RAW MATERIALS FOR MAKING OUR PRODUCTS

According to the program plans, this is to be a general survey of the things we use to make our products. Selected experts are to discuss each class of materials at later sessions of this series and they will have time to cover each item in more detail.

If I were to limit this review to those materials that are readily available at the present time, there would be little to discuss. We thought we had shortages and substitutions during the war, but the peace has not been settled yet and the supply of many materials is worse than ever. For instance, linseed and castor oils are short, titanium oxide and organic red pigments are limited in supply, glycerol and phthalic anhydride to make "DULUX" resins are both tight and so it goes. Furthermore, we need increased supplies of these materials all at one time, because an overabundance of one item would simply make the need for another one to go with it even more critical.

Now let's take a look at the great variety of materials we use in making our products According to the plan suggested by the committee on arrangements, this is to survey briefly the different types of materials, some of their outstanding properties and uses, and a few pointers regarding economics. When you count up the total number of materials on permanent codes that we use here at Philadelphia and arrive at a number in the neighborhood of 280, you can realize what a problem we have had in boiling the data down to keep within the time limitation.

A. PIGMENTS - W CODES

First we will look at our pigments, which are designated by W codes. We will consider white pigments and extenders, then colored pigments and blacks, in that order. We will leave the details to Stuart Grayes and Pete Evans, who will discuss these materials more fully later on.

1. High Opacity White Pigments

Perhaps the most important characteristic of white pigments is hiding power, which they derive from a high index of refraction, viz. the ratio of the velocity or speed of light in air to that in the medium through which the light passes. The original white pigment, white lead, was replaced by lithopone and then titanium oxide superseded lithopone in view of increased hiding power. More recently, a further increase in hiding power of white pigments was developed in the rutile type titanium oxide.

In the high opacity group of white pigments, we have the new rutile type titanium oxides at the top of the list. The denser structure of the rutile type provides a higher index of refraction and, hence, greater hiding power. These pigments carry special surface treatments, in some cases, which affect their chalking resistance, color retention, dispersion characteristics, etc., for use in different types of products. Hence, they are not readily interchangeable.

A variety of anatase type titanium oxides were used previously. We still use, W-16 and W-5, the untreated grades in outside house paints, tank whites, etc , to provide better cleanliness because they chalk more freely than the other pigments of this class.

For some uses, the great hiding power of the titanium oxide pigment permits the use of extender to give them special application or film characteristics and reduce cost The "Ti-Cal" types are extended with 70% of a specially prepared calcium sulphate, which provides high bulking value, good color, and relatively low cost. The "R" type Ti-Cals W-49, W-51 and W-54 are based on the rutile type titanium oxide. You will note that they vary in consistency characteristics and the R-60 type, W-51, is treated to provide a measure of durability on exterior exposure which explains its use in Brush "DUCO" Enamels, since these products are used for both interior and exterior surfaces.

Since barium sulphate is less soluble in water, the analogous "Ti-Bar" type pigment, W-57, is used in exterior products and in primers due to its inherent moisture resistance. However, we carry a special restriction on water soluble salt content and a quantitative sodium specification on W-57 to be sure that it will not blister under extreme humidity conditions in refrigerator primers. Recent attempts to blend titanium oxide and blanc fixe in the mill base to match "Ti-Bar" met with initial failure because the W-30, blanc fixe, ran too high in water soluble salt content, showing the importance of this specification.

Next in order come the zinc sulfide pigments and lithopones, the latter being extended with barium sulphate. The zinc sulfide pigments as a class are less durable and more reactive than titanium oxide types We are using them currently to extend our supplies of the titanium pigments. The different types vary in surface treatment and consistency characteristics. W-33 is the enamel grade of lithopone with normal consistency. W-13 carries the "J" treatment for ease of dispersion and is high in consistency. The same grade untreated is W-113. At the present time we are trying to eliminate the "J" treatment to increase production capacity for white pigment at the Pigments Department. The HC grade, W-40, with high consistency has been used in flat wall paints because of its high flat hiding.

2. Reactive White Pigments

Some white pigments are used because of their chemical or physical action within a finish rather than their hiding power. In this class we have zinc oxides, white leads, and antimony oxide. Except for the last-mentioned, the value of these pigments depends upon their acid acceptance or soap-forming characteristics.

Zinc oxides are widely used: (a) as acid acceptors by forming reaction products in the film, (b) as mildew inhibitors due to their toxicity to certain organisms, (c) as chalking retarders due to their high ultra-violet opacity, and (d) as yellowing retarders for titanium oxide pigmented finishes.

There are generally two classes, viz., the French Process, W-20, made directly from metallic zinc and the American Process, W-8, W-19, and W-41, made from zinc-containing ores which vary in lead content and may yield leaded zinc oxides, W-18, as well as the fairly pure grades of zinc oxide. Their properties seem to depend on particle size to a great extent which governs their reactivity. The "Kadox" types, W-78 and W-154, are used for rubber compounding as well as finishes. They are so fine that they have low hiding power. Small proportions are used with titanium oxide to reduce yellowing tendencies with a maximum of gloss retention which is generally adversely affected by zinc oxides. The leaded zinc oxides are used in outside paints. The cofumed types are preferred because they carry less fines than the blended varieties and are, therefore, more durable

We have found electron microscope photographs to serve as an excellent guide in selecting zinc oxides and we may want to set up such a specification sometime when the instruments are generally available.

Only two white lead pigments are of interest for paint products, i.e., basic carbonate white lead and basic sulphate white lead. Basic carbonate white lead, W-2 and W-68, is used in exterior paint primarily for sales policy reasons and as an acid acceptor in some primers and undercoats. Because these lead pigments are toxic we follow the policy of having them supplied in paste form. Due precaution should still be exercised to prevent contamination of food products by exercising extreme cleanliness.

Antimony Oxide, W-52, was used with titanium pigments to retard chalking, but the special treatments on some of the newer types of titanium have generally resulted in replacement of this pigment. It is used in dark shades because it is more chalk resistant than any of the titanium oxides, but it causes checking in lighter shades where a greater quantity is needed. this pigment is also a stabilizer for vinyl resins, which tend to decompose in contact with iron surfaces under the influence of heat and/or light so that special stabilizing agents are required for high bake finishes and for exterior exposure.

3. Extenders and Their Uses

Extender or inert pigments do not possess the properties of hiding or pleasing color, but they greatly influence the physical, chemical and optical properties of the paint in which they are used. Thus the terms "extender" and "inert" are both misnomers, since these pigments do not merely adulterate or cheapen paints nor are they unreactive. These pigments lack hiding and opacity due to their refractive index being about the same as the dried vehicles or binders containing them and lower than the high opacity type white pigments.

