Doped Fabric

SPECIFICATIONS

FOR

AIRCRAFT FINISHING

TWELFTH EDITION

BERRY BROTHERS
Paints · Varnishes · Enamels · Lacquers
Detroit, Mich. Walkerville, Ont.

S P E C I F I C A T I O N S

FOR

AIRCRAFT FINISHING

TWELFTH EDITION

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BERRY BROTHERS INC.
Paints · Varnishes · Enamels · Lacquers

Detroit 7, Mich. Walkerville, Ont.

INTRODUCTION

No other branch of aircraft manufacture or repair, requires greater care and closer attention to technique than that of doping and painting. There are so many factors entering into the finishing of aircraft, any one of which may cause trouble, that one sometimes wonders why some jobs turn out as satisfactorily as they do. Ever since the art of finishing and lacquering began, ages ago, in the Egyptian and Chinese Empires, painters have been experiencing finishing difficulties. We dare say they always will as long as climatic conditions, human error and varying methods of application are not under absolute control.

By close observance of certain rules, use of common sense judgment, experience and interest in doing one's work carefully, a painter should have little difficulty with high grade, proven paint materials.

In the following pages we present the most modern and up-to-date methods for finishing the various parts of airplanes. These systems have been thoroughly tested and their value demonstrated. Close adherence to the instructions herein contained should enable anyone to obtain highly satisfactory results, and avoid the many pitfalls and difficulties encountered by inexperienced finishers.

The finish possessed by any object, whatever it may be, constitutes a very considerable portion of its sales appeal, and also provides the necessary protection from the elements. It naturally follows, therefore, that the more carefully and efficiently the finish is applied, the greater will be the return in sales, satisfaction and service.

With the advent of all-metal airplanes, Berry Brothers stand ready to provide efficient, light weight finishes in a wide variety of colors, especially adapted to the newest needs of aviation.

Finishing Methods for Various Surfaces

FABRIC FINISHES

BERRYLOID PIGMENTED DOPE FINISH—NEW FABRIC

The following method of obtaining a durable, highly polished pigmented dope finish is of interest to those desiring only the best.

Assuming that the components have been properly covered, brush a coat of Berryloid Clear Nitrate Dope onto the fabric, reduced 10%. It is recommended that a full, wet brushful of dope be used, and that the dope be applied evenly over the surface being doped. Do not attempt to cover too much surface with one brushful of dope. It should be remembered that the first coat is the one on which anchorage to the fabric depends. Consequently, dry brushing or stretching of a brushful of dope must be avoided. Proper saturation of the fabric and penetration of the dope calls for an evenly applied wet coat of dope. Some production shops equipped with the necessary pressure spray equipment now spray on the first coat of dope with very satisfactory results.

Allow the first coat of dope to dry thirty to forty-five minutes, depending on whether or not thinning was necessary, and on atmospheric conditions.

The reinforcing or trim tape, patches, drain grommets, etc., may be applied either with the second coat or as a separate operation immediately prior to the application of the second coat of clear dope. The most common procedure is to apply most of the tapes and patches with the second coat. This is easily accomplished by doping up to a rib or section where tape is to be applied, laying the tape on the doped surface, rubbing it down, and proceeding with the application of the dope up to and over the next area to be taped.

After the second coat of dope has been applied and all tape in place, allow this coat to dry thirty to forty-five minutes before lightly scuffing or sanding with No. 000 sandpaper, or its equivalent.

All coats after the second should be applied by spray application, but may be brushed if no spray equipment is available. The third coat of clear dope is applied, allowing a drying interval of thirty to forty-five minutes. If this coat is brushed, it may be necessary to thin the dope with Berryloid Nitrate Dope Thinner or Berryloid Reducer, to obtain proper brushing viscosity or body. If this and the following coats are sprayed, it is strongly recommended that the pressure pot method of application be used, which enables one to apply dope of heavier body, therefore saving on thinner and depositing a better building coat of dope. The use of suction

cups in the application of dope requires greater thinning, and consequently more applications, since the build or fill per coat is reduced proportionately to the greater thinning of the dope. It is recommended that whenever possible a spray gun designed especially for dope application be used with the proper pressure or gravity feed tank.

After the third coat of dope has been applied and allowed to thoroughly dry, the surface so coated should be dry sanded lightly, using No. 000 sandpaper or its equivalent. It is recommended that all components being dry sanded be electrically grounded to prevent possible static discharges and the consequent danger of fire.

On completion of the sanding of the clear dope, the next application of dope should be made. This consists of two heavy, wet coats of aluminum pigmented dope. Allow a drying time of from thirty to thirty-five minutes between each of these two coats.

Aluminum pigmented dope is used after the clear dope and before the colored dope for three reasons: First, to protect the clear dope from the actinic or destructive rays of the sun: second, as an effective filling or building pigment; third, since it is easier to sand than any other pigmented coat in the finishing of fabric. Aluminum pigmented dope is usually prepared by adding 1½ pounds of fine aluminum powder to each five gallons of full bodied clear dope. When using aluminum powder, wet the powder with Berryloid Reducer or Berryloid Nitrate Dope Thinner, making a thin paste before adding to the clear dope. Should aluminum paste be used, add 1¾ pounds of each five gallons of full bodied clear dope.

After the second coat of aluminum dope has been applied, allow eight hours to over-night drying, before sanding to a smooth surface with No. 280 wet or dry sandpaper and water. The thoroughness or degree of this sanding determines to a great extent the possibility of getting a smooth final finish, since, if not enough sanding is done here, no amount of sanding later on will accomplish the same results.

After the aluminum pigmented dope has been sanded, wipe off all dust dirt and sanding mud. It is recommended that a sponge and chamois dampened with clean water be used to completely remove all traces of loose dirt and foreign matter before applying the succeeding coats of color.

Apply three or more coats of Berryloid Pigmented Dope of the desired color. These coats should be sprayed, using pressure or gravity feed and proper dope spray gun. Thin the dope to spraying consistency, about 20 or 30%, with Berryloid Reducer. Allow a drying time of from thirty to forty-five minutes between each coat. (Note: In the event that reds or light maroons are used as the final color, it is recommended that an under coat or ground coat of orange be used to assist the reds or maroons in hiding or producing a more uniform depth of color. If dark maroons are used as a finished color, it is recommended that a little black pigmented dope be added to the first coat of this color. If dark blues are used, apply a ground or under coat of black pigmented dope before applying the blue.) These precautions are well worth the time and effort they require, since by observing them a considerable number of coats of dope, amount of time and effort will be saved.

After the final coat of pigmented dope has dried for from eight to twelve hours, it should be sanded lightly with No. 400 or No. 420 wet or dry sandpaper and water, then rubbed with Berryloid Superfine Rubbing Compound and polished. (Some finishers do not follow the practice of water sanding before rubbing, since in some colors sand scratches, as fine as they are, are all but impossible to completely remove with rubbing compound.)

Using the above system, applying all coats wet, and using the dope as heavy as is practical, makes it possible to produce a finish on fabric with equally as high a polish as secured on metal surfaces when a rubbed lacquer or pigmented dope finish is applied thereon.

IMPORTANT NOTE:

When suction rather than pressure type spray guns are used, all spray coats should be double the number given here. This is due to the extra thinning required for dope used in suction type guns.

BERRYLOID PIGMENTED DOPE FINISH FOR NEW FABRIC
NATURAL GLOSS WITH NO RUBBING

The same system as used above is followed for this type of finish, with the following exceptions:

A water sanding, using No. 320 wet or dry sandpaper, is given the second coat of pigmented dope after an eight to twelve hour drying.

After the third coat of pigmented dope, or the final color coat, a flow coat is applied. This flow coat is mixed as follows: One-third Berryloid Pigmented Dope, color of previous coats; one-third Berryloid Clear Nitrate Dope, one-third Berryloid Reducer or Berryloid Anti-Blush Reducer. This final coat assists in producing as high a natural gloss or luster as it is possible to get on fabric surfaces without rubbing.

BERRYLOID PIGMENTED DOPE COLORS

The following standard colors are available at our branches, from our distributors and dealers and at all the important air centers, throughout the country. We can safely say that no manufacturer of aircraft finish materials has better distribution than Berry Brothers.

BERRYLOID PIGMENTED DOPES

(*All colors listed here are shown on chart appearing inside back cover*)

Diana Cream	**Insignia Red**	**Stearman Vermilion**
Loening Yellow	**Berry Red**	**Stinson Green**
Piper Cub Yellow	**Stinson Red**	**Light Blue**
A & N Orange Yellow	**Galatea Orange**	**Travel Air Blue**
Deluxe Aluminum No. 2705	**Deep Orange**	**Consolidated Blue**
Waco Gunmetal Gray	**International Orange**	**Fairchild Blue**
Aircraft Gray		**Insignia Blue**

Special colors can be made up in 50-gallon lots; and of course new colors will be added to our line from time to time.

The new colors in reds and vermilions are sunfast, being the finest that money can buy.

Such colors as greens, yellows, oranges, browns and black give the most durable finishes. Light creams, white, light grays, some blues, purple and maroons do not hide well, and often change color under sunlight.

Dark blues and maroons should have black mixed with the first coat to give the color a proper undercoat.

