TEXTILE COLOUR THEORIES.

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PHENOMENA OF TEXTILE PROGRESS.

IN the varied phenomena of textile performance concerning mechanism, manufacture, fabric design, and colouring, developments are taking place which tend to more economic and improved artistic productions.

Progressive changes are being effected in the construction and efficiency of carding, spinning, and weaving machinery; but these do not involve a modification of radical principles which practice and commercial use have established and confirmed. It would be a subtle and complex task to devise and carry out automatic schemes of work, more capable of exact manipulation of fibrous materials in yarn construction, and of threads in fabric making, than those deduced by a sequence of invention from simple manual methods.

Ancient craftsmen handled flax in preparation for spinning much in the same manner as it is treated in the heckling, drawing, roving and spinning frames electrically driven in the Ghent International Exhibition of 1913. To trace the working of any class of fibrous material from the natural condition to the woven fabric reveals the utilisation in modern practice of systems of work of early historic origin. This does not impose finality of attainment in mechanical means, nor does it contract the scope for the exercise of inventive faculty. The achievements of Watt and Stephenson were the *Alpha* and not the *Omega* in locomotive design and construction, and, in an equally emphatic sense, the carding device of Arkwright, the mule-jenny of Hargreaves, the spinning frame of Crompton and Roberts, the power loom of Cartwright, and the combing machine of Heilman, were the beginning and not the finality in textile mechanical contrivance. The law of evolution in the inventive world is constant and progressive, at once discovering and accomplishing the possible of attainment. It is alike operative in mechanism and in the processes of manufacture, converting practical routine, hitherto determined and controlled by raw and crude methods, into systems of work based upon scientific data and experiment.

Art and colour theories and practice compose an essential part of the history and development of loom work. Relating to the æsthetics of woven manufactures, they are, in a sense, not

affected by mechanical developments or by industrial growth due to the application of scientific and technical knowledge to the processes of textile production.

RECOGNITION OF TEXTILE COLOURING AS A DISTINCT BRANCH OF APPLIED ART.

A high standard of design excellence is evident in the decorative textures of the Renaissance, and woven during the middle ages in the looms of Florence and Venice; in the Lyonnaise silks of the Louis XIV. period, and in the loom-work of Eastern craftsmen—Chinese, Japanese, Indian, and Persian. Culture and a knowledge of technique, associated with inventive skill, are the bases on which artistic colouring and designing are originated; yet the curricula in Continental, American, and English schools of textile science less than 25 years ago did not treat of the art and technology of woven colouring. The value and service of colour in imparting tone, quality and freshness to design, and its utility in tinting the surface of the fabric were recognised, and laws of colour harmony were observed in developing pattern and ornament by interlacing warp and weft yarns; but it remained for research, experiment and analysis to unravel the principles and data relating to the application of colour to woven surfaces, and to deduce a theory of textile colouring. That this differentiated from colour theories applicable to other materials, and branches of technical and practical art, was apparent; but to what degree, and in what sense, could only be demonstrated by having regard to the technical elements involved.

EARLY HISTORIC TEXTILE COLOUR SCHEMES—PURITY OF HUE.

Colour notions and life themes, expressed in the earliest writings on colour, dating nearly 4,000 years ago, harmonise with modern theories and practice. Colour is known to suggest certain associations of ideas, and to evoke a sense of rest, gladness, warmth, purity, clearness, or freshness. Ancient Eastern definitions of colour inference, and suggestiveness, are in accordance with modern and Western views. They neither trangress in principles or law. The appropriateness of the application of the several colours—rarely spectral hues—to woven pattern and texture, is singularly apt and correct in the light of modern art and science. The value of purity of hue was esteemed and understood. Colour might be weakened in intensity, or deepened in tone, yet neither process detracted from the quality of the hue; but if the hue were changed, the purity and distinctiveness of the colour suffered. Tone-upon-tone colouring in pure hues was practised as being competent of giving clearer, and more precise definition of pattern detail, than combining tones of colour obtained from changing the hue. In ancient colour craft, hue contrasts are properly regarded as more potent than mixed hue contrasts, whether composed of tones or tints. Derivative hues,

being less transparent and distinctive in character than pure hues, have an important place in ancient as in modern schemes of design, and one for which the simple or primary hues, by reason of their quality of purity, are unsuitable. Purity of hue in textile, as in other phases of colouring, imparts peculiar freshness to shades and tints, rendering them applicable to all species of design effects in which clearness and distinctiveness of colour tone are desired.