Extenders as a class occur abundantly in nature and are generally mined or quarried at relatively low prices. The deposits are natural rock, rock decomposed by weathering, and fossil deposits of certain organisms. Some extenders are manufactured as by-products from some process or as deliberate attempts to improve upon the natural product.

In general, solvents are the only other paint making materials that are cheaper than extender pigments. They range in price from 1/2 to 8 cents per pound. The importance of these pigments can be gathered from the fact that about 35% of the total pigments handled by the Division in 1941 were extenders. High quality house paints carry 35 to 75% of extender in the pigmentation. In lower quality types, e.g., the Chivo Line, the extender content may go up to 75% of the pigment. Primers and surfacers use as much as 85% extender pigments.

Extender pigments vary in specific area according to type, shape and structure of the particles as follows:

1. High specific area due to dimorphous nature and porous structure, e.g., Diatomaceous Earth, W-44, and Chalk Whiting, W-90.

2. High specific area due to irregular surfaces, composed of clusters of needle-shaped particles or having many indentations, e.g. Precipitated Calcium Carbonate, W-73.

3. High specific area from fibrous, elongated or plate-like particles, e.g., Asbestine, W-4, Talc, W-132, and Mica, W-71.

4. Relatively low specific area due to solid particles with regular shape and few indentations and little porosity, e.g., Blanc Fixe, W-30, Barytes, W-34, and Silica, W-31 and W-62.

Whereas the white pigments are used to furnish hiding, a pleasing appearance, and to protect the final film from too rapid deterioration due to light rays, etc., the extender pigments by contrast are used primarily for the following purposes:

1. To strengthen and toughen the films to prevent cracking and flaking.

2. To provide abrasion resistance.

3. To reduce film shrinkage and thereby promote adherence to the substrate.

4. To increase consistency so thicker films can be applied without sags or runs.

5. To lower gloss in semi-gloss or dull finishes with velvety appearance.

6. To improve moisture resistance and mildew resistance.

7. To reduce settling of other pigments in the package.

8. To impart good sanding properties to undercoats and rubbing varnishes.

9. To improve hiding at higher pigment volumes and in emulsion paints.

10. To lower cost.

4. Colored Pigments

Now let us review briefly some of the colored pigments that we use in our business of making finishes. You are all familiar with the fact that white light may be broken up into all colors of the rainbow. So color results when light waves strike an object and some of the rays are absorbed and others reflected. The color varies according to the wave length of the reflected light in decreasing order as follows where a milli-micron is the unit of measure for wave length amounting to about 39 billionths of an inch.

Red	-	610-700	milli-microns
Orange	-	590-610	"
Yellow	-	570-590	"
Green	-	500-570	"
Blue	-	460-500	"
Violet	-	400-460	"

With the addition of brown and black pigments this will form the outline for our consideration of the colors we use.

Some pigments may be colored but are used primarily for other purposes, e.g., Red Lead, W-307 and W-316, and Zinc Chromate, W-609, are used for metal protective primers. These are generally quite reactive, like zinc oxides, and care in handling and use must accordingly be exercised. For purposes of this discussion, we will restrict ourselves pretty much to those pigments used chiefly for their color characteristics.

(a) Red Pigments

Iron oxides are amongst the oldest known colors. They occur naturally as ore deposits in admixture with limestone and siliceous matter or are precipitated by chemical means and possibly blended to yield special types. The most brilliant iron oxide we normally use is W-372, Persian Gulf. It contains 65-70% iron oxide and requires no calcination. Spanish Oxide, W-369, contains 80 to 85% iron oxide but is contaminated with lime making it reactive. The domestic oxides, W-371 and W-878, vary considerably in iron oxide content, viz., 35% to 80%, and in tone and tinting strength. The synthetic oxides are made (a) by heating copperas $FeSO_4 \cdot 7H_2O$, for Indian Reds like W-303, or (b) reacting copperas with lime or whiting in a furnace to make Venetian Reds like W-306, or (c) by precipitation from copperas with an alkali followed by controlled oxidation for relatively pure iron oxides like Mapico Red, W-895. These generally vary in masstone and tinting strength and cost according to iron oxide content which ranges from 40% to 98%.

The next class of red pigments are the organic reds and maroons, a highly specialized group of dyestuffs. They are complicated organic compounds used alone or precipitated on some base to form a so-called "lake". Essentially, they comprise azo pigments and azo salts plus a miscellaneous group of vat dyes and alizarine dyestuffs.

The azo pigments are represented by W-865, Toluidine Red, and W-880, Fire Toner, which are bright colors with good lightfastness in masstone, but fade in tints. Otherwise, they have good durability and vary in bleeding tendencies from slight to bad. In this class also may be put the Para Toners, W-317, W-864, and W-874, which are soluble azo dyes made at relatively low cost but are poor in durability and fugitive in the light due to the presence of reactive groupings.

Some azo pigments are precipitated as metallic salts which generally vary in characteristics according to the metal iron used as follows:

<u>Barium & Calcium Salts</u> - Brightest, but poor in stability and durability. Typical pigments are W-331 and W-339, the lithol toners, which do not bleed in most vehicles but darken on exposure, fade in tints and are otherwise poor in durability.

<u>Aluminum & Iron Salts</u> - Dark and dull in color. Intermediate in stability and durability. A typical pigment in this class is W-873, Infrex Maroon, which is dark, non-bleeding, darkens in masstone and fades in tints with fair durability,being better than lithols but inferior to the next class.

<u>Manganese Salts</u> - Intermediate in color characteristics and best in stability and durability. Hence, these are most suitable for high-grade products. A typical pigment is W-875, Victoria Maroon, which is non-bleeding, rather difficult to grind, has good durability but tends to darken in masstone and fade in tints.

The vat dyes are represented by our W-889 and W-311, Indo Maroons, which are thioindigoid types with bright masstone color and relatively good durability although they fade slightly in tints and darken and bronze in masstone. These pigments are reactive and their high cost limits their usefulness to special products. Among the alizarine types, we use W-308, Madder Lake, used for Tuscan Reds and to blend with mineral oxides, and W-380, Maroon Lake, used for toning dark maroons and for tinting whites. These pigments are "laked" to reduce the cost. They both have bright color but are relatively poor in light stability and in film integrity on exposure.

