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FABRICS AND FINISHES DEPARTMENT

CHEMICAL DIVISION

PARLIN LABORATORY CLASS A-I RESEARCH REPORT NO. 987

PROJECT NO. J-1044

SUBJECT: SANDING AIDS FOR FURNITURE SEALERS

DATE ISSUED: JUNE 23, 1950

PERIOD COVERED: NOV. 20, 1947 TO DEC. 31, 1949

PREVIOUS REPORTS ON SAME SUBJECT: NONE

NOTEBOOKS: 2222, 2246, 2266 and 2286

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INTRODUCTION

A sanding sealer serves as an undercoat for the topcoat, whether the latter be lacquer, a baking synthetic or a varnish. The sealer is applied after the stain, wash coat and filler. The main purpose of a sanding sealer is to produce a smoothly sanded surface for the application of topcoats. Because sanding involves considerable labor, furniture manufacturers demand sealers which can be sanded with a minimum of labor after a very short drying time. The sealer must therefore cut to a smooth surface rapidly, with a minimum of scratches and without gumming or clogging of the sandpaper.

Ease of sanding is universally obtained by means of zinc stearate. A sanding sealer is one of the weakest constituents of a furniture finishing system. Sanding sealers are brittle and impair the quality and clarity of an otherwise highly satisfactory furniture finish. It is for this reason that occasionally on high grade furniture and usually on pianos, a sanding sealer is not used.

Objectives

Project J-1044, Parts I, II, III and IV, provided funds for the investigation of the factors which control ease of sanding and intercoat adhesion, with a view toward arriving at sealer compositions which represent a superior balance between the two than exists in currently available sealers, either of our own manufacture or marketed by competition.

Summary and Conclusions

In our general background study of sealers the following was established:

1. Zinc stearate functions as an efficient sanding aid primarily because of its lubricating properties.
2. Zinc stearate embrittles the sealer film and impairs topcoat adhesion.
3. When a sealer ages for sometime in the package before use, particularly under conditions of relatively high temperature, the intercoat adhesion is still further reduced.
4. Zinc stearate is fairly soluble in aliphatic and aromatic hydrocarbons. Consequently their presence or absence in the solvent composition largely determines the package stability of a sanding sealer.

On the basis of the above the problem of formulating an improved sealer was approached from several directions: (a) Evaluation of materials other than zinc stearate as sanding aids, (b) improvement of the stability of zinc stearate sealers through solvent adjustments and/or encasing the zinc stearate particles in an insoluble envelope, and (c) utilization of zinc stearate as a dry sanding aid.

Although a great many inorganic and organic materials were evaluated as sanding aids, none was sufficiently promising to warrant replacing zinc stearate. Low molecular weight polythene and methylol stearamide were among the more promising materials examined.

By replacement of hydrocarbons with alcohols, the solvent of 19380 sealer was reformulated to secure about a 60% improvement in stability. This sealer is susceptible to temporary blushing and its solvent composition is more expensive. A similar improvement in stability can be effected by packaging the hydrocarbon diluent separately, to be added at the time the sealer is applied. By packaging the zinc stearate separately in dispersion form, to be added to the 19380 Clear at the time of application, a 100% improvement in stability can be obtained. These three systems were recommended to the Sales Department in Parlin Laboratory Release Letter No. 421.

Attempts to insolubilize the zinc stearate particles with sundry insoluble coatings proved to be unsuccessful.

An entirely new and original approach was the utilization of zinc stearate as a dry lubricant either dusted on the sealer or coated on the sandpaper. By this means sealers containing no sanding aid can be sanded with great ease. Of course the film properties are markedly improved and the instability problem is completely eliminated. Although this new method permits easier sanding than the conventional sealer, rate of abrasion per stroke is less, so that the relation of work to abrasion is about the same in either case.

Action Taken

On August 8, 1949 Parlin Laboratory Release Letter No. 421 was issued recommending the following, listed in the order of preference:

1. Packaging the zinc stearate mill base separately, to be added to the clear sealer at the time of application.
2. Packaging the hydrocarbon diluent separately, to be added to the sealer at the time of application.
3. Replacing the hydrocarbon diluent with ethyl alcohol, not requiring separate packaging.

Subsequently it was mutually agreed with Industrial Sales not to move out for the time being along the lines of Nos. 1 & 2 or with the coated sandpaper but to confine Sales efforts to recommendation No. 3. To date progress on this has been limited.

Patents

A patent proposal, FFD-1018, covering zinc stearate coated sandpaper was submitted to the Legal Department. Management decided not to proceed with this because the benefits to be derived did not warrant the cost of obtaining a patent and the case was not a strong one. It was thought equally as much could be derived by disclosing this idea to one of the sand paper manufacturers, like Behr-Manning who is a customer of ours, (reference Dr. C.E. Bartsch's letter January 3, 1950 with attached correspondence).

Experimental

A. Background Studies

1. Specifications of an Ideal Sanding Aid

When work was originally started on this project the characteristics of an ideal sanding aid were considered. Such a material should promote easy and efficient sanding by minimizing drag, clogging and rolling of the sandpaper. It should not impair the adhesion, color, clarity and quality of the finish. It must be stable in the package by not dissolving in the sealer upon long-time storage and must be permanent in the dried film by not blooming out. Finally it should be cheap and readily available.

2. Theory of Sanding Aids

Early in our study some attention was given to determining how a sanding aid functions. Does it promote sanding by serving as a lubricant, by making the film more friable or in some other way? Unfortunately it was not possible to obtain a complete answer to this question.

It was not possible to obtain good sanding properties via friability alone. For example the substitution of low viscosity nitrocellulose (1/8" or lower) versus high viscosity, (5" to 6") and the introduction of brittle gums like ester gum, gave very little if any improvement in sanding properties.

On the other hand good sanding properties were invariably associated with lubrication in some form or other. For example mineral oil or soap and water applied to the dried film, and talc or lanolin added to sealer composition, markedly aided sanding. Apparently a lubricant whether internal or external, not only serves to reduce friction, but permits the sandpaper to bite into the film and prevents the abraded film

particles from clogging the sandpaper. Furthermore, as will be discussed later in this report, zinc stearate, whether a component of the sealer film itself or applied to the sandpaper, functions about as well either way. In the absence of data that any other characteristic or property of a sanding aid promotes easy sanding to the degree that the lubricating properties do, it was concluded that this is by far the predominating factor.

3. Evaluation Procedures

Aside from noting the general chemical and physical properties of any material under consideration as a sanding aid, major attention was given to: how well it promoted sanding, its effects on appearance, durability and quality of the finish, and its effect on the package stability of the sealer.

Sealer 19380 with 6.5% zinc stearate on the solids, was selected as the standard for comparison. This is our largest moving sanding sealer which we currently market and field experience has shown that 6.5% zinc stearate represents the absolute minimum which can be incorporated into the formula without encountering complaints from our customers on hard sanding. Comparisons were made with the 19380 control in respect to dispersion, settling, sanding characteristics, film properties including intercoat adhesion, scratch resistance and durability and stability.

The usual method of dispersing the sanding aid was to grind the finely divided material with solvents in a one quart mill with porcelain balls. Grinding was continued until a satisfactory dispersion was attained, indicating proper particle size and sufficient wetting. The resulting mill base was then added to clear 19380 in a ladder of levels considered to cover the range of interest as a sanding aid.

The experimental sealers were tested for the following sanding properties with 6-0 MM sandpaper at a film build of one mil after about forty-five minutes dry. Ratings from 0 to 10 were based on a standard of 10 for 19380.

Start - ease of sanding the first six strokes
Ease - ease of sanding the next ten strokes
Flour - the amount abraded with a standard weight (10 lbs. on 4 sq.in.) in five strokes
Clog - The amount of clogging of the sandpaper with twenty heavy strokes.

Film properties of the experimental sealers were evaluated in complete test finishing systems on mahogany and walnut veneer panels. Half of each panel was coated with the experimental sealer and half with 19380 control. Thus the system was identical on the whole panel except for the

sanding aid being compared to the standard zinc stearate in the sealer coat. Tests with coin and knife for mar resistance, scratch resistance, toughness, and adhesion were made on the green finish after one day dry at room temperature and again after three days additional dry at 120°F. Whenever it was deemed necessary, cold crack and oven durability tests were run.

Coin Test Ratings

0 = White, complete separation of film
1 = Heavy, white streak
2 = Medium, white streak
3 = Light, white streak
4 = Indentation only

Knife Test Ratings

0 = Lifts in continuous sheet
1 = Lifts in strip easily
2 = Cuts off strip cleanly
3 = Cuts off pieces with good resistance
4 = Film removes raggedly with bits of wood

It should be noted that adhesion and toughness are two separate and distinct characteristics of any surface coating. In practice they are so closely related that the practical furniture finisher seldom attempts to distinguish between them. Brittleness and poor adhesion are present in finishes that scratch white or mar easily at the slightest impact. For example a piano lacquer (like types D or H) will invariably produce a more brittle finish over a sanding sealer like 19155 than the same lacquer directly over wood or a primer like 1366. The toughness of the topcoat is entirely lost by the brittleness of the undercoat. In this report we shall attempt to differentiate between brittleness and poor adhesion.

Package stability of the liquid sealers was tested, for the most part, by accelerated aging. The sealers were aged simultaneously for three days at room temperature and at 125°F. with 19380 as a control. The aging at elevated temperature was found to closely reproduce the aging effect on 19380 of about three to six months at room temperature. In the case of the most promising sanding aids, these data were supplemented by actual aging for long periods at room temperature. In either case the aged sealer was tested for sanding and film properties versus unaged sealer. Wherever variations from this general pattern of test procedure were necessitated by the peculiarities of the sanding aid under test, brief descriptions of the modified techniques are given.

Taber Abraser

An effort was made to establish our tests on a semi-quantitative basis through the use of a Taber Abraser.

The Taber Abraser is a testing instrument for measuring the rate of wear of surface finishes subjected to rubbing abrasion. Rubber, abrasive containing discs rest on the material under test which is mounted on a turn-table. Rotation of the table causes the abrasive discs to rotate with an abrading action. Abrasion is measured by the number of cycles to wear through the test material or by the weight of the material abraded in a selected number of cycles. Comparison may be made to a standard material or to standard values expressed in cycles or weight. The coarseness of the abrasive wheel and the weight on it may be varied to suit the material under test.

It was thought that the Taber Abraser might be useful to measure sandability of sealers. The method of weight loss of abraded material was chosen for several reasons. The wear through method requires even film builds accurately measured. It requires close watching and varying and longer test runs. The weight loss method requires two weighings but was considered subject to greater accuracy. Aluminum panels were found to yield greater accuracy than steel in weighing to 1 milligram.

Tests were conducted with sealers containing calcium silicate, polythene, and varying amounts of zinc stearate. Best results were obtained by using a CS-17F wheel with 250 gms. weight, 1000 cycles, and the film dried 16 hours at 120°F. While the variations in sanding aid did reflect in the amount of sealer abraded, the reproducibility and sensitivity could not be developed to show superiority to hand sanding tests. The indicated correlation between the Taber Abraser data and known sanding quality did not justify the more involved machine test.

The Taber Abraser was also evaluated as a means of testing adhesion. Finishes were coated on small plywood panels to fit the turn table. Ball and coin shaped tools tested on the finishes were found to require a weight far in excess of the capacity of the machine. The "Shear-Hardness Attachment", a tool with a cutting edge, was found of some use; but interpretation of results depended on visual evaluation of the cut film. This did not prove to be a very valuable test method.

B. Improved Sealer Formulation

1. Role of Zinc Stearate

Practically all wood furniture is coated with a lacquer sealer. This sealer is dry-sanded smooth before the application of any topcoats. To facilitate the dry sanding, a lubricant, known as a sanding aid, is incorporated into the sealer. The sanding aid used throughout the industry is zinc stearate. Zinc stearate is a smooth, slippery soap. It minimizes scratching of the film and clogging of the sandpaper.

2. Sandability versus Appearance and Quality

A sanding aid, like zinc stearate, always detracts from the toughness and adhesion of the finish. Sealers heavily loaded with zinc stearate to give easy, powdery sanding after a short air dry, give good hold out and are economical in labor but produce a brittle finish.

The zinc stearate in sealers tends to settle. If not well stirred before use, the sealer from the bottom of the container will contain too much zinc stearate and the film will be brittle. The sealer drawn from the top will not contain enough sanding aid and will be difficult to sand.

Serious consideration was given to reducing the zinc stearate in 19380 to improve the film properties. Although changes over a fairly wide range were made from time to time, the demands of the furniture trade, as evidenced by actual field experience, indicated that 6.5% zinc stearate on the solids is the minimum acceptable to maintain the required ease of sanding.

Zinc stearate varies only slightly in composition and properties between the various grades available. By way of illustration, a variety sold under the trade name "Metallac" and highly recommended by the manufacturer (Metasap Chemical Co.) was found to be identical in properties as a sanding aid to the grade used in 19380 under the code G-601. The prospects for obtaining an improved sealer through the selection of a superior grade of zinc stearate did not appear promising.

As already discussed the inclusion of zinc stearate embrittles the sealer film and impairs topcoat adhesion. Furthermore ample evidence was obtained to show that when a sealer containing zinc stearate ages for some time in the package before use, particularly under conditions of relatively high temperature, the intercoat adhesion is still further reduced.