CONSISTENT PRINCIPLES OF COLOUR SCIENCE—HARMONY.

Colour science and artistic considerations as affecting laws of colour harmony and contrast, nomenclature, purity and quality of hues, and colour inference, have a universal meaning and rendering, which are not subjective to varied interpretation with a variation in the type of design or nature of the material employed. Colour harmony is consistent as it obtains in the decorative tapestry, composed of numerous shades and tints of dyed yarns, or the pictorial mosaic of even a larger range of colours developed in pieces of opaque glass; in the rich purple colouring of the moors and in its warp-and-weft prototype as seen in the Bannockburn tweed, or the heather mixture; and in the brilliant tinting of the costly silk or the humbler toning of the cotton-blouse material.

Scope in colouring is affected by the nature and facility of design characteristics, but harmony of composition is not effected. Patternwork, consisting of varied species of form, affords possibilities of colour treatment of a distinct, and more diversified quality, than patternwork composed of minute details, and line effects, as in the Cashmere shawl. The latter is a kind of lattice or fretwork design wrought in threads, a tracery or outlining of form, rather than broad figure production, and requiring expression in strong and vivid colours. The application of subdued hues and tints to this branch of woven design would render the details indistinct. Minuteness of effects in design, necessitates the combination of pronounced colour contrasts, otherwise the beauty of the whole pattern suffers. Colouring should proceed on lines and methods adapted to the character of the ornamental factors, and the material and structure of the fabric.

VALUE OF TECHNIQUE.

The art of colour practice is dependent upon a knowledge of technique. As enunciated and explained, the principles of harmony, of quality, and tone of colour are not variable, but technique, which is a governing and active factor, varies with the material and scheme of manufacture. The colour work of the artist, in architectural design in mural decoration, may be suggestive and inspiring as examples in harmony of colouring, but are chiefly instructive as general principles when viewed in relation to other methods of application. With a variation in

quality of ornament, schemes of form and design—geometric, floral and conventional—the mode of colouring must be modified, hence the marked difference in the colouring typical of Japanese and Indian loom-work, the former being a composition of varied subdued and decided contrasts, but the latter of precision of colouring due to the use of a few definite and distinctive hues, such as red, green, blue and gold interweaving with black and white.

COLOURING IN PATTERN DESIGN.

Textile colouring relates, moreover, to what is known as patternwork, as distinct from decorative work, and here specialised training in the principles of technique is as essential as specialised training in the general principles of harmony of colouring as interpreted in pure Art teaching. It is a species of surface colouring developed by the minutest design features, due to the construction of the fabric and the materials and yarns combined. It may be defined as line definition, emphasised as developed in stripe and check patterns, and in an unlimited diversity of effects obtainable by systems of interlacing warp and weft. To these small styles, as also to decorative designs. colour can only be successfully applied by those conversant with the technique of textile manufacturing, and with the feeling for colour derived from Art culture.

COLOUR QUALITY—PHYSICAL PROPERTIES OF THE MATERIALS.

Colour may be modified in brilliancy, intensity, and quality of hue, by changing the physical properties of the material, and the structure of the surface in which it is expressed. The pearl carpet of Baroda being a tissue of pearls, rubies, sapphires, and diamonds, is rendered unique in colour harmony, by translucency and iridescency of hue. As an example of Arabesque design, arranged in jewels and in two tones of green, blue and coral red on a soft pearly white ground, it is a magnificent specimen of applied art. A corresponding colour scheme wrought in silk, wool, or cotton, would undergo gradation of toning by a change in the material, but no virtual modification would occur in the colour contrasts.

