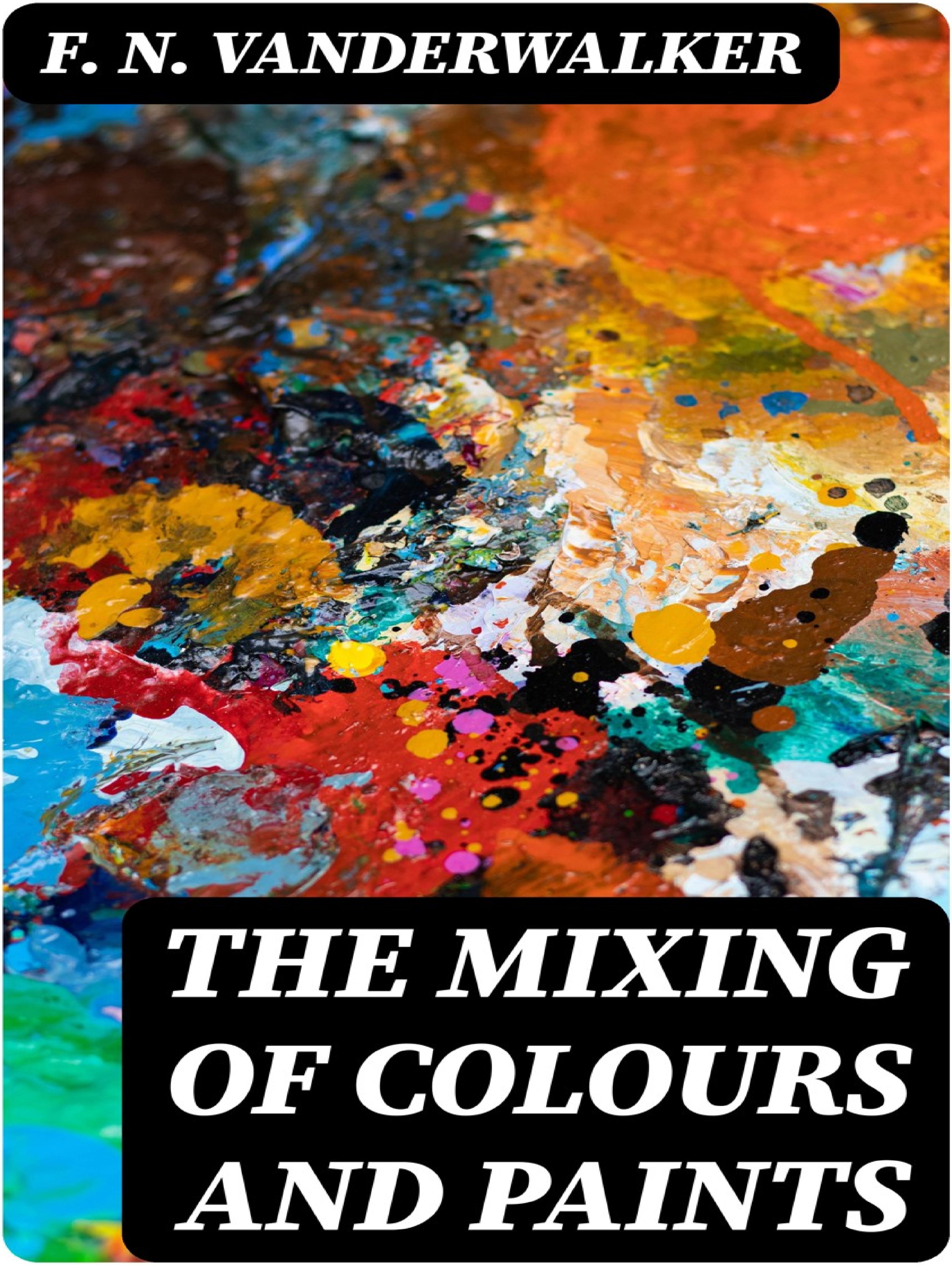
F. N. VANDERWALKER



THE MIXING OF COLOURS AND PAINTS

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PREFACE

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A strict interpretation of the title of this book would call for the presentation of only such information as pertains to the mixing of colors, paints and printing inks; but the possession of skill in mixing is only a means to an end, and that end is a more tasteful and effective use of colors.

To select the principles of the science of color essential to a better understanding and use of color by students, apprentices, journeymen, printers, interior decorators and master house painters, and to reduce the statement of such principles to the most simple terms—these are the attainments aimed at in the writing of this work.

