

SPECIFICATIONS FOR
AIRCRAFT
FINISHING

FOURTH EDITION



BERRY BROTHERS^{INC.}
Varnishes - Enamels - Lacquers - Stains
Bleachers of Shellac
DETROIT • MICHIGAN

Specifications

∴ for ∴

AIRCRAFT FINISHING

4TH EDITION



ESTABLISHED 1858

Property
of
Russell T. Gerow

BERRY BROTHERS^{INC.}

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INTRODUCTION

Since issuing our 3rd Edition of "Specifications For Aircraft Finishing" early in 1928, Berry Brothers have developed new and improved methods of finishing to meet a popular demand along these lines. Laboratory research, practical field work, and the cooperation of our many friends and customers in this great Aircraft Industry have brought forth these finishing improvements which are detailed in the following pages.

It is our desire to make this technical information available to all persons in any way interested and to those who at sometime may need the fundamental knowledge contained herein. Already many flying schools have adopted this as their text book so that their graduates may obtain a correct foundation on this important phase of aviation.

During the past season the Berryloid Color Service has developed many novel and beautiful color schemes for airplanes, notable among these being the bird color combinations in our "Berryloid Fleet" series of advertisements and those in our "Berryloid Colorgraph".

Practical men giving service to our many customers cover the entire country and adequate stocks of aircraft finishes are now available in all important centers.

Berry Brothers in these many ways is endeavoring to give the customer just a bit more than he expects in service and to assure him of ultimate satisfaction as the years go by.

THOMAS B. COLBY,
Manager Aviation Division

June, 1929



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FINISHING MATERIALS

1. *Oleo-Resinous Materials*

a. Varnish

The term "varnish" may be applied to any liquid which, when applied to a surface, hardens to a more or less transparent coating which improves the appearance and enhances the life of the base material.

There are two general classes of varnish, namely, (1) Oleo-resinous varnishes (of which floor, piano and spar varnishes are typical examples) and (2) spirit varnishes (such as cut shellac and clear pyroxylin lacquers, etc.). However, the term "varnish" will be here understood to mean only the oleo-resinous type.

These varnishes dry by absorption of oxygen from the air and by chemical action within the drying film. Varnishes are made by melting suitable resins (Rosin, ester gum, Kauri copal, synthetic resins, etc.) and combining them at temperatures around 450° F with Linseed or China Wood oils and the necessary driers. When these ingredients have been properly cooked together, the product is cooled and thinned to the desired viscosity with turpentine or mineral spirits. The varnish is next thoroughly filtered to remove all solid matter and emerges as clear, transparent liquid. Finally, it is pumped to storage tanks and allowed to "ripen" for a period of from three to twelve months, depending on the grade.

In order to allow our varnishes to "ripen" properly, and at the same time to keep a supply of "ripe" varnish on hand, sufficiently large to fill all orders and to meet emergency demands, a very extensive storage capacity is obviously necessary. Berry Brothers have a total varnish tankage of one and one-half million gallons.

b. Enamels

Oil enamels are made by grinding the proper pigments in suitable varnish vehicles. They produce finishes characterized by exceedingly high gloss and hardness. Baking enamels and Japans may be classified under this heading, but require the application of heat for thorough hardening.

2. *Pyroxylin or Lacquer Materials*

A pyroxylin finishing material is one which consists of essentially nitrocellulose either alone, or in combination with resins, plasticizers and pigments dissolved in solvents which will permit of the deposition of a homogeneous coating.



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a. Dopes*

"Dope" is the name that has been given to the cellulose base solution used as a filling and finishing material for the fabric covered surfaces of airplanes. It is a product which has been developed to meet a need in the aircraft industry which could not be filled by ordinary finishing materials in use when aircraft were being perfected. Its first use was that of producing a gas film for balloons and airship bags.

The first gliders were covered only by unfinished fabric and it was due to a desire to make this fabric more airtight that finishes were applied. Starch solutions, glue sizes, and other similar water soluble finishes were tried. These were too greatly affected by rain and moisture to be of any lasting value. Varnish was tried and this, though it gave greater resistance to weathering than the previously used water soluble finishing materials, still did not meet the demands. The fabric could not be held sufficiently taut and rigid.

Someone used collodion, a solution of guncotton or cellulose nitrate dissolved in a mixture of ether and alcohol. This produced a clear hornlike film, which filled the pores in the fabric, but also produced another effect, namely that of causing the fabric to tighten and produced a smooth, fairly rigid surface conforming to the airfoil section.

This collodion solution was perfected, using less toxic solvents than ether and alcohol and was the fore-runner of the present airplane dope and modern automobile finish.