To take a more ordinary example—a union rug texture, woven in Botany worsted roving, and Saxony woollen yarn of a similar counts or diameter, and treated in finishing routine to have the extraneous surface fibre, in one specimen removed, and in a second specimen raised into a pile or nap; two comparisons in colour quality in the same grouping of shades are suggested. In the first comparison, which is originated by two causes (1) a degree of difference in the quality of the material, and not in the roving and woollen yarn; and (2) to distinct methods of thread construction—the colours in the texture produced in the worsted roving being fresher in tone and brighter in hue than those developed in the texture woven with the woollen yarn.

The treatment of the materials in dyeing and in the colouring of the two fabrics being identical, two features affecting textile colour combinations which are of important value, are the quality and nature of the material, and the scheme of fibre arrangement in the manufacture of the yarn.

The colour contrasts are more pronounced in the second class of comparison, due to two methods of finishing having been practised. Here, materials, yarns, colours and all technical details of manufacture correspond, but in one fabric, namely, that from the surface of which the fibre has been removed in finishing, the colour contrasts are sharp and decided; and, in the second texture, in which the fibres have been raised into a compact dense series, thereby effacing the threadlike characteristics of the surface, a subdued and softened tone of colouring is developed, with the hues of the fibres somewhat blending or mingling in such sections of the pattern where the effects of the different shades are juxtaposed.

The technicality involved is purely textile in quality and is suggestive of how, and in what degree, the tone of colouring produced and defined in the loom, is alterable in the treatment of the fabric in the finishing processes.

TEXTILE COLOUR THEORIES DETERMINED BY QUALITY OF FIBRE, YARN, AND FABRIC.—STRUCTURE AND METHODS OF MANUFACTURE.

These elementary comparisons serve to show that technical data and elements of a textile class have to be observed in applying colour to woven materials. The quality of the fibre, the structure of the yarns, the scheme of intertexture, and the routine of finishing are all group factors entering into the treatment of colour, either in the production of the design in the loom, or in the modification of the colour tone of the woven texture. Each group factor is constituted of technical principles and features determining Theories of Colour in textile manufacturing and designing, and relate to:—

1. Qualities of fibrous materials and colour purity.
   - (*a*) Distinctive colour features of silk, wool, cotton, flax, jute, ramie, artificial silk, and wool substitutes.
   - (*b*) Compound colour qualities, dyed to the same hue, shade, or tint, but using fibres of different physical properties.

2. Methods of yarn construction and colour definition and distribution in the texture.
   - (*a*) Colour qualities of ordinary or plain yarns prepared by distinct systems, *e.g.*, woollen and worsted, mule and frame spun yarns, natural and spun silk.
   - (*b*) Colour qualities of folded and several-ply yarns, composed of threads of the same or different fibres, and of similar or different counts of yarn.

3. Colour blending of fibrous materials.
   (*a*) Value of hues, tones, and tints, as constituent elements of fibrous mixtures.
   (*b*) Quantitative proportion of colours as determined by intensity and purity of hue, and colour quality of the blend or mixture.
   (*c*) Blending of fibres of similar qualities but of different colours.
   (*d*) Blending of fibres of dissimilar qualities and colours.
   (*e*) Production of toned or graded mixtures to a definite chromatic scale.
   (*f*) Production of mixtures of corresponding depths of tone but of different colour elements.
4. Fabric structure and colour expression.
   (*a*) Hand and machine made lace.
   (*b*) Plain and fancy knitted textures.
   (*c*) Felted textures made of wool without yarn preparation.
   (*d*) Woven fabrics with the warp threads parallel to each other, and the weft threads interlacing at right angles.
   (*e*) Gauze, leno, and open-work textures, with separate threads or groups of warp threads twisting or wrapping round separate threads or groups of warp threads, with the weft interlacing, but forming "net" or perforated effects.
   (*f*) Pile, plush, and velvet fabrics, with the pile, plush, or shag of fibres or loops of threads produced by special warp or weft yarns.
5. Schemes of intertexture.
   (*a*) Colour pattern expressed in single-weave textures.
   (*b*) Colour pattern expressed in compound-weave textures.
   (*c*) Interchanging compound weaves.
   (*d*) Systems or plans of warp and weft interlacing devised for specific colour expression and localisation.
6. Fabric treatment and routines of finishing.
   (*a*) Routine to develop colour.
   (*b*) Routine and processes to soften the hue, tint, or tone of colour.
   (*c*) Routine to produce specific colour effects due to fibrous characteristics.