The third class of red pigments are the cadmium sulfoseleindes, which are inorganic precipitates used alone or extended with barium sulfate to make so-called lithopone grades. They vary in color from light red to dark maroon. They are non-bleeding and have fair durability although they tend to chalk, check and fade in tints. They are quite expensive and hence limited in use. Our codes from the lightest to the darkest are W-383, Light, W-384, Medium Light, W-382, Medium, W-381, Deep,and W-843, Maroon. These find special use in washing machine finishes because they are alkali resistant and in products where bleeding is prohibited.

(b) Yellow and Orange Pigments

The yellows and oranges line up somewhat like the reds in type. First, we have the earth colors, such as W-602, French Ochre, and W-616, Domestic Ochre, which are cheap and used for making tints and browns and some oil colors. They contain 20% to 60% iron oxide blended with alumina, siliceous matter and combined water of crystallization. These were used during the war as ferrite yellow substitutes, but are being replaced again with the better grade pigment which does not settle out so badly.

Ferrite Yellow, W-624 and W-630, synthetic grades of iron oxide, which vary in color according to the degree of hydration, is higher in hiding and tinting strength than ochres and used for shading buffs, ivories, grays, tans, browns, olive greens, etc. It is rather difficult to grind and some of the recent developments have been to provide low oil absorption grades with easier dispersion, e.g., Mapico LO and Reichard Coulston's ED types.

Then we have an organic dyestuff type, W-614, Hansa Yellow, which is one of the azo pigments characterized by poor hiding but good tinting strength. It has good lightfastness in masstone but fades in tints. It bleeds considerably and is therefore limited in use.

By far the most extensively used yellow and orange pigments are the inorganic chrome types W-679, W-676, W-677 and W-610, which vary in color according to chemical composition, lead sulfate being used for yellow and lead oxide for the red tone with the lead chromate base. These are relatively cheap pigments and provide good long term durability with good film integrity and some rust inhibition. They darken on exposure, especially in sulphide fumes. They are used in enamels and some grades W-697 are blended with iron blues to make chrome greens.

Finally, we have a special Molybdate Orange, W-622, which is made like a light chrome yellow but some of the lead sulfate is replaced by molybdate, making the pigment stronger and more opaque but also making it darken more on exposure. We are using it to extend less available lead chromates in Safety Color Code Alert Orange and Coal Marking Red Paints.

(c) Green, Blue and Violet Pigments

Most of our greens are formulated with Shading Yellow, W-697, and Milori Blue, W-582, but these combinations darken on exposure as solid colors, fade in light tints and are sensitive to alkali. Greater stability is obtained from the Chromium Oxide pigments, W-754 and W-789, which are almost pure Cr_2O_3 made by roasting sodium dichromate in a reducing atmosphere. They have good hiding lightfastness and chemical resistance; but they are fairly expensive. Guignets Green, W-701, is a hydrated chromium oxide made by fusing sodium bichromate with boric acid and hydrolyzing in water. It is a bright color with good lightfastness and chemical resistance but it is poor in hiding and relatively expensive.

The most recent development in green pigments is our W-785, Monastral Green, which is expensive at $4.00 a pound but the tinting strength is so good that it is economical to use in light tints which are clean and very lightfast. However, this pigment bronzes badly if used as a solid color.

The iron blue pigments are made from potassium ferrocyanide and comprise three familiar types. Prussian Blue, W-580, is used in black enamels and solid blue colors. It has a dark, slightly brown masstone and a reddish tint. Chinese Blue, W-583, is a dark, jet blue masstone with a greenish tint. It bronzes badly in solid colors, fades in light tints and is poor in alkali resistance. Milori Blues, W-582 and W-586, have light plum color in masstone and a greenish tint. They are used in making chrome green blends and in medium and dark blue tints. These pigments also bronze badly on exposure in solid colors, fade in light tints and are sensitive to alkali.

Ultramarine Blue, W-514, is a calcined mixture of china clay, silica, soda ash, sodium sulfate and sulfide. It varies from a greenish to a reddish tint, is fugitive and relatively expensive. It is used primarily for tinting whites. Blue Lake, W-512, is a dyestuff precipitated with aluminum hydrate on blanc fixe. It is low in tinting strength and hiding power but is quite lightfast. Hence, it finds some use in relatively light-stable pale blue tints and for toning blues generally.

The Monastral or phthalocyamine blues are the latest addition to this group of pigments. They are quite reactive and we have had difficulty in dispersing them. W-505 has been found preferable to W-515 but both seem to have their uses due to difference in tone but W-515 is restricted by its poor color drift. They are expensive but are clean and green-toned. They bronze on exposure in solid colors.

The only violet pigments we use are W-501, Mineral Violet, and W-518, Purple Toner. Mineral Violet is a manganese ammonium phosphate used for tinting whites. The Purple Toner is a blue dyestuff precipitated with phospho-tungstic acid. It is not very lightfast hence limited in use to interior finishes.

(d) Brown Pigments

Many tan and brown colors are made by blending bone black with ferrite yellow and iron oxide, etc., but sometimes it is desirable to use a straight brown pigment. Some of the oldest known are the earth siennas and umbers, which are similar to the ochres mentioned previously under yellow pigments. They vary in iron oxide content and may contain some manganese dioxide to yield the browner colors which also makes them reactive. W-422 is a light raw Italian Sienna containing about 60% iron oxide and is the best of the siennas in color and tinting strength. W-450 is one of the domestic siennas which are usually not as bright as the Italian grades. This one contains about 50% Fe_2O_3. W-377 is a Burnt Sienna, which is lightened and brightened in color by heat treatment. These are all used for masstone, e.g., in oil colors, and as tinting pigments in tans, buffs and ivories.

The term "Turkey Umber" comes from the fact that the best umber came from the Island of Cyprus which once belonged to Turkey. W-420 is the raw umber type yielding a greenish-brown tone. W-719 is the burnt umber type which improves the brightness through the heat treatment. Both of these pigments are used in brown stains and for tinting purposes.

Domestic browns are both natural and synthetic like the iron oxide reds. W-401, Metallic Brown, is a natural earth pigment containing about 76% iron oxide. W-402, Van Dyke Brown, was originated by the Flemish painter and was imported from Germany originally. It contains about 60% organic matter. W-407, Prince's Metallic Brown, contains about 50% iron oxide and is rigidly controlled for specification requirements.

The synthetic types are either mechanical mixtures or co-precipitated black and red iron oxides. W-476, Mapico Brown, is one of these used principally in VZ specialties.

All of these pigments have good durability as far as checking resistance is concerned although they tend to chalk and lose gloss.