A STUDY IN ITSELF

The chemistry of preparing airplane dopes or automobile finishes is a study in itself, dependent upon the availability of various organic solvents, gums and plastics. The essential features are covered as follows:

Dope is essentially a colloidal solution of cellulose acetate or cellulose nitrate, together with sufficient softeners to give a smooth, homogeneous, flexible film when dry, produce tautness, and thus increase the strength of the fabric.

A fabric-covered surface without the addition of a protective film would be very susceptible to humidity changes, becoming slack or taut with every increase or decrease of atmospheric moisture. It would also lose its strength quite rapidly and could not give any protection to the interior wing structure. Coating the fabric-covered surfaces renders them weatherproof, tightens the surface to conform to the wing section, and produces a more nearly rigid airfoil.

*Excerpt from "Airplane Dopes and Their Application" by Gerald P. Young, "Aviation", April 23, 1928.

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The essential constituents of clear dope are five in number:

- a. The film-base compound.
- b. The softeners or flexilizers for producing a flexible film.
- c. The solvents for film-base material.
- d. The diluents for thinning the solution.
- e. The high-boiling compounds for controlling and preventing blushing, that is, provided ventilation is properly controlled.

The film-base compounds are cellulose acetate or cellulose nitrate. Cellulose acetate is the more expensive compound owing to the cost of the raw materials required to prepare it and to its more complicated process of manufacture.

Softeners or flexilizers are required to produce a flexible film, as the cellulose acetate or nitrate alone would be too brittle.

The solvents are the liquids which are used to dissolve the cellulose base materials. Acetone, methyl acetone, and methyl acetate are the most commonly used for cellulose acetate. Amyl acetate, butyl acetate, and ethyl acetate are the most commonly used for cellulose nitrate.

The diluents or thinners are liquids which have no appreciable solvent power by themselves, but are added to the solution to keep down the expense of the dope mixture. They evaporate completely with the volatile solvents. Common diluents for both cellulose acetate and nitrate dopes are benzol, ethyl alcohol, and methyl alcohol. The high boilers help to prevent whitening or blushing of the dope while it is drying. They tend to hold the cellulose acetate in solution when it is dried under conditions of relatively high humidity and in the presence of the water that forms on the surface owing to the chilling caused by evaporation of the highly volatile solvents.

Besides producing, when dry, a tautness of the fabric that is not greatly affected by changes in atmospheric moisture, dope should act as a protective coating to prevent rapid deterioration from weathering. A clear film of either cellulose acetate or cellulose nitrate dope is transparent to sunlight, and sunlight is the greatest factor in the deterioration of dope and fabrics."

b. Lacquer

Lacquer is a pyroxylin finishing material which is used as a final protective and decorative coating over any desired surface. The various ingredients must be carefully selected and proportioned in order that the lacquer may perform the particular duty for which it is formulated.



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Nitrocellulose imparts strength and toughness to the lacquer; resins, the necessary hardness, gloss, and adhesion; and the plasticizers (or flexilizers) the requisite softness and flexibility. The importance of careful formulation can be readily understood when it is realized that too much resin will produce brittleness, while too much plasticizer will leave a soft, "tacky" film which may never dry.

Automobile Berryloid is intended for use on automobiles and other metallic surfaces, over suitable priming and surfacing coats, to give a hard, durable protective coating, which can be rubbed to a high gloss. Aircraft Berryloid is intended for use on metallic parts of aircraft, over suitable priming and surfacing coats. Greater flexibility and higher gloss are required for this type of coating than for the automobile type since rubbing is seldom resorted to. Aircraft Berryloid, however, is too hard and not quite flexible enough for use on fabric.

Fabric Berryloid is made from Aircraft Berryloid by the addition of from four to six ounces of Plasticizer per gallon. This addition increases the flexibility of the Aircraft Berryloid sufficiently to make it suitable for use as a fabric coating, but if used on metal, provided it dries at all, early checking will result.

Clear dope is highly affected by the actinic rays of the sun which break down both dope and fabric causing rapid deterioration. The effect of these rays may be cut out by the introduction of an opaque filler or covering to be used on the final coats.



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FINISH FOR AIRPLANES

1. Fuselage and Landing Gear

a. Finish for steel tubing fuselage and landing gear, etc.

1. Interior Protection

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

No better material than Lionoil can be used for this purpose. It flows quickly, 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 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 forced through from a pressure tank by compressed air. It should enter at a point in one of the lower longerons and go up to the top. 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.

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 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 that must be removed before finishing. The most efficient method is that of sand-blasting, now adopted in many of the larger plants and on



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government work. Otherwise the rust and dirt should be removed with Deoxidine or equivalent 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.