In this paper it is only feasible to define briefly each theory named, following with a fuller, though necessarily incomplete, analysis of the particular theories concerning the colour qualities of fibrous materials, and the colour precision and emphasis produced by fabric structure.

1.—Qualities of Fibrous Materials and Colour Purity.

The physical formation and properties of the fibres have a colour value in textile design and pattern origination. This is

rather one of tone, purity, and brightness than one of a difference of hue developed, though this is also affected, and, in some instances, as in cotton and silk, when the materials are dyed to give the same shade. When, for instance, wools of dissimilar grades are combined and treated correspondingly in the dyeing operation, each assumes a particular colour tone in the manufactured yarn or fabric. This is clearly traceable, and forms a technical characteristic employed with a view of attaining diversity of tinting in textile work, *e.g.*, felt materials for hats, fancy yarns, and mixture costume and suiting fabrics.

The whole is a subject for specific study, experiment and practice.

2.—Methods of Yarn Construction and Colour Definition and Distribution in the Texture.

Methods of yarn production also afford scope of a distinctive order for colour facility. Should the schemes of yarn manufacture comprise the use of materials of like qualities, then the routine of mechanical work adopted influences the colour tone and characteristics. This element is typified in worsted and woollen threads—so markedly different in structural formation—the former possessing, when dyed either in the top, hank or piece, a brighter tone than the latter dyed in wool, the hank, or in the manufactured cloth. Moreover, when the yarns are similarly constructed up to the final stage of production, and a divergence is practised in the method of spinning, the colour trait which the thread develops is distinguishable in the piece-dye or in the fancy texture in which it appears. These, however, may be defined as the lesser colour values for which methods of yarn manufacture are responsible. In the many varieties of several-ply and folded yarns, applicable to specific styles of woven and knitted materials—zebelines, astrakhans, curls, knopped and looped patterns—a branch or theory of textile colouring is formulated in which qualities of fibres, and modes of thread construction are assertive colour constituents.

3.—Colour Blending of Fibrous Materials.

Four of the sections specified in the Theory of Textile Colouring comprised in the blending of fibrous materials—either for mixture shades in felts or yarns—are mainly technical in character, but in both sections (*a*) and (*b*) the problem is one purely relating to the artistic phase of colouring, and has corresponding features to that expanded in the mixture of pigments and other substances to produce diversity of tinting, irrespective of any textural properties. Dyed fibres give, however, greater visibility to the colour ingredients employed, these continuing separate and distinct in the mixed state, whereas in the mixture of pigments individuality of colour disappears and gives place to

a new shade of simple and not compound consistency. Sections (*c*) to (*f*) involve manifold technicalities, and to understand their relation and aspect combine the association of the artistic sense with a study of the principles of woven manufactures.

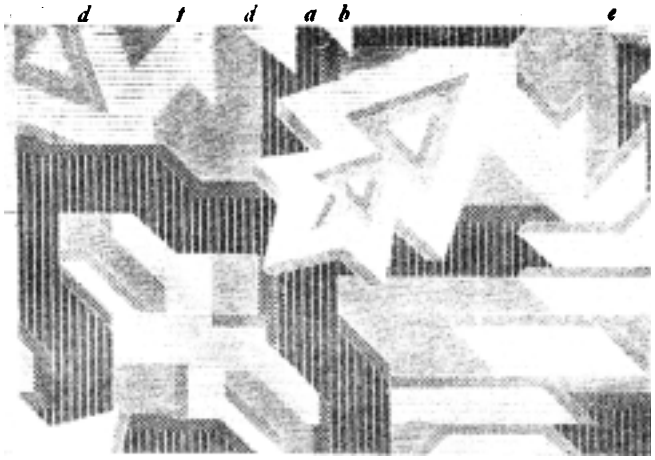


FIG. 1.

Parts *a*, *b*, *c*, *d*, *e*, *f* correspond to similar sections in Figs. 3, 4, 5, and 6.