3. New Sanding Aids

A very considerable amount of time was devoted to the search and evaluation of new sanding aids in comparison with zinc stearate. Numerous organic and inorganic materials were examined among which were the following:

(a) Metallic Soap

Barium, lead and magnesium stearates were evaluated over a range of concentrations, as sanding aids in 19380 Sealer, in place of zinc stearate. They were introduced in the same manner, namely in the form of ball mill ground dispersions, similar to the zinc stearate base MB-167 used in preparing 19380.

Magnesium stearate yielded a mill base like zinc stearate, thick in consistency; but the mill bases of the barium and lead soaps were thin and milky. As sanding aids the magnesium soap was about equal to the zinc, while the barium was slightly inferior and the lead decidedly inferior.

Sealer 19380 formulated with either barium or lead or magnesium stearate as sanding aids was comparable to standard 19380 in respect to general film properties, clarity, adhesion to filled wood and intercoat adhesion with 16303 Type III and 15002 Type O topcoats. All four sealers were rated equal in cold crack resistance tests under 16900 WE topcoat.

In respect to stability and heat aging, zinc stearate was better than magnesium, and barium and lead were a poor third and fourth. Heat aging in general tended to dissolve the stearates. This increased the gloss and impaired dry, hardness, sanding and adhesion.

Agitation at room temperature accelerated the solution of these stearates in the sealer, increasing the viscosity. The results paralleled the effect of heat, in that zinc and magnesium have the least effect on viscosity while that of lead and barium are greater.

Calcium Stearate

Several concentrations of calcium stearate were tested. A level of 8% calcium stearate on the solids in 19380 imparted ease of sanding comparable to standard 19380 with 6.5% zinc stearate. However, flouring was slightly less and clogging was slightly greater. Adhesion was superior to 19380.

By increasing the amount of calcium stearate to 12%, flouring was equal to standard but clogging increased also. Adhesion was comparable to standard. Calcium stearate appeared slightly more stable than zinc stearate, but the overall balance of properties did not warrant further interest.

Lithium Stearate

Lithium stearate was directly substituted for zinc stearate in the preparation of MB-167 Mill Base. Lithium stearate was difficult to disperse. Concentrations of 4.7%, 6.5% and 9.4% on the solids were tested in 19380. The higher concentrations of lithium stearate gave excessive clogging upon sanding and inferior film properties compared with standard 19380. The sealer with 4.7% lithium stearate was only slightly inferior in sanding and adhesion. Stability was comparable or slightly superior to standard.

Lithium stearate reduced sealer viscosity about ten seconds (#7 cup) below that obtained with zinc stearate on the same basis. Lithium stearate darkened the sealer, which color change became very pronounced upon heat aging. This color change was one of the most serious deficiencies of lithium stearate.

The balance of properties exhibited by lithium stearate did not recommend its substitution for zinc stearate.

Strontium Stearate

Strontium stearate when substituted pound for pound for zinc stearate in 19380, imparted somewhat inferior sanding and was comparable for adhesion. Stability was superior in heat aging tests. A 50% higher strontium stearate content was required to secure sanding properties equal to standard 19380. At this higher level, film properties were inferior and stability as poor as standard.

Aluminum Stearate

Aluminum stearate was not tested because of its lack of stability as previously established in a study of furniture "Duco" topcoats.

Zinc Salts

A number of zinc salts were evaluated as sanding aids. Dispersion of these materials obtained in powder form, was accomplished by grinding in a ball mill with the same solvent blend as is used with zinc stearate in MB-167 (70% butyl acetate, 18% butyl alcohol, and 12% isopropyl alcohol). Solids in the respective mill bases ranged from 15.2% to 32.6%. Samples 2258-16 and 2258-17 (See Table I) became plastic masses in contact with solvent and were not given any further consideration.

The remaining substances were incorporated into 19380 clear sealer in proportions ranging from 3 to 11% on the sealer solids. The dispersions were in general initially satisfactory. In some cases there was subsequently objectionable settling. Compounds 2258-15, 2258-18 and 2258-19 settled to a soft paste not easily redispersed.

All the experimental sealers were tested for sanding quality. The more promising were tested for film properties and stability.

TABLE I

Code	Zinc Salt of -	% T.S. in MB	% Sanding Aid on Sealer Solids	Sanding Quality	Film Properties	Heat Age Stability
G-601	C-18 Acid	23.6	6.5	Excellent	Fair	Poor
2205-215	Rosin-maleic acid adduct	23.6	6.5	Poor	Fair	-
2205-223	Stearic acid and rosin-maleic acid adduct	23.6	6.5	Fair	Good	Fair
2205-224	Rosin-maleic acid adduct	23.6	6.5	Fair	Good	Fair
2205-224	C-14 acids (Wecolin AAB)	23.6	6.5	Good	Good	Poor
2205-272	C-22 acids	19.6	3-9	Poor	Good	-
2258-12	C-12 to C-22 acids	15.2	4.5	Fair	Poor	-
2258-13	C-16 to C-22 acids	20.6	6.0 9.0	Good Excellent	Good Good	Fair -
2258-15	Half ester of Styrene - Maleic anhydride	30.8	3-10	Poor	-	-
2258-16	Diphenyl ether dioleic acid adduct	N.G.	-	-	-	-
2258-17	Hydrogenated dimer acids	N.G.	-	-	-	-
2258-18	Polythene Di-iso propanolamine sulfonate	20.0	1-11	Poor	-	-
2258-19	Dimer acids. Adduct from dry-oil acids	30.0	3-11	Poor	-	-
2258-29A	12-hydroxystearic acid	20.4	4-11	Poor	-	-
2246-242	Sebacic acid	25.0	4-11	Poor	-	-

Only one zinc salt (2258-13) was found to be comparable to zinc stearate in sanding and film properties imparted to 19380; the heat age stability appeared slightly superior to zinc stearate. However, this material is the zinc salt of C-16 to C-22 acids; and because its composition and properties are so close to zinc stearate, only limited consideration was given to it. Zinc laurate (2205-224) offered good sanding quality but it proved to be more soluble than zinc stearate. The dissolved zinc laurate impaired sanding but did not appear to affect adhesion and toughness.

As a check on the preparation of the zinc salts listed in Table I, a laboratory batch of zinc stearate (2258-38) was evaluated. While it was not identical to G-601 in all respects, the two soaps imparted very similar properties to 19380 Sealer in respect to processing, film properties and stability. These results imply that the general method used in preparing these materials was satisfactory.

Aluminum Soaps

Aluminum palmitate and aluminum sebacate were evaluated as sanding aids. Neither material imparted desirable sanding properties.

(b) Organic Materials

Stearamides

Methylene distearamide and methylol stearamide were evaluated as sanding aids. The latter was found to be of greater interest. At a concentration of 4% on the sealer solids it imparted fair sanding quality with film properties equal to standard. Initial accelerated aging tests at 125°F. for three days showed excellent stability with little or no degradation of film properties. However, aging tests at room temperature over a period of several months revealed that the methylol stearamide slowly dissolves resulting in poor sanding, but without impairing adhesion and toughness.

The following were evaluated as sanding aids and rejected because they were poor lubricants:

MP-1637 Stearamidomethyl acetate
MP-1638 Mono-octadecyl urea
MPD-1639 Di-octadecyl urea
MPD-1640 N-octadecyl carbamate
MPD-1675 Di-octadecyl carbonate

Polythene

Fine dispersions of polythene in finishes are known to impart slip to the surface of the film. This lubricating feature was thoroughly investigated as a basis for the development as a sealer sanding aid. It was established that polythene will impart ease of sanding about equal to zinc stearate, but with more clogging and less flouring. Stability and settling properties were excellent. Unfortunately, at the maximum level of polythene affording good topcoat adhesion, sanding is unsatisfactory.

Low Molecular Weight Polythene KG-3411

KG-3411 was dissolved in an equal weight of xylol (H-583) at 120°C. On cooling, the gel formed was ground in isopropyl alcohol (H-69). The resulting mill base (J-MB-X-8077) with 25% solids was of paste-like consistency. Sanding improved up to a level of 2.5% KG-3411 on the sealer solids where it was still inferior to standard 19380. At this level intercoat adhesion was comparable or slightly inferior to standard. Clarity of the polythene sealer was superior to 19380.

Polythene 6641-93

Polythene 6641-93 made at the Experimental Station, as an aqueous dispersion with an azo catalyst and having a particle size of 0.5 - 3.9 microns, was evaluated. This polymer is soluble hot, in the usual solvents and fuses at 120°C. Polythene 6641-93 was dissolved in xylol at 130°C. and rapidly cooled with constant agitation to a gel which was subsequently ground overnight in a ball mill. The resulting grind was coarse and poor in respect to dispersion. We did not succeed in dispersing Polythene 6641-93 satisfactorily.

0 - 2.0% of 6641-93 was added to 19380 Clear. The results were of limited interest since the poorly dispersed polythene gave a rough sealer.

Polythene 6641-165

Polythene 6641-165 was prepared at the Experimental Station with a persulfate catalyst and at a particle size of approximately 0.3 microns. This polymer is insoluble and does not fuse below 250°C. 0-2.0% polythene 6641-165 was tested in sealer films. The sealer with 1.3% polythene, compared with standard, had better starting and greater ease of sanding but was inferior in flouring and clogged the sandpaper. Topcoat adhesion was comparable or better than standard. On heat aging, this polythene sealer maintained a superiority in adhesion and film properties.

Polythene 6623-102

Polythene 6623-102 received from the Experimental Station was ground to a smooth mill base in butyl acetate (H-6). The solids content was 22.7% polythene and 9% processed linseed oil (H-141). A range of 1.5 - 8.0% polythene on the sealer solids was tested.

At 4% polythene 6623-102, adhesion was comparable to standard. At this level there was good ease of sanding but some clogging and very poor flouring. Polythene 6623-102 was submitted as an equivalent to 6641-165. However, with the latter, better sanding and comparable adhesion were obtained at the 8% level.

Polythene From the Polychemicals Department

Four samples of polythene were obtained from the Arlington Laboratory of the Polychemicals Department.

Code	Melting Point C.	Grade No. *
D-55	115	112
S-879	115	13.4
S-882	130	2.4
D-15	110	0.3

*Grams extruded in 10 minutes at 190°C. through a standard orifice.

These materials were supplied in a particle size too coarse to be ground for use as a sanding aid. D-55 was dispersed by cooling a solution in hot xylol and grinding to a mill base of 8-10% solids.

Properties of the sealer were about equal to those obtained with other polythenes such as KG-3411 when treated in a similar manner.

Difficulty was encountered in making dispersions of these four polythenes fine enough in particle size to be usable in sealers, both from the point of view of appearance and sanding. The first grind of D-55 required 80 hours for reduction to the necessary particle size. The other three polythenes, even on prolonged grinding, were too coarse for use in sealers.

To produce finer particles various grinding media were tried, such as, heavy petroleum naphtha (H-200), butyl acetate, methyl isobutyl ketone, blown castor oil, processed linseed oil, perchloroethylene, xylol and toluene. This approach did not give the desired reduction of particle size.

The Banbury mixer was investigated as a means of producing fine particle size polythene. The dispersed polythene was much too coarse to be usable.

Another approach was to try more rapid cooling of dilute polythene solutions. Concentrations were reduced from a range of 25-50% to about 15%. Very rapid cooling was obtained by shock cooling the hot polythene solution in a dry ice-kerosene bath with rapid mechanical agitation. Extremely rapid precipitation was obtained by the addition of a second portion of cold solvent just as the first polythene particles appeared. By pretreating D-55 in this manner it was possible to disperse it by overnight grinding to yield a satisfactory particle size. S-882, S-879 and D-15 did not respond satisfactorily to this treatment.

Polythene Dispersion Without Grinding

Still another approach to the problem of polythene dispersion was the rapid cooling of very dilute solutions, 1.0 - 1.5% in toluene (R-47), and direct incorporation into the sealer without grinding. The resulting dispersions were inferior as judged by pours on glass. However, it was found that spraying greatly improved the degree of dispersion, producing much smoother films. It was also established that a colloid mill (Disper Mill) would effect good dispersions in the sealer, of shock cooled polythene. KG-3411 and S-879 yielded the finest dispersions and D-55 and D-15 the coarsest. In general, sanding and adhesion of these sealers showed no great variations. KG-3411 seemed slightly better in sanding and slightly poorer in adhesion, while D-15 seemed slightly inferior in sanding and superior in adhesion. It is possible that these differences may be related to particle size and degree of dispersion. These results indicated that the polythenes imparted similar properties as sanding aids and that particle size, dispersion, as well as proportions were of great importance. No improvement in the sanding - adhesion balence of properties was obtained with this method of dispersion.

Polythene in 19155

To cross check the vehicle of 19380 as a testing medium for polythene sanding aids, 0.7 - 6.7% KG-3411 was evaluated in 19155 Clear Sealer. Polythene KG-3411 imparted good ease of sanding, but this was accompanied by clogging and poor flouring at the low proportions necessary for good topcoat adhesion.

These results roughly paralleled those obtained with 19380 Clear. However, since 19380 was the superior sealer, it was deemed advisable to test polythene in the better medium to avoid any masking effect of the poorer properties of 19155.

Polythene with Zinc Stearate

The partial replacement of zinc stearate with polythene in 19380 was thoroughly investigated. Results showed that not enough zinc stearate could be replaced to improve stability without impairing sanding properties to an unacceptable degree.

