate VI.).

III. Light brownish olive (No. 9) with medium green (No. 3, Plate VI.).

These shades also combine satisfactorily with the dark and deep blues given in Nos. 7, 8, and 9 of Plate IV.

From the orange tints (Nos. 10, 11, and 12, Plate VI.) it will be noticed that by mixing white with this secondary, salmon and gold colours are obtained. They are useful in making twist threads, and are also employed, to a considerable extent, in silk yarns in the manufacture of vestings, spotted textures, neckties, and fancies. Satisfactory styles result from combining them with either tints of green or blue.

32. *Purple.*—There is no colour comparable with purple (No. 6, Plate III.) as regards depth of hue. Its characterizing qualities are softness, bloom, and richness of tone. It is a composition of the warm and the cold, and the showy and the quiet elements of the spectrum, namely, of red and blue.

It only yields congruous combinations with a limited range of shades, and these generally belong to the derivatives of yellow. Purple and pure yellow form a very pronounced contrast—an example of which obtains in the common pansy. In this flower, the deep but lustrous tone of the purple opposes the luminous and pure hue of the yellow. From this natural combination of these tints, it is possible to learn with what class of colours purple will form the most effective contrasts. These are shades in which yellow preponderates, such as tans, light olives, and olive browns. To give bloom and richness of aspect to combinations of fawns, olives, and similar shades, purple, in conjunction with white, may be employed. Some excellent tapestries, bordered rugs, and travelling mauds are produced in which this hue is one of the principal colours.

The derivatives of purple are applied to dress fabrics, but are rarely used in textures for men's wear, except for line striping and checking purposes. The examples given in the tints and shades of this colour, in Nos. 13 to 18, Plate VI.,

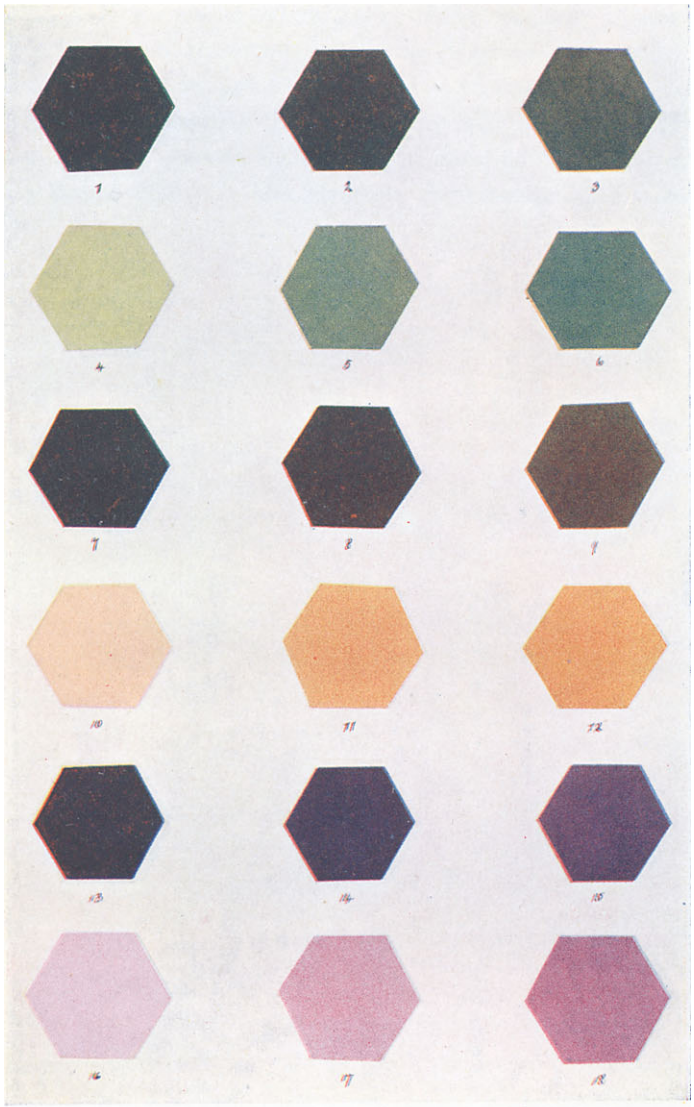


Plate VI

TONES AND TINTS OF THE "SECONDARIES"