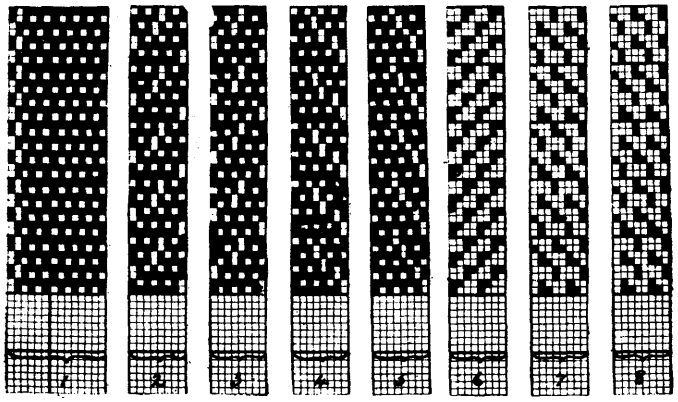


FIG. 2.—SECTIONAL WEAVES FOR FIG. 1.

4.—FABRIC STRUCTURE AND COLOUR EXPRESSION.

Fabric structure in relation to colouring comprises several branches of technical study. Each structure of fabric defined has a special weight and power of modification of result as regards colour compounds, due to the method of warp and weft interlacing and the fabric surface formed. The subject will only be dealt with as affected by the woven fabrics defined in section

(*d*); but it should be observed in reference to gauze, lappet, and other open-work textures, that textile designers have, perforce, to consider in a special way the structure or build of the fabric in the use and localisation of the coloured yarns combined. A *prima facie* reason for this is obvious, specific threads being employed to produce definite or prescribed effects. The relation of these to the colour characteristics of the pattern will be apparent from microscopic examination and comparison of examples in twill and fancy weave fabrics. Colour, for instance, may be applied in gauze fabrics to either the stationary or looping

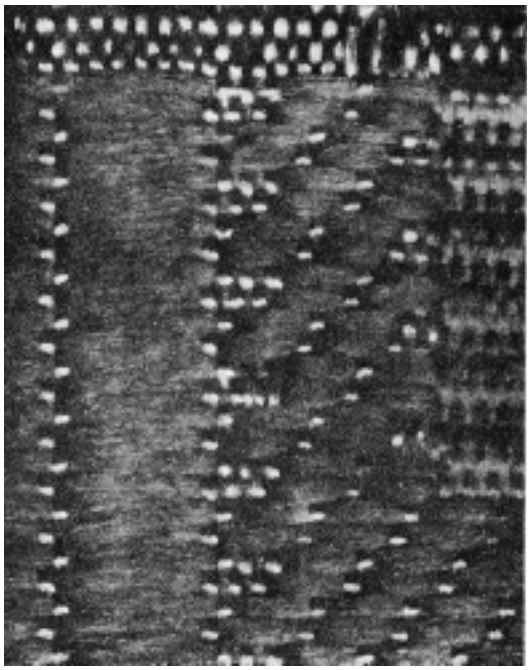


FIG. 3

threads, or to both successively, but its value differs with the section and construction of the fabric in which the coloured threads are developed.

The influence of the system of interlacing may first be considered, taking a silk texture—Figs. 1 and 2—composed of pale heliotrope and white, but containing the following:—(*a*) Well defined heliotrope in bold weft cord; (*b*) same colour subdued in tone in fancy mat; (*c*) an intermingled shade in apparently a plain woven surface; (*d*) lustrous silver white in clear weft twill; (*e*) dull tone of white in warp cord; and (*f*) a still duller white in small warp cord or rib. Taking and comparing micro-photographs of the textural

surfaces—Figs. 3 to 6—the power of fabric construction to control colour expression, whether a development of the warp, weft, or both, is clearly pronounced. Figs. 3 and 4 are compounds of the weft cord, fine warp cord and plain, and Fig. 4 also of fancy mat; Figs. 5 and 6 also contain sections of twill. From the process-block illustrations the change in colour tone is distinguishable, as caused by a change in texture, and the relative qualities imparted by the two shades of yarn.