Vermilions and reds cover well over a dark yellow or medium orange undercoat, which adds to the durability as well as to the final depth of the finish.

Airplane manufacturers have found complete agitation of pigment in ordinary drums or barrels to be impossible. We therefore ship Pigmented Dope in quarts, gallons, and five-gallon open-head buckets and agitator drums, all well suited to your convenience.

BERRYCHROME PIGMENTED DOPES

Berrychrome Pigmented Dope can be applied only by the spray gun method and is best applied in not too wet a spray. Too wet a coat allows the fine metallic particles to "float," resulting in non-uniformity of color. Any good spray hand, however, will have no difficulty in spraying on this material properly in a manner similar to the application of Berryloid Pigmented Dope.

In the use of Berrychrome Pigmented Dope it is essential that the finish be properly built up so it can be polished to bring out the full metallic lustre of the finish. It is therefore necessary to use at least four (4) wet coats of Clear Nitrate Wing Dope, two (2) wet coats of Aluminum Pigmented Dope and at least three (3) coats of Berrychrome Pigmented Dope, with proper amount of sanding between coats to insure a smooth surface on which to polish. Berryloid Rubbing Compound is recommended for the polishing operation.

Color cards of Berrychrome Pigmented Dope are available on request and prices are shown in the price lists.

MACHINE BUFFING AND POLISHING

Some manufacturers have used the following system of polishing pigmented dope to avoid the expense of hand polishing:

One particular make of machine that has been satisfactory in operation is manufactured by N. A. Strand and Company, Chicago. It is a ½ H.P. motor, a 3-speed pulley, 2700 to 3600 R.P.M., a 14-foot flexible shaft with a carborundum 8″ pad, using an 8″ Bonnett Type Sheepskin Pad over it. The buffing unit alone weighs about 3 pounds and must be held up while buffing the fabric to prevent burning. Just a soft gliding motion is all that is necessary. The regular system of doping may be followed, but after the last coat has dried overnight, the following schedule is recommended before buffing:

1. Hand sand with 400 paper and water.
2. Dry and wipe all foreign matter off carefully. This is very important.
3. Now apply a small quantity of McAleer's Machine Compound No. K-60 that has been thinned with water about 50%. Rub buffing pad over only once lightly which gives a beautiful high gloss that is perfectly uniform.

IMPORTANT:

Be sure to ground any fabric or other surface to be buffed or polished by clamping wire to wing, etc., and then to waterpipe to prevent sparking.

REFINISHING WITH BERRYLOID PIGMENTED DOPE

If the old fabric finish is cracked or weathered badly, the covering will be condemned by the Department of Commerce Inspector. The fabric and finish when deteriorated badly, cannot be refinished again satisfactorily, and complete re-covering, doping and finishing is the correct procedure.

In refinishing, light, poor covering colors cannot be used over dark, strong colors, with any degree of satisfaction. Sometimes a seal coat of aluminum pigmented dope can be used to hide the old finish, but we recommend the darker, stronger shades for refinish work.

First of all it is recommended that the dope surface to be refinished be first thoroughly cleaned off with No. 405 Refinishing Cleaner—VM&P Naphtha or Benzol to remove all traces of wax or grease. Water sand with No. 320 Water Sandpaper to remove the oxidized surface. Spray on a section at a time enough No. 823 Retarder to soften and slacken the dope. While still soft and slack spray on the new coats of Berryloid Pigmented Dope in the regular manner, using enough coats to secure proper hiding. If polishing is desired proceed in the regular manner when the dope system has thoroughly tautened and dried.

Note in a later chapter the use of Berryloid Fabric Rejuvenator.

WAX FREE PAINT AND DOPE REMOVER

ITS USES AND DIRECTIONS FOR USE

The ordinary types of paint and varnish removers have acetone as a base, and contain a quantity of wax, to prevent rapid evaporation. Acetone has a strong "cutting" action on paint materials, but is extremely volatile, and without the wax would not remain wet on the surface sufficiently long to become effective.

The indiscriminate use of a remover containing wax would, of course, be unwise on fabric or plywood. The dissolved wax might work into the pores of the covering and, being almost impossible to wash out of such surfaces, the succeeding coats of paint or dope would never dry.

Berry Brothers, realizing the definite need for a remover and solvent for aircraft finishes, developed, after considerable experimentation, Wax Free Paint and Dope Remover. This is a blend of strong, effective solvents and retarders that soften dope and lacquer without leaving any harmful ingredients on the surface; in fact, this Remover is completely volatile, but just slow in evaporating.

The uses of this product in the up-to-date aircraft paint shops are numerous; and it is really indispensable for the economical, satisfactory refinishing demanded by owners and operators today. Thousands of dollars in unnecessary re-covering will now be saved annually, and more lasting refinish jobs will be secured.

Removing Dope and Lacquer from Covering:

The complete removal of the dope finish from the fabric is best accomplished on the upper side of horizontal surfaces where the remover will lay on the area to be cleaned sufficiently long to soften the dope down to the fabric. In so far as practical, wings and other surfaces should be disassembled and laid flat for this operation. If this cannot be done, the vertical surfaces can be softened by using soft rags soaked in Wax Free Paint and Dope Remover, and the dope wiped and scraped off as the solvent takes effect.

When it is possible to climb or slip back into the fuselage, the following system has been found to be very effective: Soak the old finish with rags wet with Wax Free Remover until the rags can be pushed into the old finish well enough to hold their weight; leave the rags on the fuselage, covering the area on the *outside* that can be reached from the *inside* of the fuselage. When the finish has dried thoroughly and hard, usually over night, get inside the fuselage and spray a heavy coat of Wax Free Remover onto the unfinished (or inside) side of the fabric. The rags on the outside of the fuselage can be removed and the finish will be removed to the fabric.

Of course, this system cannot be used on small parts or wings, but saves a lot of time and material on places where it can be used.

The general procedure on flat surfaces is to take an area a foot or so square at a time and remove the dope before passing on to the next area. The dope must be scraped or rubbed off while it is still soft, for if allowed to stand, the surface will dry up and become hard again. A wide, flexible putty knife is used to scrape off the softened dope, and the fabric is then rubbed over with rags soaked in the remover to take off the remaining dope. This same system is used in cleaning off areas to be patched.

Removing Isolated Checks and Ringworms:

Where small areas of checks or ringworms are to be taken out of fabric finishes, each spot should be treated separately. Take a clean soft rag wet with remover and rub the area with a circular motion, softening and wiping off the dope at the same time. While the area is still soft from this treatment, build up again with the necessary number of coats, as originally used. Mixing about 25% of Wax Free Paint and Dope Remover with the first coat of dope is recommended. This has a tendency to soften the old dope and give a better bond between the old and the new.

Refinishing Over Old Surfaces Not Badly Cracked:

Refinishing over old surfaces, and those that have been waxed is hazardous and the results may not always be satisfactory even after the surface has been well cleaned. Caution must be used in proceeding to refinish over such surfaces.

In re-doping over old dope or lacquer surfaces, when the finish is very old, or has been waxed often, it is best to rub a section of the stabilizer with rubbing compound; wash with Benzol and try the application of remover and new finish to see how it will come out, since all finishes do not act the same way. Do *not* sand the old finish before refinishing.

After all oil, grease and dirt have been carefully cleaned off the old surface, spray the remover directly on until the finish becomes slightly soft.

Follow immediately with the first coat of dope, using approximately 25% remover in this coat. Follow with regular clear or pigmented dope, as required. If the old finish has lost its tautness, a couple of coats of clear dope should be used before applying the pigmented coats. In refinishing, use the minimum number of coats possible to get the desired results.

Refinishing Cracked Surfaces without Removing Down to Fabric:

Where the top coats of the old dope or lacquer finish are weathered badly, displaying flaking or checking, the color coats should be removed. This is best accomplished by wiping off with rags wet with the remover. Only the color coats should be wiped off, and while the surface is still soft, apply at least one coat of clear dope thinned 25% with Wax Free Paint and Dope Remover. Follow this with the pigmented dope finish unless more coats of clear dope are needed to obtain the desired tautness, as mentioned previously.

Removing Plywood Finishes:

A successful method of cleaning off plywood wings, where the use of wax type removers is prohibited, has been developed. If the wing or surface can be taken off and laid flat, the top side is wet with the Wax Free Paint and Dope Remover and rags saturated in it are laid on areas to be removed. It is best to do only a section at a time. Keep the surface wet in this manner for about five minutes, until all the paint coats are thoroughly softened, and the finish can then be scraped off easily, with broad, flexible putty knives, down to the plywood.

If the surface cannot be laid flat, or if the underside of the wing must be cleaned *on the ship*, the soft rags can be tacked on the surface and then kept wet by spraying on the remover until the necessary results have been accomplished.

This system has been used very successfully on wings of Fokkers and Douglas amphibians.

In conclusion . . . remember that practice makes perfect, and the more you use Wax Free Paint and Dope Remover, the better you'll like it, and the more you'll learn about using it to get best results.

BERRYLOID FABRIC REJUVENATOR "NEW LIFE FOR OLD"

Very often you can save that old dope job without re-covering. Here is a penetrating solution properly plasticized and balanced with sufficient body to prevent sagging or run-off even when sprayed on a vertical surface. Berryloid Fabric Rejuvenator penetrates right into the heart of the old dope job, thoroughly softening and plasticizing the entire surface through to the fabric. Old cracks can be sealed together and dead, flabby dope brought back to life and normal tautness again.