1, 2, 3. Tones of Green	4, 5, 6. Tints of Green
7, 8, 9. .. .. Orange	10, 11, 12. .. .. Orange
13, 14, 15. .. .. Purple	16, 17, 18. .. .. Purple

inclusive, show that its admixture with white produces hues of a lilac class, and with black, hues of a deep indigo blue character. Materials dyed alizarin blue possess a similar purplish bloom as these shades, being warmer and redder in tone than the pure indigoes they are dyed to imitate.

Though purple and its derivatives are not largely employed along with other colours in the construction of fancy patterns, yet they are of utility in the blending department of a woollen factory.

CHAPTER III.

CONTRAST AND HARMONY.

33. Colours Affected by Adjacent Colours—34. How Colours are Changed by Juxtaposition—35. Contrast—36. Examples in Contrasts—37. Economic Contrasts—38. Two Kinds of Contrasts—39. Poly-chromatic Contrasts—40. Mono-chromatic Contrasts — 41. Toned and Tinted Contrasts — 42. Comparison of Contrasts by Shade and Contrasts by Colour—43. Shaded and tinted Compositions—44. Bright Colour Contrasts Modified with Black and White — 45. Successive and Simultaneous Colour Effects — 46. Methods of Neutralizing the Effects of Strong Colour Contrasts — 47. Harmony — 48. Principles of Harmony.

33. *Colours Affected by Adjacent Colours.* — The intensity, potency, and hue of a colour may apparently undergo change by placing it in juxtaposition with other colours. The process of colour modification has been considered, when it was indicated in what manner hues are subjective to change in proportion to the quantity of black, white, or a colour which forms part of their composition; but the behaviour of colours when in contact or close together remains to be explained. Change of hue and tone of colour originated by the laws of contiguity is both varied and subtle. Trained and practical colourists realize some difficulty in determining the precise nature of the alteration, but it is none the less evident. That the attributes of colours are somewhat modified when the hues with which they are blended are combined, is an essential principle of shade compounds. If, for example, a series of small scarlet spots were woven on black, grey, and white grounds in succession, the hue of the scarlet, when the several fabrics were compared, would prove to be different in appearance in each sample, though the same scarlet yarn were employed in the production of the respective textures.

Cutting away the grounds and comparing the spots from each on a common surface would show that identically the same scarlet had been used in the three fabrics: yet so apparent is their dissimilarity of hue that a casual examination would pronounce them distinct shades. Thus, on the black surface the spots gain intensity and lustre; on the grey they appear murky and dingy; whereas on the white surface the spots are bright, but evidently pale and washy as compared with those on the black ground. On varying the colour of the spots a different set of modifications ensues. Taking blue as the spotting colour, the black ground neutralizes a degree of its bloom and brightness; on the grey it suffers in lustre, but retains its precision of colour, and increases in richness and fulness of tone on the white fabric. Continuing this idea: if a batch of red threads were interspersed in a white warp, a degree of the colour quality would be subdued by the white threads; but should similar yarns be introduced into a black warp, an augmentation in the intensity of the red would be observed, because of the contrast thus created between the sombreness of the black and the rich brightness of the red: a contrast which, if the quantity of the red be large, is sufficient to give a copper-coloured cast to the black threads with which the red is in immediate contact. A law of colours is, that if the fancy shade is lighter than the ground colour, it will increase in brightness of tone; but if, on the other hand, the "fancy" is darker than the coloured surface on which it is distributed, it will suffer in tone. Moreover, if two colours, such as light and dark olive, were arranged together in the same warp, the former would appear lighter and the latter darker than they really are. This illusory alteration is entirely attributable to contrast. Colours of contrasting qualities and tones undergo two modifications when juxtaposed; first, they alter in depth, and, second, in nature of hue. When yellow and blue yarns are woven together, each is subject to this two-fold change produced by contrast; first, as to tone, the yellow becomes brighter and the blue deeper; second, as to hue, each is tinged with the complementary colour of the other.