If in two shades such a diversity of colour expression is producible by a modification in the structural surface of the fabric

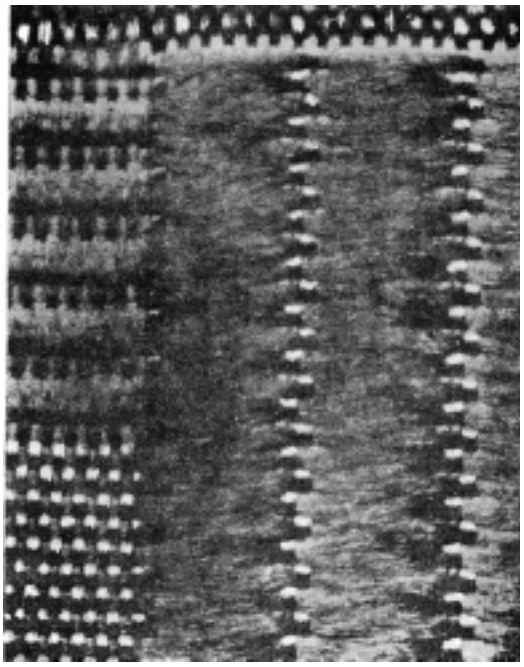
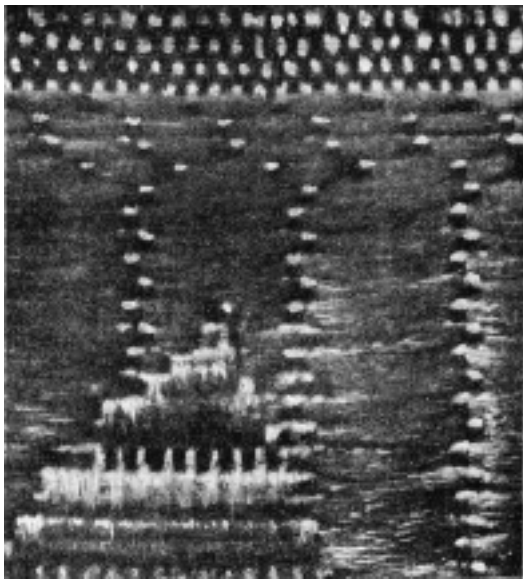


FIG. 4.

to coincide with the ornamental or design characteristics, what may not be obtained by the use of six to ten colour units?

But there is another aspect of this analytical synopsis of the theory propounded, and one which affords possibilities of colour modification affected by a change in texture, namely, the nature of the yarns combined with the textile filament utilised. To make this section of the subject apparent, the effects of fabric construction plus the use of yarns composed of two qualities of fibres, as, for example, worsted and silk, may be dissected in relation to colour definition. These fabrics—Figs, 7, 8, and 9—are developed in fine and pronounced warp face twills, and weft cord weave. The

influence of the folded and the single yarns, and of silk in contrast with the wool fibres on the tinted features of the textures is at once noticeable. Three colour tone modifiers are present in these specimens—weave formation, yarn construction, and fibrous contrasts. Elementary woven examples have been selected, such as to typify the colour influence of these factors without the complication of colour diversity as to shade units. But two shades have been employed as in the weave compound fabric described, these consisting of a dark shade of worsted yarn and of a light shade of silk yarn. The more evident colour presence of the latter in the three specimens is not to be attributed solely, or even mainly, to its being the lighter shade; nor is the fibrous



e *a*

FIG. 5.

assertiveness of the worsted to be chiefly assumed to its being the darker shade. It is more particularly, if not expressly, the difference in the physical properties of the two classes of fibres which accounts for these textural elements—a difference in colour value and relation to the build of the fabric to which they have been applied. In types of design in which the respective materials are employed to denote component sections of the style—*e.g.*, vestings and costumes—the colour distinction becomes more marked.