Ethylene Polysulfone

A sample of ethylene polysulfone GC-2-161 was obtained from Dr. I.L. Haag of the Grasselli Chemicals Department, Cleveland, Ohio Laboratory. This material was ground with solvents in a ball mill, and the resulting mill base was added to 19380 Clear. Proportions ranging from 2-10% of the sealer solids were evaluated. Ethylene polysulfone did not offer the ease of sanding of polythene. It clogged badly and was low in flouring. Topcoat adhesion was much less adversely affected by ethylene polysulfone than by polythene when used on a pound for pound basis in 19380 Clear.

A sample of ethylene polysulfone CDNB-6516-8 was obtained from Dr. A.B. Ness of the Experimental Station. This was tested in comparison with GC-2-161. Dispersion of CDNB-6516-8 was better, and consequently the sealer film clarity was also better. It was slightly superior in sanding and about equal in adhesion.

Lanolin

Anhydrous lanolin (USP Adeps Lanae) was added to 19380 Clear Sealer in proportions of 2.5-20% of the film solids. At the 10% level, sanding was almost equal to standard with more slip but less flouring. The film was slightly softer than standard, but topcoat adhesion was satisfactory. In the aged finish, the lanolin appears to exude somewhat through the topcoat. Heat age stability was good except for more pronounced exudation.

Polymerized RC-800

RC-800 is the monomer, tetraethylene glycol dimethacrylate. It was thought that by tumbling or grinding, a solution of the monomer might polymerize to fine particles rather than a solid cake. Tumbling would offer continuous agitation; while a ball mill would offer in addition a grinding action during polymerization. Tumbling did not convert 5, 10 or 25% solutions in three days, and this method was not further considered. Fourteen grinds were run with varied proportions of RC-800 and solvents, catalyst, and processed linseed oil (H-141) as a dispersing agent. Difficulty was encountered due to the fact that the concentration of RC-800 necessary to convert resulted in rather immobile mixtures and ineffective grinding. Seventeen percent was found to be the minimum level for conversion. This level (2246-52-0) was selected for further study.

2246-52-0

RC-800	100
HB-6	315
H-12	81
H-69	54
Cobalt Nitrate	4
Benzoin	4
H-141	24
	582

After polymerization, consistency was reduced for further grinding by addition of 25 grams of the solvents and 25 grams of H-141. The grinding effected gradual improvement up to 34 hours. The mill base 52-0 and 19380 clear were combined in several proportions.

Fine particle size polymerized RC-800 offered some ease of sanding along the line of friability, but it was very harsh and hard with none of the smooth slip and bite of a good sanding aid. The clogging incurred was undesirable, and the flouring was extremely poor.

(c) Inorganic Materials

"Santocel" C

"Santocel" C is a fine particle silica marketedby the Monsanto Chemical Co. as a flatting agent. Its possibilities as a sanding aid were investigated. "Santocel" C ground in solvents and added to 19380 Clear tended to disperse poorly. Addition of plasticizer to the grind gave a satisfactory dispersion.

"Santocel" C in 19380 Clear did not adversely affect viscosity and settled to a soft thick layer which redispersed readily. As a sanding aid "Santocel" C was not comparable to zinc stearate and was of little value. From 0.6 - 7.8% "Santocel" C in the sealer film gave optimum results, whereas 10-12% adversely affected film properties. Low levels of "Santocel" C afforded improved adhesion to topcoats. Heat age stability of "Santocel" C was excellent.

"Santocel" C and Polythene

It was considered that the poor sanding but good adhesion imparted by "Santocel" C might be improved or balanced by the better sanding but inferior adhesion imparted by polythene. Varying proportions of "Santocel" C and polythenes 6641-165 and KG-3411 respectively, were evaluated in 19380 Clear. The sanding properties of the straight polythene sealer were degraded by the addition of "Santocel" C without any corresponding improvement in adhesion. Heat age stability was good.

"Santocel" C - Polythene - Zinc Stearate

Unsuccessful attempts were made to blend "Santocel" C, polythene and zinc stearate to achieve a balance of good sanding, good stability, and satisfactory adhesion.

Lanolin and "Santocel" C

It was considered that lanolin might be combined with "Santocel" C to advantage as a sanding aid. Although a fairly high degree of ease of sanding was attainable, clogging of the sandpaper and reduced flouring were encountered. Topcoat adhesion was satisfactory. Package stability was superior to 19380. However, as previously mentioned, lanolin tends to exude from the dried film upon aging.

Calcium Silicate

Lepisil, a grade of calcium silicate obtained from the Owens-Illinois Glass Company, was evaluated as sanding aid in 19380 and 16020. While calcium silicate did impart ease of sanding, this was inferior to zinc stearate (7 vs. 10). Two percent calcium silicate was considered the optimum proportion, since more than this did not improve sanding and tended to impair film clarity, toughness and adhesion.

Calcium silicate in 19380 Clear settled rapidly to a solid, pasty layer which was difficult to redisperse. One percent of Nylon (Type 8A1-DV-80) on the calcium silicate was added to the mill base. It was hoped that the Nylon would aid in the suspension of the calcium silicate. The addition of Nylon did not reduce the hard settling.

Calcium Silicate-Polythene

Combinations of calcium silicate and polythene (KG-3411) were evaluated. As the proportion of calcium silicate increased, sanding quality was reduced and adhesion improved. No worthwhile balance of properties could be attained with these materials.

Talc W-132

W-132 is a hydrated magnesium silicate of tabular structure. This talc was ground with thinner in a ball mill for forty hours. The resulting mill base was added in varying proportions to 19380 Clear.

The experimental sealers in pours on glass were coarse, showing poor dispersion; but spraying produced smooth films. Microscopic examination showed a good distribution of small particles with some scattered larger particles or agglomerates. Talc imparts good ease of sanding but with a harsh feel and rasping sound rather than soft and essentially noiseless sanding with zinc stearate. There was a slight tendency to clog, and flouring

was extremely poor. Sanding did not improve much with increased proportions of talc. Film properties and adhesion were satisfactory and superior to 19380 in complete test finishing systems. Talc reduced film clarity to an undesirable degree.

Micronized Asbestine

Micronized asbestine was ground with thinner in a ball mill. Quantities of 2 to 10% were added to 19380 Clear on a solids basis. Dispersion was good, but hard settling was encountered. Micronized asbestine gives fairly good ease of sanding but with excessive clogging and low flouring. Adhesion of topcoats is not seriously impaired. Clarity is reduced, especially at the higher levels of micronized asbestine.

Polymer K

Polymer K (hydrated nickelous oxide) was evaluated as a sanding aid. A pulp process pigment dispersion of Polymer K was used to replace MB-167, zinc stearate in 19380 Sealer. Proportions of 5 and 10% on the sealer solids were tested for sanding properties. These tests showed no indication that Polymer K is of any value as a sanding aid.

(d) Miscellaneous

In our search for ways and means to obtain ease of sanding, without zinc stearate or with reduced amounts of the latter, the brittleness or friability of the dried sealer film was varied over a reasonably wide range. For example, nitrocellulose of different viscosities, the introduction of a brittle gum and a change in type and amount of plasticizer were studied. These and other studies added to the evidence that friability per se does not produce good sanding properties. A lubricant of some type is required.

Nitrocellulose Viscosity

To investigate the effect of nitrocellulose viscosity on sealers, 19380 was made with 10-15 ops., 1/8", 1/4", 4-6", and 40-60" grades respectively. Standard 19380 is formulated with a 1/8 - 1/4" blend of nitrocellulose. In all cases zinc stearate was required for good sanding properties. All the sealers exhibited comparable sanding properties. Although the 1/8" and 1/4" grades were somewhat superior in package stability, in no case was the stability afforded zinc stearate outstandingly superior. No basis for altering the nitrocellulose viscosity in 19380 was established.

Ester Gum

In an attempt to improve sanding, 10% and 20% of the nitrocellulose in 19380 Sealer were replaced with ester gum (G-608). The resulting sealers were tested with zinc stearate and polythene-zinc stearate, as sanding aids. The substitution of ester gum slightly reduced ease of sanding and increased clogging with either sanding aid. The ester gum impairs film properties in the complete finishing system as measured by coin and knife tests.

Triphenyl Phosphate

Triphenyl phosphate (G-628) was evaluated as a plasticizer in place of blown linseed oil (H-141) in 19380. Various proportions of this plasticizer and nitrocellulose were tried, yielding a range of films from very brittle to overplasticized. Sanding was poor with rolling and clogging in the absence of zinc stearate.

4. Zinc Stearate Stability in 19380 Sealer

Since the replacement of zinc stearate did not appear possible without unacceptable sacrifices especially in sanding properties, several avenues of minimizing the deficiencies of zinc stearate were investigated. It was decided first to make a study of the instability of zinc stearate in 19380 Sealer to determine what happens on aging and why.

Study of 19380 Stability

When 19380 ages the main stability factor of interest is the impairment of adhesion and toughness in a finishing system as measured by coin and knife tests. For the purposes of this investigation, changes in the following were considered:

1. Appearance
2. Viscosity
3. Acid Value
4. Dissolved Zinc Stearate
5. Drying
6. Film Properties
7. Wood Adhesion
8. Intercoat Adhesion

Water Content

The amount of water in 19380 Sealer was one of the first factors considered in regard to the stability of zinc stearate. The only material of standard quality that would yield more than a trace of water in 19380 is the nitrocellulose. This contributes about 0.5% to the sealer. The effect of 0-4% water was evaluated in 19380. Water decreased the viscosity of the lacquer but had little other effect. Anhydrous 19380 was found to offer no improvement in stability with zinc stearate.

Inorganic Acids

Another factor considered was acidity. Standard grades of nitrocellulose may be expected to introduce 0.01% acid to 19380. The effect of 0-0.1% acid (H_2SO_4 and HNO_3) was evaluated. Excess acid decreases the viscosity, increases the acid value, slows the drying, softens the film but does not affect adhesion to wood nor topcoat. Excess acid in the heat aged sealer appeared to increase zinc stearate solubility but not enough to account for the changes in adhesion to topcoats.

Excess of both acid and water reduced viscosity, slowed drying, and embrittled the film but did not impair adhesion.

Organic Acids

Addition of linseed oil fatty acids, to represent an increase of 5 and 10 in the acid number of the H-141, did not seem to affect the lacquer except to raise the acid value.

Extensive tests were run to determine what the effect of stearic acid would be from any possible hydrolysis of zinc stearate. If all the zinc stearate in 19380 hydrolyzed, there would be 1.17% free stearic acid in the lacquer. More than 0.2% stearic acid retarded drying and hardening of the sealer. The effect on adhesion was inconclusive. The main point learned from these tests was that more than a small amount of stearic acid would markedly slow up the dry of the sealer. Any amount less than this would not noticeably affect the film properties of the system.

Stearic acid was considered of less importance when an analysis of heat aged 19380 showed the presence of only minute amounts of stearic acid. Retarded drying was never observed with aged sealers.

Triethanolamine

A sample of 19385 Sealer, J-571052, several months old produced films that were soft and cheesy, imparting poor adhesion to topcoats. Addition of 1% triethanolamine made the film slightly softer and improved adhesion very slightly.

Analysis of 19380

19380 type sealers were prepared with 0, 2.75% and 5.5% zinc stearate mill base MB-167. The latter is the amount which was present in the standard formula. The sealers were aged for three days at room temperature, 110°F. and 140°F.

Analysis of the aged sealers showed that at room temperature 20% of the zinc stearate dissolved in 19380 (5.5% MB-167), 22% dissolved at 110°F., and 44% dissolved at 140°F. The sealers contained very little free stearic acid since the combined free fatty acids were generally of the order of 0.01% and not more than 0.03%.

At 110°F. the viscosities of the three sealers dropped 7 to 8" in No. 7 cup. At 140°F. the decreases in viscosity were 13", 19" and 22", increasing with the amount of mill base present. The higher temperature caused darkening of the sealers, yellowing of the films, and impairment of sanding.

With sealers aged at 110°F. the film properties of the finishing systems were unimpaired. With the sealers aged at 140°F. there was only slight degradation in the case of the clear but a pronounced impairment with the sealers containing zinc stearate.

It may be concluded that elevated temperatures causes a large increase in the zinc stearate dissolved in 19380. This apparently correlates with a decrease in viscosity, a darkening of color, and an impairment of film properties in the finishing system. Solution of the zinc stearate does not result in an increased free stearic acid content.

Zinc Stearate Solubility

Consideration of the analytical data suggested that the zinc stearate might dissolve directly or possibly through some intermediate reaction. To determine if possible the mechanisms whereby zinc stearate dissolved in the sealer vehicle, selected combinations of the ingredients in 19380 were heat aged three days at 125°F. and the remaining ingredients were subsequently added to complete the formula.

Formula Designation	Std.	Std.	A	B	C	D	E	F	G	H	I
Ingredients Heated		PX H-111 H-120 Solvents MB-167	PX Solvents MB-167	PX H-120 Solvents MB-167	PX H-111 Solvents MB-167	H-111 H-120 Solvents MB-167	H-120 Solvents MB-167	H-111 Solvents MB-167	H-120 MB-167	H-111 MB-167	Solvents MB-167
Ingredients Added After Heating	PX H-111 H-120 Solvent MB		H-111 H-120	H-111	H-120	PX	PX H-111	PX H-120	PX Solvent H-111	PX Solvent H-120	PX H-111 H-120
Color	Cream	Lt. Yellow	Lt. Yellow	Lt. Yellow	Lt. Yellow	Lt. Cream	Lt. Cream	Lt. Cream	Lt. Cream	Lt. Cream	Lt. Cream
No. 7 cup visc.	59"	50"	51"	50"	50"	61"	60"	61"	46"	53"	58"
Film	Good	Poor	Fair	Poor	Poor	Poor	Poor	V.Poor	Good	Good	V.Poor

The ingredients which were heated were subjected to 3 days at 125°F., before completing the formula as indicated. Each of the resulting sealers was compared with 19380 standard, heat aged and not heat aged, for film properties in a complete finishing system on walnut.