Finish

1 coat Berryloid Primer (oil base only).

1 coat Aircraft Berryloid (color to match upholstery desirable).

This finish adheres better, wears longer and produces a finer appearing job than any other for this purpose. Although dope will soften the lacquer, it will not "lift" the primer and the finish will "harden down" when the dope dries.

Spray on one coat of primer. This operation is performed by spraying in a mere fraction of the time that brushing requires, and is more thorough. Use only the best oil base primer. Pyroxylin primers lack rust inhibitive qualities and are absolutely condemned for airplane work.

Allow the primer to air dry 24 hours or bake $1\frac{1}{2}$ hours at 225° F. Then apply one spray coat of Aircraft Berryloid thinned with an equal quantity of Berryloid Reducer.

Alternative Finishes

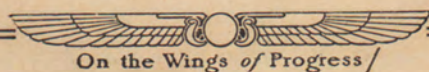
When a lacquer finish is not practical, satisfactory results may be obtained with one coat of Lionoil Clear, when dry, followed by a coat of Lionoil Aluminum. The Lionoil Aluminum is prepared by mixing one gallon Lionoil Clear with $1\frac{1}{2}$ pounds of Aluminum Bronze Powder. Add a small quantity of the Lionoil to the powder and stir into a heavy paste before thinning down with the remainder.

Berryspar may also be used for above purpose with excellent results. If necessary to reduce Berryspar Aluminum for spraying, use only naphtha.

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.

Berryloid Red Oxide, Gray and White Dope-proof Paints are being used with success by many concerns. All three are exceedingly resistant to the lifting action of dope solvents, when thoroughly air dried.

When baking equipment is available we can recommend our Lionoil Raven Baking Enamel. This material bakes on at 250° F. in 2 hours or at 400° F. in 30 minutes time, producing a perfect rust preventive and absolutely dope proof finish.



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b. Finish for Wood Fuselages

See paragraph III-2 "Wood Ribs, Spars, etc."

For Shop

2. Wood Ribs, Spars, Etc.

Finish

2 coats of Lionoil Clear or Lionoil Prussian Blue, or 1 coat of Lionoil and 1 coat Berryspar.

Where quantity production makes it practical, a large dip tank containing the Lionoil gives a quick, economical and very thorough method of finishing. Assembled wings and other wooden parts are given two dip coats allowing sufficient time for drying. Lionoil is being sprayed in the majority of the plants and in a few cases is brushed on.

Berryspar should be sprayed or brushed as it will eventually skin over if left in dip tanks. It is too heavy in body to successfully dip.

Metal surfaces in the wing structures coming in contact with the fabric should be given a coat of Berryloid Dope Proof Paint to resist the dope.

NOTE: Under no circumstances use shellac or ordinary Pyroxylin lacquer on bare wood as their waterproofing and protective qualities are practically nil on this material under conditions of exposure.

3. Fabric Covering for Airplanes

A technical discussion of the subject of airplane fabric covering is obviously beyond the scope of this volume. Nevertheless, the cover plays such an important part in the finishing of airplanes, that a short review of the methods of application of fabric, seems very desirable.

There are two methods of covering now commonly followed (a) the "envelope" method and (b) the "blanket" method. Both systems have the following in common; all surface seams are lap-stitched and run parallel to the line of flight.

a. The Envelope Method

The "envelope" (or pillow case) method derives its name from the fact that the cover is sewed together and then slipped on to the structure which it is to cover, in a manner quite similar to the process of covering a pillow with a pillow-case.

This system is the best from a production standpoint because it minimizes hand sewing operations and saves much time and labor. The fabric must be accurately laid out and sewed, in order that it shall fit snugly, the structure it is intended to cover. The main disadvantage of this method is that it cannot be used on certain types of wings.



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b. The Blanket Method

The "blanket" method is probably the simplest known method of applying the cover on aircraft but requires a large expenditure of time and labor for hand sewing, etc.

To cover a wing the raw edge of the fabric is placed along the trailing edge and the fabric wrapped around the leading edge, back to the other side of the trailing edge. When the sections of fabric have been lapstitched, the cover is pulled tight and pinned to a cloth covering, which has previously been wrapped around the trailing edge. The cover is then sewed up at the trailing edge.

NOTE: It is very important that only fabric approved by the United States Air Corps be used for airplane coverings since cheap or unapproved materials are generally much weaker than standard and frequently contain unneutralized alkali from the mercerization process which will cause early deterioration of both fabric and finish.

In order to produce a satisfactory wing surface several things should be considered.