Proper and judicious use of Berryloid Fabric Rejuvenator will save operators thousands of dollars annually in refinishing costs. If the fabric itself has become weak or rotten, we do not recommend refinishing — by all means re-cover in such cases.

DIRECTIONS FOR USE

Clean all wax, grease and foreign substances off the surface of the old doped fabric. For this purpose use clean rags and No. 405 Dope Refinishing Cleaner. After scrubbing vigorously, wipe off well to be sure that all wax is thoroughly removed. This cleaner will remove oil base insignia colors and numbers as well. Now sand with No. 320 Water Sandpaper.

Berryloid Fabric Rejuvenator is most uniformly and best applied with a spray gun at full body. Spray on one good wet double coat. Do not spray on too heavy, or running and sagging will occur. The surface will remain tacky and will gradually soften, depending upon the thickness and age of the original dope film. Allow to set and when still slightly tacky and soft, follow with a good additional double cross coat. If, at the end of an hour, the dope job has not become thoroughly soft and flabby, a third application might be necessary.

Over sections showing badly cracked surfaces best results will be obtained by brushing over these sections so that the Berryloid Fabric Rejuvenator may smooth out the breaks. After the last coat of Berryloid Fabric Rejuvenator has set for one hour, spray on two double coats of Berryloid Clear Nitrate Dope. This forces the plasticizers and solvents down into the old finish, sealing in the life-giving constituents, and tautening the finish.

Allow the dope to dry for twenty-four hours and then finish with Berryloid Pigmented Dope in any one of the regular approved methods.

STEEL FINISHES

FINISH FOR STEEL TUBING FUSELAGES, LANDING GEAR, ETC.

1. INTERIOR PROTECTION

The Government requires rustproofing of the interior of steel tubing in the fuselage. This should be done only after all welding operations are complete.

No better material than Lionoil can be used for this purpose. It flows quickly and freely and penetrates the smallest crevices. Lionoil dries rapidly to a tough elastic film, giving a protective coating that adheres to all surfaces so treated. It is superior to linseed oil for this purpose because it

(a) Dries in a much shorter time.
(b) Has superior adhesion.
(c) Becomes harder and tougher.
(d) Produces a denser, more compact film which makes for greater moisture and corrosion resistance.

Many of the best known aircraft concerns are forcing Lionoil through the tubing under pressure. Small holes up to $\frac{1}{16}''$ in diameter are drilled through the longerons at points where the shorter connecting tubing joins on, so that when the welding is complete, the entire interior of the fuselage is thus connected.

Lionoil may then be warmed and forced through the tubing from a tank by compressed air. It should enter at a point in one of the lower longerons and fill the entire inside of the tubing of the fuselage. Then allow to drain, and seal all holes in the tubing, thus making the unit air and water tight. The brass "drive-screws" now on the market make excellent seals. (Warming should be done over steam coils.)

This operation of protecting the interior of tubing is highly recommended where utmost safety and long service is desired. Corrosion can be easily detected on the outside and stopped, but it works its havoc unnoticed on the inside.

2. EXTERIOR FINISH

All steel tubing and welded joints in the various units of an airplane are covered with either scale or rust which must be removed before finishing. The most efficient method is that of sand-blasting, now adopted in many of the larger plants and on government work. Otherwise, the rust and dirt should be removed with Deoxidine or some similar metal cleaner. Apply Deoxidine as indicated on its direction label.

When once clean, the metal should be finished immediately and not touched by ungloved hands until at least a priming coat has been applied; otherwise, corrosion will later set in.

The most satisfactory finish yet found for finishing the exterior of tubing is obtained by spraying two coats of Berryloid Zinc Chromate Primer, with 4 ozs. of aluminum bronze powder per unthinned gallon in the second coat of primer. This finish provides excellent protection against corrosion, and is very dope-proof (will not lift when dope

is applied). It also presents a pleasing appearance. If it is desired to color the tubing, use one coat of Berryloid Zinc Chromate Primer and one or two coats of Berryloid Military Lacquer of the desired shade. Please also refer to the chapter on Zinc Chromate Primer.

Ordinary Pyroxylin primers lack rust inhibitive qualities and are not generally used for airplane work. Good synthetic base primers are especially recommended.

That portion of the longerons coming in contact with the doped fabric should be given a protecting strip of tape or a coat of dope-proof paint. Adhesive tape one inch wide is very satisfactory for this purpose.

The above system is in full accordance with current Army and Navy procedure.

BERRYLOID POLISH (AVIATION TYPE)

Here is a product that should be kept in every plane to remove grease and grime, dust and dirt. It is excellent as a polish and cleaner; also for unpainted, all-metal Alclad planes. It can also be used to clean glass or pyralin windshields and windows.

Apply with a damp rag moistened in water. Rub over surface to be cleaned and polished. Let dry thoroughly and wipe off with a clean cloth or rag.

Keep harmful dirt and residue off your plane and prolong the life of the surface finish.

BERRYLOID ZINC CHROMATE PRIMER

Berry Brothers was the first in the field with a new type ZINC CHROMATE, corrosion inhibiting primer for all varieties of alloy metal surfaces, including dural, aluminum, Alclad, as well as cadmium plated parts. This primer was developed in our own laboratories to meet specified requirements for the priming and protection of Naval Aircraft. Berryloid Zinc Chromate Primer was the first primer on the market to meet the Navy Department Specification No. P-27 and was the first to be adopted in the plants of leading contractors for use on Naval Aircraft and later on Army Aircraft. This has since been superseded by the current specification AN-TT-P-656.

Berryloid Zinc Chromate Primer is unusual in many respects. It has a synthetic gum base, yet it dries more rapidly than pyroxylin primer and still has the adhesion and water-proofing qualities not obtainable in lacquer base primers. It can be thinned 200% to 300% for application by spray and is dope and lacquer proof immediately.

When mixed with aluminum powder it can be used as a dope-proof paint and a sealer to prevent bitumastic paint from "bleeding" into the finishing coats. One coat of Berryloid Zinc Chromate Primer followed by a coat mixed with aluminum powder makes an excellent protective coating for interior metal parts of aircraft. It is very light in weight as compared with other types of primers. Without a doubt, it is the most anti-corrosive primer on the market, being suited for use under all types of finishing materials. Test results from five of the leading paint research laboratories in the United States, including one in England, with the P-27 type of pigmentation, show conclusively that it is the only type that actually inhibits corrosion on aluminum alloys and other alkali-earth metals like magnesium.

BERRYLOID ZINC CHROMATE PRIMER, Specification AN-TT-P-656, because of its rapid drying quality, is best applied by the spray gun method; but on small areas, can be brushed or dipped. To spray, thin with 2½ parts Toluol (toluene) to one part Primer. *Spray on a wet, thin coat to secure even covering without loading.* The spray gun should be held close to the surface to be primed to prevent drying and dusting of the primer before it reaches the metal. When properly applied it leaves a smooth, even film, greenish in color and requiring no sanding. Modern lacquer spray equipment gives best results.

For application by the dipping method, slightly less thinning is recommended. Our Dipping and Brushing Retarder for Zinc Chromate Primer mixed equally with the primer gives great satisfaction.

This primer will dry to handle almost immediately, and in emergencies succeeding coats of lacquer, or enamel, may be applied in just a few more minutes, but for best results it is desirable to allow at least a few hours for drying real hard. Overnight drying is excellent. Baking at any temperature up to 250° F. will improve its ultimate durability, "*but temperatures higher than this will cause difficulty in recoating, due to excessive hardness.*"

The use of this primer for dope-proofing is approved by the Naval Aircraft Factory. When so used it is best if applied at a heavier body and thinned with equal parts of Toluol. It may also be used as a sealer over old paints and when mixed with aluminum bronze powder, 1 pound per gallon, successfully seals many bituminous paints from bleeding.

WHAT IS BERRYLOID ZINC CHROMATE PRIMER?

Berryloid Zinc Chromate Primer is a combined Glyceryl Phthalate-Heat reacted Plastic Phenol Formaldehyde Vehicle with Pure Zinc Chromate dispersed throughout by a special dual controlled method of grinding and dispersion of Micronized particles. It is supplied as a viscous semi-opaque yellow liquid for use as a rust inhibitive priming coat on all alkali-earth metals.

WHY ZINC CHROMATE IS USED FOR THE PIGMENT CONTENT

The value of the chromate ION as a rust inhibitive is generally known and is borne out by the following explanation, using steel as an example:

When moisture reaches steel, since no vehicle is 100% waterproof, the following reaction takes place: The iron exhibits its solution tension to give Ferrous ion liberating electrons. The water present is in balance with the hydrogen and Hydroxyl ions, and therefore, is neutral.

The electrons generated by the solution tension of Iron have sufficient potential properties to discharge the hydrogen ion (H+) from the water as hydrogen, leaving the (OH) or Hydroxyl ion in excess, giving an alkaline reaction. Dissolved salts, such as Sodium Chloride, *NaCl*-, greatly accelerate this reaction, which explains the importance of greater protection on seacoasts.