Conclusions:

A, B and C darkened and viscosity decreased similarly to standard. These were the only formulas where nitrocellulose was heated, and apparently this is a factor in these changes. However, film properties are not necessarily related to viscosity or color changes, since D, E, F and I showed that poor film properties may result even though color and viscosity remain unchanged. A to F and I were poor in film properties and in all these instances the solvents were heated; G and H were unimpaired in film properties and in these cases no solvents were heated. In I, only the zinc stearate and solvent were heat aged; and the resulting sealer exhibited by far the poorest film properties. This may have been due to the more concentrated solvent effect. E and G were repeated with check results on film properties but not on viscosity.

This work indicated that zinc stearate dissolves in and may possibly react with 19380 solvents.

With this evidence of the solubility of zinc stearate in 19380 solvents, further investigation was conducted to determine the effect of each of the lacquer solvents and diluents. Aliphatic and aromatic hydrocarbons were found to have the greatest solvency while the lower alcohols had the least. Higher alcohols, esters and ketones were intermediate in effect but closer to the lower alcohols.

As a basis for formulating sealer solvents with low solvency for zinc stearate, considerable study was made of the limited literature available on the subject. No direct information on zinc stearate was found, but data on related compounds such as stearic acid and other soaps were combed for leads.

The literature showed a decrease in solubility for the longer chain compounds and a rise in solubility with an increase in temperature. The metallic stearates vary in solubility, for example lithium stearate is reported more soluble than magnesium stearate. Hydrocarbons were scarcely mentioned, but one reference showed stearic acid to be twice as soluble in toluene as in ethyl acetate. Water in ethyl alcohol was shown to repress stearic acid solubility. Butyl and isopropyl alcohols were given as better solvents for stearic acid than ethyl alcohol.

Indications that methanol and nitromethane might be poor solvents for zinc stearate led to their evaluation in 19380 sealer. They were found to be about equal to ethyl alcohol in improving stability. Being toxic they were of little further interest. An attempt was made to determine the solubility of zinc stearate in common lacquer solvents and diluents at 20°C. and 50°C. The data were not considered very significant because petroleum naphtha (H-29) was shown to be less of a solvent than ethyl alcohol (H-1) and no lead toward improving 19380 solvents to reduce zinc stearate solubility was indicated.

Zinc Stearate Solubility in Plasticizers

It was considered possible that triglyceride esters might react with either dissolved or undissolved zinc stearate in sealers. Investigation was made to determine whether a sealer free of triglycerides would be more stable than 19380 containing nitrocellulose and blown castor oil. Sealers made with nitrocellulose and dibutyl phthalate were evaluated. Standard 19380 solvents and non-hydrocarbon solvents were included in the study.

This investigation did not indicate any marked superiority of dibutyl phthalate over blown castor oil in respect to sealer stability. However with conventional solvents there was a little evidence in favor of dibutyl phthalate. Where zinc stearate solubility was repressed with non-hydrocarbon solvents, there was no difference in favor of dibutyl phthalate.

Zinc Stearate and Water

Zinc stearate, acetone, and water 1:2:2 were mixed and the mixture was air dried with the anticipation that a maximum amount of water would be retained with the soap. However, the treated zinc stearate was no less stable than the untreated zinc stearate in 19380 stability tests.

Two and four per cent of water were added to zinc stearate mill base MB-167. This resulted in bodying which required a 50 to 75% addition of solvents to reduce to normal mill base consistency. These mill bases yielded very inferior film properties in 19380, although here the amount of water was only .1 and .2% on the film solids. Mill bases made with anhydrous and 95% ethyl alcohol yielded standard quality sealers. It was considered of interest that the 95% ethyl alcohol added 3.8% water to the grind, but this did not affect the sealer film properties.

Further work showed that 2% water added to an anhydrous ethyl alcohol mill base grind would not adversely affect adhesion and stability, while 2% added to a butyl acetate grind would greatly body the mill base and seriously impair the adhesion of the sealer even when fresh. This deleterious effect is similar to that of aging 19380 at ordinary or elevated temperatures. It suggests that hydrophilic alcohol can repress the effect of water on the zinc stearate, whereas other relatively hydrophobic solvents do not. This suggested the following:

Zinc stearate + water $\rightleftharpoons$ zinc hydroxide + stearic acid

Retention of water by alcohol would stabilize the zinc stearate.

Analysis of mill base samples showed that addition of 2% water to MB-167 increased the dissolved solids from .6% to only 1.1% of the total solids. This corresponds to an increase of .04% to .07% of the sealer film solids. Additional tests indicated this figure to be under .1%. Since the dissolved matter was so small and mostly stearic acid, it was not believed to account for the poor adhesion under discussion.

Study of all the evidence available indicates that the effect of water in bodying the mill bases, where subsequent impairment of the sealer is involved, is mainly a physical, surface enomena. The zinc stearate does not appear to react or dissolve in the mill base, although this may happen subsequently in the sealer.

Small amounts of water added to the complete sealer do not have the same deleterious effect as when added to MB-167. This water is probably held by the lacquer solvents and thus does not promote solution of the zinc stearate. The improvement in stability obtained by the substitution of alcohol for hydrocarbons suggests some relationship which bears some further investigation.

Coating Zinc Stearate

An investigation was made of the possibility of coating zinc stearate particles with an insolubilizing substance that would not impair sanding.

Four MB-167 grinds were prepared with additions of:

(a) 1% of a 10% solution of polyvinyl alcohol 70-05 in water.
(b) 0.8% of G-650 ureaformaldehyde
(c) 4.7% of a 10% solution of Vinylite VYLF in methyl ethyl ketone.
(d) 4.7% of a 10% solution of Vinylite VMCH in methyl ethyl ketone.

Sealers made with these mill bases sanded comparably to 19380, but no improvement in stability on aging could be demonstrated.

Zinc stearate was mixed with 2, 5, 10, 25, 50, 100 and 200% of RC-800 dissolved in acetone. Four percent each of cobalt nitrate and benzoin based on the RC-800 were added as a catalyst. These batches were treated as follows. Excess solution was drained off, and the mixture was baked overnight at 130°F. to polymerize the RC-800. The resulting cake was ground in a ball mill with MB-167 type solvents for several hours to a satisfactory degree of dispersion. Experimental sealers were prepared with these respective mill bases and with MB-167 for comparison. The sealers were all aged three days at room temperature and at 130°F.

The treatment of zinc stearate with polymerized RC-800 slightly impairs its properties as a sanding aid due to the coarser particle size produced. The treated sanding aids showed no improvement in stability, although one or two sealers showed improved adhesion attributable to the larger particle size.

Attempts were made to coat zinc stearate particles with polymerized ureaformaldehyde to improve stability in sealers. Zinc stearate was mixed with 20, 50 and 100% of RC-721 and 10% of C-174 catalyst based on the RC-721. These batches were treated in a manner analogous to RC-800 described above and the results were very similar.

The coating experiments may have been negative for the following reasons:

1. Polymerization may not have been complete.
2. The polymers may not have enveloped the zinc stearate particles.
3. The coatings may have been abraded off in grinding.
4. The coated particles may have been reduced in size on grinding.
5. The coating may have dissolved in the solvents.

Any possible further work should be prefaced by a careful study of the surface adsorption characteristics of zinc stearate. Zinc stearate might be stabilized by the chemical or physical bonding to some additive. However this may be accompanied by impaired sanding properties.

Alcohol Sealers

Replacement of the hydrocarbons in 19380 by ethyl alcohol resulted in improved package stability. The solvents were formulated to increase the alcohol content to a maximum and minimize larger solvent molecules by use of only enough ethyl acetate (H-136) to dissolve the nitrocellulose. A further reduction in active solvents was attempted through the use of alcohol soluble nitrocellulose (SSPX). This was unsatisfactory because of excessive blushing due to the greater water content in the SSPX and to its greater sensitivity to water.

The ethyl acetate, ethyl alcohol (H-136/H-1) formulations while offering improved stability had the related, bad features of poor sanding (rough film) and blushing, due to rapid evaporation rates.

The effect on stability of higher boiling alcohols, esters, and ketones was determined. Those found nearly as good as ethyl alcohol and ethyl acetate were butyl alcohol (H-12), methyl isobutyl carbinol (H-48), butyl acetate (H-6), amyl acetate (H-80), methyl ethyl ketone (H-35), and methyl isobutyl ketone (H-44).

It was found that excessive temporary blushing could not be eliminated in a high alcohol content sealer, but that the resistance to permanent blushing may be maintained by large proportions of high boiling solvents or the use of a retarder, (a low proportion of a very high boiler). Formulas 2266-254-X and 2265-254-H are examples of sealers with excessive temporary blush but permanent blush equal to 19380.

2266-253-X		2266-254-H	
PX-7555	11.7	PX-7555	11.7
PX-7600		PX-7600	
H-75-d	5.0	H-75-d	5.0
H-44	34.0	H-44	24.0
H-48	6.0	H-79	3.0
H-1	30.8	H-1	43.8
H-120	5.9	H-120	5.9
HE-111	1.1	H-111	1.1
MB-167	5.5	MB-167	5.5
	100.0%		100.0%

2265-254-H was set up as formula J-19000-X-10533 and recommended for field testing in Parlin Laboratory Release Letter No. 421. This sealer is considered to offer about a 60% improvement in stability over 19380. It also reduces the appearance of gray pores through a leaching effect on dye type stains. The cost per gallon is slightly higher than 19380.

5. Two Package Sealers

The stability of 19380 may be improved about 60% by packaging the hydrocarbon diluent separately, to be added to the sealer at the time of application. This type is recommended under the codes J-19000-X-10532 and J-3800-X-10535 in Parlin Laboratory Release Letter 421. No differences in ingredient cost compared to 19380 are involved.

The instability of 19380 may be completely eliminated by packaging the zinc stearate mill base separtely, to be added to the clear sealer at time of application. This sealer is recommended as J-19000-X-10531 and J-MB-X-10534 in Parlin Laboratory Release Letter No. 421.

6. Zinc Stearate as an External Sanding Aid

Study of the background of data developed in this project led to the theory that the main purpose of a sanding aid is to act as a lubricant and prevent clogging of the sandpaper by abraded particles of the sealer. This suggested the use of zinc stearate as a dry lubricant, preferably applied as a spray coating of MB-167 on the sandpaper.

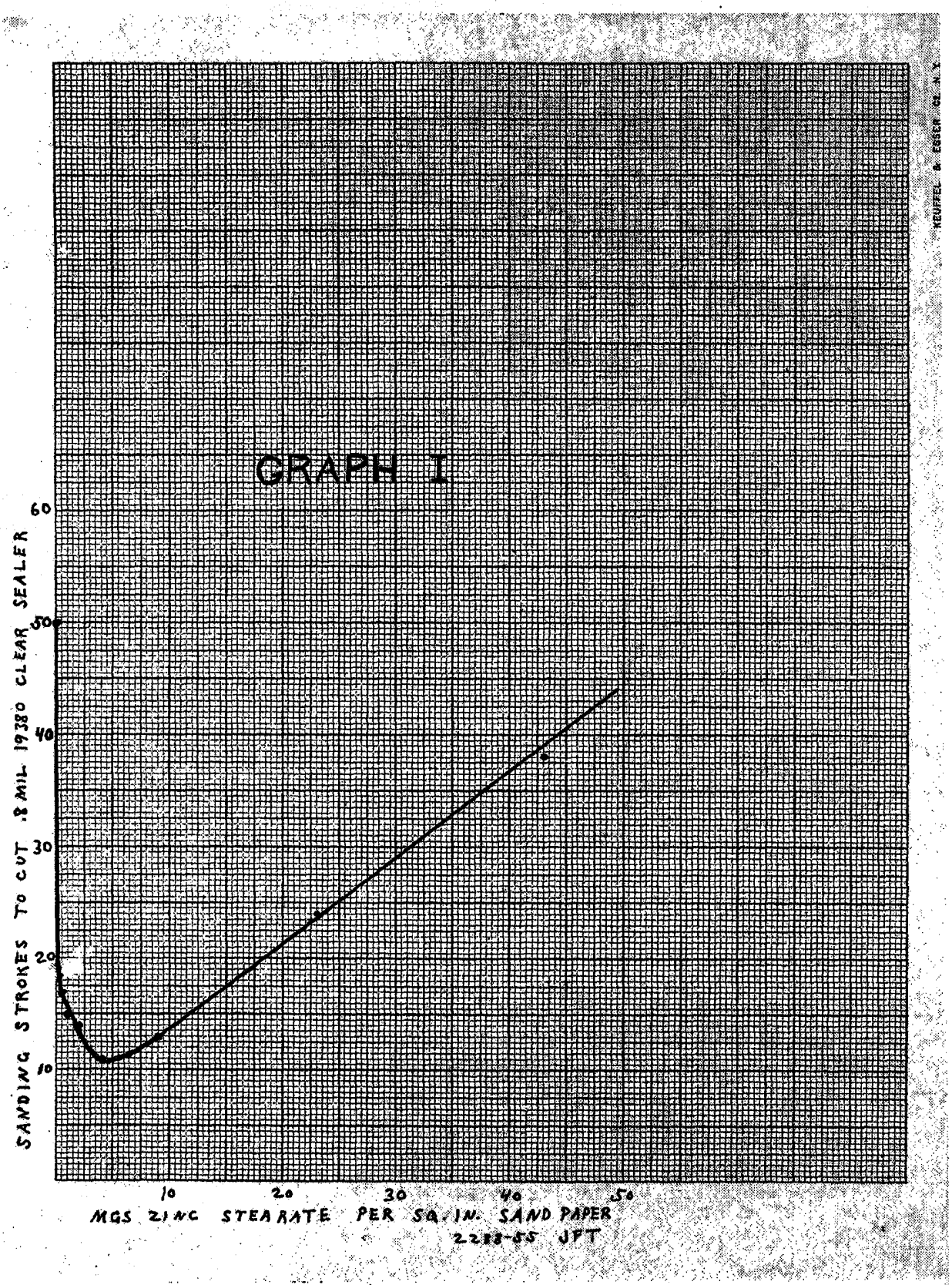
It was shown that a characteristic curve exists for certain sealer films when sanding rate is plotted against zinc stearate coating weight on the sandpaper. A conventional lacquer sealer without sanding aid sands with difficulty, causing rolling and clogging of ordinary untreated sandpaper. With, for example, 19380 Clear, the rate of abrasion can be greatly increased with a very light coating of zinc stearate on the sandpaper. Further improvement in sanding quality, including rate of abrasion, can be effected by adjusting the stearate coating to an optimum weight per unit area of sandpaper. Zinc stearate in excess of the optimum range promotes easier sanding but reduces the rate of abrasion (See Graph I).