The fabric should be stretched to a uniform degree of tautness throughout the surface. This tautness can be determined only by trial as the dope will add to that already given the fabric when applied and is limited only by the strength of the structure. It is not possible to exert manually sufficient force to weaken the fabric in its application, but if it is stretched too tightly at the start the dope will cause a marked distortion of the wing structure when it has thoroughly dried.

To produce a surface that will have the least variation of tautness with subsequent changes in atmospheric humidity, the surface should be doped the same day if possible, that the surface is covered with fabric. If the fabric is stretched tightly over the structure and then not doped for several days, it assumes a permanent set and loses tautness and will not produce a satisfactory finish. Changes in atmospheric humidity will also cause a variation in the undoped fabric if allowed to wait several days before doping.

4. Finishes for Fabric Covered Airplanes

The finish possessed by an 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 thoroughly the finish is applied the greater will be the return in sales, satisfaction and service.

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For Shop

Airplanes depend, to an even greater extent than do other commodities, upon the finish since the latter must provide not only the necessary appearance and protection, but must also tauten and maintain the tautness of the fabric under varying atmospheric conditions of temperature and humidity.

The systems used in finishing aircraft may be classified into three general types, (a) Lacquer (Aircraft Berryloid) Finish, (b) Pigmented Dope Finish, (c) Semi-pigmented Dope Finish.

a. Aircraft Berryloid System (lacquer)

The Aircraft Berryloid (lacquer) system has been used with success by a large number of manufacturers. Brush one coat of Berryloid Clear Nitrate Dope; allow to dry and apply tape. (It is common practice to use ready-doped tape). Brush a second coat of Clear Dope simultaneously with, or as soon as possible after laying the tape, to avoid "high spots". When dry, *gently* scuff off nap of fabric with 280 speed grits or equivalent.

Next, spray or brush a third coat of Berryloid Clear Nitrate Dope (Use pressure feed spray system). For best results do not thin Berryloid dopes. Allow plenty of time for drying between coats. Then spray three coats of a semi-pigmented aluminum dope (1 lb. Extra Fine Aluminum Powder in 12 gallons Berryloid Clear Nitrate Dope). Sand thoroughly—* and then spray two *light* coats of Aircraft Fabric Berryloid thinned approximately 60 parts thinner to 40 parts Berryloid with regular Berryloid Reducer. Allow 12 hours between final dope coat and first lacquer coat and about one hour between coats of Aircraft Fabric Berryloid.

Some finishers prefer to omit the aluminum coats and apply six coats of Clear dope instead. In this case, however, it is necessary to use more lacquer to obtain the desired covering.

NOTE: Aircraft Berryloid is an aircraft lacquer containing the maximum amount of plasticizer that will permit drying of the finish over primer on metal. However, when it is applied over dope, some of the plasticizer (which gives lacquer its elasticity, but in too large quantities reduces tautness) is absorbed into the dope. *It is therefore, necessary to add four to six ounces of Berryloid Plasticizer per gallon of Aircraft Berryloid before reducing in order to maintain the desired flexibility of the finish when applied on fabric.*

*See paragraph 7 in "Production Notes".



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b. Berryloid Pigmented Dope System

The following system will produce on airplane fabric, a taut, well filled finish which is lighter, cheaper and somewhat more durable than the Berryloid system, but does not produce as glossy a finish.

Brush one coat of Berryloid Clear Nitrate Dope. Allow to dry (see footnote) and apply tape (It is common practice to use ready doped tape). Brush a second coat of Clear Dope simultaneously with or as soon as possible after laying tape, to avoid "high spots". When dry, *gently* scuff off nap of fabric with No. 280 speed grits or equivalent.

Next, spray or brush three coats of Berryloid Clear Nitrate Dope, allowing each coat to dry thoroughly. (Use the pressure feed system for spraying). For best results, do not thin Berryloid Dopes. The fifth coat of dope should be well sanded when dry.* Now spray or brush two coats of Berryloid Pigmented Dope of the desired color. Allow each coat to dry and then spray a good coat of a gloss thinner made by mixing one part Berryloid Anti-Blush Reducer with two parts Regular Berryloid Reducer. To obtain still higher gloss, rub with Berryloid Rubbing Compound and polish with a soft cloth.

c. Berryloid Semi-Pigmented Dope System

This system produces a finish on fabric, somewhat lighter and having greater durability and natural gloss than does the Berryloid Pigmented system, but cannot be used where it is desired to produce intricate designs and two-tone jobs on planes.