(e) Black Pigments

Black pigments are probably the oldest colors known. They are classified as follows: Mineral, Vegetable, Animal, Lamp and Carbon Blacks, with the latter being most important not only for finishes but for rubber tires and many other products.

The mineral blacks comprise W-318, Graphite, characterized by lead pencil streak, greasiness to touch and excellent resistance to chemicals and weather; W-214, W--221 and W-235, the Coal Blacks, having a brown tone, low oil absorption and good durability, used chiefly as extenders; and W-215, Mapico Black, iron oxide prepared synthetically and used in primers and as tinting pigment where rust inhibition and the property of chalking the same shade as the original are required.

We no longer use a vegetable black, but we use quantities of bone black, the animal type, produced by calcining the bones of cattle or sheep, ending up with a composition of about 10 to 20% carbon mixed with calcium phosphate and ground to proper fineness. We use W-284, Bone Black, for shading grays, tans and olive greens due to its relative freedom from "floating" or "flooding".

Some of the earliest documents of China, India and Egypt refer to the use of Lamp Black. W-205 is made by collecting the carbon smoke from burning coal by-products in a limited supply of air as a free flame. The size, shape, height, color and temperature of the flame are important factors in determining the quality of the lamp black produced. It is used as a tinting pigment to give blue-toned grays, etc. W-222, Molacco Black, is a hybrid type black pigment being a coarse particle size carbon black obtained from burning natural gas in a furnace as a free flame and collected like a lamp black. It has a bluish tone like lamp black in gray tints and has less tendency to flood than lamp or carbon blacks.

We use a number of carbon blacks which are obtained from the incomplete combustion of natural gas by impingement of the flame against metal surfaces and collected by scraping. Carbon black has the finest particle size, highest tinting power, and highest color values of all black pigments. The pigments we use may be classified roughly according to density of color:

The highest color black and most expensive are W-217 and W-230, Neospectra Beads and Mark II. The pigment is the same but the beaded black is specially compacted to improve ease of handling and reduce dusting tendencies. Due to its high oil absorption this type of black is difficult to formulate into finished products and great care must be used in handling the bases and enamels containing it to obtain maximum color without loss of dry on aging, bodying, gelation or seeding troubles.

The medium color blacks are typified by W-201 and W-223, Superba Beads and Powder, respectively, which have fairly good color, grinding qualities and stability with a medium price. Hence, Superba is widely used in our products.

The low color blacks comprise W-275, Excelsior, and W-224, Raven Beads, which are lower in price, oil absorption, masstone color and tinting strength. They are, therefore, used in cheap orthodox paints, primers, etc.

(f) Metal Powders and Pastes

Finally in the category of "W" codes, we have a few metal powders and pastes. Zinc Dust, W-36, is used for special primers, particularly where adhesion to galvanized surfaces is required. Then we have several aluminum pastes, W-64, W-72 and W-163, which comprise various particle sized aluminum powder wet with stearic acid to promote leafing and enough high flashing thinner to form a usable paste. The dry powders tend to ignite under certain conditions of dusting and exposure to air, hence for safety sake we use pastes. Even these must be handled with some caution and a standard practice has been set up recently for doing so. Besides their use in well-known aluminum paints, which give good metal protection, heat reflection and appearance, they are more recently being used to give the metallic "sparkle" to so-called metallized or polychromatic finishes.

B. VARNISH GUMS AND SYNTHETIC RESINS - G CODES

Now let us briefly survey the G codes designating the varnish gums and synthetic resins we use as binders for the pigments just reviewed. We start off with the natural gums including rosin, asphalt and pitches. Then we will discuss the rosin modified varnish gums and finally the synthetic resins, including phenolics, alkyds, urea and melamine resins and finally the vinyl resins.

1. Natural Gums

The imported natural gums we used before the war are still hard to obtain. When plentiful, some of them are used because they are usually cheaper than specially treated rosin and phenolic types. Manila gum is a copal type of alcohol-soluble resin available in various grades according to age. The MA grade G-346 is one of the softer types used in chemical specialties. The harder grades find general use in traffic paints. Congo, G-36, is a hard, fossil resin with limited solubility in oil and solvents until it is run, G-8, or esterified. It yields good rubbing and quick dry varnishes with good adhesion to metal surfaces. East India, G-29 and G-32, is a semi-fossil resin related to the dammars but readily soluble in hydrocarbon solvents. It yields varnishes with good alkali resistance and quick solvent release. It was used in VG-4295, Kwik-Lac, before the war with good success.

Shellac is derived from the secretion of the lac insect prevalent in India. Bleached Shellac, G-72, is the most popular type used because of pale color. We use it for venetian blind primers and it is popular for finishing floors. It is simply dissolved in alcohol but deteriorates on aging for long periods either solid or cut in solvent.

Rosin is derived by tapping pine trees to yield the gum variety or by extraction from pine stumps blasted out of the ground to yield the wood rosin grades. Rosin is sold on the basis of visible color the American grades being in the order of decreasing color - B, E, E, F (or FF for wood rosin which is slightly redder), G, H, I, K, M, N, WG, WW, and X. The price increases with paleness. We use the WG grade as G-40 and H grade as G-42, which is preferred for varnish work because of lower cost.

One of the useful characteristics of rosin is its acidity, mostly abietic acid, which permits esterification, as we shall mention later, and the formation of lime and lead soaps in VC-950 & VC-810, respectively. These varnish formulating vehicles thus have slightly better dry, hardness, water resistance and lower solids at a given body, resulting in low cost orthodox products.

The Penbro Resin, G-88, is a dark, partially polymerized rosin residue gum, which was used during the war as a substitute but it was found satisfactory in Freight Car Paints and is much cheaper than other grades of rosin so we continue to use it in these products where pale color is not important. Asphalts, pitches and tars have been used since ancient times as binders for preserving the dead, for waterproofing boats, etc. We still use these naturally occuring bitumens, G-61, or the still residues from distillation processes in the petroleum and vegetable oil and fat industries, G-65 and G-59, to make black varnishes, cheap black paints and roofing compounds. Blown Asphalts, G-381, have a higher penetration for a given softening point and are more viscosity stable with varying temperature. These materials vary in consistency from very soft and soluble to the hard, semi-fusible and less soluble grades. Hydrolene, G-57, is a still residue from cracking petroleum oil; Stearine Pitches, G-59 and G-323, are still residues from animal fat recovery processes and Cottonseed Pitch, G-314, is the soft carbonaceous residue left from refining cottonseed oil.