It appears that as the abrasive becomes coarser, the curve is displaced and becomes flatter, reflecting the greater cutting power of the coarser abrasive and the diminished effect of excess zinc stearate on rate of abrasion.

An automotive primer-surfacer is an example of a pigmented finish formulated for ease of sanding. Zinc stearate coated on sandpaper makes no improvement in abrasion rate since the finish does not roll or clog in sanding. However, a test on a red "Duco" showed that a pigmented lacquer with poor sanding characteristics exhibits the same relation of sandability to zinc stearate coated sandpaper as the 19380 Clear. It was also established that abrasives of silicon carbide, aluminum oxide, and flint yield to similar improvement in sanding efficiency by coating with zinc stearate.

In the comparison of uncoated sandpaper on 19380 and coated sandpaper on 19380 Clear, the latter method offers much greater ease of sanding with a corrpsponding decrease in abrasion rate of 30-50%. The total work expended is estimated to be the same by either method. With very short drying cycles of less than thirty minutes, the coated sandpaper shows less clogging and a more favorable rate of abrasion than uncoated sandpaper on standard 19380.

The following salts of stearic acid were tested as sanding aid coatings on sandpaper; aluminum, barium, calcium, lead, magnesium, strontium, and zinc. Two grades of polythene, methylene distearamide, and methylol stearamide were also tested. All of these compounds imparted improved sanding quality, but none excelled zinc stearate. Stearamide and paraffin imparted ease of sanding but with excessive clogging.



Some work was done investigating the coating of abrasives by chemical reaction. A coating might either polymerize on or react with an abrasive to form a chemical bond. Such materials as dimethyl dichlorosilane, octadecytrichlorosilane, (silicones), and butyl titanate offered little or no improvement in sanding quality.

The great advantage of the new technique of coating abrasives is of course that it provides excellent sanding while keeping the sanding aid out of the finish. No degradation of the finish by the presence of a sanding aid can occur. The sealer stability problem is also completely eliminated. This innovation should be thoroughly investigated for possible exploitation in industry.

JFT:MCN

APPENDIX

Sealer 19380 (10-11-46)

First Portion	
H-47	4.9%
HB-6	7.1
PX-7700(17" in 5015)	9.8
H-1-d	5.3
Second Portion	
HA-136	6.6
3224	3.0
H-69	10.0
H-47	34.3
H-202	3.0
H-141	10.5
MB-167	5.5
	100.0%

Wt/gal: 7.60 lbs. @ 25°C.
Visc: 55-65" 7 cup @ 25°C.
Color - Light
Reduction - None

Solids		Ratio
PX	9.8	10.0
H-141(solid)	8.9	9.1
G-601	1.4	1.4
	20.0%	

Sealer 19155 (1-8-47)

First Portion		
H-47		4.5%
HB-6		9.1
PXC-431	)4" in	10.5
PX-7400	)5012	
H-75-d		4.5
G-608		10.7
Second Portion		
H-35		12.1
3224		4.1
H-47		28.8
H-125		1.7
MB-167		14.0
		100.0%

Wt/gal: 7.67 lbs. @ 25°C.
Visc: 85-105" 10 cup @ 25°C.
Color - Medium
Reduction - 30%

Solids		Ratio
PX	10.5	10.0
G-608	10.7	10.2
H-125	1.7	1.6
G-601	3.3	3.2
	26.2%	

Zinc Stearate Mill Base MB-167 (10-27-47)

M1.6	45.3%	
E-69	7.4	Grind
E-12	11.1	
G-601	23.6	
HB-6	8.6	
H-69	1.5	
H-12	2.5	
	100.0%	

Wt/gal: 7.49 lbs. @ 25°C.

Solids

G-601	23.6%

Mill Grind Data

Mill: PL
Wt/gal: (Gr.) 7.55 lbs.
Ratio: 60/70/75.2
Cycle: Grind 2 hrs. and pull

J-19000-X-10531 "DUCO" SEALER

First Portion	
H-47	5.3%
HB-6	7.7
PX-7600)20"	12.4
PX-7610)5015	
H-1-d	5.3
Second Portion	
HB-6	9.1
HA-136	7.2
H-12	10.4
H-224	.8
H-47	12.7
H-29	11.1
H-1	10.6
H-120	6.2
HE-111	1.2
	100.0%

Wt/gal: 7.47 lbs. @ 25°C.

Visc: 60-70" 7 cup 25°C.

Filt: F & N

Color: Light

Reduction: 51 to 3 of J-MB-X-10534 by volume.

Type: 19380

Solids		Ratio
PX	12.4%	10.0
H-120	6.2	5.0
HE-111	1.2	1.0
Theo:	19.8%	
Anal:	19.5%	

ICC Class: Liquid
Flash Point: 20-80°F.

For information re Perlin Lab. Release Letter No. 421

Alcohol Usage Code No.011

PATENT MARKING: NONE

* * * * * * * * * * * *

J-MB-X-10534 SEALER SANDING AID

MB-167 100.0%

Wt/gal: 7.49 lbs. @ 25°C.

ICC Class: Liquid
Flash Point: 20-80°F.

PATENT MARKING: NONE

For information re Parlin Lab. Release Letter No. 421

J-19000-X-10532 "DUCO" SEALER

First Portion	
H-1	6.9%
HB-6	10.0
PX-7600)21"	16.2
PX-7610)5015	
H-1-d	6.9
Second Portion	
HB-6	11.9
HA-136	9.4
H-12	13.5
H-224	1.1
H-1	6.9
H-120	8.1
HE-111	1.5
MB-167	7.6
	100.0%

Wt/gal: 7.81 lbs. @ 25°C.
Visc: 60-70" 10 cup 25°C.
Filt: 100 mesh wire
Color: Light

Reduction: 44% of J-3800-X-10535 by volume

Type: 19380

Solids		Ratio
PX	16.2%	10.0
H-120	8.1	5.0
HE-111	1.5	.9
G-601	1.8	1.1
Theo:	27.6%	
Anal:	27.2%	

ICC Class: Liquid
Flash Point: 20-80°F.

For Information re Parlin Lab.
Release Letter No. 421

Alcohol Usage Code No. 011

PATENT MARKING: NONE

* * * * * * * * * * *

J-19000-X-10535 THINNER

H-47	61.8%
H-29	38.2
	100.0%

Wt/gal: 6.70 lbs. @ 25°C.

ICC Class: Liquid
Flash Point: 20-80°F.

For information re Parlin Lab.
Release Letter No. 421

PATENT MARKING: NONE

J-19000-X-10533 "DUCO" SEALER

First Portion	
H-1	5.0%
H-41	7.2
PX-7600)23"	11.7
PX-7610)5015	
H-1-8	5.0
Second Portion	
H-44	16.8
H-79	3.0
H-1	38.8
H-120	5.9
H-111	1.1
MB-167	5.5
	100.0%

Wt/gal: 7.32 lbs. @ 25°C.
Visc: 65-75" 7 cup 25°C.
Filt: Centrifuge
Color: Light
Reduction: None
Type: 19380

Solids		Ratio
PX	11.7%	10.0
H-120	5.9	5.1
HE-111	1.1	.9
G-601	1.3	1.1
Theo:	20.0%	
Anal:	19.7%	

ICC Class: Liquid
Flash Point: 20-80°F.

Alcohol Usage Code No.011

For Information re Parlin Laboratory Release Letter No. 421.

JFT:MCN

Raw Material Codes

H-1	23A Specially Denatured Alcohol
H-1-d	2-BDA/7% water, ethyl alcohol of dehydration
HB-6	Butyl Acetate (90%)
H-12	Butyl alcohol
H-29	Petroleum naphtha (88°-142°C and A.P. = 55°C)
H-35	Methyl ethyl ketone
H-44	Methyl isobutyl ketone
H-47	Toluene
H-69	Anhydrous isopropyl alcohol
H-75-d	Isopropyl alcohol (95%)
H-111	Dibutyl phthalate
H-120	Pale Blown Castor Oil
H-125	Butyl Stearate
H-136	Ethyl Acetate
H-141	Blown linseed lacquer oil
H-202	Hydrocarbon (130-190°C. and A.P. 2°C)
H-224	Butyl Cellosolve
G-601	Zinc Stearate
G-608	Ester Gum

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FABRICS AND FINISHES DEPARTMENT

CHEMICAL DIVISION

PARLIN LABORATORY

CLASS A-II(a) RESEARCH REPORT NO. 990

PROJECT NO. J-2023

SUBJECT: EVALUATION OF BCM (RC-800) AS A FINISH INGREDIENT

DATE ISSUED: June 15, 1950

PERIOD COVERED: JUNE 8, 1948 TO APRIL 4, 1949

PREVIOUS REPORTS ON SAME SUBJECT: PARLIN LAB. REPORT NO. 933 BY MESSRS. O.L. HARGIS AND W.K. MOFFETT

NOTEBOOK NOS. 2201, 2261, 2278 AND 2303

PREPARED BY: C.G. MURPHY
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C.J. Welz

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PARLIN LABORATORY REPORT NO. 990

PROJECT NO. J-2023

SUBJECT: EVALUATION OF BCM (RC-800) AS A FINISH INGREDIENT

I. Introduction

This report covers the work done intermittently from June 8, 1948 to date on the subject project. Previous work had indicated that furniture finishes with very attractive properties can be formulated with RC-800, modified with nitrocellulose and an alkyd resin. Based on the results of previous work three compositions at three levels of RC-800 appeared worthy of further study; viz., ratios of RC-800/nitrocellulose/alkyd resin of 55/35/10, 45/45/10 and 35/55/10.

II. Objectives

Three main objectives have guided the direction of the work as covered in this report. They are:

1. To critically study the three compositions mentioned above, with a view to ultimately offering for field test, a furniture topcoat finish based on the preferred ratio of these ingredients over a suitable undercoat system. This involved a study of not only the physical and chemical properties of the RC-800 containing topcoats but also of each component in the finishing system, from the wood up, through stain, wash coat, filler, sealer, shading lacquer and/or glaze to the topcoat; establishment of methods of application, processing, drying times and baking temperatures, as well as, catalyst/inhibitor ratios to give the maximum shelf life consistent with the lowest possible conversion temperature.

2. To evaluate modifiers for RC-800, other than those mentioned above, with a view to obtaining a more flexible and possibly a more thermoplastic film, at a lower cost. This involved a study of other film formers in place of nitrocellulose and also of plasticizers other than alkyd resin. Considerable attention was given to the possibility of achieving internal plasticization by copolymerizing "in situ" of RC-800 with a mono-functional linear type monomer, such as the monomeric alkyl esters of acrylic and methacrylic acids and other similar materials.

3. To evaluate other thermosetting materials and any commercial finishes as they appeared on the market from time to time, which might be competitive with RC-800.

III. Summary and Conclusions

The results of our evaluation of RC-800/nitrocellulose/alkyd resin compositions may be summarized as follows:

At the 55% RC-800 level, maximum quality (i.e. hardness, heat and solvent resistance, toughness, etc.) is obtained, whereas at the 35% level, the reverse is true. On the other hand, RC-800 is an expensive ingredient and the more there is present, the higher the cost will be of any given composition. Consequently, a formula containing 45% RC-800 on the solids was selected for field testing, as representing a good compromise between cost and quality.

In a small scale field test at the Bassett Superior and Lane Companies, it was demonstrated that the application properties of the 45/45/10 = RC-800/NC/RL-255 formula are satisfactory for conveyorized furniture finishing. As anticipated, the man hours required for processing were from one and one-half to three times greater than that required for furniture "Duco" or "DULUX".

Besides high ingredient and processing costs, RC-800 formulas are accompanied by certain technical difficulties. However, before making additional expenditures to resolve the latter, it seems desirable to determine whether the furniture industry is sufficiently interested in RC-800 finishes to pay the extra money for the superior quality obtainable.