Brush one coat of Berryloid Clear Nitrate Dope. Allow plenty of drying time between coats. When dry, apply tape. (It is common practice to use ready-doped tape). Brush a second coat of Clear Dope simultaneously with, or as soon as possible after laying tape to avoid "high spots". When dry, *gently* scuff off nap of fabric with No. 280 speed grits, or equivalent. Next, brush or spray (preferably the latter) two coats Berryloid Semi-Pigmented Dope of the desired color. For best results do not thin Berryloid Dopes (use pressure feed spray system). Allow plenty of drying time between coats and sand last coat when dry*. Now spray three coats of Berryloid Semi-Pigmented Dope. This should produce a finish having high natural gloss. However, this can be increased by rubbing with Berryloid Rubbing compound and polishing with a soft cloth.

NOTE: A very satisfactory grade of Semi-Pigmented Dope is obtained by mixing Berryloid Clear Nitrate Dope and Berryloid Pigmented Dope in equal proportions.

*See paragraph 7 in "Production Notes".

Allow plenty of drying time between dope coats. The dope may be considered dry when no appreciable solvent odor may be detected.

Good System

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5. Finishes for Steel and Dural

a. Cowling and Exterior Metal Surfaces

1. Preparation of Surfaces

Hand-sand aluminum or duralumin cowling with 00 sand paper or 180 garnet paper. Sandblasting or wire brushing is satisfactory when properly performed. Clean off with Deoxidine or equivalent using rubber gloves to protect hands. Then wash off with water (hot water preferable) and when dry wipe or blow off dust. Keep bare hands off the metal until primed! Hi-test gasoline or lacquer thinner are inadequate cleaners as they merely dilute the oily surface and will not neutralize the alkali on the metal. These cleaners result in poor adhesion of the primer and will not check incipient corrosion.

2. Priming Steel

When primer for steel is to be air dried the best results are secured with regular Berryloid Primer (red oxide, or gray). This material should generally be reduced 20% with naphtha for spraying consistency. Lionoil may also be used for a reducer when baking ovens are available or a longer period of air drying can be allowed.

Only a *thin* uniform coat of primer should be used. Too ^{thick} quick a film will retard the drying and give poor adhesion. Allow to air-dry 24 to 36 hours.

Baking facilities greatly increase production and are now installed in many plants. Primers when baked at 225° F. for 1½ hours adhere better than primers air dried.

When bake ovens are available we recommend reducing our Berryloid Red Oxide Primer with equal parts of Lionoil Clear. This when baked on at 225° F. for 1½ hours produces a wonderfully elastic and adhesive primer—the best we have ever found. Lionoil Clear also makes an excellent primer when baked on at 200° F. for 1½ hours.

3. Priming Aluminum and Dural

A thin uniform spray coat of Lionoil Clear or Lionoil Prussian Blue has been found to yield the best results, from the point of view of adhesion to Aluminum and Dural surfaces. Bake on if possible.

A thin uniform coat of Berryloid Red Oxide Primer has also produced excellent results. Pyroxylin Primers are not recommended for use on aircraft. They will not adequately prevent corrosion nor give proper adhesion.



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4. Surfacing

When the metal surfaces are extremely rough, it may be desirable to use a coat of Berryloid Sanding Surfacers over the primer. This will impair the elasticity of the finish, however.

Before applying the Aircraft Berryloid, the Primer or Surfacers should be sanded with 000 sandpaper or 280 waterproof sandpaper. Be careful not to sand through to the metal.

5. Lacquering

Brush or blow the dust off the surfaces. Apply two cross spray coats Aircraft Berryloid reduced (40 parts lacquer to 60 parts thinner). Allow at least 1/2 hour between coats.

When a particularly smooth and glossy finish is desired, rub the second coat with No. 320 waterproof sandpaper. Apply one final coat consisting of 30 parts Lacquer and 70 parts Reducer. Seventy to eighty pounds of air should be used in the spray gun, and when using a pressure feed tank the lacquer fluid should be kept under a pressure of 5 to 8 pounds for best results. After 24 hours, polish to a high gloss with Berryloid Rubbing Compound for a high lustre.

Gum
pressure

b. Structural Members

Our Lionoil Prussian Blue has been approved and is in use by the Ford Motor Company, Sikorsky, Aircraft Development Corporation, Louis Breuget and other American, French and Italian metal aircraft constructors for this purpose. Use one or two spray or dip coats.

Cleaning

See that all surfaces are first well cleaned, preferably by use of Deoxidine.

c. *Interior (Cockpit or Cabin Finish)*

Instrument Boards:

Berry Brothers Instrument Dull Black (oil base) can be brushed on easily and stays where it is put. It air dries over night producing a smooth, beautiful finish.