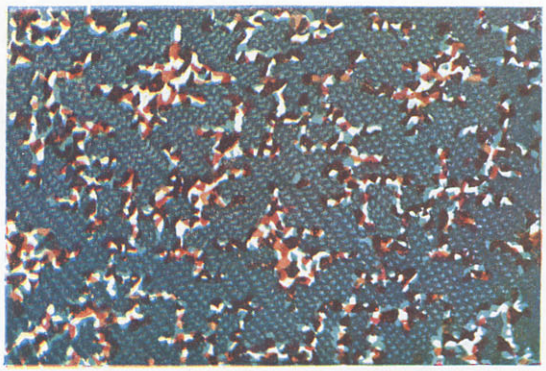
34. *How Colours are Changed by Juxtaposition.*—It is a

generally accepted principle of colours that when two surfaces of different shades are placed in contiguity, each is changed as though it had been mingled with the complementary of the other. Chevreul relates an incident, in his Treatise on Colours, which so clearly sets forth this important rule that it may be stated here. Certain merchants requested a firm of manufacturers to ornament red, violet blue, and blue woven stuffs with black spots or figures. When the goods were produced, the merchants complained that the spots were not black, as ordered, but that those on the red fabrics were tinged with green, on the violet with dark greenish yellow, while those developed on the blue were toned with a chocolate or coffee-coloured shade. Chevreul,[1] in order to prove that the spots were perfectly black, covered the separate grounds with white paper, when it was at once discovered that the changes in the colours of the spots were entirely due to the contrast ensuing between the black shades and the respective grounds on which the spots had been arranged. All this conclusively shows that colour is a modifier of colour, and hence those hues which possess bloom and richness of tone on one species of coloured surface may be quite different on another. It is a good plan to combine the shades in the precise order in which they are intended to occur on a black ground. Classification in this way enables the colourist to estimate at a glance, without putting the pattern into the loom, the general tone of the shades.

A common law of Colouring is, that the general effect of combining colours is that they appear further apart in the chromatic scale. Thus, when orange and red are combined, the former does not become reddish or the latter orangish, but the red seems to approach purple and the orange to assume a greenish cast. Complementary colours—*i.e.* those farthest apart in hue—are the least affected by association, as is evidenced by the results of such contrasts as red and green, blue and orange, and yellow and purple. An illustration may elucidate this primary principle of colour combinations. If a striped fabric were composed of bands of rose (Tint 4, Plate IV.) and lavender (Tint 10, Plate IV.) colours, one hue would help to give

[1] Chevreul: *The Laws of Contrast of Colour*, p. 120.

1



2

Plate VII

1. BLUE TEXTURE
2. FANCY-TWIST YARN SPECIMEN

prominence to the other, because they strongly contrast with each other. On the other hand, if the same rose tint were combined with straw or primrose (Tint 16, Plate IV.), then the individuality of the separate colours would suffer, for, being similar in character, they would neutralize each other's attributes, and would impinge upon one another. Hence, if in colouring textiles, it is required to preserve the intrinsic attributes of a shade, it should be combined with such colours as will differ most decidedly from it in hue and other qualities; whereas, if it is sought to change, by the law of contrast, any particular shade, it should be brought into contiguity with potent colours more or less allied to it in tone and hue.

35. *Contrast.*—What is termed "contrast" is that principle or quality of tints which produces a change in their lustre, depth, saturation, and hue, when in immediate contact with each other.