Relative to the other objectives, no plasticizer superior to the alkyd resin currently used was uncovered. Efforts to plasticize RC-800 internally were unsuccessful. Copolymerization with low molecular weight polyesters such as ethylene and propylene glycol maleate/adipates, resulted in incompatibility. The replacement of nitrocellulose with thickening agents (e.g. methyl methacrylate, ethyl cellulose, and polyvinyl butyral, respectively), which are soluble in cheaper solvents than esters and ketones, has not proven feasible to date because of compatibility limitations and the higher conversion temperature (180°F. versus 130°F) required.

Two materials which have appeared on the market, "Phenoplast" and Bakelite's XV-17911, are not likely to offer any serious immediate competition to RC-800 because of application difficulties and other limitations.

IV - Action Taken

Parlin Laboratory Release Letter No. 439 recommends a field testing program aimed specifically at determining whether the furniture industry is sufficiently interested in the improved quality obtainable with the RC-800 finish to accept the increased costs. Such a program has been arranged by Industrial Sales and is in the process of being carried out.

V - Patents

Patent 2,498,091 issued on February 21, 1950, in the name of W.K. Moffett and assigned to duPont, covers the formula it is proposed to field test, as per Parlin Laboratory Release Letter No. 439.

VI. Experimental

The experimental work undertaken to reach the three objectives listed in the introduction of this report, may be divided into the following two main sections for the purpose of this report:

(A) a study of the properties of the topcoat
(b) a study of the individual components of the undercoat system.

A. A Study of the Topcoats

In the study of the properties of the topcoats selected from the results of previous work, the following built-up system was employed:

Stain:	Luxol	- air dried 30 minutes
Wash Coat:	1366	- air dried 30 minutes
Filler:	27-5017	- air dried 4 hours
Sealer:	1366	- air dried 1 hour
Topcoat:	Air dried 1/2 hour, baked 2 hrs. @ 130°F.	

Application of the three initially selected basic topcoats over this undercoat system indicated the following:

(1) All showed varying degress of pinholing, depending upon the porosity of the piece of wood over which they were applied.

(2) The 35/55/10 and 45/45/10 formulations showed fairly good levelling and freedom from surface defects (other than pinholing). This was particularly true of the 35/55/10 composition.

(3) The 55/35/10 composition showed poor levelling and varying amounts of ridging and cratering.

Preliminary experiments showed the pinholing to be due to the porosity of the wood. A discussion of the experimental work to correct this defect, will be found later on in this report under the topic of undercoat system.

(1) Application

Early experiments to produce a flat RC-800 topcoat had indicated that Santocel "C" had a beneficial effect on the levelling of the RC-800 topcoat. Experiments were undertaken to follow up this lead and to overcome the surface defects occurring with the 55/35/10 formula. It was found that the incorporation of Santocel "C" up to 10% on the solids completely eliminated the ridging and cratering of this composition, and also tended to reduce the pinholing. It was also found that this was true regardless of whether the Santocel "C" was ground 15 hours in a laboratory crock or 144 hours. The

only effect of the longer grinding cycle was to increase the gloss (Reference: Notebook Pages 2201-140, 153, 166, 173, 181: 2261-40).

Other pigments and materials examined for this purpose were as follows:

(a) Aluminum Stearage (G-217): This soap also eliminated ridging and cratering but did not appear to have any effect on the degree of pinholing and did not yield as transparent a film as Santocel "C" (Reference: Notebook page 2201-157).

(b) Linde's Coated Silica #30: This pigment also tended to eliminate cratering and ridging but did not seem to have any effect on pinholing. The films also were somewhat gritty. It is believed that this could be overcome by better dispersion (Re: Notebook Page 2201-161).

(c) Blanc Fixe (W-30): No apparent effect on blistering, ridging or cratering was noted at the same pigment level as Santocel "C" but if the amount was increased to three times that of Santocel "C" on a volume basis, it too eliminated these surface defects (Re: Notebook pages 2201-166, 172).

(d) Silex Silica (W-31): Did not eliminate ridging and cratering when used on an equal weight basis with Santocel "C" (Re: Notebook Page 2201-166).

(e) Tamms' Gold Bond Silica: Did not eliminate surface defects when used on an equal weight basis with Santocel "C" (Re: Notebook Page 2201-166).

(f) RBH Dispersions' RV-62: Reduced pinholing and eliminated most surface defects on an equal weight basis with Santocel "C" but did not yield as good clarity (Re: Notebook Page 2201-183).

(g) Iron Hydroxide: Did not eliminate surface defects when used on an equal weight basis as Santocel "C" (Re: Notebook page 2201-188).

(h) Chromium Tetrahydroxide: Did not eliminate surface defects when used on an equal weight basis as Santocel "C" (Re: Notebook Page 2201-194).

From these results, it appeared that Santocel "C" was effective either because of its high bulking value and large surface area with adsorbed air or that it adsorbed something from the film which causes the ridging and cratering.

Experiments were therefore conducted in which Santocel "C", Blanc Fixe, Nuchar, a low absorbent silica GRS-440-52, micronized asbestine, Silex silica and Tamms' silica, were added

to the composition in excess, thoroughly mixed and then filtered out. The filtered compositions showed no improvement in ridging, cratering, etc. This indicated that the effect of Santocel "C" is probably that of a bulking value due to its large surface area.

Other materials examined as possible aids in eliminating surface defects which would still permit the formulation of a clear were: (1) calcium octoate and (2) G.E. Silicone S1069. Calcium Octoate inhibited the conversion while the G.E. Silicone S1069 had no beneficial effect on ridging and cratering. (Re: Notebook Pages 2261-92, 2276-4, 2261-84, 2276-62 and 2303-50, 54).

One additional experiment was conducted using an RC-800 syrup (Re: Notebook Page 2248-136) prepared at the writer's request by Mr. Claus Victorius in place of RC-800 monomer. While cratering and ridging of a 65/25/10 composition were not eliminated entirely they were decreased noticeably (Re: Notebook Page 2261-92).

Therefore, for the present, it was decided to confine future work to a clear at the 45/45/10 ratio and a flat containing 10% Santocel "C" on the solids at a 55/40/5 ratio.

(2) Plasticization

Both of these formulations show good resistance to cold checking. However, they were felt to be more brittle than is desirable and attempts were made to improve their flexibility by the use of (1) external plasticizers, and (2) internal plasticization through copolymerization. It was felt that the latter might also increase the thermoplasticity of the film and therefore reduce the labor needed in processing.

Earlier work in which a large number of plasticizers were evaluated had indicated that RL-255, a castor oil modified alkyd resin, was the most satisfactory plasticizer for RC-800/nitrocellulose. Most of our efforts were therefore confined to attempts at internal plasticization.

The following materials were examined:

(a) Butyl Cellosolve Methacrylate Monomer (BCMa)

(1) Castings made in an attempt to copolymerize RC-800 with BCMa showed only a slight flexibilizing action below 25% BCMa - above this percentage, cheesiness, rather than toughening, was apparent. The joint polymerization rate of BCMa/RC-800 decreased as the amount of RC-800 decreased.

(2) In films, only a slight plasticizing action could be noted, being more apparent with ethyl cellulose as the bodying agent than with nitrocellulose. (Re: Notebook Pages 2201-104, 196, 198, 200, 212, 226; 2261-28, 34).

(b) Normal Butyl Methacrylate Monomer (n-BMa):

(1) Castings made in an attempt to copolymerize n-BMa with RC-800 showed only a slight flexibilization, less than with BCMa and again cheesiness rather than toughness developed as the amount of n-BMa monomer was increased. The joint polymerization rate of n-BMa and RC-800 also decreased as the amount of n-BMa increased.

(2) Films showed only a slight plasticization (Re: Notebook Pages 2201-208, 224; 2261-38).

(c) Lauryl Methacrylate Monomer (LMa)

(1) Castings made in an attempt to copolymerize LMa with RC-800 showed only a slight flexibilizing action, less than with BCMa and again cheesiness rather than toughness developed when the LMa ratio was increased. Again the joint polymerization rate of LMa and RC-800 was decreased as the ratio of LMa increased.

(2) Films showed only a slight plasticization (Re: Notebook Pages 2201-203, 222).

(d) 2-Ethyl Hexyl Acrylate (2EHA)

Castings made in an attempt to copolymerize 2-EHA with RC-800 showed only a slight flexibilization, developing cheesiness rather than toughness as the amount of 2-EHA to RC-800 was increased (Re: Notebook Pages 2201-260).

(e) Allyloxy Ethyl Acrylate (7090-164) (AOEA)

(1) In thin films with RC-800 it was too volatile at 130°F.

(2) By itself, when catalyzed with cobalt nitrate hexahydrate and benzoyl peroxide, in a test tube it would not convert in 65 hours at 60°C. (Re: Notebook Page 2201-248).

(f) 1,4 diallyloxy-2-butene (1,4 DAB)

(1) Did not polymerize "en masse" when catalyzed with cobalt nitrate hexahydrate and benzoyl peroxide in 60 hours at 40°C. Incompatible with RC-800 at ratios higher than 50%, 1,4 DAB. At this ratio it did not appear to speed up the joint polymerization with RC-800.

(2) In thin films it volatilizes from the film at 130°F. (Re: Notebook Pages 2201-116, 246, 250).

(g) Diallyl phthalate and Diallyl Glycolate (DAP & DAG)

Did not appear to convert in RC-800 system at 130°F. Acted more like a non-drying oil alkyd (Re: Notebook Pages 2201-148, 214, 215).

(h) 60/40 Allyl Acrylate/Styrene (PRCR-7176)

Incompatible with RC-800. Converted with cobalt catalyst in 2 hours at 130°F. to a non-tacky, soft film (Re: Notebook Pages 2201-236, 246).

(i) 50/50 Allyloxy Ethyl Acrylate/Styrene (PRCP-7168)

Incompatible with RC-800 yielding a hard brittle film of low strength (Re: Notebook Page 2201-191).

(j) PRCP-81522 (a straight glycerol allyl ether phthalate resin)

(1) When used as a plasticizer in the RC-800 system, tended to embrittle the film.

(2) By itself with cobalt catalyst, it converted in 16 hours @ 150°F. to a fairly tough film. (Re: Notebook pages 2201-118, and 2261-68).

(k) PRCP-92135 (a glycerol allyl ether phthalate modified dehydrated castor oil alkyd)

(1) When used as a plasticizer in the RC-800 system it tended to embrittle the film.

(2) By itself with cobalt catalyst it converted in 16 hours @ 150°F. to a somewhat soft but fairly tough film. (Re: Notebook pages 2201-118 and 2261-68)

(l) Propylene Glycol Maleate/Adipate (PMA)

(1) Incompatible with RC-800 when polymerized "en masse" at ratios of 25/75 to 75/25. Addition of monomeric styrene to RC-800/PMA produced a compatible polymer but did not speed up conversion. Castings were exceptionally hard and flexible but tended to embrittle on aging indicating a loss of unreacted styrene monomer.

(2) Thin films of RC-800/PMA/styrene in which nitrocellulose was used as the bodying agent showed excessive cratering and crawling (Re: Notebook Pages 2201-254, 258, 268; 2261-42).

(m) Polyethylene Glycol Maleate/Adipate (PGMA)

Incompatible with RC-800. When catalyzed with cobalt nitrate and benzoyl peroxide, converted to a cheesy film in 2 hours @ 130°F. which crawled and cratered on both glass and wood.

(n) Dioctyl Phthalate (DOP)

This plasticizer was tried as a replacement for RL-255 but when freshly prepared, the highest ratio of DOP that could be used without spewing out was RC-800/PX/DOP = 55/40/5. On aging several months, even this composition showed some spewing (Re: Notebook Page 2201-162).

(3) Processing

As can be seen from the attached properties chart (see page 2.) the RC-800 formulations are much more difficult to process than either "Duco" or "DULUX". This was found to be true in the laboratory and was substantiated in a small-scale field test conducted at the Bassett Superior and the Lane Companies. The following studies were made to reduce the work required in processing.

(a) Methods

1. Dry Sanding - No improvement (Re: Notebook Page 2278-52).

2. Camphor in Octyl Alcohol as Lubricant - No improvement (Re: Notebook Page 2278-57).

3. Silicone Oil (G.E. 81069) in Film - No improvement (Re: Notebook Page 2278-62).

(b) Two-Stage Conversion

Experiments had indicated that the labor of processing the RC-800 finishes can be materially reduced, approaching that of "Duco", if the finish is partially converted to an "A" stage, processed, and then the conversion completed to the "B" stage. Conversion to the "A" stage was accomplished by overnight drying at 70°F. or a short force dry such as, one hour at 110°F. However, unless a thermosetting sealer was used, objectionable shrinkage occurred: (Re: Notebook Pages 2261,90; 2278-12, 76, 80, 88 and 90).

(4) Shrinkage

As stated above, when the topcoat bake was split to allow easier processing, objectionable shrinkage occurred when the film was completely converted to the final or "B" stage. The following factors were investigated in an effort to control shrinkage:

(a) RC-800 Syrup in place of Monomer - Some improvement in shrinkage (Re: Notebook Page 2278-4).

(b) Measure of volume change of film at various stages of conversion - Some decrease in volume, 0.7%, occurred between air-drying overnight and 2 hours @ 180°F. This was not a large enough change to explain the degree of shrinkage being encountered. Indications were that most of the shrinkage was due to the undercoat system (Re: Notebook Page 2278-64).