A most attractive and practical finish for this purpose is Berry's One Coat Crystallizing Japan—now available in eight colors. Must be baked on in gas ovens. Full details on application.

d. *Duralumin Pontoons and Flying Boat Hulls*

1. Interior: One coat Berryspar Varnish
One coat Berryspar Aluminum



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2. Exterior: Sand paper or wire brush and clean same as airplane cowling. Do not touch after cleaning with Deoxidine and hot water.
1. Apply one coat Berryloid Red Oxide Primer, (oil base) or Lionoil Prussian Blue. Air dry or bake.
2 coats Berryspar Aluminum, allow to dry hard between coats.
2. Regular Aircraft Berryloid Finish recommended when colored finish desired. Severe tests in the salt spray have shown Berryspar Aluminum (when correctly applied) to be the most durable protective finish for duralumin in salt water.

6. Finish for Plywood

a. Pyroxylin Finish

A new Pyroxylin system has been recently developed for finishing plywood. This system has been found satisfactory by several manufacturers of plywood covered ships. Sand the wood thoroughly, and brush one coat of Berryloid Exterior Clear Lacquer No. 507, full body to seal the pores of the wood. Allow one hour to dry. Spray one or two coats of Berryloid White Wood Surfacer No. 507 thinned equal parts with Berryloid Reducer (do not use No. 569 Reducer), allowing a half-hour between coats of surfacer. Glaze in the deeper irregularities with the unthinned surfacer. Allow to dry one hour and sand across the grain to a smooth surface (papers ranging from No. 180 to No. 280 speed-grits or equivalent will dry sand satisfactorily). It is essential to have only a thin film of surfacer over the wood—only enough to produce a smooth surface. Finally, spray two coats of Berryloid Wood Finish No. 507 in the desired color. This lacquer may be thinned with Regular Berryloid Reducer but not with No. 569 Reducer. If higher gloss is desired, spray one coat of Berryloid Exterior Clear No. 507 over the lacquer. Colors on special orders only.

b. Oil Finish

An oil base system which has given satisfactory results is as follows:

One brush coat Lionoil Clear on bare wood (which has been thoroughly sanded); sand when dry. One spray or brush coat of Lionoil or Berryspar containing 1½ pounds Aluminum Bronze per gallon. *Allow to dry hard.* One or two spray coats Berryloid Primer (oil base), sand lightly when dry. Two spray coats Berryloid Wood Finish No. 507 in the desired color.



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An excellent natural finish can be secured as follows:

One coat of Lionoil Clear, followed by two or three coats of Berryspar or Aircraft Spar Varnish.

7. Other Progressive Aircraft Finishes

a. Aircraft Berryloid Clear No. 351

A clear vehicle for aluminum bronze powder, or gold powder. Can be used on fabric and metal. Pronounced by several Government contractors as the best material of this type they have ever used. Reduce 25% for spraying. Use 1/2 lb. of bronze powder per gallon.

aa. Aircraft Berryloid Aluminum No. 351

"The finest Aluminum Lacquer we have seen", says one large builder of Navy and Army Pursuit Planes. We are importing an extra fine grade of Aluminum Powder for use with this lacquer which gives a velvet finish that is indeed beautiful. This finish can be sprayed over Nitrate Dope on fabric, and over oil base primer on metal parts. Must be thinned with Berryloid Reducer to spraying consistency.

b. Berryloid Exterior Clear No. 507

Can be used wherever a clear, tough, finishing lacquer of high grade is desired for either interior or exterior. Can be sprayed at full body but will take reduction with Berryloid Reducer.

Ordinary clear lacquers are not recommended for outside exposure, but we have developed this lacquer base which is unaffected by the actinic rays of the sun.

c. Berryloid Quick Tautening Nitrate Wing Dope

Is recommended for use on fabric when tautening on the first coat is deemed necessary. This dope has given complete satisfaction to a large number of customers.

d. Aluminum Finishes

An excellent aluminum finish may be obtained in either of the following manners:

1. Dope and tape in the above described manner and apply a total of five or six coats of Berryloid Clear Nitrate Dope. Sand* the last coat well and spray two coats of Aircraft Berryloid Aluminum No. 351 or two coats of Berryloid Pigmented Aluminum Dope (made by mixing 5 oz. Extra Fine Aluminum powder per gallon of Berryloid Clear Nitrate Dope).

*See paragraph 7 in "Production Notes".



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2. Brush two coats of Berryloid Clear Nitrate Dope, taping before second coat. When dry scuff off nap of fabric and spray or brush four coats of Semi-Pigmented Aluminum Dope (2 oz. Extra Fine Aluminum powder per gallon of Berryloid Clear Nitrate Dope).

e. Gold Finish

Excellent results are obtained from the following systems:

1. Over five or six coats of Berryloid Clear Nitrate Dope, Spray two coats of Gold Lacquer made by mixing 8 to 10 oz. best quality Pale Gold Bronze Powder per gallon of Aircraft Berryloid Clear No. 351.