The mixing of colors and paints by painters, decorators, and others is intimately related to effective and tasteful color use. Consequently, it seemed essential that all such kindred subject matter as is in any way related to better taste in color use should be included to promote the primary, if indirect, purpose of this book.

The difficulties of the task were many, since the subject of color is involved and can be confusingly technical and scientific. Yet it must be stated simply, if a working knowledge of color use is to be contributed to those whose daily work to decorating, painting and printing does not permit them the time to pursue the study at length.

It is hoped that in this writing the simple interpretation of this fascinating study will lay the foundation for better and more tasteful use of color.

F. N. VANDERWALKER.

THE MIXING OF COLORS AND PAINTS

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CHAPTER I
COLOR AND LIGHT

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Sunlight is the source of all color as well as of heat and light. With the setting sun all colors disappear from the earth. If it were not for artificial light our nights would be devoid of colors, relieved only by a contrast of moonlight and shadows.

Color is the property of light rays which causes visual action on the retina of the eye.

The Spectrum.—In the rainbow we see an array of colors. The image is called the sun spectrum. The spectrum is caused by the reflection of light rays from the sun. The same array of colors, or spectrum, you will notice when a ray of light passes through a raindrop or through a piece of three-sided plate glass, or a glass prism.

Prism.—A solid glass body of triangular shape.

A more formal definition of a spectrum is:—an image formed by rays of light passing through a glass prism in which the parts of light are arranged according to their wave lengths, forming a band displaying the colors of the rainbow. A beam of light from any source, such as the sun or ignited vapors (gas), passing through a glass prism is reflected and separated into colored light rays; these projected upon a surface constitute the spectrum. Red is red to the eye because it is composed of light ray vibrations of one wave length; blue is caused by a different wave length; yellow is vibrations of a still different wave length.

The array of colors called the spectrum is identically the same in character, and in the order of their arrangement, whether seen in the rainbow, a raindrop or a glass prism.

Primary Colors.—The strongest colors noted in the spectrum are red, blue and yellow. These are called the primary colors. In color theory all other colors are mixed from red, yellow and blue.

Secondary Colors.—Between these primary colors (red, blue, yellow) in the spectrum will be noticed violet, green and orange. These are called the secondary colors.

Intermediate Colors.—In the spectrum, again, between the primary colors and secondary colors there are six intermediate colors. They are violet-red, blue-violet, blue-green, yellow-green, orange-yellow, orange-red.

The order in which the colors of the spectrum are arranged is illustrated in Plate I.

In nature color is lavished in over a thousand (actually counted) delicate tints and shades on wild flowers, fish, birds, butterflies and other insects, or rocks, earth formations and elsewhere. And all of these colors are simply gradations of the primary, secondary and intermediate colors of the spectrum seen in the rainbow, the raindrop and the glass prism through light reflections.

Before passing on it is an excellent idea to study the spectrum. Since neither a rainbow nor a raindrop are likely to be handy when you want them, secure a glass prism or a piece of thick plate glass. Lay the glass flat on a desk or some dark surface in such away as to cause the direct rays of the sun to pass through the glass at an angle of about 45 degrees. It is easiest to do this with a late afternoon sun.