Contrast may be explained by considering the effect of black and grey yarns in a woven style to which white is subsequently added. There is contrast in the pattern before the white is introduced, but it lacks precision and force. The addition of white imparts lustre to the grey, and fulness of tone to the black. Correctly speaking, neither the black nor the grey are changed by the white; they are, as it were, developed by it. White, in this instance, has the same function as in shaded drawings, in which clearness and boldness are given to form and outline by increasing the dark element of some parts and the light element of others. What may be designated a Tempered Contrast, originates when a quantity of grey intervenes in a mixture of black and white. In the shading of a round surface, this kind of contrast, in neutral tints, is developed to perfection, undue harshness of effect being neutralized by the gradual toning of black into white; but in the shading of angular objects, the sudden transitions from the extreme light to the extreme dark end of the scale of shades, produce good illustrations of the characteristics of Decided Contrasts. A pattern composed solely of black and white yarns is full of this kind of contrast, but by adding grey a toning element is introduced which forms a mellowed or tempered combina-

tion. Decided or "hard" contrasts, resulting from the use of positive (primary and secondary) colours, are exactly the reverse of graduated ones; they are inartistic, and deficient in softness which constitutes good colouring; on the other hand, toned contrasts possess richness and mellowness. Contrasts obtained by combining pure colours may be harsh and displeasing to the eye. Red and blue, for example, form a strong colour contrast, but this may be subdued by changing them to tones or tints. This will be seen by combining the following derivatives of these primaries: dark brown (Shade 1, Plate IV.) and dark blue (Shade 7, Plate IV.), and rose pink (Tint 5, Plate IV.) and blue lavender (Tint 11, Plate IV.). On account of the colours in these cases being either shades or tints, they produce mellow or tempered and not harsh or pronounced contrasts.

36. *Examples in Contrasts.*—On Plate VIII. and in Nos. 1 and 2, two illustrations in contrast are given. In No. 1 the two ground colours, pale blue and straw, form a passable contrast, but the small lines of orange impart harshness of effect to the stripe. The strength of hue of this colour is not suitable for the stripings on which it is placed. Providing only three colours were allowable in this composition, then to prevent the orange from being too pronounced, it should be softened or tempered as in the illustration, No. 2, Plate VIII. While in this latter example the pale blue and straw remain the same, yet the mellowing of the orange into a paler tint produces a strip of colouring in which each element, being of similar depth of tone, is equally prominent and effective. Comparing these illustrations further, it is obvious that in No. 1 the orange characteristic first strikes the eye. The slight hardness of tone does not arise from any want of beauty in the separate colours, but from the relative undue strength and vividness of the shade of orange. Providing this hue were replaced by green, an imperfect contrast would be formed; for green, while detracting from the lustre of the pale yellow or straw, would also harmonize indifferently with the lavender or tempered blue. From these illustrations it will be evident that in a satisfactory blend of colours all hues contribute to the attractiveness of the *ensemble*;

but in an imperfect contrast one or more colours may subtract from the lustre of adjacent hues, and partially neutralize their effect.

37. *Economic Contrasts.*—Economic Contrasts comprise the production of the most effective styles with a minimum variety of hues. It does not follow because a pattern contains a diversity of shades that it will be attractive. Just as it frequently happens that the most permanently beautiful patterns result from the simple but unique methods of amalgamating forms, so by the artistic arrangement of a few choice colours excellent contrasts may be produced. To multiply the diversity of hues in any combination without marked increase of beauty is calculated to be more detrimental than beneficial to the style. An economic method of colouring consists in blending shades or tints of the same colour, and freshening or brightening the style by the use of "extras" or "fancies." To practise economy in colour compounds, the first care should always be to obtain appropriate ground shades: if these produce harmony and possess a rich though subdued bloom, but few bright colours will be necessary to impart freshness and lustre to the style. On the other hand, an indifferent selection of foundation shades implies the employment of an increased range of fancies to tone, strengthen, and brighten the contrasts.

38. *Two Kinds of Contrasts.*—All types of colour compounds may be included under two heads: namely, Mono-chromatic and Poly-chromatic Contrasts. The former comprise all species of contrasts due to a diversity of tint or shade in one colour; the latter comprise all kinds of contrasts arising from combining two or more distinct colours. The strongest and most effective colourings occur in poly-chromatic contrasts; while soft, subdued, and graduated tonings are largely characteristic of analogous colour contrasts. Blends of scarlet and green, yellow and blue, and orange and purple are colour couplets which illustrate the principles of contrast due to a diversity of hues; but blends of two shades of brown, blue, or slate, form contrasts belonging to the mono-chromatic class. In textile designing both these types of colouring obtain. They are frequently present in the same pattern, for a style may contain contrasts in shade, as well as

contrasts in hue. For example, if two shades of brown, forming the bulk of a pattern, are brightened by extra threads of scarlet and blue, its colour elements are a co-mixture of both kinds of contrasts defined above.