2. Rosin-Modified Varnish Gums

The simplest synthetic resin and the first to be used in the finishing business is ester gum, G-43 and G-608, which is rosin essentially abietic acid esterified with glycerol. This process raises the softening point and makes the gum less reactive chemically, thus improving the water and alkali resistance of varnishes made from it. This esterification process can also be modified by using some maleic anhydride to produce the original Amberol type gums, G-104 and G-105, which have still higher melting points, better color characteristics, faster bodying rates and better durability.

When phenol-formaldehyde resins were invented by Baekeland in 1909, they were used to modify ester gum and we now use F-7, K-12-A and BS-1 Amberols, G-327, G-17 and G-328, respectively, in varnish vehicles because they have improved water and alkali resistance compared to the original ester gum. Also, the phenolic constituent increases the melting point and bodying rate and helps to cure Chinawood oil which is generally used with these gums.

More recently, another polyhydric alcohol, pentaerythritol, has come into commercial use and this will esterify rosin to yield higher melting point, better color and faster bodying gums than the corresponding glycerol types. Although several grades have been used in the past, we have tried to do some simplification recently and we now use Pentalyn G, G-55, a maleic modified PE ester, where color is important and Amberol M-93, G-107, or Pentalyn M-802-A, a new one coded G-114, which are highly modified phenolic pentaerythritol rosin esters for use where chemical resistance, hardness and toughness are required.

Further experimental work is in progress in the Philadelphia Laboratory to determine the most advantageous varnish, gum and oil combinations to use from the standpoint of quality and cost, so some additional simplification and replacements will come along later.

These gums find their chief use in our varnish clears and formulating vehicles, such as VC-1329 and VC-805, which go into a wide variety of orthodox products for industrial use.

3. Synthetic Resins

The next class of synthetic resins that are important in our varnish business are the phenolic types based on the condensation of phenols with formaldehyde, which first became prominent commerically in 1928. Both acid and alkaline catalysts may be used for this reaction to yield two essentially different types of resins, non-heat reactive, oil soluble types such as G-15, G-18 and G-20, and the heat reactive types, which advance on heating to the infusible state. Various modifications of these essential types are made possible by using different phenolic compounds and methods of processing. In general, these resins speed the bodying rate of varnish oils, improve the durability characteristics and give increased resistance to moisture and alkalis. However, they are notoriously poor in yellowing resistance in spite of their pale initial color, so their use is limited to spar varnishes, floor and deck vehicles and solid color paints and enamels. The thermosetting or heat reactive types, G-5, G-60 and G-318, are particularly useful for baking enamels, can coatings, alkali resistant primers, and insulating varnishes.

During the war, the Bakelite Corporation exploited a phenolic dispersion resin which we know as G-39, Bakelite Gook. This is a gelled short oil, phenolic resin varnish treated with zinc oxide to reduce acidity for stability reasons and dispersed in a hydrocarbon diluent. It is characterized by speed of dry which occurs on evaporation of the solvent. This is one of the important constituents of zinc chromate primers used for aircraft.

I mention the well-known alkyd or "DULUX" resins only in passing because they are important intermediates based on the interaction of various oils with glycerol, H-2, and phthalic anhydride, G-243, but are not raw materials as we normally consume them. However, we are using some competitive alkyd resins from Reichhold nowadays to extend our supplies of oil, glycerine and phthalic so these then come into the category of raw materials. Leo Hubbuch will elaborate on alkyd resins on October 29.

In conjunction with the alkyd resins as plasticizers, we use for 700 Line products some urea-formaldehyde, RC-718, and melamine-formaldehyde, G078, resins, which are thermosetting or heat-reactive polymers yielding hard, chemically resistant finishes with good color retention characteristics. They are soluble in alcohols and are restricted in compatibility with other materials carrying lean thinners like mineral spirits. Hence, some care is necessary in using them and mixing directions should be followed more carefully than in the case of the more tolerant orthodox varnish and alkyd "DULUX" type products.

✓ Just recently we have been working with vinyl resins based on copolymers of vinyl chloride with vinyl acetate and this development will undoubtedly become more important in coming days. These materials are generally thermoplastic, i.e, they soften under heat and pressure, require active solvents, such as ketones and aromatic hydrocarbons, and are limited in compatibility with other resin vehicles we use. Hence, extreme care is required in handling these relatively new materials. They produce finishes with exceptional chemical resistance and are finding use for kitchen appliances, tank linings, can coatings, etc. There is considerable competitive activity in this field so our work is being continued to exploit the possibilities of using vinyl resins, both in solution and as dispersions.

Finally, we have been using some hydrocarbon resins such as Velsicol AD-4 and AD-6-3, G-335 and G-113, respectively, for varnish type can coatings. Just recently, some of the rubber companies have started to exploit their compounds from synthetic rubber plants and we are looking at some interesting polymers based on styrene and butadiene, etc., which seem to have good color characteristics, speed of dry, etc., and may find a place in our business. Therefore, our use of hydrocarbon resins derived from coal tar or petroleum should expand in the near future as these new developments find their place on the market.

4. Waxes

Then we have uses for a number of waxes, both petroleum and natural types, which we should mention. They are important in chemical specialties and provide certain marproofness, blocking resistance and yellowing resistance in some products.

Carnauba Waxes, G-311, G-370 and G-390, are the hardest types with melting points in the range of 80-90° C. These are used principally in chemical specialty polishes but are hard to obtain these days since they are imported from South America.

Candelilla Wax, G-4 and G-392, is harder than beeswax but not as hard as Carnauba, having a melting point of about 65-70° C. It is used to provide marproofness to 700 Line baking enamels where it also seems to improve yellowing resistance as well. Some is also used to modify a special flooring wax.

You are all familiar with the paraffin waxes, especially those used for household canning. These are derived from petroleum and can be made in various grades of color, wetting point, solubility, etc. We use G-86, G-94 and G-95 in chemical specialties such as paint and varnish remover and in some special varnishes and wax polishes.

As representative of the synthetic waxes, G-690, is hydrogenated castor oil which is used in an alkyd plasticizer for lacquers. Halowax, G-233, is a chlorinated paraffin used in a furniture wax and polish.

C. OILS - H CODES

Chemically speaking, the oils we use are fatty acids esterified with glycerol. The fatty acid chains give flexibility to the dried film. The chains may contain double bonds indicating unsaturation, and these are responsible for the bodying and drying reactions that convert an oil from a soluble liquid to an insoluble solid. Now let us examine some of the oils used in our paints, varnishes and synthetic resins, their sources, treatment, important characteristics and general usefulness.