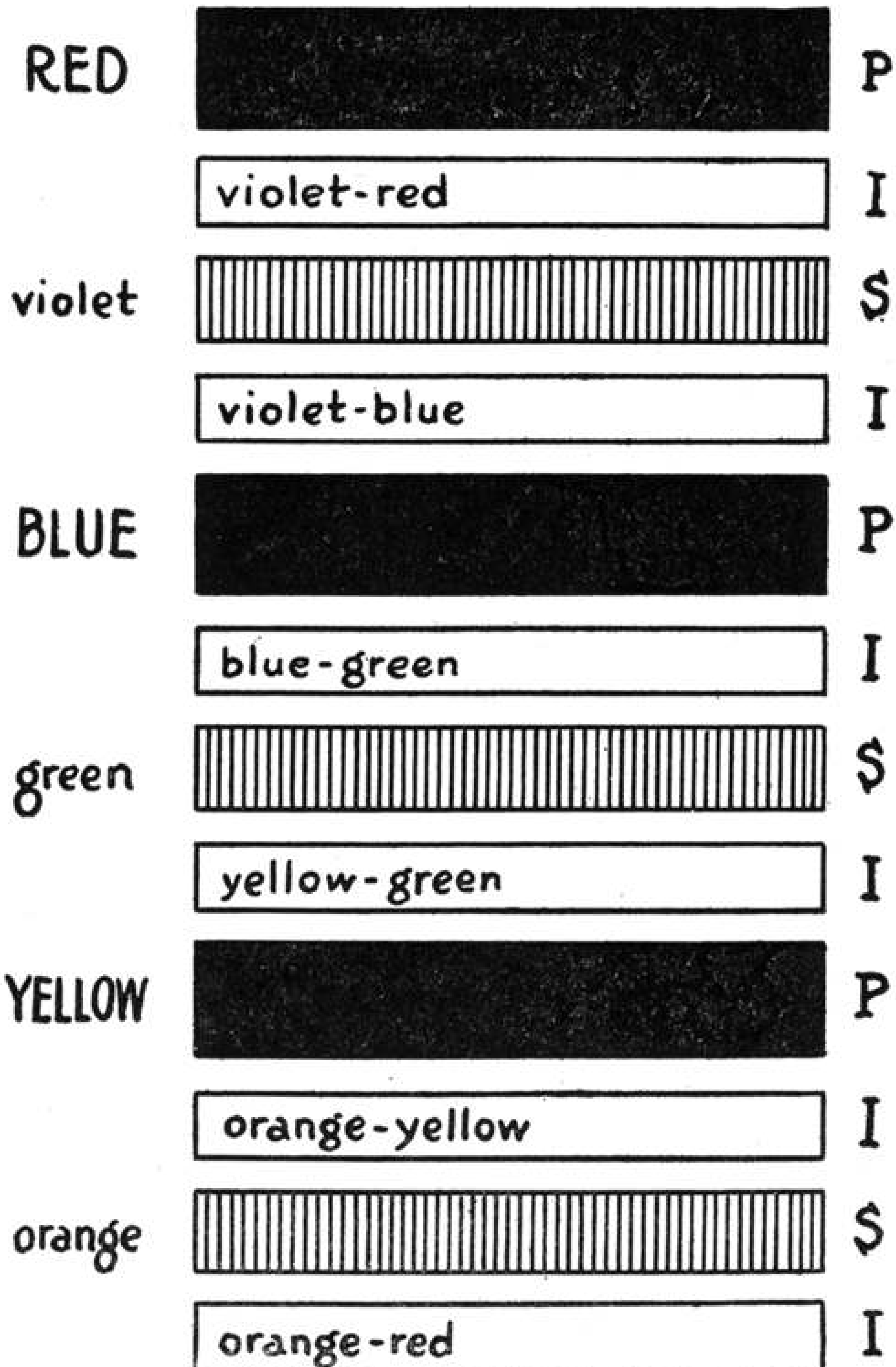
RED
P
violet-red
I
violet
S
violet-blue
I
BLUE
P
blue-green
I
green
S
yellow-green
I
YELLOW
P
orange-yellow
I
orange
S
orange-red
I

Plate 1.—Spectrum order of colors: Primary, Secondary and Intermediate Colors

When we come to the subjects of color mixing, color harmony and color use, later on in this book, more will be included about the practical use of primary, secondary and intermediate colors. So it is well for the student to keep these divisions of the spectrum in mind, and, particularly, that they are given to us through the laws of nature and the science of man. Man had nothing to do with the creation of the spectrum, but simply named it, classified its colors, and noted how they exist throughout the world.

It is interesting to note that objects do not possess colors of their own, but depend for color upon light reflected from their surface. By way of illustration, surfaces which are capable of reflecting all color rays appear red in red light, blue in blue light and white in daylight. In daylight all the color waves are present. Some surfaces are capable of absorbing all the light rays and reflect none;—these surfaces appear black, no matter what colored light falls upon them.

When part of all the light color rays is reflected and part absorbed, the surface appears gray.

In the case of leaves on plants, they appear green because they reflect green rays and absorb all other colored light rays. If, however, a leaf is taken out of the sunlight and flooded with red light it will appear black, because there are no green rays in the red light to be reflected by the leaf to the eye.

Flowers are red, yellow or blue, depending upon their ability to absorb some colors and reflect others;—that is true of all opaque objects.

In the case of transparent surfaces, they are colored by their ability to screen out certain light rays. Glass is red when only red rays pass through it. A glass or other surface which transmits all colors equally well, as does pure water in small amounts, is considered to be colorless.