39. *Poly-chromatic Contrasts.*—A suggestive illustration of this species of colour arrangement is given on Plate VIII. in No. 3. It is a scrap of textile ornament, borrowed from a Japanese work on decorative fabrics found in a Buddhist temple. A more vigorous combination of colours, possessed of greater potency and lustre, it would be difficult to conceive. With such chromatic science have the various hues been associated that each retains, unaffected, its individual strength and vividness. Considering that this group of forms contains no fewer than seven colours, in addition to black and white, and that the ground shade is a deep purple, the lustre of the separate hues is exceptional and a forcible quality of the design. Purple, as a rule, is a shade that, in virtue of its potency, alters all colours with which it may be mingled that are in any way akin to it, such as greens, blues, and reds; but it forms strong and decided contrasts with yellow, orange, and their derivatives. It becomes, therefore, an interesting inquiry, why in this blend of hues, green and blue lose none of their freshness and saturation. The method of arranging the colours, or the plan of combination — comprising the couplets scarlet and orange, deep and pale greens, and deep and pale blues— supplemented by the ingenious touches of black and white, are elements at the base of the colour emphasis characterizing the entire pattern. For the purpose of making the sequent analysis as lucid and instructive as possible, one of the four triple-leaved conventional forms surrounding the central diamond figure may be isolated, and its colourings alone considered; for each of these not only comprises every kind of hue entering into the design, but also illustrates the system of colour-mingling adopted throughout the design. Starting with the minute spots of scarlet—they are contingent, on the one side, with the purple ground: and, on the other side, with the small curved strips of orange. If the eye is allowed to single out and rest upon these scarlet sections where they are in contiguity with the purple,

it will be noticed that the scarlet gains a crimsonish hue; but the eye takes simultaneous cognizance of the whole series of hues—a feature of the pattern which markedly contributes to the freshness of the individual colours. As a result of the incompetency of the eye to view the colours separately, and also on account of the method of arranging the colours, green at once associates itself in the mind of the observer with scarlet, and orange with pale green and deep blue. The law of contrasts brings the complementary colours in affinity, and, as a consequence, develops strength and fulness of hue. Impingement of colours is by this means avoided. The white edging of the leaves prevents the purple ground from affecting the purity of the pale blue, and also imparts clearness of outline to the ornament in general.

The lessons to be learnt from this colouring may be summarized as follows: First, pure complementary colours, when adjacent, do not neutralize, but develop the qualities of each other; second, that by an appropriate use of white and black, as agents for separating colours, kindred hues may be arranged to produce an attractive contrast; and third, a medium shade of green gives lustre to scarlet, and palish green and deepish blue are complementary to orange.

Some useful ideas may be gleaned from this example in Colour Contrasts for textile purposes. Thus, the small figures composed of the tints, as arranged in one of the conventionalized leaves of this design, may be grouped on a sateen system in a style for fancy vestings. It is suggestive in other ways. Ideas for cotton stripes or checks of a flannelette class may, for example, be obtained from it. Stripes of the blue shades here given, placed on a white ground, and brightened with a few threads of the orange hue, would form harmonious colouring. Again, a fabric of a dress-stuff description, in which the same arrangement of tints is observed, but the colours softened or tempered with black, could be appropriately coloured on this system. In such an instance scarlet would be replaced by dark brown (Shade 1, Plate IV.); orange by reddish olive (Shade 9, Plate VI.); medium green by deep green (Shade 2, Plate VI.); pale green by toned green (Shade 3, Plate VI.); blue by dark blue