A simple test illustrating this reaction and the value of the addition of the chromate ion, is the one used by the Bakelite Corporation, as follows:

Test:

A clean iron nail is placed in an aqueous jelly (AGAR-AGAR) in a petrie dish. To this jelly add a few drops of Potassium Ferrocyanide solution and a few drops of Phenolphthalein solution before jelly solidifies. The former in the presence of Ferrous ions turns a deep blue, and the latter from colorless, to pink or a deep red in the presence of Hydroxyl ions. In a few hours there will be found a deep blue area surrounding the nail, indicating where the iron has dissolved, liberating Ferrous ions, and a pink area indicating the liberation of Hydroxyl ions to give the alkaline reaction.

Now if another dish is prepared as above, and Zinc Chromate pigment is stirred in before the jelly sets, no blue or pink area appears. If, however, Lead Chromate is used or Iron Oxide instead of Zinc Chromate *the ionization producing the blue and pink areas proceeds at the normal rate*, INDICATING NO RUST INHIBITIVE PROPERTIES.

A test of this kind boiled down is conclusive proof that of all the pigments available for use in a priming coat, when inhibitive properties are desired in the pigment content, ZINC CHROMATE is outstanding.

THE SUPERIORITY OF BERRYLOID-PRIMER VEHICLE

Though the best of pigment be used, all of the advantage may be lost if an incompatible inferior vehicle is used. In formulating BERRYLOID ZINC CHROMATE PRIMER *thirty-six modifications* of Glyceryl Phthalate and Phenol formaldehyde resin were exposed to tidewater exposure in Florida for eight months, in order to arrive at a choice. The best of these combinations now is used as the vehicle portion of the Primer.

Also from a standpoint of workability and ease of handling, the vehicle plays an important part in drying. Affinity for top coats AND THE ABILITY TO PROMOTE THE MAXIMUM ADHESION WITH THE MINIMUM OF GLOSS is valuable in this type of primer.

FINISHING ALUMINUM AND DURAL

ENAMEL SYSTEM

On a properly prepared aluminum surface that has been treated with Deoxidine or Metalprep the following system has proven very satisfactory:

No. 1—One spray coat of Zinc Chromate Primer. Dry 30 minutes or more.

No. 2—One cross spray coat BOXX Primer-Surfacer. Dry 8 hours or overnight and sand with No. 320 Water Sandpaper. Clean up thoroughly with a damp sponge.

No. 3—One or two cross spray coats Aircraft Speedline Enamel in the desired color. This enamel dries to a natural high gloss without the need for rubbing and polishing.

PROTECTION OF ALCLAD DURING FABRICATION

To prevent scratching or marring of the bright surface of Alclad during the process of aircraft manufacture, several large contractors have adopted the following system:

The fresh, clean sheets of Alclad are removed from the shipping crates and immediately dipped into a tank of Lionoil Clear thinned 40% with mineral spirits (such as Varnolene). The sheets are hung on racks and allowed to drain and then dry. The production requirements in many factories now make a conveyor system desirable and some are using conveyor ovens for force-drying at 150° F. This Lionoil Coating has general acceptance with the services as a protective top coating. Our No. 64 Q. D. Lionoil is recommended where production requires a rapid drying in this operation.

After assembly and completion of the aircraft, some manufacturers apply a second coat of Lionoil (tinted with Prussian blue) to the interior parts, while others use a coating of aluminized Zinc Chromate Primer. The Lionoil shop coating is generally removed from the exterior Alclad surfaces, using a suitable brush wash or remover for this purpose.

METAL FINISHES

CLEANING SURFACE FOR PRIMING

One of the most important steps to insure a durable primer coating is the proper preparation of the surface. This is particularly true when subjected to severe conditions of exposure, as are seaplanes and flying boats.

In the past it was considered satisfactory to prepare surfaces for priming by washing with a solvent type of cleaner, such as coal tar or petroleum hydrocarbons, turpentine, or lacquer thinners, etc. Laboratory and service tests definitely indicate that this method of cleaning is very unsatisfactory and cannot be recommended.

The most common type of failure produced from this method of cleaning is lack of adhesion, resulting in blistering and peeling. Evidence of this type of failure is directly proportional to the quality of the priming material.

There are many theories that would attribute this loss of adhesion to the difference between the surface tension of the cleaner and of the material on the surface being cleaned, as in the case of alkali cleaner containing silicate, which will tend to destroy adhesion.

SURFACE TREATMENT FOR METALS

The best adhesion of any prime coat and finish is obtained on slightly dull and unpolished metal. In the case of steel tubing and fittings, sand blasting removes the scale and leaves clean, virgin metal which requires no further cleaning if the prime coat is immediately applied. Highly polished aluminum, aluminum alloys or Alclad do not give the best base for paint. The dull "gray plate" finish now available in aluminum and duralumin is an excellent type of surface for painting. Just remember that polished, shiny metal presents a glass-like surface, and should be sanded, dulled or roughened for best adhesion of any paint system. Anodized dural makes an excellent base for paint if it is primed, without handling, shortly after the anodizing.

In all other cases, it is recommended that all surfaces (Aluminum Alloy, Alclad, Magnesium Alloy, Stainless Steel, Cadmium Plating, Steel and Alloyed Steel) be cleaned with some phosphate or phosphoric acid cleaner such as Deoxidine or Metalprep which are commercial products most commonly used. This type of cleaner reacts with the metal, which renders the metal passive and less reactive to moisture. The two properties these cleaners have, first their chemical reaction and, second, effectively removing all dirt, grease or oil, render them very satisfactory agents for preparing surfaces for priming.

The U. S. Navy Specification SR 15c recommends the following cleaning procedures:

CASE No. 1

Cleaning before anodizing. The material used in the hot bath should be basically two parts of Oakite and one part of Fanon's Navy Specification XM 355, or two

parts C67 Navy Specification (used in place of the Oakite) and one part of Fanon's Navy Specification XM 355. The proportion is just the same, only in one case Navy C67 is substituted for Oakite.

CASE No. 2

Cleaning of parts after shop work and after the first coat of Primer. Parts such as hulls, cowling, etc., that have accumulated grease or dirt during shop work are usually too large to go back into the Oakite bath and must be cleaned on the floor or in the Paint Shop. Use a solution of Fanon's Cleaner Navy Specification RM 70. This material is a free rinsing soap. The parts should be washed down with RM 70 and thoroughly rinsed in clear water, preferably HOT. Cold water may be used if this is not practical. RM 70 should not be used in the hot tanks before anodizing.

Of course, the regular HOT water rinses should be used after the Oakite bath and after the anodize bath, as usual.

BERRYLOID MILITARY LACQUERS

For military and all-metal aircraft Berry Brothers have developed a quality line of lacquers to Army and Navy specifications. These are light weight, quick covering, flexible synthetic type lacquers of the most modern proven formulations. Tidewater tested in Florida, they have met the toughest of exposure tests successfully.

These lacquers can be thinned with our regular lacquer thinners and those approved for use by Army and Navy. They are generally thinned one part thinner to one part lacquer and sprayed in the ordinary manner.

Commercial automotive lacquers are not satisfactory over Zinc Chromate Primer and are not generally suited to aircraft usage.

PROTECTION OF INTERIOR DURAL SURFACES

Interior dural surfaces and structural members are subject to deteriorating effects of heat and humidity, and since these parts can be inspected only with difficulty, if at all, they should be given as much protection as the exterior surfaces. One coat of Berryloid Zinc Chromate Primer followed by one or two coats of Berryloid No. 507 Lacquer Aluminum gives ideal interior protection with lightness of weight for all metal aircraft.

Manufacturers of all metal airplanes have received excellent results from the application of one spray coat of Lionoil Prussian Blue. This material is our famous Lionoil Clear into which has been mixed a small amount of Prussian blue. This small amount of coloring matter serves merely as a guide to the finisher and insures complete covering of all parts. Allow to air-dry 24 hours. Parts may also be dipped and baked.

INTERIOR (COCKPIT OR CABIN) FINISH

Berryloid Instrument Dull Black Lacquer, Bronze Green Dull Lacquer (Spec. 3-158) or Amberry Dull Black are recommended for use over Berryloid Zinc Chromate

Primer on instrument panels, particularly when baking facilities are not available. They dry rapidly to a smooth, beautiful, dull finish.

A most attractive and practical finish for instrument boards can be obtained by the use of Berry Brothers Ruf Kast Finish.

This finish can be baked in steam, electric, gas or infa-red ovens.

Cabins lined with dural may be finished in Berryloid Primers and Berryloid Lacquer as previously described.

DURALUMIN PONTOONS AND FLYING BOAT HULLS

The treatment accorded finishes on pontoons and flying boat hulls in service is so severe that special care must be observed in their selection and application. The metal must be thoroughly cleaned, either by mild sandblasting, Deoxidine or preferably by anodizing; if possible, the sections should be primed before assembly. This procedure assures maximum adhesion of the primer, and hence, of the entire finish. After assembly, the primer should be washed with VM&P Naphtha, or Navy approved cleaner, to remove grease and dirt. Any unprimed spots which may have developed during assembly should be touched up with Berryloid Zinc Chromate Primer. When dry, scuff the primer lightly all over with No. 400 Carborundum paper and wipe clean.