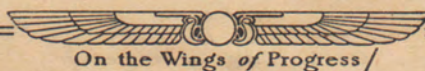
2. Spray two coats of Gold Dope (8-10 oz. Pale Gold Bronze Powder per gallon of Berryloid Clear Nitrate Dope) over five or six coats of Berryloid Clear Nitrate Dope. Allow to dry thoroughly. Apply two coats of Berryspar, sanding lightly between coats.

f. Exhaust Stack Bronzing Liquid

To be mixed with three quarters of a lb. of Aluminum Bronze Powder per gallon for spraying, 1½ lbs. per gallon for brushing. Brush or spray on *clean* exhaust stacks and let dry. Then run the motor and the finish will bake on, giving a durable protective coating.

g. Aircraft Spar Varnish

Meets Government specifications and costs less than Berryspar. Has a good body and excellent durability.



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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 of the finish obtained depends very largely upon the quality of the doping job upon which it is based. A smooth dope job will give a smooth lacquer finish. It should be borne in mind that "just anyone at all" will not do as a "doper".
4. The more dope applied per coat, the fewer the number of coats required to obtain a given surface.
5. In cold weather, dopes left in unheated rooms or outside, become 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.
6. Spraying dope economizes time and labor and also produces the best finish. Berryloid Dopes can be sprayed without thinning by the use of proper spraying equipment. Information concerning "dope" nozzles will be furnished by Berry Brothers on request, or can be obtained from the local representatives of the various spray equipment manufacturers.
7. The doped surface may be smoothed and "levelled" out before applying the finishing color coats, by "wiping" with rags soaked in regular Berryloid Reducer, care being taken to avoid sagging and spotting through the use of excess reducer. This wiping operation produces a buffed effect on the dope and gives a smoother surface and more quickly than could be produced by sanding. This operation also removes the "blush" from the doped surface. Government jobs may be "wiped", but not sanded.
8. Failure of the finish will eventually occur where the dope has "blushed". Troubles from this source can largely be eliminated by the adequate use of Berryloid Anti-Blush Reducer. The proper amount to be used varies with the temperature and humidity. Too much Anti-Blush Reducer retards drying excessively. In general, approximately one-half pint Berryloid Anti-Blush Reducer added to one gallon of Berryloid Clear Nitrate Dope will produce the desired effect.

To remedy blushing of lacquer, thin with a mixture of one part Berryloid Anti-Blush Reducer and three parts Berryloid Reducer. This mixture will also greatly increase the inherent gloss of the lacquer.

Sanding

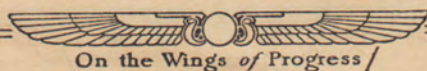
Blushing



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9. Should the fabric adhere to spars, braces, etc. on application of the first few dope coats, a plumbers rubber force-cup, on a short handle will pull it loose by suction without marring the finish, if used before the dope has set.
10. Lacquer should never be applied over "green" dope. An absolutely safe rule is to allow overnight drying between the last coat of dope and the first coat of lacquer.
11. Two thin coats of Fabric Berryloid over seven coats of Berryloid Dopes produces a much more economical and durable finish than four coats of Fabric Berryloid over five coats of dope, and is much lighter in weight. *For durability build the surface with dope.*
12. "Orange Peel" will result from insufficiently reduced lacquer, or when the spray gun is held too far from the surface to be painted. Cheap thinners tend to aggravate this trouble and also to reduce the inherent gloss of the lacquer. Use only thinners made and recommended by the lacquer manufacturer.
13. Pin holes in a lacquer 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 with heat.
14. Wet areas on a lacquered surface indicate that oil, grease, wax, soap, etc., which may have been on the surface previous to lacquering had not been properly removed. *Thorough cleaning of all parts to be painted must be insisted upon.*
15. Lacquer 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.
16. Runs, sags, laps and streaks are caused by improperly adjusted spraying equipment or by improper application of lacquer. Excess material will run before it has had a chance to dry. Streaks may be eliminated, by not thinning the lacquer enough, and by cross spraying, i. e., spraying one coat horizontally and the next, vertically. Laps will show if the last coat of lacquer was insufficiently reduced. A coat of reducer consisting of one part Berryloid Anti-Blush Reducer and three parts Regular Berryloid Reducer will eliminate this trouble. Cross spraying is advised in using lacquers.
17. Two tone combinations are most easily produced by first applying the lighter color, masking off the design and then spraying the darker color.