CHAPTER II
DESCRIPTIONS OF COLOR PIGMENTS

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We cannot paint and decorate with light rays and color reflections from the spectrum of the rainbow, raindrops or a glass prism, as described in Chapter I.

Man has therefore searched out material substances from the soil, mines and vegetation, through his ingenuity in manufacturing and chemistry, to match the colors he sees in the spectrum. What these color substances are should next concern one who is anxious to become skilled in color mixing and use.

The number of shades of a single color found upon the market today is legion;—the siennas, umbers, venetian and Indian reds, chrome yellows and ochres varying in shades depending upon what part of the world they come from, upon manufacturing, chemical, grading and toning processes employed in their production.

These differences also have a bearing on prices charged for colors. The matter of price is always relative as to colors; care must be exercised in buying and in using them. Each grade of colors is made for certain purposes and it is wasteful or disappointing to use them indiscriminately; for instance, the use of a low-priced grade of tinting colors for rough barn painting may prove satisfactory and economical, but such colors certainly would prove disappointing if used on fine interior decorating. And the use of decorators' or artists' colors for rough work would certainly prove expensive and wasteful.

THE EARTH COLORS

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Among the first color pigments used by man in the early stages of civilization and, indeed, during the savage ages, were colors which were nothing more than natural deposits of colored earth found in many parts of the world. The colors of these earth pigments are due to their content of more or less oxide of iron and other mineral substances. As a class they are permanent in color, durable and economical.

The principal earth colors are raw umber, raw sienna, yellow ochre, mineral browns, venetian red and Indian red—the last two are now made by chemical processes. These are used just as they are dug out of the ground after washing and screening to eliminate roots, stones, etc. They are dried and ground to make them fine and are classified according to shades of color. Next they are mixed or ground in linseed oil or water, or Japan to make them ready for the painter.

The earth colors are also burned, or calcined, to change their colors. Raw umber which is a dull, grayish brown, becomes a deep chocolate brown when calcined and is called burnt umber. Raw sienna, a rather dull yellow, becomes a cherry red in the burning process and is then called burnt sienna.

Raw Sienna.—One of our most valuable colors, an earth pigment, named after the city of Sienna, Italy, near which natural deposits of an especially bright and clear yellow raw sienna earth were found. These were very fine, rich and transparent colors of great beauty and permanence. When mixed with a white base, clear and delicate tints result.

Sienna earth is found in pockets surrounded by earth of a different character. It owes its color to hydrated silicate of iron, probably precipitated from ponds and bogs containing a solution of iron and silica. There are great variations between different deposits as to brightness of color, texture, fineness and freedom from sand and stone. High quality raw sienna is essentially a yellow ochre of great purity as to color. It is not only brighter in color but has greater tinting strength than yellow ochre and so produces clearer tints when mixed with a white base. It is not muddy, or cloudy like yellow ochre, but quite transparent, which makes it valuable for mixing stains, graining and glazing colors. Both raw and burnt sienna are in the group of most permanent colors known and have been used for hundreds of years.

Burnt Sienna.—Made by roasting raw sienna, which process changes the yellow color to rich brownish red. Burnt sienna, when properly roasted, possesses substantially the same qualities as the raw sienna from which it is made, and is used for the same purposes in decorating and tinting where clear reds and pinks are wanted.

Raw Umber.—Italy claims the origin of umber as well as sienna. The color takes its name from Umbria, Italy. However, in modern times the island of Cypress, in the Mediterranean Sea, appears to be in possession of more deposits of this drab earth color. It has been marketed through Constantinople and so gained the name of Turkey umber.

The characteristics and history of umber are much like sienna. The difference in color is due to its content of a large percentage of manganese in addition to oxide of iron. This possession of manganese makes the umbers very good drying colors—raw umber, in fact, is used in the manufacture of liquid driers.

Raw umber in color is a dark, greenish brown. It is almost transparent, has great tinting strength and produces clear tints when mixed with white.

Raw umber is very durable, permanent to light and invaluable for mixing dark greens, olive greens and cold drabs which are more permanent in strong light than those mixed from chrome green alone. Some of the umbers possess a reddish rather than a greenish tone and, of course, are not cold, but warm colors not so suitable in the mixing of greens.