The first group are drying oils. Chinawood Oil, H-7, has been imported from China and more recently grown in the southern U.S. At the present time, it commands a premium price about 40¢ a pound, but it is still "tops" for quality as a drying oil. It is outstanding in speed of bodying and dry but must be properly cured to prevent frosting or crowsfooting. It yields hard, water-resistant films, but tends to discolor on exposure to light and dark. Oiticica Oil, H 553, comes from Brazil and is related to Chinawood oil in characteristics except it tends to become more brittle on aging. We would use some Perilla Oil, H-340, from Manchukuo or India, if we could get it. It bodies and dries rapidly being intermediate in this respect between Chinawood and linseed oils. Linseed Oil, H-19, comes from flaxseed and we can't get enough right now to go around because Argentina is not supplying the usual amounts. It is the old standard for paints and varnishes, alone or in combination with Chinawood oil. It dries fairly well, retains flexibility better but is less water-resistant than Chinawood oil. Soya-bean Oil, H-59, is becoming more popular since its slower drying characteristics can be improved by treatment with maleic anhydride or pentaerythritol. Its color retention characteristics are definitely better than linseed. Dehydrated Castor Oil, H-156, is chemically prepared from the non-drying type of castor oil so that it will body and dry somewhat like linseed and soya-bean oil and has color characteristics somewhat better than soya-bean oil. Fish Oil, H-106, has found little use in our products so far but it has properties of flow on application plus good drying characteristics that make it interesting for further development whenever the supply becomes adequate and the price is right. The odor is removed by careful refinement.

We have a few semi-drying oils. Cottonseed Oil, H-250, is used mostly for modifying alkyd resins to be used in "DUCO" lacquers, since it is durable, light in color and retains flexibility fairly well. Corn Oil, H 335, is used in a special varnish VC-837, for coating bus bar insulation in view of its inherent slip, flexibility and electrical resistance. Here also I might mention Tall Oil, H-453, which is a by-product of the kraft paper industry containing oil acids mixed with resinous acids like rosin. It is rather cheap. It is slow-drying as is but can be treated with maleic anhydride and pentaerythritol or sorbitol to make pretty good varnishes which may find some use later on.

Finally, we have a couple of non-drying oils. Castor Oil, H-22, familiar from childhood days, is pressed from beans imported from Brazil and India. It has good retained flexibility and color characteristics when used in lacquers or baking products. Coconut oil can be used as is or hydrogenated to form "Opalwax", our G-700, for making alkyd resin plasticizers for lacquers and 700 Line baking enamels where good durability, heat resistance, and retained flexibility are desired.

These raw or refined oils are used for paints and varnish cooking or they may be further treated to produce better dispersing, compatibility or drying characteristics by the following techniques:

(a) Boiled Oil, H-108, is heat-treated with driers present to form "in situ" driers for promoting dispersion and oxidation.

(b) Blown Oils, H-249 and H-141, are heat-treated while being blown with air, which forms peroxides to accelerate drying and increases the compatibility and wetting characteristics.

(c) Heat Bodied Oils, H-241 and H-410, are heat-treated, possibly under vacuum, without driers added for relatively long periods of time to develop a high degree of polymerization.

(d) Solvent Extracted Oil, H-571, is made by a special process whereby the faster drying fractions of linseed oil are separated from the slower drying portion.

(e) Chemically Treated Oils, H-557 and H-592, are oils or fatty acids modified by special chemical processes with maleic anhydride, pentaerythritol, styrene, diclopentadiene, sorbitol, etc., to improve drying, bodying rate, chemical resistance, color retention and other characteristics. These were developed during the war as substitutes for Chinawood oil but they have something to be desired and will probably only find specialty uses from now on.

(f) Catalyzed Oils are those treated with special chemical compounds which accelerate the bodying rate while maintaining the other essential characteristics of the oils. "Kellitol",KH-3437, produced by Spencer-Kellogg is one of the most promising of these specialties on the market so far. It bodies in one-third of the time as H-19. The chief advantage of these oils is the ultimate savings in fire time and kettle capacity involved in their use.

D. SOLVENTS AND THINNERS - H CODES

Now let us consider very briefly the liquid raw materials we use as solvents or thinners which comprise the volatile portion of the various products we make. We will consider three general classifications in order - resinous types, oxygenated types, and the hydrocarbons.

1. Resinous Solvents

The resinous solvents are derived from the distillation of pine sap or pine wood chips. They include Gum and Wood Turpentine, H-266 and H-58, Dipentene, H-152, Terpene Hydrocarbons, H-472, and Pine Oil, H-502. Turpentine has been replaced by petroleum hydrocarbons which are more plentiful and cheaper. Dipentene is higher boiling and expensive but is used in some specification products. The terpene hydrocarbons are derived from the synthetic camphor process and are similar to dipentene. Pine oil is a very high boiling fraction and slow evaporating. Small amounts are used for brushability, flow, and other application characteristics. It is also an active wetting agent for 700 Line products.

2. Oxygenated Solvents

The oxygénated solvents such as alcohols, esters, ketones and ethers find considerable use in lacquers. However, a few are used for special purposes in some of our products. Denatured Ethyl Alcohol, H-1, is low boiling, fast evaporating and used for stains and paint and varnish remover. Isopropyl Alcohol, H-84, is slightly higher boiling and used in a variety of our products. Butyl Alcohol, H-12, is still higher boiling and is the chief solvent in 700 Line products where a definite proportion must be used to maintain solubility and stability of these finishes. Methyl Isobutyl Carbinol, H-48, is a new product put out by Shell and is similar to butyl alcohol in solvency with slightly higher evaporation rate. Diacetone Alcohol, H-39, is rather high boiling and is an active solvent due to the ketone substitution. It is used in varnish stains. In this category belong Glycerine, H-2, and Pentaerythritol, G-419, which are polyhydric alcohols used for esterifying rosin and phthalic anhydride to make ester gums and "DULUX" resins, respectively, but could not strictly be classed as solvents for our purpose.

We use no esters except for special experimental products and for cleaning purposes, where their high solvency is an asset. Butyl Cellosolve, H-224, is an ether-alcohol with rather high evaporation rate which we use for 700 Line thinners and special products. The ether group increases its solvent power beyond that of an alcohol of the same boiling point.