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18. Four coats of Berryloid Semi-Pigmented Dope produce a finish of maximum durability and minimum weight. Only sufficient pigments have been added to this product to protect the finish from the actinic rays of the sun, without in any way affecting the brushing, filling and tautening qualities of the dope.

This system is probably the most economical one known, from the point of view of production, as it reduces the time that the plane must spend in the paint shop to a minimum. It is likewise, the lightest finish that it is possible to obtain, as it provides the necessary tautness and protection in four coats. It is obvious, however, that the finish will not be as smooth nor as glossy as the one requiring more coats of finishing materials. It is also much more susceptible to the formation of "high and low" spots. To obtain a very smooth, glossy surface it is necessary to fill the interstices of the fabric to a uniform level.

19. 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. The 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 should be "pinked" or frayed about one quarter of an inch, all 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.

20. The weights per square yard of the various Berryloid fabric finishing systems are as follows:

Berryloid system (lacquer finish) 9 coats, 5.5 to 5.8 oz.

Berryloid Pigmented Dope system 7 coats, 4.7 to 5.0 oz.

Berryloid Semi-pigmented Dope system . . . 7 coats, 4.5 to 4.7 oz.

Berryloid Semi-pigmented Dope system . . . 4 coats, 3.0 to 3.5 oz.

21. 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.

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SPECIFICATIONS FOR AIRCRAFT FINISHING

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 or handling wings, cowling and other parts to be sprayed.
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.
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.
6. Necessary quantity of air and fluid hose.
7. An Air duster for removing loose dust and dirt from the work is almost indispensable.
8. Adequate containers for mixing lacquers, dopes, etc.
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 between 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.



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SPECIFICATIONS FOR AIRCRAFT FINISHING

FIRE HAZARDS AND THEIR PREVENTION

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.
2. Proper ventilation is necessary both in spray booths and Dope Rooms.
 - a. An exhaust fan 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 building.
5. No smoking should be permitted in aircraft factories nor should open flames be allowed near the finishing rooms.
6. Firefighting equipment should be readily available.
 - a. An overhead sprinkling system will pay for itself in a few years on savings in fire insurance.
 - b. Fire extinguishers of the foamite 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 room 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.

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SPECIFICATIONS FOR AIRCRAFT FINISHING

BERRY BROTHERS PROGRESSIVE AIRCRAFT FINISHES

GROUP 1.

Nitrate Wing Dope (Gov't Standard)
Nitrate Dope Thinner
Berryloid Reducer
Anti Blush Reducer

GROUP 2.

Berryloid Pigmented Dopes
(34 Standard Colors)
Aircraft Berryloid (Spraying Lacquer)
Aircraft Berryloid Clear No. 351
(Vehicle for bronze powder)
Aircraft Berryloid Aluminum No. 351
(Aluminum spraying lacquer for
metal and fabric)
Berryloid Clear Exterior No. 507
(For wood finishing)
Berryloid Primer (oil base) Gray, Red
Oxide, White
Berryloid Sanding Surfacer (oil base)
Berrycraft Quick Drying Enamels
Berryloid Plasticizer
Berryloid Rubbing Compound
Masking Paper and Tapes
Rexit Paint and Varnish Remover

Spot Putty (oil base)
Standard Grade Aluminum Bronze
Powder
Extra Fine Aluminum Bronze Powder
Special Gold Bronze Powder

GROUP 3.

Lionoil Clear
Lionoil Prussian Blue
Lionoil Colors
Aircraft Enamels—
Berry Brown, Brewster Green, Gray,
Cream, Jet Black, Adirondack Green,
Yellow, Essex Green, White, Auto
Blue, Adirondack Blue, Auto Red,
Azure Blue and Rich Vermilion
Instrument Dull Black (oil base)
Exhaust Stack Bronzing Liquid
Brushing Lacquer—all colors
Brushing Lacquer Thinner
Berryspar
Berryloid Aero Clean Polish
Aircraft Spar Varnish (Gov't Standard)
Liquid Marine Glue
Instrument Dull Black Lacquer (for
spraying)



QUESTIONNAIRE ON AIRCRAFT FINISHING

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Concern You Are With

Occupation

1. Does "Specifications for Aircraft Finishing" 4th Edition, fill your needs?

Ans.

2. What additions, improvements or changes would you recommend based on your experience.

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3. State specific information desired not contained in the "Specifications."

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Remarks and Comments

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It will be greatly appreciated and should result in general good for the industry if all persons receiving this booklet will send this questionnaire to the Aviation Division, at Berry Brothers, Detroit, Michigan. Additional data resulting from the information obtained will then be forwarded to you.

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