Contrasting the results as they are developed in the specimens under dissection, the quality of the colouring is better emphasised in the broad, compact twills in which the warp threads move in

groups—Fig. 7—and more intermingled in the finer twills, in which the weft interlaces with the warp threads singly as Fig. 8. The third combination—Fig. 9—is rendered more forcible by the introduction of the band or stripe of weft yarn, single in structure, and consisting solely of wool fibres. Each example is expressive of the importance of weave combined with yarn and fibrous qualities, in relation to the application of units of colour to textile surfaces. Definite technical principles and artistic elements are involved, which establish a specific theory of woven colouring.

It has been suggested that other fabric structures are equally distinctive in their colour characteristics, as in pile and velvet

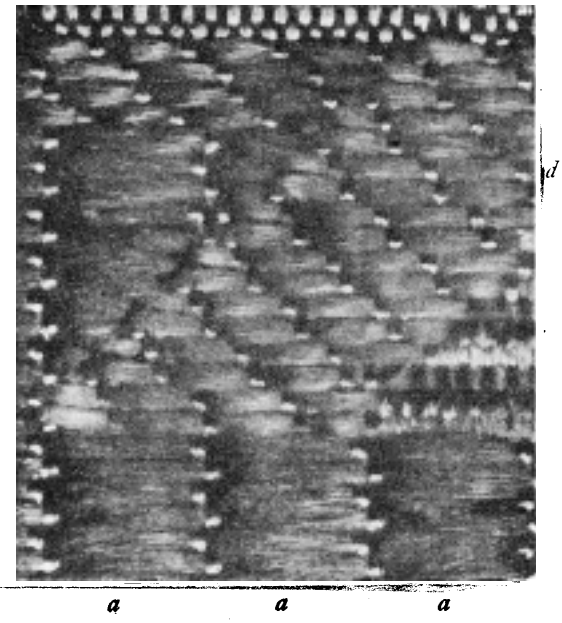


FIG. 6.

weaving, in which two or more separate tones or tints of colour are formed in the texture by the combination of the ends or tips of fibres in cut pile, and of rounded surfaces of the loops of threads in the uncut sections. In lappet designs, sets of yarns, distinct from the warp and weft proper, are displayable in several colours on the surface of an ordinary texture; and in certain varieties of compound cloths, the patterns are acquired by the interchanging, or reversing, of the positions of the colours in textural consistency, and not in isolated threads, from the face to the underside of the fabric or *vice versa*.

These and other technical considerations determining the build of the texture, in relation to colour expression, form fields

for research and elucidation; but it has been considered desirable, under Theory 4, to attempt to analyse what are, perhaps, the more subtle and problematic questions associated with definition

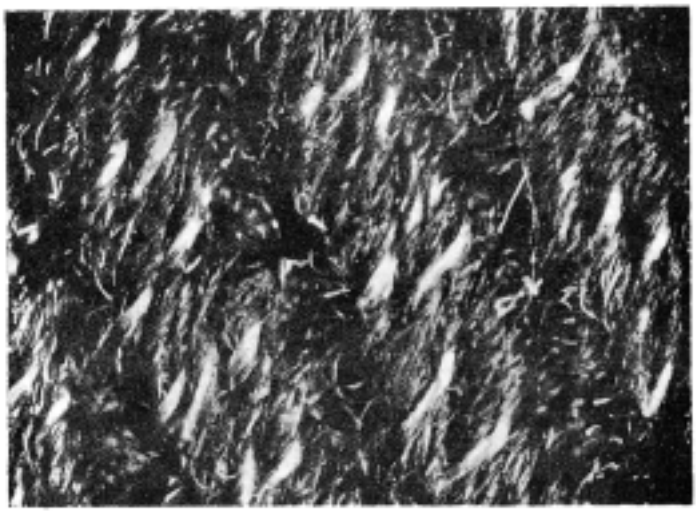


FIG. 7.