The ketone solvents are quite active and are required for the newer vinyl resin formulations. Acetone, H-30, is the fastest in evaporation and is used in paint and varnish remover Methyl Ethyl Ketone, H-35, is a relatively low boiling ketone. Methyl Isobutyl Ketone(or Hexone), H-44, is next in boiling range and hence somewhat less active as a solvent. Cyclohexanone, H-66, is an aromatic type with the highest evaporation rate of this series of ketone solvents. Some higher boiling ketones are available and may be required later on for vinyl vinishes such as Methyl Amyl Ketone, Disobutyl Ketone and Isophorone.

Generally speaking the oxygenated solvents are higher in price than the resinous types and the hydrocarbons. Also in view of their solvent power, they should be handled more carefully to avoid dermatitis, burns and poisoning.

3. Hydrocarbon Solvents

The hydrocarbons are divided into two main types based on derivation, viz., coal tar or petroleum, and into two classifications according to chemical structure, viz., aliphatic for straight carbon chain types or aromatic for carbon ring types. The high solvency petroleum naphthas are hybrids being a cross between the aliphatic and aromatic types. The composition of the hydrocarbon solvents varies with the location of the different crudes as follows:

Michigan - almost 100% paraffinic
Texas - high in naphthenic
California - high in aromatic.

Generally speaking, in each classification, solvent power decreases with increased evaporation rate or boiling range. Solvent power increases with aromaticity. Cost increases with solvent power.

Formerly, our aromatic hydrocarbons were derived only from coal tar but recently the petroleum industry has made improvements in their cracking and fractionation processes so that they are able to duplicate the coal tar products. We still use coal tar Toluol or Toluene, H-47, which is the fastest evaporating and best in solvency of this group but some petroleum grades are available on the market. In the case of Xylol or Xylene, H-583, we have swung over to the petroleum grade because it is lower in cost. It is somewhat higher boiling and slower evaporating than H-47. In the high flash naphtha class, we now use a petroleum hydrocarbon, Solvesso 100, H-596, since it is more active and more readily available than the coal tar variety, H-278. These aromatic hydrocarbons are chiefly used for 700 Line and vinyl resin finishes although some other varnish and "DULUX" products require them in lesser amounts. A rather high boiling coal tar fraction, Tetralin, H 550, is used in a special "Winter Thinner", where it is oxidized to speed up the drying of air dry "DULUX" enamels particularly under adverse conditions. Last in this class is Creosote Oil, H-264, which is very high boiling but has good wetting and impregnation properties, hence finds use in shingle stains.

In the hybrid group of high solvency naphthas, we have a similar range in evaporation rates increasing in the order named. H-51 is similar to Toluol in evaporation rate being quite fast. Next is H-202, which is in the evaporation range of Xylol. Then comes H-200, which is in the class of slower evaporating solvents like high flash naphtha. We have no really high boiling naphtha in this class but some of the petroleum companies are working on such a composition and we may have another one to add to this series later on.

In the aliphatic series we have a greater spread in evaporation rates. H-29 is somewhat like H-47 and H-51 but evaporates noticeably faster than either of these. Next comes H-257, V.M. & P. (standing for Varnish Makers and Painters) Naphtha, which is somewhat like H-202 but slightly faster in evaporation rate. Then we have H-287, the familiar Mineral Spirits, which is widely used in orthodox varnish and "DULUX" enamel formulations but is not so good in 700 Line or vinyl resin products. This is the accepted replacement for turpentine, except for odor characteristics. We are still looking for a mineral spirits with better odor but they have only been different so far. A still higher boiling type of aliphatic hydrocarbon is H-262, Heavy Mineral Spirits, used for paint products, where low cost and lots of time for brush lapping is needed. Next in line is H-265, Kerosene, which is familiar as a fuel, but also goes into some paint products to promote brushability by slowing down the evaporation of solvent. Finally, a hydrocarbon oil is used in some chemical specialties known as Neutral Oil, H-520, which is practically a lubricant and not strictly a solvent type.

In this category as thinner I mention in passing H-506, which many a greenhorn has been sent looking over the plant to find just as the storekeeper sends his new clerks for a bag or paper stretcher and the mechanic sends his new apprentice out to look for a left-handed monkey wrench. H-506, City Water, is getting to be a popular and usable diluent now for emulsion paints like "Speed-Easy" and we may see other types coming on the market soon. It is cheap and it has good odor characteristics provided it is cleaned up on coming from the Schuylkill or the Delaware.

E. MISCELLANEOUS AGENTS

We should mention briefly that variety of chemical agents we use as driers and catalysts, which speed the rate of drying, bodying or other chemical reaction, the inhibitors which retard drying, settling, etc. for practical reasons, certain surface-active compounds which serve as flatting and bodying agents, and a few fungicides which retard the growth of harmful organisms. Let's review them quickly in that order.

1. Driers and Catalysts

The common metallic driers we use are cobalt, lead and manganese soaps of naphthenic acids which are quite soluble, stable and relatively easy to disperse. H-172 is a 6% cobalt solution which we reduce to 2% metal content as VD-1450 to permit more accurate weighings. It acts generally as a top surface drier or oxidation promoter. H-171 is a 16% lead solution which we use at this concentration as VD-1428 since larger amounts of lead are used generally to promote thorough dry of heavy films. H-173 is a 6% manganese solution which we reduce to 3% metal content for use as VD-1846; it acts as a promoter for the cobalt and lead driers and is particularly good where wrinkling is often a problem. In this connection also, G-434, Diphenyl Guanidine, has been found useful to promote drying of air-dry products.

A few oxide type compounds are used for varnish making where they react with the oil and gums to form resinate driers "in situ". W-603, Litharge, is a lead oxide used as a catalyst for alkyd resins as well as a varnish drier. G-240, Manganese Oxyhydrate, is used for varnishes. G-212, Calcium Hydrate, or lime is used to body up and harden formulating varnishes based on rosin where low cost products are desired.

H-184, Zinc Naphthenate, is used as dispersing agent and hardener for special products. H-181, Iron Linoleate, and H-182, Iron Naphthenate, are used as hardening agents for can coatings and some paint products.

G-218, Caustic Soda, is used as catalyst in resin cooking operations.

2. Inhibitors

Chemical antioxidants are used as drying inhibitors and flocculating agents are used to suspend pigments so as to prevent settling on longtime storage. As inhibitors we use:

(a) Creosote solutions based on H-505 which is the cheapest one available.

(b) Thymol, G-495, which is relatively expensive but better smelling than creosole.

(c) Hydroquinone, G-498, and Triethanolamine, H-534, which are used as frosting inhibitors on baking 700 Line products.

(d) N-butyraldoxine, more familiar as chemical ASA, H-580, which is relatively new but works well as a skinning and bodying inhibitor without slowing up the dry so much due to its relative volatility.