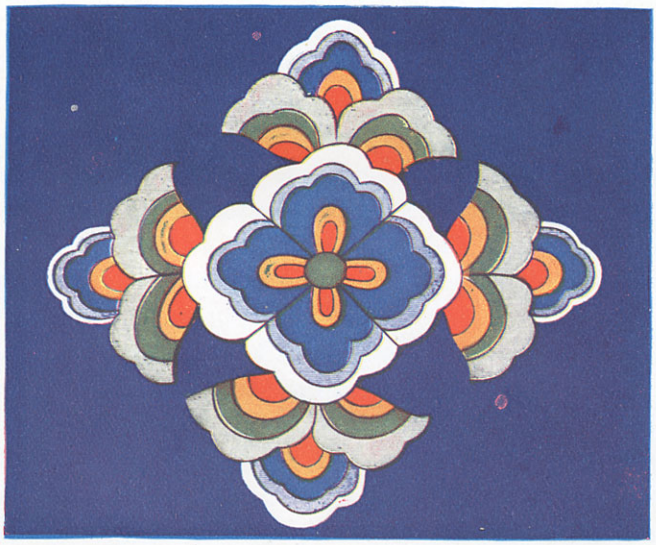
(Shade 7, Plate IV.); and pale blue by toned blue (Shade 9, Plate IV.). It is evident from this group of shades that such a brilliant blend of hues as that composing the design given in No. 3, Plate VIII., may be turned to useful account; for in this instance it has been made to form the base of a new scheme of combining a number of dark colours adapted to a dress-stuff style. Of course it will be noticed that the modified colours are related in hue to the pure colours of the specimen of colour contrast considered; hence it follows that if the original colouring is characterized by balance of tone and harmony, the resultant blend of shades must possess similar qualities mellowed and tempered in intensity.

One further thought on this plan of colour-mingling should be alluded to. In the foregoing example in shade-deduction from a combination of bright hues, dark colours have been employed; but it is equally feasible to appropriate tints as follows: rose (Tint 6, Plate IV.) for scarlet; pinkish orange (Tint 11, Plate VI.) for orange; pale blue (Tint 11, Plate IV.) for blue; lavender (Tint 10, Plate IV.) for light blue; pale green (Tint 5, Plate VI.) for green; and very pale green (Tint 4, Plate VI.) for light green. This series of tints, when associated with suitable quantities of white, might be applied to textiles with satisfactory results, more especially if the system of grouping given in No. 3, Plate VIII., were adopted. Illustrations, based on this interesting specimen of colour amalgamation, have been multiplied because they indicate how useful "hints" in harmonious colouring may be gleaned from an apparently extravagant though elegant arrangement of hues.

40. *Mono-chromatic or Analogous Contrasts.*—This kind of colour contrast is extensively applied to all classes of decorative work. Nature abounds with suggestive illustrations of the principles of these colourings, a few of which may be described. Amongst flowers and plant forms which exhibit contrasts in reddish hues, the rose and stem of a forced rhubarb are particularly good. Take the rose first. What a beautiful delicate series of red tints it contains, and how mellow and rich are its finely gradated tones! There is an entire absence of harshness or even tendency to hardness of tinting in its

1

2



3

Plate VIII

EXAMPLES IN COLOUR CONTRASTS

2. Stripes. 3. Figuring in Bright Colours

colour composition. Ruskin, writing on gradation of hues, observes: "The victorious beauty of the rose as compared with other flowers depends wholly on the delicacy and quantity of its colour-gradations, all other flowers being either less rich in gradation, not having so many folds of leaf, or less tender, being patched and veined instead of flushed." A stem of rhubarb also contains an infinite variety of gradations of crimson. At the base, it commences with a saturated crimson which alters in intensity to a palish pink. Not only are examples in red contrasts discovered in natural forms, but also shadings and tintings of green, blue, and brown. In the flimsy, delicate petals of the harebell several gradations of blue occur, running from a deep to a palish tint. For browns, the foliage of autumn only need be referred to. The leaves teem with diversity of shade, yet all the colours are of a brownish cast, varying from bright tan to rich russet. Some species of sandstone and pebbles exhibit useful gradations of fawn, such as cool and warm colours, especially suitable for application to textile patterns.

The chief characteristics of graduated contrasts—which compose a large variety of colourings in decorative design—are softness and mellowness of toning, combined with lustre and force of effect. Compared with hue contrasts, they may lack strength and precision of emphasis, but they possess a soft, saturated fulness which makes them useful in the production of fancy textures.