Burnt Umber.—Substantially the same as raw umber except for color. The calcining or roasting of raw umber changes its color from a greenish brown to a deep chocolate brown. This warm brown makes burnt umber a valuable color for tinting a white base to tan and many other useful colors in paints. It is a quite transparent color and so is extensively used for mixing stains, for glazing color and for graining.

Yellow Ochre.—In this color we have another earth pigment. And it is doubtful if any color is found on the market having greater variations of quality. The name yellow ochre on a product may mean any one of several materials or grades.

Deposits of yellow earth are found broadly distributed over the earth's surface in the form of sand or clay. Not many of them have any real value as a color or paint pigment.

In France deposits of the best quality yellow ochre are found and they are very similar to raw sienna. High grade French yellow ochre is clear and bright, as to color, but cannot be used as a glaze, stain or graining color. It is durable and permanent in strong light. Domestic and some other foreign yellow ochres are muddy and dull in color; they have not the tinting strength of French ochre and have but little in common as a color, paint or tinter with French ochre.

Correctly made yellow ochre is one of the most useful tinting colors, but unusual care must be shown by manufacturers in washing, floating and separating to eliminate coarse sand, if a color with good tinting strength is to be produced.

Yellow ochre is the body, the solid opaque yellow of nature, while raw sienna is the transparent yellow which can be used as a glazing color and a stain.

For the mixing of yellow tints—tans, creams, buffs and olive green—good French yellow ochre has no superior; it is durable, fast to light and economical.

Vandyke Brown.—An earth pigment of a rich, deep brown similar to but richer than burnt umber. It takes its name from the old Dutch master, Vandyke, who used the color with remarkable effect. It is of bog origin and contains iron and bitumin. As made today Vandyke brown is quite permanent, is an excellent tinting color and so transparent that it is invaluable as a glazing and graining color where a richer brown than burnt umber is needed. It is unsurpassed for glazing old bronze effects and for staining to imitate old English, antique and bog oaks. Used to color a white base, the tints have a lavender tinge to them.

CHEMICAL COLORS

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The chief chemical colors commonly used are Prussian blue, ultramarine blue, cobalt blue, black oxide of iron, black lead sulphide, graphite, manganese black, chrome green and chrome yellow. Chrome yellow is made in orange, medium and lemon. The vermilions—American, Chinese and English—are chemical colors, as are also Venetian red and Indian red.

Such chemical colors as Prussian blue, chrome yellow and green are manufactured by mixing together certain chemical solutions. The reaction which then occurs causes a precipitation, or throwing down, of a very fine colored pigment. When the chemical action has spent itself the water is drawn off the top of the tubs and the wet pigment is put into filter presses which squeeze out the balance of the water.

These chemically pure colors are very strong and it would be wasteful, as well as expensive, to use them in the pure state; so they are ground in linseed oil, water (distemper) or Japan and at the same time inert white pigments are added as extenders to make the paste tinting colors such as the painting trade uses. These colors, like the earth pigments, are sold also in the dry powder form, principally for mixing calcimine.

Lampblack.—A paint pigment of rather ancient origin and well known to all. It has great opacity and is an excellent pigment both for solid color and tinting purposes. A slow drying color which requires the addition of more than the usual amount of Japan drier.

Lampblack is made in many ways and from many materials which will burn with a slow, smoky flame. It is made from dead oil resulting from coal tar distillation, also from rosin and tallow.

The smoke from burning these oils is collected in chambers or bags attached to flues. The burning must be controlled by the amount of air admitted. Too much air makes grayish blacks and not enough air adds oil or volatile acid to the lampblack. In fact, much skill is required in the manufacture of lampblacks. Time must be allowed; if the burning is forced too rapidly an inferior black is produced which contains both oil and acid sufficient to cause spontaneous combustion. Thus a dangerous dry pigment to handle results and one which is slow to dry and likely to corrode metal because of the acid content. Such a black paint destroys metal surfaces it is supposed to protect. Lampblack made of rosin is especially likely to do this and it is difficult to detect from other blacks.

Gas and carbon blacks often added to high quality carbon black with the intention of giving greater tinting strength are really detrimental because they cause jet blacks to take on a brownish tone and also cause the pigment to separate from oil with which it is ground or mixed—uneven, streaky black paint and muddy gray tints are so produced.

A high quality lampblack, then, is clear, jet black, of good tinting strength with white bases, one free from dangerous oils and acids and a black which will dry within a reasonable time without using an excess of drier.