(c) Effect of Filler

1. Length of Filler Dry - No effect on shrinkage. (Re: Notebook Page 2278-65).

2. Flash Dry vs. 27-5000 line Filler - No effect - (Re: Notebook Page 2278-70)

3. Double Filling - No effect (Re: Notebook Page 2278-70).

4. U.F. Modified 27-5000 line Filler - No effect (Re: Notebook page 2278-72, 74).

(d) Effect of Sealer

1. 1366 vs. nylon sealer - Nylon sealer was poorer. (Re: Notebook page 2278-82).

2. RC-800/PVB Sealer - required a high baking temperature or overnight at 120°F. but essentially eliminated shrinkage (Re: Notebook Page 2278-84).

3. RC-80C/VMCH Sealer - Required a high baking temperature or overnight at 120°F. but minimized shrinkage. Re: Notebook Page 2278-96).

4. Increasing dry of 1366 and/or nylon sealer - No improvement (Re: Notebook Page No. 2278-98).

5. RC-800/VYCC Sealer - Required a high baking temperature or overnight at 120°F. but practically eliminated shrinkage (Re: Notebook Page 2278-102).

6. Nylon Sealer plus catalyst to crosslink - No improvement when nylon plus citric or maleic acid as catalysts to crosslink nylon, were used (Re: Notebook page 2278-104).

7. Topcoat as Sealer - Eliminated shrinkage essentially one hundred percent (Re: Notebook page 2278-106).

The above results indicated that in order to reduce shrinkage, which occurs when RC-800 finishes are processed to an "A" stage and subsequently converted to a "B" stage, it is necessary to use a thermosetting sealer or one unaffected by the solvents of the topcoat. The extra cost of baking the thermosetting sealer, however, tends to neutralize any savings gained in reducing the labor needed for processing by splitting the bake.

(5) Adhesion

On occasions poor adhesion of the RC-800 topcoat to the 1366 Sealer was encountered. It was investigated as follows:

(a) Effect of Dry of 1366 - None (Re: Notebook page 2278-165)

(b) Effect of Film Thickness of 1366 - Adhesion increased slightly with increased build (Re: Notebook Page 2278-166).

(c) Effect of Moisture Condensed on Sealer (1366) Surface - None (Re: Notebook Page 2278-168)

(d) Effect of Poor Drying Conditions During Entire Finishing Schedule - Promotes poor adhesion (Re: Notebook Page 2278-176).

(e) Effect of Heavy Coats of Stain - Promotes poor adhesion, particularly if not thoroughly dried (Re: Notebook Page 2278-178).

(6) Stability

Initial tests indicated that the shelf life of the 45/45/10 formula without catalyst, at room temperature, in partially full glass containers is approximately one month and in partially full tin containers it is approximately 3 weeks. (Re: Notebook Page 2261-88). The 55/40/5 formula containing 10% Santocel C on the solids, compared to the 45/45/10 composition in partially full phenolic-lined containers, had a shelf life at room temperature, of 12+ months versus six weeks.

A further study of containers (Re: Notebook Page 2261-94) with storage at 105-110°F. indicated the following for the 45/45/10 composition.

Glass	7 days	Re: Notebook Page 2278-8
Iron	40 hours	
Tin	4 days	
Glass	7 days	Re: Notebook Page 2278-39
Aluminum	7 days	
Stainless Steel	4 days	
Galvanized Iron	4 days	
Tin	4 days	

This indicated that the best commercial container is either tin for small quantities or phenolic-lined, for larger quantities.

A study was then made of other methods of splitting the formula and of inhibitors (stability at 105-110°F).

(a) Split Packaging (Re: Notebook Page 2303-134)

System I - Clear topcoat minus catalysts at 41.4% T.S. 1 week
Catalyst solution (cobalt nitrate + benzoin)- No apparent deterioration.

System II - RC-800 - 1 week
Clear topcoat minus RC-800 but with catalysts present.
No apparent deterioration.
Catalyst solution - No apparent deterioration.

System III - RC-800 - 1 week
Clear topcoat minus RC-800 but with catalysts present.
No apparent deterioration.

System IV - RC-800/PX at 57.2% T.S. - 1 week
RL-255 + catalyst solution - No apparent deterioration.

System V - RC-800/RL-255 at 89.1% T.S. - 3 weeks
PX + catalyst solution. No apparent deterioration.

System VI - System I with 10% nitrobenzene on RC-800 - 8 weeks.

This indicates that nitrocellulose does not improve the stability of RC-800 but that RL-255 does, and that nitrobenzene is a stabilizer for RC-800.

(b) Effect of Various Stabilizers

(1) 10% nitrobenzene on the RC-800 in 45/45/10 formula increased the shelf life at 105°F., in tin, from one to five weeks (Re: Notebook page 2303-56).

(2) 50% nitroethane on the RC-800 in 45/45/10 formula increased the shelf life at 105°F., in tin, from one to two weeks. (Re: Notebook page 2303-62).

(3) Toluene in an amount equal to that in the final formula, added to RC-800 increased the shelf life of RC-800 from 10 days to 12 weeks plus, in tin at 105°F. (Re: Notebook Page 2303-64).

(4) 20% nitrobenzene or nitroethane on the RC-800 in a 45/10 combination of RC-800 and RL-255 at 45% T.S. in toluene increased the shelf life from three weeks to twelve weeks plus in tin at 105°F. (Re: Notebook page 2303-70).

(5) 30% Terpene B on the RC-800 in RC-800/RL-255 = 45/10 reduced to 45% T.S. with toluene, increased the shelf life from three weeks to six weeks plus in tin at 105°F. (Re: Notebook page 2303-114).

(6) From 60-170 ppm. anhydrous NH_3 on the RC-800 increased the shelf life of RC-800, in tin, at 105°F. from one week to four weeks plus (Re: Notebook page 2303-128).

(c) Relative Stability of Various Lots of RC-800

Lot 22 (received 5/9/49) - 10 months at R.T. in phenolic-lined containers

Lot 46 (received 10/5/49)- 1 month in R.T. in phenolic-lined containers.

All stability tests except those on the split package tests listed under (a) above, were run on lot 22. The split packaged systems listed under (a) above employed lot 46.

From these results it appears that one of the best ways to increase the shelf life of the RC-800 monomer is to reduce it with all of the toluene in the formula and/or add Terpene B. The best split system for shipping to the customer is that of packaging the RC-800/RL-255 at 45% T.S. in a toluene/Terpene B mixture in one container (partially full and phenolic lined) with the nitrocellulose, nitrocellulose solvents and the catalysts in the second package. Tin-lined containers can be used for batches of a gallon or less.

(7) Reduction in Cost

As a means of reducing the cost an investigation of thickening agents other than nitrocellulose and ones soluble in hydrocarbons, was undertaken. Three film formers meeting the requirements of solubility in low cost solvents were examined: viz., methyl methacrylate, ethyl cellulose and polyvinyl butyral.

(a) Methyl Methacrylate

Satisfactory conversion cannot be obtained in 2 hrs. at 130°F. with cobalt nitrate and benzoin as catalysts. Temperatures of 180-190°F. are required. No low cost third modifier, compatible with MMa and/or RC-800 was uncovered. Hence an appreciable decrease in cost at the 45% level of RC-800 was not possible. (Re: Notebook Pages 2303-26, 66, 94, 102, 108, 110, 116, 122, 124).

(b) Ethyl Cellulose

Satisfactory conversion is not obtained in 2 hours at 130°F. with cobalt nitrate and benzoin as catalysts. Temperatures of 180-190°F. or a longer bake at 120°F. than 2 hours, are required. No low cost third modifier compatible with ethyl cellulose and/or BCM was uncovered, preventing an appreciable decrease in cost at the 45%, level of RC-800. Also poor adhesion on aging, to 1366 Sealer, was obtained. (Re: Notebook Pages 2303-72, 74, 80, 86, 92, 112, 118, 120 - 2261-24).

(c) Polyvinyl Butyral

Satisfactory conversion is not obtained in 2 hours at 130°F. with cobalt nitrate and benzoin as catalysts. Temperatures of 180-190°F. are required (Re: Notebook page 2303-68).

An appreciable reduction in cost per gallon (approximately 20 cents) is indicated in the RC-800/PX/RL-255 = 45/45/10 formula, by changing the catalysts from cobalt nitrate and benzoin to cobalt naphthenate. An equivalent degree of conversion was obtained at an equal metallic cobalt content (Re: Notebook pages 2303-58, 84).

(8) Catalysts

A high spot investigation of the catalyst requirements for the RC-800/PX/RL-255 (45/45/10) formula indicated:

(a) A minimum metallic cobalt content on the RC-800 of 0.2% (Re: Notebook page 2261-33)

(b) Benzoyl Peroxide without cobalt nitrate is ineffective as a catalyst at 130°F. (Re: Notebook Page 2278-18).

(c) In the presence of cobalt nitrate and benzoin the RC-800/FX/RL-255 formula can be converted in one hour under UV (weatherometer) equivalent to 2 hrs. at 130°F. (Re: Notebook Page 2278-36).

(9) Cold Crack Resistance

Cold crack data indicate that the check resistance of the RC-800/FX/RL-255 formulae, either at 45/45/10 or 55/40/5 plus 10% Santocel "C", is very good even when 1/8" nitrocotton is used. However when extra thick films are applied and for the highest quality finish, 1/4" nitrocotton must be used. This reduces the total solids at spraying viscosity for these formulae from 32% to approximately 26-27% (Re: Notebook Page 2303-88).

(10) Blue Haze

From time to time various difficulties in the application and formulation of the RC-800 finishes have arisen and have been overcome by one means or another. One difficulty that has occurred on only a few panels and for which we do not have an explanation but only a theory, is the occurrence of a blue haze. While we have not been able to reproduce this condition we believe it to be an incompatibility which arises as the panel ages. It will occur in the dark, but heat or light accelerates it.

The following experiments were undertaken to determine the cause of the difficulty, with negative results. They are being recorded here for reference purposes only. All systems were exposed either to carbon arc or to ultra violet.

(a) Effect of Catalysts: None, cobalt nitrate plus benzoyl peroxide, cobalt nitrate plus benzoin and straight cobalt nitrate - baked 2 hrs. at 250°F. - No blue haze.

(b) Same as (a) except baked 2 hrs. @ 130°F. Where no catalyst was employed finish was baked 2 hrs. @ 250°F. No blue haze. (Re: Notebook page 2278-155).

(c) Type of Stain: No stain, NFL, Luxol and oil stain - no blue haze (Re: Notebook Page 2278-153).

(d) Effect of (a) Sealer: None, 1366, 1366 + stain, nylon primer (Re: Notebook Page 2278-163).

(b) Stain: Normal and 5 times normal amount. No haze in either case (Re: Notebook page 2278-163).

(e) Effect of light and heavy coats sealer 1366 - No blue haze (Re: Notebook page 2278-166).

(f) Effect of 1366 vs. RC-800/ethyl cellulose wash coat in a system employing a thermosetting sealer - No blue haze (Re: Notebook page 2278-167).

(g) Effect of moisture on sealer: 1366, 1366 + water, no sealer, and water on filler surface before 1366 was applied - No blue haze (Re: Notebook page 2278-168).

(h) Effect of drying under adverse conditions (72°F. & 84% R.H.) - No blue haze (Re: Notebook page 2278-176)

(i) Effect of amount of stain and dry of stain: No stain, normal VS-4489, 5 times normal VS-4489, air dried 1/2 hour, and 5 times normal VS-4489 force dried 2 hrs. at 130°F.; each under 1366 and J-1300-X-10362, (1366 made with PVB of our own manufacture) - No blue haze (Re: Notebook Page No. 2278-178).

(j) Effect of Adding Film Formers to the Stain: Polyvinyl butyral and ethyl cellulose - No blue haze (Re: Notebook page 2278-180).

(k) Effect of Slow Solvents in 1366: Butyl lactate, ethyl lactate, Cellosolve and Cellosolve acetate - No blue haze (Re: Notebook page 2278-183).

(l) Comparison of Oil Type, NFL and Luxol Stains - Applied in normal and in extra heavy coats - No blue haze (Re: Notebook Page 2278-183).

(m) Influence of Each Element in System with normal and 5 times normal amount of stain - No blue haze (Re: Notebook page 2278-184).

(n) Wash Coat: 5% T.S. RC-800/E.C. up to 25% RC-800/E.C. and 15% T.S. RC-800/N.C. - No blue haze (Re: Notebook page 2278-190).

(o) Effect of Blending RC-800/EC with RC-800/PX/RL-255: No blue haze (Re: Notebook page 2278-192).

(p) Effect of Using a High Alcohol 1366 - No blue haze (Re: Notebook page 2278-195)

(q) Effect of Dry of Wash Coat - No blue haze (Re: Notebook page 2303-3).

(r) Effect of high alcohol 1366 vs. 1366 + 5% Cellosolve - No blue haze (Re: Notebook page 2303-5)

(s) Effect of 1366 vs. 1366 + 5% ethyl butyral - Over normal and heavy stain - No blue haze (Re: Notebook page 2303-7).

(t) Effect of speeding up the dry of the system - No blue haze (Re: Notebook page 2303-10)

(u) Effect of normal and extra heavy wet coats of topcoat - No blue haze. Re: Notebook page 2303-16)

(v) Effect of 1366 in Topcoat - No blue haze (Re: Notebook page 2303-18)

(w) Effect of stain in topcoat (NFL and Luxol) No blue haze. (Re: Notebook page 2303-20)

(x) Effect of temperature of conversion of topcoat - No blue haze (Re: Notebook page 2303-22).