41. *Toned and Tinted Contrasts.*—Mono-chromatic compositions may be considered under two varieties, namely, Toned and Tinted Contrasts. The former comprise all associations of shades in which the colours have been toned or darkened by admixture with black; while the latter are composed solely of colours which have been tinted with white. These contrasts comprise the most valuable assortments of colours seen in fabrics produced for wearing purposes. Their quiet and mellow toning makes them of great utility in textile designing. Probably the largest proportion of fancy textures manufactured for men's wear, results from this sort of colour composition.

Illustrations in this type of colouring deserve to be carefully considered. The first example which will be alluded to is

on Plate IX., No. 1. It is a toned contrast, being a mixture of the three browns, Shades 1, 2, and 3 on Plate IV. The style is suitable for either woollen or worsted materials, and is of a check description. The mode of sketching shows the effect due to the simple twilled weave used in its construction, as well as the peculiar form of check resulting from the plan of blending the shades. But it is the colour element of this fabric, with its gradated contrasts, that is at this stage most important. The three shades of brown have been combined thus in both warp and weft: 8 threads of dark brown, 8 threads of medium brown, 8 threads of light brown, and 8 threads of medium brown. The medium shade thus alternates with the dark and light colours, maintaining one depth of contrast throughout the pattern. Blues (Shades 7, 8, and 9, Plate IV.), greens (Shades 1, 2, and 3, Plate VI.), or olives (Shades 7, 8, and 9, Plate VI.) might have been selected with similar results as the browns of this illustration. Three greys would also have shown the principle of this type of contrast, for compositions of dark, medium, and light greys form an endless diversity of textile patterns. But to return to this brown example. The contrast is of a mellow kind. There is no marked distinction between the shades, the three composing a softly-toned coloured effect. This characteristic of the style is of course attributable to the several shades being derivatives of the same hue—the red element predominating in each. Whatever kind of shaded or tinted contrasts are considered, they are characterized by the same tone of colouring seen in this pattern.

In order to show the precise nature of this class of contrast in tints instead of shades, another illustration is that in No. 2 on Plate IX., composed in this instance of three lilac tints similar to those given in Nos. 16, 17, and 18, on Plate VI. Again, the plan of the weave of the fabric is cassimere twill, but the system of colouring has been diversified; thus, it consists of 16 threads of the deep tint, 8 threads of the medium tint, 16 threads of the light tint, and 8 threads of the medium tint. While this arrangement forms a somewhat more varied style than the preceding method of combination, the tints of which it is composed are distributed in equal quantities, producing a

uniform colouring. Its quality of mellowness is even more pronounced than that of No. 1. Being a light pattern, it possesses a unique delicacy of toning. This applies to all compositions of tints, which, when properly graduated, constitute the most mellow type of colouring producible.

These illustrations in Toned and Tinted Contrasts are typical of the general effects obtainable by combining colours of the same hue but of different degrees of lightness and shade; they show that while effective compositions may be acquired with shades or tints, yet they are usually deficient in that force of contrast characterizing patterns containing a variety of hues.

42. *Comparison of Contrasts by Shade and Contrasts by Colour.*—Relatively considered, contrasts in several colours are more definite and brilliant than contrasts in shades or tints; hence the former are applied to all classes of decorative fabrics, while the latter constitute the bulk of the colouring in textures made for wearing purposes. Of course, both systems of colouring largely overlap each other, making it impossible to limit the classes of fabrics in which each finds expression; still, in the general run of styles, tempered colours are the most appropriate for the ground or foundation of wearable textures; while, on the other hand, bright and positive colours impart the most telling precision to ornamental forms. Hence it may be affirmed to be a common law in textile colouring, that shades and tints compose a large proportion of styles intended for garments, whereas the special province of hue contrasts is in the development of figured designs. Tartan checks or plaids (see Plates V. and X.) are amongst the principal exceptions to this rule.