Drop Black.—The name comes from the fact that when first marketed this pigment was sold in the form of small drops or lumps. It is no longer marketed that way.

Drop black consisted of mixtures of animal and vegetable blacks ground to a very fine pigment in water, oil or Japan. The bulk of this black manufactured is used by sign, carriage and automobile painters.

As now made drop black is a very fine quality of pigment resulting from burning animal bones to make charcoal, which is then ground, first in water, and then reground in oil, Japan or water and glue or gums for binders.

For the manufacture of the finest ivory drop black only the hardest animal bones are used such as teeth and shinbones. The bones are crushed and roasted in crucibles to make the charcoal. Soft bones make blacks which have a brownish tone and which lack clearness. Such blacks are, obviously, much less valuable.

Cheap bone blacks, called sugarhouse blacks, are made from the bone charcoal used in sugar refineries to bleach the sugar. When this charcoal has become saturated with color matter it is re-burned and ground for a cheap paint pigment. It lacks the beauty and clearness of ivory drop black.

High quality drop black makes a beautiful pigment both for solid colors and tints and shades with a white base. Pearl grays, rich warm olives and bronze greens of pure and lively tone are mixed with it.

Drop black takes less oil than lampblack and is a slow drying pigment. It has greater density and opacity than lampblack.

Ivory Black.—While a limited amount of ivory black is made from ivory chips and turnings, the bulk of this pigment is made from selected hard animal bones, the choice bones which are also valuable for making buttons and knife handles.

This is a very clear, jet black particularly valuable as a solid color. It is not so strong for tinting purposes as some other blacks.

Ivory Black is made, like drop black, from bone charcoal and is also called ivory drop black.

Indian Red.—One of the original colors extensively used and at first it was strictly an earth pigment. It was an especially bright oxide of iron earth found as a natural deposit near the Persian Gulf.

As manufactured today Indian Red is really classed with the chemical color group. In steel mills certain acid liquors are used to remove scale from iron and steel. After such use these liquors were dumped as waste in years past and were very destructive of fish in the lakes and streams into which this waste was run.

Today this waste acid containing iron scale is evaporated and from it sulphate of iron (copperas) is crystallized out. When this copperas is roasted a pure oxide of iron powder is recovered and the acid is again used to remove more scale.

This oxide of iron is Indian red. Its quality, shade and strength vary according to the care and ability shown by its manufacturers in roasting the copperas, in freeing it from acid and in grinding it. If the acid is not eliminated completely it will start an iron or tin roof to rusting, instead of protecting such surfaces as a paint should. Consequently, this Indian red must be made by able chemists and manufacturers.

High quality Indian red, then, must be pure oxide of iron, free from corrosive acids, have a deep, rich red color with a purple tinge to it, have a non-fading quality and possess good tinting strength.

Venetian Red.—Originally an earth pigment, venetian red is made by substantially the same process as Indian red and should therefore be classed with the group of chemical colors.

Venetian red is an oxide of iron red made by partially neutralizing the acid liquors used in removing mill scale from iron and steel as described under the section on Indian Red.

In making venetian red the acid liquors are mixed with lime. What is precipitated is sulphate of lime and hydrated oxide of iron. When this precipitate is roasted the acid is eliminated at a lower temperature than is needed in recovering Indian red and so venetian red is lighter and brighter in color.

Some of the cheap venetian reds used for box cars and rough barn work are recovered by crude processes and on a coarse, cheap base. While they are useful for some rough work, they do not compare favorably in value with venetian red made by highly efficient processes and better materials.

The cheaper venetian reds are not suitable for use as tinting colors and are not as good even for solid red paints.

High class venetian red produces bright, lively tints and shades and is clear enough for delicate pink.

Carefully selected venetian red ground to a fine pigment in linseed oil makes about the most durable red paint known today.

Ultramarine Blue.—A most pleasing and valuable color made originally from a precious stone called Lapis Lazuli. It is a deep sky blue to a greenish blue in color. Made by a chemical process of burning in crucibles, such substances as China clay, carbonate of soda, sulphate of soda, sulphur, quartz, infusorial earth, charcoal and rosin.

It is interesting to note that in this process, discovered in 1828 by Guimet, a French chemist, the hot mass changes first to a beautiful rich brown which takes fire and burns in defiance of many efforts to hold it as a color pigment. Next the mass turns green and this color also disappears in flames on exposure to the air. Blue appears next, but if heated too long, it turns to violet, then to red and finally to white. After the mass cools off, if the fire is extinguished at the right time, the top layer is a clear bright blue. The bottom layer is a greenish blue of a lower grade.