(y) Effect of age of topcoats before application - No blue haze. (Re: Notebook pages 2303-24, 28)

(z) Effect of excess phosphoric acid in filler - No blue haze (Re: Notebook page 2303-30).

(aa) Effect of inhibitor in filler - No blue haze - (Re: Notebook page 2303-32-34).

(bb) Benzaldehyde as a Contaminant - No blue haze (Re: Notebook page 2303-52)

(cc) Effect of Urea as a Contaminant - No blue haze (Re: Notebook page 2303-60).

B. Study of the Components of the Undercoat System

The recommended undercoat system for the preferred topcoats consists of the following:

(a) Stain
(b) Wash coat
(c) Filler
(d) Sealer
(e) Glazing Stain } where needed
(f) Glazing Lacquer }

Any system may vary from consisting of just sealer to containing all of the above components. Considering them individually and in the order listed above, each was investigated as follows:

(1) Stain

(a) Over close grain woods such as birch and maple, oil type stain has been found to be satisfactory if dried overnight or its equivalent (Re: Notebook page 2278-62)

(b) Over porous woods such as walnut or mahogany, either a "Luxol" dye stain or an NFL may be used. However, over mahogany with a 27-5000 line filler, gray pores and poor adhesion may develop, if the stain is applied in heavy coats and is not thoroughly dried (Re: Notebook pages 2261-78, 2278-184 and 2303-40).

(2) Wash Coat

Early in the work on this project considerable pinholing was encountered. We were able to show that this was due in the main to the porosity of the wood. To a less extent, how well the wood was filled and how thoroughly the filler was dried were also shown to have some effect. (Re: Notebook Page 2201-142).

A study of various means for sealing the wood was therefore undertaken and the following materials examined as possible wash coats:

(a) RK-5760 Furniture "DULUX" at 12% T.S.

When baked 2-1/2 hours at 130°F. was definitely superior to 1366 from the standpoint of reducing pinholing, but it impaired adhesion (Re: Notebook Page 2201-108).

(b) 13016 Penetrating Primer at 12% T.S.

Poorer than 1366 for pinholing (Re: Notebook page 2201-108).

(c) RC-600/PX/RL-255 (55/35/10) at 12% T.S.

Some improvement in pinholing but not as good as RK-5760. Adhesion was poorer than with 1366.

(d) Shellac

No improvement in minimizing pinholing. (Re: Notebook page 2201-108).

(e) Vinylite VMCH at 8% T.S.

No reduction in pinholing. Impaired adhesion (Re: Notebook Page 2201-139).

(f) RC-600 at 12% T.S.

No decrease in pinholing. Impaired adhesion. (Re: Notebook page 2201-139).

(g) Cellulose Acetate (CA-108)

Slight reduction in pinholing. Adhesion was weakened. (Re: Notebook page 2201-139).

(h) Ureaformaldehyde (RC-721 @ 12% T.S.)

No improvement in eliminating pinholing. Adhesion was weakened. (Re: Notebook page 2201-139).

(i) Phenol Formaldehyde (XV-17911)

Prevented RC-800 topcoats from converting. (Re: Notebook page 2201-139).

(j) 19380 Sealer at 8% T.S.

No improvement in eliminating pinholing. Adhesion weakened. (Re: Notebook page 2201-145).

(k) Animal Glue

No improvement in eliminating pinholing. (Re: Notebook page 2201-192)

(l) Styrenated Alkyds (Styresol 4250 and 4400)

Styresol 4250 showed no reduction in pinholing. Styresol 4400 shows a slight reduction in pinholing. (Re: Notebook page 2161-14).

(m) Butyl Titanate

Some improvement in minimizing pinholing was obtained accompanied by indications of impaired adhesion (Re: Notebook page 2261-56).

(n) RC-800/Ethyl Cellulose

This combination gave a very definite reduction in pinholing, essentially eliminating it and with no sacrifice in scratch resistance. A 50/50 ratio was considered optimum. Medium ethoxy ethyl cellulose was found to be more foolproof from the standpoint of conversion with RC-800 (Re: Notebook pages 2201-245, 252, 262; 2261-48 and 2303-76).

(3) Filler

Because earlier work indicated that under-dried 563-line filler was more apt to cause cratering and ridging than 27-5000 line filler, the latter was selected for use in our preferred undercoat system. A detailed study of the drying conditions necessary for 27-5000 line filler showed 4 hours @ 130°F. to be optimum, if the RC-800/ethyl cellulose wash coat were used (Re: Notebook pages 2201-133, 156).

At this bake, 563-line filler also is fairly satisfactory. It tends to puff somewhat more but is definitely superior in freedom from gray pores in a mahogany system with 1366 as the sealer (Re: Notebook page 2303-40). This is true over an NFL stain, but does not hold over a "Luxol" stain.

(4) Sealers

Earlier work had indicated that 1366 Penetrating Primer was definitely superior to 19380 type sealer in an RC-800 system and that a sealer was necessary to provide maximum adhesion, hold out, and foolproofness against surface defects, such as ridging and crawling. Since 19380 definitely impaired the scratch resistance of the system, 1366 was selected as the sealer in the initial work. A further sealer study was made (1) to improve adhesion and minimize gray pores, and (2) to reduce the shrinkage in the system. Work covering the latter has already been discussed under the heading "Shrinkage" in a previous section of this report (see page 13).

The following study of various sealers was made to improve adhesion.

(a) Nylon 8A1 DV-80

This film former was found to give improved adhesion, more "life" and better pore definition with a minimum of gray pores. Over porous woods such as walnut and mahogany, it yielded the greatest improvement in adhesion when used as a wash coat as well as a sealer. However, it had two defects: (1) high cost, and (2) the built up system exhibited objectionable shrinkage (Re: Notebook pages 2261-44, 74 & 2278-24-98).

(b) Miscellaneous Sealers

Various other sealers were evaluated, such as 10% polyvinyl acetate dissolved in butyl acetate, 4% polyvinyl butyral (G-649) in butyl acetate/alcohol, 10% low molecular weight, solution process, polyvinyl butyral (Re: Notebook page 2249-95), 13016 Penetrating Primer and a penetrating primer based on low molecular weight, solution process polyvinyl butyral. All were either poorer for adhesion or no better for adhesion than 1366 (Re: Notebook page 2278-16).

Based on these results, 1366 was selected as the best sealer except perhaps on maple where the shrinkage of Nylon SA1-D-80 is not of importance.

(5) Glazing Stains and Shading Lacquers

Two basic types of glazing stains were evaluated for possible use in the RC-800 system; viz: one based upon a drying oil vehicle and coded in the 307 line and the other formulated with castor oil and carrying a 28 line code. The latter was found to be definitely better from the standpoint of adhesion than the former (Re: Notebook Page 2303-42).

The 266 line shading lacquers based on blends of 259 line "Duco" were found to be satisfactory for use in the RC-800 system (Re: Notebook page 2303-44, 46).

(C) Competitive Thermosetting Finishes

Two competitive finishes were evaluated versus the RC-800 system. They were the finishes offered under the trade name "Phenoplast" and Bakelite Corporation's XV-17911. The latter is a phenolformaldehyde type which Bakelite offered to manufacturers of wood finishes.

Our evaluation indicated that "Phenolplast" when properly cured, and over a suitable primer, provided a tough, mar, solvent resistant finish equal to our proposed RC-800 type finish (45/45/10). Although it sprayed or brushed fairly well, it tends to crater and crawl in the same manner as some of the earlier RC-800 type formulas containing high amounts of RC-800. Also its color retention was inferior to our RC-800 finish.

From its general appearance and physical characteristics, "Phenolplast" is apparently very similar to XV-17911, Bakelite's low temperature baking finish for wood. The latter is characterized by the same advantages and disadvantages.

It is not believed that "Phenolplast" as now formulated is a serious immediate competitor in the field in which we contemplate exploiting RC-800 finishes (Re: Notebook pages 2278-23, 25 thru -33).

APPENDIX

(A) TENTATIVE RATING CHART
FURNITURE FINISHING SYSTEMS WITH RC-800 TOPCOAT

Properties	Type A "DULUX"	Type H "Duco"	RC-800 Clear
1. Cold Check	6	9	10
2. Durability	-	9	10
3. Humidity	3	10	10
4. Water Resistance	9	8	10
5. Alcohol Resistance	9	5-1/2	10
6. Solvent Resistance	5	0	10
7. Heat Resistance (212°F)	9	4	10
8. Scratch Resistance	8	8	9-1/2
9. Mar Resistance	8	6	9
10. Resistance to Discoloration	9	8-1/2	6
11. Print Resistance	8-1/2	8	10+
12. Clarity	6-1/2	8-1/2	9
13. Sanding	8	7-1/2	4
14. Rubbing	5	8	5
15. High Polish	5	8-1/2	8-1/2
16. Shrinkage	7	8	9
17. Spraying Solids	42%	26%	32%

(B) Compositions of the clear and flat RC-800 topcoats and the ethyl cellulose/RC-800 wash coat are as follows at spraying viscosity:

(a) Clear (45/45/10)

PX-7555 (dry)	14.30%	(1/8 sec. Hercules Nitrocotton)
H-1-d	7.70	(alcohol of drhydration)
H-1	9.00	(ethyl alcohol)
HB-6	18.10	(n-butyl acetate)
HA-136	8.40	(ethyl acetate)
H-12	2.50	(n-butyl alcohol)
RL-255	5.40	(50% castor oil alkyd)
KG-4121	0.45	(cobalt nitrate hexahydrate)
KG-4122	0.45	(benzoin)
KH-4120	14.30	(RC-800 monomer)
H-47	19.40	(toluene)
	100.00%	

Theo: T.S. = 32.7%
Gal. Weight = 8.01#
Visc. 7 cup = 45-55"

(b) Flat (45/45/10)

PX-7555 (dry)	13.0%	(1/8 sec. Hercules Nitrocotton)
H-1-d	7.0	(alcohol of dehydration)
H-1	6.5	(ethyl alcohol)
HB-6	14.7	(n-butyl acetate)
HA-136	7.6	(ethyl acetate)
H-12	3.3	(n-butyl alcohol)
RL-255	4.1	(50% castor oil alkyd)
KG-4121	0.4	(cobalt nitrate hexahydrate)
KG-4122	0.4	(benzoin)
*Mill Base	14.1	(see below)
KH-4120	13.7	(RC-800 monomer)
H-47	15.2	(toluene)
	100.0%	

Theo: T.S. = 32.8%
Gal. Weight = 8.04#
Visc. 7 cup = 45-55"
Sheen = 94 (Gaub)

*Mill Base

H-1	17.0%	
H-47	2.5	
HB-6	18.3	
HA-136	9.5	
RL-255	7.4	
G-222	11.0	(Santocel C)
H-47	16.5	
**Clear Base	13.7	
	100.0%	

**Clear Base

PX-7555 (dry)	35.0%
H-1-d	18.8
H-47	15.7
HB-6	17.5
HA-136	9.1
H-12	3.9
	100.0%

(o) Wash Coat (Thermosetting)

KG-4123	5.0%	(7 cps. med. ethoxy Ethocel)
KH-4120	5.0	(RC-800 monomer)
H-1	12.5	(ethyl alcohol)
H-47	43.5	(toluene)
H-12	5.3	(n-butyl alcohol)
H-583	21.5	(xylene)
H-35	7.0	(methyl ethyl ketone)
KG-4121	0.2	(cobalt nitrate hexahydrate)
	100.0%	

(C) RECOMMENDED SYSTEMS FOR USING RC-800 TOPCOATS

Operation	Open Grain Wood (Mahogany & Walnut)	Close Grain Wood (Maple and Birch
1. Stain	NFL for walnut and Luxol for mahogany to minimize gray pores.	307 line (oil type)
Dry	15 to 30 minutes at room temperature.	16 hrs. or longer at room temperatures of 60°F. or higher
2. Wash Coat	1366 for good quality veneer J-RK-X-10336 for poorer quality grades of veneer	None -
Dry	1366 should be flashed 1 hour J-RK-X-10336, if baked simultaneously with the filler, should be flashed one hour. Otherwise bake J-RK-X-10336 for 2 hours or longer at 130-140°F.	-
3. Filler	27-5000 line	None or 27-5000 line
Dry	Filler, or filler plus wash coat, are baked 4 hrs. at 130-140°F.	Filler if used to be baked 4 hrs. at 130-140°F.
4. Sealer	1366	1366
Dry	One hour at room temperature (60°F. or higher)	One hour at room temperature (60°F. or higher)
Sand	Scuff lightly with #360 paper	Scuff lightly with #360 paper.
5. Glaze	Optional. 28 line as represented by the composition of P-28-R-555674.	Optional. 28 line as represented by the composition of P-28-R-55674.
Dry	Flash off solvents which should not require more than 1 hour	Flash off solvents which should not require more than 1 hour.

Operation	Open Grain Wood (Mahogany & Walnut)	Close Grain Wood (Maple & Birch)
6. Shading Lacquer	Optional. 266 line	Optional. 266 line
Dry	1 hour at room temperature (60°F. or higher).	1 hour at room temperature (60°F. or higher.
7. RC-800 Topcoat	For maximum quality apply 2 coats, flashing 30 minutes between coats and 60 minutes prior to baking.	For maximum quality apply 2 coats, flashing 30 minutes between coats and 60 minutes prior to baking.
Bake	2 hours at 130-140°F. and 35% R.H. Cannot be air dried.	2 hrs. @ 130-140°F. and 25% R.H. Cannot be air dried.

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