Large builders of pontoons and flying boat hulls have used Berryloid Exterior Clear No. 507 Lacquer mixed with aluminum powder (½ pound per gallon) for a number of years with unequalled success. This finish is standard on the great world-wide fleet of aircraft, operated by Pan American Airways, and protects hulls against corrosion in most of the countries where aircraft operate.

Two coats of this lacquer are generally sufficient.

When colors are desired, use Berryloid Lacquers.

Berryspar Varnish mixed with 1¾ pounds of fine aluminum bronze powder per gallon and properly thinned for application has been used with great success by the U. S. Coast Guard and we can recommend this finish also.

PLYWOOD FINISHES

PIGMENTED DOPE FINISH

Several leading builders have tested and adopted for production the following system, which is the strongest and most durable finish for plywood ever devised. As a matter of fact, the strength of the plywood is increased approximately 15% by this method.

Sand the plywood thoroughly to obtain a smooth, regular surface and to remove as much glue from around the joints as is possible. Brush one coat of No. 64 Q. D. Lionoil Clear and allow to dry ½ hour.

Brush or spray two coats of Berryloid Clear Nitrate Dope, allowing 45 minutes between coats. When dope is thoroughly dry, tack Balloon Cloth in place, and with a stiff bristle brush dope the fabric to the surface, using Berryloid Clear Nitrate Dope thinned equal parts with Berryloid Reducer. (Note: brush in one direction only in order to eliminate bubbles between the undercoats and fabric. Puncture fabric with pins to release imprisoned air if necessary. Follow with a second brush coat of Berryloid Clear Nitrate Dope before the preceding coat has completely dried out, if possible. Allow to dry thoroughly.) Scuff sand with No. 320 Water Sandpaper.

Spray two or three coats Berryloid Pigmented Dope in the desired color. Water sand smooth with No. 320 carborundum grits. Wipe clean and finish with one wet spray coat of a mixture consisting of equal parts Berryloid Pigmented Dope and Berryloid Clear Nitrate Dope thinned to spraying consistency with Berryloid Reducer.

If a higher gloss is desired, rub with Berryloid Superfine Rubbing Compound.

ENAMEL SYSTEM

OPERATION No. 1

One brush coat of No. 65 Q.D. Lionoil reduced on the basis of 3 parts Lionoil to 1 part Toluene Substitute. Dries in 45 minutes to 1 hour.

OPERATION No. 2

On Mahogany Plywood brush a coat of Speedline Wood Filler reduced 33⅓ to 50% with VM&P Naphtha, be sure to brush well into the grain of the wood. If sprayed, reduce 50 to 75% with VM&P Naphtha. Allow to set for two or three minutes, sufficient for the solvent to evaporate. Wipe off the excess across the grain with burlap or rough cloth. Dries in one hour. Close-grained woods do not require filling. As an added precaution all plywood seams should be taped in the usual manner, using clear dope as the adhesive.

OPERATION No. 3

Spray a cross coat of BOXX Primer-Surfacer (available in Pink, White or Gray). Dries to sand in 6 to 8 hours. Sand with No. 380 or 400 sandpaper. Water or gasoline is recommended to facilitate this operation. Clean thoroughly with a damp sponge.

OPERATION No. 4

Spray one or two cross coats of Aircraft Speedline Enamel in the desired color, reduced on the basis of 4 parts enamel to 1 part Speedline Reducer. This enamel dries with a high natural gloss, requiring no rubbing or polishing to complete the finish.

WOOD RIBS, SPARS, ETC.

Wood ribs, spars and other internal wooden members should be finished as follows: If dip tanks are available, apply two coats of Lionoil Clear or one dip coat of Lionoil Clear or No. 64 Q.D. Lionoil and one spray coat of Berryloid Aircraft Spar Varnish. If dipping facilities are not available, spray or brush two coats of Berryloid Aircraft Spar Varnish or Lionoil.

Where quantity production makes it practicable, a large dip tank containing Lionoil gives a quick, economical and very thorough method of finishing. Assembled wings and other parts are given two dip coats, sufficient drying time being allowed after each application. Lionoil may also be sprayed or brushed.

Note: All structural surfaces finished in an oil-base system, which are likely to come in contact with fabric during the doping process should be given a coat of Berryloid White Dope Proof Paint to protect them against the action of the solvents in the dope. Zinc Chromate Primer is also used as a dope-proof coating.

AMBERRY ENGINE ENAMEL

GLOSS BLACK

The above enamel is now being sold to several large operating companies and air lines as a finish for air cooled engine cylinders.

We find that it stands up much longer than many other engine enamel blacks, and is far more satisfactory from the application standpoint. It can be applied to the bare metal without a prime coat; or can be applied over the old finish after the surface has been thoroughly cleaned. It dries to touch in just a few minutes and dries hard in a few hours. It can be applied by brush at 40% reduction with solvent naphtha, or can be sprayed on when thinned 75 to 100% with Toluol, Solvent Naphtha or Amberry Reducer. It is weather resisting, and withstands the action of engine oil and gasoline to an unusual degree.

One of our large customers has had an engine in operation for 400 hours and reports that this finish looks almost as good as new, showing only a slight dulling after all this time in the air. They have had a large number of engines in service finished in Amberry Enamel, Gloss Black, and they recommend it most highly for all operations.

BLUE GRAY

Amberry Engine Enamel Blue-Gray is available in a good shade of slate blue for use on motor accessories and crankcases. It air dries rapidly and withstands oil, gasoline, heat and moisture to an unusual degree.

NOTE: Berryloid Military Lacquer (Spec. AN-L-29) is being used successfully on airplane engines over a primer coat of Berryloid Zinc Chromate Primer. It air dries rapidly and withstands oil and gasoline extremely well.

FINISHING HINTS

To insure a good finish, be certain that the structure is *ready* for the covering.

(a) Smooth off sharp corners and rough spots.

(b) Cover bolt heads and nuts, rivets, etc., coming in contact with the covering, with adhesive tape.

(c) In the event of a metal covered leading edge on metal ribs, it is advisable to tape a piece of fabric over the entire nose of the airfoil, before the cover is pulled on.

(d) Sand edges of wooden ribs and fairing strips; then put a strip of adhesive tape down the fairing strips. This precaution will tend to prevent cracking of the finish over these otherwise sharp corners.

When the cover is on and sewed up, a complete inspection of same should be made to see that there are no tears, wrinkles, creases, etc. In the event wrinkles or creases are found, a sponge dampened with water and rubbed briskly over the affected area will remove same.

Any oil or grease spots found on the bare fabric should be washed out with naphtha or thinner.

Be sure the covering is dry and ready for its first coat of dope. Specifications for finish application will be found elsewhere in this volume. Some points that require special attention follow:

1. See that all dope to be used has been at a temperature of 70° to 75° F. for 24 to 48 hours before its use.
2. Brushing the first two coats is generally advised, since spraying seems to lift the nap and cause the finish to be much rougher than when the coats are brushed.
3. If desired, the wing tape may be applied as a separate operation *before* the second coat of dope is applied. This procedure has the advantage of giving the tape as many coats as the rest of the surface. Another method is to use tape which has been saturated with dope in one of two methods, and then allowed to dry.
   a. One method is to merely soak the roll of tape in dope and then let it dry after it has been completely saturated.
   b. A more satisfactory method is to rig up a pair of rollers on saw horses; run the tape from one horse through a pan of dope equipped with brass rollers in the pan to keep the tape submerged, on to another roller mounted on a horse 25 or 30 feet away. The tape will dry sufficiently between the two horses so that it can be rolled up without sticking.
   c. Yet another method, which by the way is quite helpful on large wings, is as follows: Have a box or can fixed so that the tape may be threaded through the box, being submerged in the dope it contains, and coming out wet with dope. Place a scraper on the top of the box so that it will remove the surplus dope on one side of the tape. Pull the tape through and on to the wing or other surface, using the saturated or wettest side next to the surface.

4. The second coat is then applied. If it is necessary to thin this coat, do not attempt to stick patches or tape with this coat. To satisfactorily stick tape or patches, full bodied (or unthinned) dope must be used.

5. The third coat may be brushed or sprayed. If sprayed (which is advised), a pressure tank is necessary. A suction cup is not satisfactory, since the dope must be thinned too much to have appreciable filling or tautening qualities left.

6. A good sanding at this point makes the finish much smoother and makes the next sanding much easier. Use No. 150 production paper or No. 180 or No. 220 wet or dry paper, used dry.

7. Apply three coats of color, as per specifications.
   a. Take care that all color coats are strained.
   b. Be sure that fluid hose is clean.

8. Give a water sanding after the second coat, if a rubbed finish is to be had. Use No. 320 wet or dry paper.

9. If the finish is to be rubbed, it is safer to apply a very thin coat of the same mixture as the first two color coats; if not to be rubbed, use the gloss coat as specified.

NOTE: There are various ideas in the industry as to just what constitutes a coat of dope, or lacquer. Just how much material is to be called "a coat"? For some time practically all spraymen using a suction type gun have cross-sprayed (*i. e.*, spray all horizontally, and then re-spray vertically over all, while the first application is still wet). This procedure prevents "low spots" and streaks.