Ultramarine blue is a combination of silica, alumina, sulphur and soda. The sulphur content of this color makes it an unsatisfactory blue to use with white lead, since sulphur turns white lead carbonate to lead sulphide, which is black. Traces of sulphur and sulphide in ultramarine blue discolor many pigments but not zinc oxide. It is not safe to use this blue with white lead.

The deep, rich color of ultramarine blue with its purple tinge is far more pleasing than Prussian blue, which has a greenish cast to it. Ultramarine blue is an excellent tinting color and glazing color; it is permanent in light (except with white lead) and durable on exposure to weather.

Ultramarine blue may be used on new plaster or cement walls, since lime, soda and alkali do not affect this blue. Fading and spotting occur when Prussian blue is used on such surfaces.

Cobalt Blue.—This is a color which is substantially the same as ultramarine blue—it is the purest and lightest blue so made, having neither the purple tone of most ultramarine from the top of the crucible nor the greenish cast of the bottom layer.

Cobalt is a most beautiful color pigment deserving of wider use by painters and decorators for delicate azure tints, using zinc oxide as the white base. White lead should not be used, unless in small proportions with zinc, since the sulphur content of cobalt blue may discolor the white lead, changing it to lead sulphide.

For the mixing of clear, light greens with zinc, or compounds where zinc predominates, cobalt is very fine. It is strong in tinting strength, durable and permanent in strong light. Hot lime and alkali spots in new plaster or cement walls do not spot and fade this blue as with Prussian blue.

Real cobalt blue is a combination of oxide of cobalt metal with alumina. It is so made for use as artists' water colors. It isn't so good as an oil color. The high cost of real cobalt blue prevents its general use in quantities.

Prussian Blue.—The best known and most extensively used of the blue pigments. Varying shades of Prussian blue are marketed under such names as Berlin, Chinese and Milori blue.

This is a chemical color discovered by accident. In the year 1700 a Berlin colormaker learned that when oxblood and wood were burned together, the ashes yielded a yellow solution which could be precipitated by iron as a brilliant blue color pigment. This yellow solution was yellow prussiate of potash or ferrocyanide of potassium.

The chemical process used in making Prussian blues now has, of course, been perfected far beyond its crude beginning. As done today yellow prussiate of potash is mixed with sulphate of iron (copperas) and the result is that a fine white pigment is precipitated. On being exposed to the air this white substance oxidizes into blue.

The blue color may have a purple, bronze or green cast to it or it may be quite a pure blue, depending upon the manipulation during the chemical process of formation.

Lime, soda, white wash, hot spots in new plaster and cement walls cause Prussian blue to fade and tints made with it to become spotty.

Prussian blues are rather fugitive in sunlight and are not used on exterior painting. They are among the strongest tinting colors and produce bright and clear tints on any white base. Prussian blue is used considerably as a glazing color.

Chrome Yellow.—Chromium is a metal remarkable for the beautiful colors it compounds. The precious stone called emerald has wonderous beauty because it contains chromium.

Chromium combined with lead produces a series of yellows which is most valuable. These yellows range from pale canary, citron or lemon yellows, through medium shades of yellows to orange chrome and finally to orange, red and scarlet.

These beautiful colors are made by the mixture of chemical solutions. Solutions of bichromate of potash, or soda, are mixed with solutions of nitrate or acetate of lead; from this a yellow pigment is precipitated. The water is drawn off, the pigment is put through a filter press to remove more moisture and is then ground in oil for the market.

Manipulations of the chemicals and other elements in the process enable the manufacturer to make the many yellows in this group: Canary, Lemon, Light Medium, Medium, Light Orange, Orange and red-orange chrome yellows.

Chrome yellows are bright, clear and opaque colors with great tinting strength. Because they are not transparent they are not suitable for glazing colors, stains or graining. They are very durable as protective coatings and quite permanent as to color in strong light. If not well made they are easily affected by gases of the atmosphere and strong light, which cause them to fade, get spotty and dingy.

Chrome Green.—The combination of Prussian blue and lemon chrome yellow makes chrome green. The combination is made intimately at the time the two color pigments are precipitated from the solutions.

This intimate mixture is very important; that is, the time when the blue and yellow are mixed. When each color is made separately (a yellow and a blue) and mixed later to