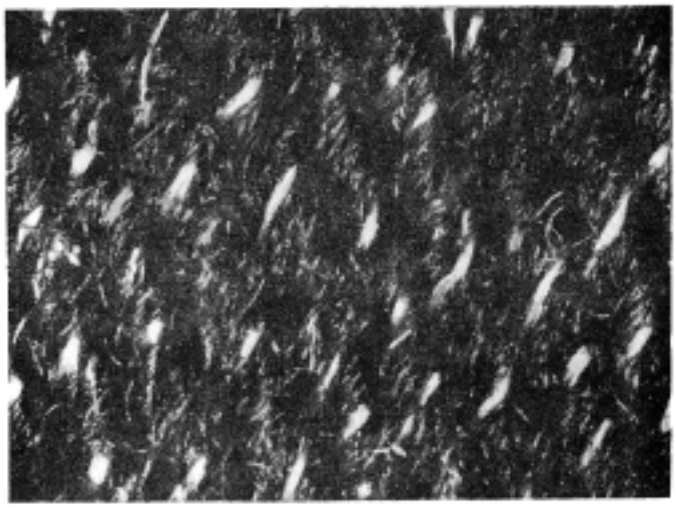


FIG. 8.

of colour tone as determined by weave variation, and also colour characteristics, for which fibrous qualities and yarn structures, in combination with the theory of fabric construction, are responsible.

5.—SCHEMES OF INTERTEXTURE.

Some explanations are called for on schemes of intertexture as producers of pattern, when combined with the mode of grouping coloured yarns. Here, a mathematical base has been formulated. It was first treated of at length in 1892 in a special treatise "Colour in Woven Design," but it had been previously suggested and defined in "Wool Manufacture," under the titles of "Pattern Design" and "Colour Effects in Twilled Weaves." Subsequently the subject was dealt with by my esteemed and late friend, Herr N. Reiser,* of Aachan—so competent a textile exponent—and also by my colleagues, M.M. Lelarge and A. Ledent,† of Verviers. Other writers have contributed expositions in

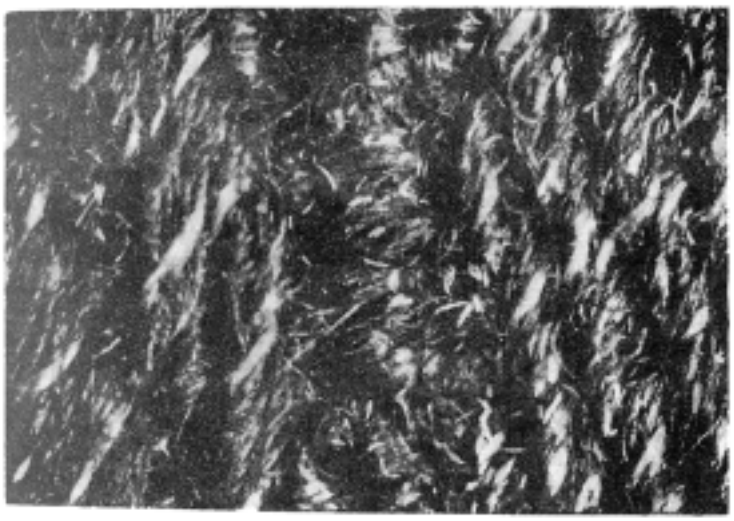


FIG. 9.

different French, German and English, and American technical journals; so that the theory does not, in this connection, need more than a passing word. It has been built up on experimental research, and like other mathematical theories, is capable of indefinite expansion and development.

The question of "Colour Standardisation," to which I, in collaboration with Mr. Thomas Hollis, Lecturer in Yarn Manufacture at the Leeds University, devoted considerable attention, is of too pressing a nature to be omitted from consideration. Briefly, it aims at colour science and practice, based on the selection of colour units, and of their classification and mixture in producing new shades, or shades of distinctive hues, tones and tints, by the utilisation of a

* "Handbuch du Weberei."

† Cours Methodique de Tissage.

comparatively limited series of colours; and is planned to accomplish this without detracting from colour efficiency in actual manufacture. A mathematical base again has been formulated, which is not restricted in range of possibility. The system demands technical fulness of treatment derived from proficiency in manufacturing practice combined with Art knowledge. In this work, as in other branches of textile colour science, the Textile Institute has facilities for encouraging research and fostering original experiment, and thus of promoting advance in textile knowledge, to add to the available sum of which would be to achieve a great and enduring task.

[Figs. 4 to 9 are from micro-photographs by Mr. Alex. Yoodall, of the Leeds University.]