Cross spray coat is generally considered one coat. The amount of material applied by such a method is variable, but is limited by the fact that excessive amounts will "run" or "sag." Practically all points pertinent to actual spraying, amounts per coat, etc., are necessarily abstract, since so many variable factors are present; for example, the speed of the sprayman, the distance from the job, humidity, etc.

With the advent of the new dope guns, many sprayers have continued to use the cross spray system, while others have changed into spraying in one direction only, for one coat. In our specifications, we consider the cross spray coat as one coat when *pressure* spray systems are used, and one-half coat when *suction* equipment is used.

COMMON TROUBLES IN AIRCRAFT FINISHING AND HOW THEY CAN BE PREVENTED

For those who are not so well acquainted with finishing problems and their cures, we will endeavor to explain in this article how the common troubles may be overcome.

Finishing troubles may be divided into the following groups: (a) Faulty finishing materials. (b) Incorrect methods of application. (c) Unsuitable equipment. (d) Unusual climatic and atmospheric condition, including temperatures of material as well as air.

Faulty finishing material may oftentimes be adjusted for proper results by an experienced finisher. Generally it is advisable to "call in" a technical representative from the concern that manufactured the goods.

For each correct method of application, there are a dozen or more incorrect ways. Paints, dopes, varnishes, lacquers, enamels, et cetera, are applied in many ways, including brushing, spraying, dipping, "rolling" and "tumbling." The last two mentioned systems are not used in the aircraft industry as yet.

Goods, to be brushed, must not be too heavy or they will "pull" and dry rough and streaked on the surface. If too thin they will run, sag and not "cover" properly.

Spraying materials must be thinned with suitable thinners or reducers (designed for use with specific products) to the proper degree. The type of equipment and air pressures available generally determine the degree of thinning. Generally such materials, if not thinned sufficiently, will pit, pebble and "dust on" the surface to which they are being applied. If thinned too far, the pigment or vehicle will "break"; furthermore, the thin material may run or sag if heavily applied and may not properly "cover," or "hide."

Only certain finishes can be applied by the dip method, and must be formulated for this purpose. Some come all ready for application, but generally a definite amount of thinning is necessary with a specified thinner. Materials remaining in a dip tank without occasional freshening by use and addition of new material spoil and cannot be used again. It is advisable to strain and clear the dip tank from time to time. Mechanical agitation can be accomplished by the use of a small motor driven propeller at the bottom of the dip tank.

Here are some of the more common troubles and means of handling them, as they come to mind:

(1) IN COLD WEATHER, dopes left in unheated rooms or outside become quite viscous. These should be kept in a warm room between 75-80° at least 24 hours before using—when in 50 gallon drums, it will take the dope 48 hours to reach this temperature. Cold dopes will pull and rope under the brush, and if thinned sufficiently to spray or brush, will needlessly use extra thinner and lack "body" when the thinner evaporates.

(2) "BLUSHING" in dopes or lacquers is common in humid weather. This condition in nitrocellulose products is caused by rapid evaporation of thinners and solvents, which lowers the temperature on the surface, causing condensation of moisture in the atmosphere. This moisture on the surface of the wet dope or lacquer precipi-

tates the nitrocellulose out of solution, thus giving the white appearance known as "blush." Of course such a decomposed finish is of no value either in tautening or protecting the surface for any period of time. Therefore, the blush must be eliminated if the finish is to endure. This is best accomplished by spraying the blushed surface with a mixture of Berryloid Reducer and Berryloid Anti-Blush Reducer in approximately equal parts, depending on the degree of blushing. If badly "blushed," a greater proportion of Anti-Blush Reducer is required, or less when slightly "blushed." Berryloid Anti-Blush Reducer can also be successfully added to the lacquer or dope to assist in prevention of "blush" during application.

Remembering the old motto—"An ounce of prevention is worth a pound of cure," we feel it wise to include herewith some information on the best atmospheric conditions for a dope room and methods of "blush" control.

The best working conditions in a dope room are obtained at temperatures between 65-80° F., with a relative humidity not over 65% at these temperatures.

Methods of humidity control are as follows:

(a) SIMPLE (HEAT) METHOD—When the relative humidity is only high enough to cause a small amount of blushing, an increase of 5° or 10° F. in the room temperature will generally stop the trouble. This method is limited in its scope because temperatures over 90-95° F. cause too rapid drying of dopes—a common cause of pinholes in the finish.

(b) MECHANICAL METHOD—This is by far the best method of humidity control, as it is possible by the use of proper equipment to produce any desired atmospheric condition. This is accomplished by the use of refrigeration and heating equipment, wherein moisture is removed from the air by cooling (refrigeration) to a sufficiently low temperature and the low humidity air then reheated to the proper temperature before passing into the room.

The main drawback in the use of this type of equipment is the initial expense involved. (It is likely that local conditions may be such as to make it possible to reduce the cost by the elimination of part of the above process and its requisite equipment.)

(c) SOLVENT METHOD—If the blushing troubles are not too severe (i. e., if the relative humidity and temperature are not in excess of 70% and 85° F.), it is possible to eliminate the difficulty by the addition of anti-blush reducer to the dopes and lacquers, in quantities not to exceed one quart of anti-blush reducer to one gallon of dope or lacquer.

The disadvantages of this system are (1) increase in time required for finishing, due to slowing up of drying, and (2) cost of the anti-blush reducer.

Many finishers of aircraft have found it possible to combine methods "a" and "c" to produce the desired result in a very economical fashion, without materially affecting production time.

(3) "ORANGE PEEL" or "pebble" on a lacquer or pigmented dope finish will result from insufficiently reduced lacquer or pigmented dope, or when the spray gun is held too far from the surface to be painted. Cheap thinners tend to aggravate this trouble as well as reduce the lustre of the finish. Use only those thinners made and recommended by the manufacturer of the dope or lacquer. The proper spray gun with proper adjustment is a prime requisite.

(4) "PIN HOLES" in a lacquer or dope finish are caused by entrance into the spray gun of water or oil in the air line. Hence, air lines and air conditioning units should be kept clean and in first class condition at all times. "Pin holes" and "blisters" may also be caused by force drying of the lacquer or dope with heat. "Rushing" the application of coats is also harmful. Also unbalanced air and fluid pressures, causing poor atomization.

(5) WET AREAS on a lacquered or doped surface indicate that oil, grease, wax, soap, etc., which may have been on the surface previous to lacquering or doping, had not been properly removed. Thorough cleaning of all parts to be painted must be insisted upon.

(6) Lacquer or dope will "blister" if applied in too heavy or too wet a coat over a priming coat which has not thoroughly dried. The only remedy is to clean off the surface and refinish.

(7) RUNS, SAGS, LAPS and STREAKS are caused by improperly adjusted spraying equipment or by improper application of material. Excess material will run before it has had a chance to dry. Streaks made by not thinning the material enough may be eliminated by cross spraying, i.e., spraying one coat horizontally and the next vertically. Laps will show if the last coat was insufficiently reduced. A coat of reducer consisting of one part Berryloid Anti-Blush Reducer and three parts regular Berryloid Reducer will remedy this trouble. Cross spraying is advised in using lacquers and pigmented dopes.

(8) PEELING or FLAKING of a finish on metal parts results from improper undercoats of primer or improper treatment of the surface. The metal should be mechanically roughed by sand blast, wire brushing, or hand sanding, as paint will not properly adhere to a glassy dural or aluminum surface or to scaly steel tubes or fittings. After the above operation, clean with Deoxidine and wash off with warm water and dry, leaving a virgin, neutralized surface of metal ready for the prime coat. If possible, use oil base or synthetic metal primers and bake on at suitable temperatures; otherwise, air dry. Pyroxylin primers do not check incipient corrosion, and are more subject to peeling than are high grade oil base primers.

(9) Refinishing troubles are varied and many. So many types of materials and methods of application have been used that it seems impossible to specify a system of refinishing over old fabric that will always give satisfactory results. In the first place, most ships are finished at the factory in the maximum number of coats that it is desirable to apply to the fabric, and additional coats may cause trouble. Secondly, the weathering of the original finish changes it chemically, and when new material is applied, will very likely cause cracking.

If the paint job is badly cracked and the fabric two years old, the Dept. of Commerce inspectors generally demand re-covering.

Oftentimes the old dope and paint can be partially removed with Wax Free Paint and Dope Remover, and built up again with additional coats. Remember, the old surfaces should first of all be cleaned with high test gasoline, or benzol, and at least softened up with a solvent such as above mentioned. It is generally advisable to refinish a small

surface or section at first, and if satisfactory, complete the whole job in the method that gives the painter best results.