43. *Shaded and Tinted Compositions.*—These may either result from the use of one or more colours. First, suppose an instance in which blue shades are combined with blue tints, or in which the same hue prevails throughout the whole of the colouring. Thus, take the three shades given in Nos. 7, 8, and 9, and combine them to form a striped pattern with the three tints, Nos. 10, 11, and 12, on Plate IV. Providing they are arranged in the order here mapped out, they would constitute a perfectly toned shade of blue. The gradations would run from a deep shade to a light tint, or from an extreme dark to an

extreme light blue. An idea of how shaded patterns are arrived at in woven textures, in one hue of colour, may be gleaned from this example, for it is evident from the elements of its arrangement that a shaded effect may be produced in all kinds of hues, such as brown, olive, and green, if they are capable of yielding a sufficient diversity of toning.

But, in addition to this method of associating tints and shades, these colour derivatives are also combined in distinct hues, forming a varied assortment of colourings. A ground pattern, for example, consists solely of an arrangement of shades; but, in order to give brightness to the style, a few fancy threads of tints derived from other hues—possibly of opposite, or may be of complementary, qualities to those from which the shades have originated—may be called into requisition. This principle of colouring may be clearly demonstrated by referring to the brown check pattern given in No. 1, Plate IX. To impart a degree of freshness to this design, blue tinted threads might be employed, say about two between each shade. Exactly the same tint should not be introduced between the checks of the several shades. For the darkest shade the deepest tint should be used, for the medium shade the medium tint, and for the light shade the light tint; in other terms, whatever the nature of the shade, a corresponding tint is requisite. Balance of colouring and of contrast is only attainable by strict adherence to this rule. If the same tint were used for all the shades, it would appear stronger and more pronounced in some sections of the pattern than others. The blue tint which produces exactly the desired contrast when associated with the light brown of this pattern, would have a very different effect if placed on the dark brown: so that in applying tints to a good blend of shades, or shades to a good blend of tints, to secure diversity and freshness of pattern, combined with uniformity of contrast, care must be exercised in the selection and appropriation of these fancy or brightening elements, otherwise they are likely to prove more or less effective in some instances than calculated, and to destroy the harmony of the whole colouring.

The methods of acquiring Colour Contrasts by combining tints and shades may be summarized as below: I. Compositions

1

2

Plate IX

MONO-CHROMATIC CONTRASTS

1. Contrasts in Tones
2. ,, ,, Tints

of several Shades or Tones of the same Hue;[1] II. Compositions of several Tints of the same Hue;[1] III. Compositions of Shades of different Hues; IV. Compositions of Tints of different Hues; V. Compositions of Shades and Tints of the same Hue; and VI. Compositions of Shades and Tints of different Hues.

44. *Bright Colour Contrasts Modified with Black and White.*—Some elaborate check patterns for dress and other materials consist of bright colours. An example of this type of contrast is supplied on Plate X. The colouring is harmonious and choice; showing that the most potent colours may be used in textiles with satisfactory results.

However this pattern is examined, it is lustrous and rich in composition. Possibly the black and white introduced into the texture mellow and soften the general colouring, for they undoubtedly subdue the strength of the contrast arising from three such positive hues being in immediate affinity with each other. It is already understood that these shades are of great utility as mellowing agents when combined with bright colours. They prevent the sharp contrast which sometimes ensues when several lustrous hues are in close proximity with each other. Blue and red in certain forms constitute a harmful contrast, the two producing anything but delicate harmony. Vigorous as the contrast is, in this instance it is not harsh or defective. There are several elements which are conducive to its harmony. First, there are the black and white threads just alluded to; second, the quantities in which the several colours are associated; and third, the peculiar effect due to the plan of interlacing the warp and weft threads in the construction of the texture. Weaving largely multiplies the effects due to a combination of colours, as is instanced by this pattern, which, though only comprising four distinct colours, and white and black, contains many varieties of colouring. These result from the different colours crossing and blending with each other in the formation of the check. At intervals, the scarlet weft covers the scarlet, blue, green, yellow, white and black warp yarns, producing a specific effect in every transition. Analysis shows the various effects to comprise solid checks of red, green, blue, yellow, black, and

[1] *Analogous Colours.*