The suspension agents are surface-active compounds varying in type and specific in their use as settling inhibitors and sag control agents. The following are typical ones we use:

(a) G-12, Soya Lecithin, a phosphatide derived from the refining of soya-bean oil.

(b) H-522, Turkey Red Oil, a sulphonated castor oil.

(c) H-526, Rubber Solution, a dispersion of milled crepe rubber in xylol.

(d) H-226, Coconut Oil Fatty Acids, which is derived from splitting glycerine away from coconut oil.

(e) H-555, Neofat #7, which is a specially segregated fatty acid fraction from coconut oil.

3. Flatting and Bodying Agents

In this group we use selected chemical compounds or solid, highly absorptive materials which are surface active and reduce gloss or cause an increase in body so as to provide desirable application characteristics or appearance or lower cost by permitting the use of more cheap thinner in certain products. Typical agents of this type are the following:

(a) G-217, Aluminum Stearate, used in flat varnishes principally.

(b) G-416, Powdered Bentonite, used in chemical specialties.

(c) W-1, China Clay, which is a cheap extender and bodying agent for stencil pastes.

4. Fungicides

These are selected chemical compounds with varying degrees of toxicity toward pestiferous organisms which are better known as mildew, mold, termites, barnacles and bacteria, which may cause trouble in certain paints or on the surface of finishes. In this class we make use of the following agents:

(a) W-416, Cuprous Oxide, specific for marine growths on ship paints.

(b) H-454, Phenyl Mercury Oleate, specific for wood sealer.

(c) G-276, Dowicide G, a chlorinated phenolic compound used to prevent putrefaction in protein-type water paints such as "Speed-Easy".

(d) G-231, Shirlan Extra, which is an organic derivative, salicylamide, used for mildew resisting mill whites, etc. and is relatively non-toxic.

F. SPECIFICATIONS

Finally, let me draw your attention to the procedure we use for establishing purchasing and control specifications to govern the type and quality of the raw materials we use here.

A facsimile of a raw material specification sheet is attached for reference. You will note that the specification sheet covers the following points:

a. Raw Material Code (G, H, W or K codes).

b. DuPont Title - may be same as supplier's designation if only one source of supply, but not general practice.

c. Date of Issuance and Superseding Date.

d. Gallon Weight

e. General Description - as technical as possible to provide for use by formulators.

f. Purchasing Specifications - these are provided the supplier and his material must meet these requirements in all respects. Any deviation is cause for rejection by the plant receiving shipment of the material. We show the title of the test, the TM number covering the test method and the limits established for each property, characteristic or measurement.

g. Some materials require Accessory Specifications, including an actual evaluation in a finished product where the material must perform equal to a given standard, previous satisfactory production or within certain stated limits. Sometimes a special test is required for only one or a few materials and a test method (TM) is not written to cover it, since they are restricted to general tests, but the test procedure is actually shown on the specification sheet. Certain precautions regarding possible impurities or contaminants, handling of toxic or hazardous materials (we have a number of these in use) and any other special notations are included.

h. The Control Specifications are generally a series of letters, A, B, C, etc., to refer to the Purchasing Specification tests, which the Plant Control Laboratory makes on arrival of the shipment of the material before it may be used in a designated class of finished products, viz., Paint & Varnish, "DULUX" enamels, or "DUCO" lacquers.

The Sampling Specification is generally designated as TM-73, which described the standard practice for obtaining a uniform, representative sample of any raw material shipment for testing and retain storage.

i. Then the list of acceptable sources of supply or names of suppliers (original or agents as the case may be) are given with each supplier's designation for the material which is used by the Purchasing Department to order the material.

j. Most of our materials are controlled by comparison with accepted standards and these must be maintained and renewed as occasion arises so we have a record on the specification sheet to show the source, designation, date of adoption and plant responsible for establishing each standard.

k. Finally the reason for issuing or revising each specification is given just as we do with our formulas, and the sheet is signed by the originator and the laboratory he represents.

That constitutes a raw material specification and sometimes the originator must endure many "birth pains" to get one properly born and then keep it growing by periodic revisions to add or modify tests for quality control, sources of supply, changes of reference standard, etc., but these specifications are a vital part of the manufacture of our products because any error at this point can cause considerable havoc in plant production or customer complaints. You might say that these raw material specifications are the "foundation stones" for building and maintaining the quality of our products. A considerable amount of research and development work is generally involved in establishing a new material and the writing of the specifications is the climax of this effort because permanent specifications are not written until a new material has been proven satisfactory in actual plant production.

CHART 5

ONE TON OF COAL

↓

TEN GALLONS OF COAL TAR

↓

2½ GALS. LIGHT OIL	1 GAL. CARBOLIC OIL	1 GAL. CREOSOTE OIL	5½ GALS. PITCH, CARBON, ETC.
(Benzol - H-503) (Toluol - H-47) (Xylol - H-15) (Coal Tar Naphthas - H-504 & H-278)	(Phthalic Anhydride)		

CHART 6

COAL TAR SOLVENTS

		Distillation Range
H-503	Benzol	79.1° - 81.1° C.
H-47	Toluol	109° - 111° C.
H-15	Xylol	132° - 145° C.
H-504	Solvent Naphtha	125° - 180° C.
H-278	High-Flash Solvent Naphtha	140° - 210° C.

CHART 7

HIGH-SOLVENCY PETROLEUM NAPHTHAS

		Distillation Range
H-51	Low-Boiling Naphtha	95° - 141° C.
H 202	High-Solvency Petroleum Naphtha	135° - 175° C.
H 200	Heavy Petroleum Naphtha	183° - 201° C.

CHART 8

TURPENTINE GROUP

		Distillation Range
H-266	Gum Spirit	150° - 170° C.
H-58	Wood	150° - 170° C.
H-158	Dipentine	170° - 182° C.
H-502	Pine Oil	185° - 225° C.

CHART 9

ALCOHOLS

		Distillation Range
H-1	Ethyl Alcohol (Denatured)	78.5° C.
H-84	Iso Propyl Alcohol	79° - 81° C.
H-12	Butyl Alcohol	113° - 118° C.
H-18	Iso Butyl Alcohol	106.3° - 108.3°C.

CHART 10

CHOICE OF SOLVENTS

1. Active carrier for the binder.
2. To reduce cost (diluent).
3. To obtain desired solids-viscosity relationship.
4. Application properties.
    a) Spray
    b) Brush
    c) Dip
    d) Roller Coat