What might be a very serious trouble is fire; so preventives of such disasters deserve serious consideration. Fire hazards in aircraft factories can be practically eliminated by observing the following precautions:

1. USE "GOOD HOUSEKEEPING" METHODS THROUGHOUT THE ENTIRE PLANT.
   a. Spontaneous combustion will occur in piles of dirty or oily rags. Remember that many fires start this way, as well as from paint materials.
   b. Dirt and spray dust on the floors, spraying equipment or in spray booth is a source of danger. Keep your equipment clean at all times.
   c. Do not allow an excess of paint, dope or lacquer to accumulate in any form (dry, dust or semi-dry) in or near the finishing department. *This is important!*
2. PROPER VENTILATION IS NECESSARY BOTH IN SPRAY BOOTHS AND DOPE ROOMS.
   a. Exhaust fans of sufficient size should be installed in spray booths. Non-sparking equipment should be used.
   b. The fresh air supply should be distributed to avoid back drafts from exhaust chambers.
   c. Keep windows closed near spray booths and admit air through designated openings, generally along the ceiling.
   d. Reputable manufacturers of spraying equipment should be consulted on this important subject.
3. SPRAYING WORK OUTSIDE OF PROPERLY DESIGNED SPRAY BOOTHS constitutes a serious hazard with all types of finishing materials. Immediate exhaustion of fumes from spraying or doping operations eliminates one of the greatest hazards of dope or lacquer.
4. All painting and doping materials not in actual use should be stored well outside of the finishing buildings.
5. NO SMOKING should be permitted in aircraft factories, nor should open flames be allowed near the finishing rooms.
6. Fire-fighting equipment should be readily available.
   a. An overhead sprinkling system will pay for itself in a few years in savings on fire insurance.
   b. Fire extinguishers of the CO_2 type are recommended for the paint department.
7. "Ground" the mechanical equipment in the paint shop to prevent sparks of static electricity.
8. Concrete floors in finishing rooms are not recommended because of sparking caused by workers' shoes. Composition flooring or rubber soles on workers' shoes will eliminate this danger.

9. When possible, separate the dope and paint rooms from the rest of the factory, preferably in another building.

PRODUCTION NOTES

1. Jigs for facilitating the handling of fuselages and wings by permitting them to be rotated about a longitudinal axis, have proved their utility as time and labor savers.
2. A much neater job can be obtained at places where patches and tape overlap by applying the patch under the tape.
3. The quality and appearance of the finished job depends on the care taken in the application of *each* individual coat and *each* sanding. A series of careful operations must certainly give a smooth, satisfactory finish.
4. In cold weather dope left in unheated rooms or outside becomes quite viscous. These dopes should be kept in a warm room for at least 24 hours before using. Cold dopes will "pull" and "rope" under the brush, thereby producing a rough finish.
5. Spraying dope economizes time and labor and also produces the best finish. There are several types of spray guns which will spray dope satisfactorily. Two of the best known are the Binks and the DeVilbiss.
   The regular suction type gun cannot give the atomization that is possible with the special dope guns; therefore, as wet a coat is not applied. The special dope guns have the advantages of excellent atomization and handling a large volume of viscous material satisfactorily.
6. In the event of a "deep" blush or a blush of long standing, the following method is quite satisfactory in removing same. Soak a rag in Berryloid Reducer or Berryloid Anti-Blush; wipe the blushed spot with the wet rag, wiping back and forth until it is evident that the blush has disappeared. This system is much more effective in "deep-seated" blushes than is merely spraying.
7. Failure of the finish will eventually occur where the dope has blushed and has not been removed. Remove the blush from each coat, do not wait until all coats are on and hope to remove blush covered by succeeding coats. Troubles from this source can largely be eliminated by the adequate use of Berryloid Anti-Blush Reducer. Approximately one-half pint of Berryloid Anti-Blush Reducer added to a gallon of dope will tend to reduce the probability of blushing. A separate spray coat consisting of one-half Anti-Blush and one-half Berryloid Reducer, sprayed on the blushed surface, will remove the blush, provided the surface has dried thoroughly. This operation will also increase the inherent gloss of the finish.
8. Should the fabric adhere to spars, braces, etc., on application of the first few dope coats, a plumber's rubber force cup on a short handle will pull it loose without marring the finish, if used before the dope is set.
9. A minimum of thirty to forty-five minutes drying time should be allowed between coats of dope. Four to twelve hours is advised for drying aluminum pigmented

dope before sanding and recoating in color. This will give a much better surface on which to sand, making that operation somewhat easier. It will also tend to eliminate the possibility of loosening the fabric, caused by pressure exerted in sanding.

10. Orange peel will result from—
    a. Insufficiently reduced lacquer.
    b. Holding the spray gun too far from the surface.
    c. Too low air pressure.
    d. Cheap thinners tend to aggravate the above trouble and also to reduce inherent gloss of the material. Use only thinners made and recommended by lacquer manufacturers.
    e. Dope being too cold.

11. Pin holes in the finish are caused by—
    a. Entrance into the air line of oil or water.
        1. Hence, air lines and air conditioning units must be kept clean at all times.
    b. Force drying with heat.
        1. Blisters are also caused by same.
    c. Application of coats without proper drying intervals.
    d. Unbalanced air and fluid pressures for proper atomization.

12. Wet areas on a doped or lacquered surface indicate that oil, grease, wax, soap, etc., which may have been on the surface prior to priming or finishing had not been removed. Thorough cleaning of all parts must be insisted upon.

13. Dope or lacquer may blister or lift the primer when applied in too heavy or wet a coating over it, if the latter is not *thoroughly* dry. The only remedy is to clean off the surface and refinish.

14. Runs, sags, laps, streaks, high and low spots are caused by improperly adjusted spraying equipment or by improper application. Excess material will run before it has a chance to dry. Streaks may be eliminated by thinning the material enough, and by cross spraying; i.e., spraying one coat horizontally and the next vertically. Laps will show if the last coat of material was insufficiently reduced. A coat of reducer, consisting of one part Berryloid Anti-Blush Reducer and three parts of regular Berryloid Reducer, will eliminate the trouble. Cross spraying is advised in using lacquers and pigmented dopes.

15. Two tone combinations are most easily produced by first spraying the lighter color, masking off the design and then spraying the darker color.

16. When it is necessary to apply a patch over a doped surface, certain precautions should be taken. Wash the area with Berryloid Reducer to remove any oil or grease which may be on the fabric. Reducer will soften the dope film, and the softened outer coats should then be scraped off with a blunt edged tool, such as a putty knife or spatula. The hole or tear should be darned if it is a bad one. The patch should be sufficiently large to extend at least one and one-half inches beyond the

broken or cut threads, and the edges of the patch should be "pinked" or frayed about one-quarter of an inch all the way around. Dope should be applied to the surface to be patched, as well as to the patch itself, and the latter then laid. It is essential that this be done, as otherwise the patch may not adhere. When the patch has dried out smooth, apply to the patch the same number of coats of similar material as were used over the original surface.

17. The weight per square yard of the Berryloid fabric finishing system is 4 coats, 4.7 to 5.0 oz.

18. Berryloid dopes, both clear and colored, will cover about 110 square feet of surface, one coat per gallon, when brushed or sprayed without thinning. Regular Berryloid, when thinned equal parts with Berryloid Reducer, will cover about 300 square feet, one coat per gallon of unthinned lacquer. The better hiding colors will cover a considerably greater area.

COLORS AND COLOR MIXING

We believe that a short discussion on colors and a description telling how many of them are obtained through proper mixing of primary, secondary and tertiary colors will prove of interest.

Red, yellow and blue are the primary colors. The secondary colors, orange, green and violet are produced by mixing the primary. That is, red and yellow give orange; yellow and blue give green; blue and red give violet. The tertiary colors, citron, olive and russet, are produced from four parts of orange and one part of green for citron; four parts of orange and one part of olive for russet; and four parts of green and one of violet to make olive. The above colors, with white, black, gray, silver and gold are all that are necessary to make the modern industrial colors ordinarily used. Varying the proportions in mixing the colors will throw the resulting color to the shade desired. That is, if a light orange is desired, use a larger proportion of yellow than of red. For a dark orange, use a greater proportion of red, and so on.

Mixtures of colors to get certain results may be tabulated as follows:

Black and Red	**make**	**Brown**
Blue, Red, White	**"**	**Lavender**
Green and Yellow	**"**	**Pea Green**
White and Black	**"**	**Gray**
White and Yellow	**"**	**Straw Color**

In mixing colors, add the darker shades to the light, as it takes a great deal more of the light shade to lighten a dark color than it does of a dark color to darken a light hue.

A little experience in mixing and tinting with the shades of color that the painter may have available will enable him to match most colors quite successfully. Often by properly mixing together some unpopular colors more saleable hues may be secured without buying additional paint. In this way knowledge of color mixing may prove most valuable to a painter wishing to cut down on his inventory of dopes and lacquers.

MATERIALS REQUIRED FOR RECOVERING SMALL AIRPLANES

Between 55 & 75 sq. yds. of fabric are required for recovering, depending on the size of the plane.

Approximately 20 to 30 gallons of clear dope and 8 to 12 gallons of pigmented dope are required on the average small plane.

To obtain a full-bodied, smooth finish it is necessary to use the larger amounts recommended.

SELECTION OF COLORS AND COLOR COMBINATIONS

The selection of colors and color combinations for aircraft should be guided by (1) durability of some colors as compared with others, (2) visibility of the colors in the air and on the ground, and (3) pleasing color harmonies.

Greens, oranges, yellows, dark grays, aluminum and certain shades of non-fading reds (like Stearman Vermilion and Fokker Red) give better hiding and protection in strong sunlight.

White, light creams and light grays "chalk" more readily and hide poorly.

Dark blues, particularly, tend to brittleness, and should be used only over black undercoatings. Light blues tend to change shade on exposure.

Some light reds and maroons, especially, as well as purple, are subject to fading.

All of these colors are used with satisfaction, but as explained, some are far superior in lending lengthy life to the finish.

The following visibility table, as published by the Physical Society of London, showing the effective range of auto signals, may be of interest:

Color	Range in miles	Color	Range in miles
Red	3-3.5	Yellow	1-1.5
Green	2.5-3	Blue	.5-.75
White	2-2.5	Violet	.5-.75

Orange yellow to vermilion orange colors have been commonly accepted after many tests in actual aircraft operation as the most visible colors contrasting with land, sky, verdure and water. These colors are also durable and resistant to fading. It is small wonder then that they are so popular, combining as they do the safety factor of extra visibility and longer life.

Another interesting table by Le Courrier, taken from the "Scientific American," may prove valuable to those using planes for advertising purposes. It gives the legibility of various color combinations.

Order of Legibility	Decoration	Background
1	Black	Yellow
2	Green	White
3	Red	White
4	Blue	White
5	White	Blue
6	Black	White
7	Yellow	Black
8	White	Red
9	White	Green
10	White	Black
11	Red	Yellow
12	Green	Red
13	Red	Green

In selecting and mixing colors it is well to remember the following:

(1) **Light, cool colors make objects look larger.**
(2) **Dark, warm colors make objects look smaller.**
(3) **Shades and tints of the same color go well together.**
(4) **Bright striking color combinations are recommended for aircraft in preference to dull or soft colors.**

For further detailed information on color, we recommend "Practical Color Simplified" by William Miskella, published in Chicago at the Finishing Research Laboratories.

We are listing herewith several color combinations selected by a leading color expert specializing in color schemes for aircraft. These will assist you and your customers we are sure.

Scheme Number	Wings and Horizontal Tail Surfaces	Fuselage fin and rudder	NACA cowl	Pants	Striping (if any)
1.	International Orange	International Orange	Silver	Silver	Black
2.	Stearman Vermilion	Stinson Red	Black	Black	Stearman Vermilion
3.	Loening Yellow	Black	Silver	Black	Loening Yellow
4.	Army & Navy Yellow	Berry Red	Berry Red	Berry Red	Gold
5.	Berry Red	Aircraft Gray	Aircraft Gray	Aircraft Gray	Gold
6.	Stinson Green	Black	Black	Stinson Green	Gold
7.	Black	Loening Yellow	Loening Yellow	Loening Yellow	Black
8.	Berry Red	Insignia Blue	Insignia Blue	Insignia Blue	Stearman Vermilion
9.	Berry Red	Berry Red	Gold	Gold	Stearman Vermilion edged with Black
10.	Silver	Insignia Blue	International Orange	Orange	International Orange or Insignia Blue

MATERIALS FOR THINNING BERRYLOID PRODUCTS

The best results in the application of finishing materials can, of course, only be obtained when the proper materials are used for thinning.

Also, an entire can of new material is sometimes spoiled because of the fact that an attempt was made to thin it with some material which might cause an immediate reaction, either precipitating the pigment or coagulating the vehicle.

The following thinners are those that are recommended by Berry Brothers for use with the Berryloid products. The use of these thinners with the various products as specified will eliminate possible difficulties on finishing jobs.

Berryloid Clear Dope, Berryloid Pigmented Dope and Berrychrome Pigmented Dope	Berryloid Nitrate Dope Thinner, Berryloid Reducer, 101 Lacquer Reducer
Berryloid Zinc Chromate Primer	Toluol Reducer
Red Oxide Primer	VM&P Naphtha
BOXX Primer-Surfacer	Toluol Reducer or Solvent Naphtha
Quick Drying Pyroxylin Primer	Berryloid Reducer
Lionoil	Turpentine, Turpentine Substitute or VM&P Naphtha
White Dope-Proof Paint	VM&P Naphtha
Berryloid Aircraft Spar Varnish, Berryspar Spar Varnish	Turpentine, Turpentine Substitute or VM&P Naphtha
Berryloid Quick Drying Enamel	Turpentine or Turpentine Substitute
Amberry Speed Line Enamels	Amberry Speed Line Reducer or Amberry Toluol Reducer
Berryloid Aircraft Enamel	Turpentine or Turpentine Substitute
Airport Marking Yellow, Airport Marking Black	Turpentine or Turpentine Substitute
Berryloid Pure Shellac	Alcohol
Berryloid Acid-Proof Black	VM&P Naphtha
BOXX Spot Putty	Toluol or Solvent Naphtha
Amberry Blue Gray Engine Enamel, Amberry Gloss Black Engine Enamel	Amberry Speed Line Reducer
Berryloid Exhaust Stack Black and Berryloid Exhaust Stack Bronzing Liquid	VM&P Naphtha
Berryloid Lacquer	Berryloid Reducer
Pyroxylin Sanding Surfacer	Berryloid Reducer
Berryloid Rubbing Compound	Low Test Gasoline or Kerosene

EQUIPMENT FOR AN AIRCRAFT PAINT SHOP

The Chief Requirements for an Airplane Shop are:

1. Adequate spray booth and exhaust fans.
2. Suitable racks and jigs for holding and handling wings, cowling and other parts to be sprayed.
   a. Pulleys and hoists are used in some cases for drying parts.
3. Air compressor and tank capable of maintaining at least 80 lbs. pressure for one or more spray guns during continuous operation.
4. Air unit—to remove oil and water from air and regulate the pressure.
   a. Oil and water traps in supply pipe also needed.
5. Dope, Lacquer and primer spray guns. We will be glad to supply list of approved types of spray guns. Syphon feed guns are satisfactory only for small shops. Production paint shops should install pressure feed equipment. Pressure tanks (for applying lacquer and dope when quantity is to be used) come in sizes from 2 gals. capacity up.
   a. Touch-up gun is very desirable.
6. Necessary quantity of air and fluid hose.
   a. Hose for each color is recommended.
7. An air duster for removing loose dust and dirt from the work is almost indispensable.
8. Adequate containers for mixing lacquers, dopes, etc.
   a. Measuring cup and a scale advised. (Graduates and Balance.)
9. Proper lighting conditions must be provided to secure the best work. Install vaporproof fixtures. The shop should be clean at all times to reduce the fire hazard and secure a finer finish on all work.
10. The finishing room should have a temperature betwen 70° and 80° F. and be well ventilated. Use only steam heat where lacquer or dope is in use.
11. All brushes, when not in use, should be washed out in reducer. Spray equipment will not give satisfactory results unless cleaned thoroughly when each day's work is finished. Special care should be taken to drain and wash out all fluid lines daily.
12. Fire prevention and fire fighting equipment.

COVERING CAPACITIES

BERRYLOID No. 102 NITRATE WING DOPE weighs 7.2 pounds, No. 101 weighs 7.45 pounds per gallon, and cover 110 square feet per gallon, per coat.

BERRYLOID PIGMENTED DOPE weighs approximately 7.5 to 8 pounds per gallon, depending on color, and covers 110 square feet per gallon per coat.

BERRYLOID ZINC CHROMATE PRIMER weighs 10.4 pounds per gallon, and covers 1100 square feet per coat after thinning with 2½ gallons of thinner.

DOPE PROOF PAINT weighs 11.7 pounds per gallon, and covers 400 square feet per gallon.

LIONOIL weighs 7 pounds per gallon, and covers 600 square feet per gallon.

BERRYSPAR VARNISH weighs 7.3 pounds per gallon, and covers 500 square feet per gallon.

WEIGHTS OF DOPE FILMS IN FABRIC FINISHES

The following film weights are approximate averages for one coat reduced to the proper consistency for spray in the case of each product:

	Weight per Square Yard
Zinc Chromate Primer	.65 oz.
Lionoil	1.30 oz.
No. 64 Lionoil	1.45 oz.
Berryspar	1.55 oz.
Aircraft Enamel	2.20 oz.
Aircraft Lacquer	1.95 oz.

No. of Coats		Weight of Film per Square Yard
1	No. 102 Clear Nitrate Dope, Brushed	.725 oz.
2	No. 102 Clear Nitrate Dope, Sprayed	.710 oz.
3	No. 102 Clear Nitrate Dope, Sprayed	.715 oz.
4	No. 102 Clear Nitrate Dope, Sprayed	.715 oz.
5	Pigmented Dope, Sprayed	1.25 oz.
6	Pigmented Dope, Sprayed	1.35 oz.
	Total Weight per Square Yard	5.465 oz.

Weight of Grade A fabric, bare, 4 oz. per sq. yard.

No. of Coats		Weight of Film per Square Yard
1st	No. 101a Clear Nitrate Dope, Brushed	1.50 oz.
2nd	No. 101a Clear Nitrate Dope, Sprayed	1.25 oz.
3rd	No. 101a Clear Nitrate Dope, Sprayed	1.25 oz.
4th	Pigmented Dope, Sprayed	1.50 oz.
5th	Pigmented Dope, Sprayed	1.60 oz.
	Total Weight per Square Yard	7.10 oz.

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BERRYLOID PIGMENTED DOPES

On the Wings of Progress

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LOENING YELLOW

PIPER CUB YELLOW

A & N ORANGE YELLOW

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WACO GUNMETAL GRAY

AIRCRAFT GRAY

INSIGNIA RED

BERRY RED

STINSON RED

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