SECTION 2

DOPE AND FABRIC WORK

Chapter 2.1

DOPES AND DOPING

The purpose of dope is to render the fabric portions of a glider watertight, airtight, and to tauten the fabric so that the shape of the surfaces is kept correct.

Without going into the chemistry of dope it is enough to say various makes of dope do not always agree, when one make is applied on top of another. For this reason it is a sound plan always to use the same make of dope for repairs as was used in the original construction. The dope used is quoted in the front pages of the glider's log book.

There are three basic types of dope that the glider repair shop will have to use. These are:

1. Clear dopes or adhesives;
2. Pigmented filler type dopes;
3. Finish colour dopes.

In addition all three types of dope can usually be bought in varying degrees of tautening intensity.

The use of these types of dope is roughly as follows: The clear dopes or adhesives are mainly used to stick the fabric to the wooden structure. A typical use of this material is when re-covering a component. The wooden structure would be given two coats of the clear dope, and when dry the fabric would be stretched over the component and pinned in place. The clear dope would then be brushed in wherever the fabric touched the wood, and thoroughly rubbed in by means of a pad of fabric. Two coats applied thus would securely attach the fabric to the structure. The term 'clear dope' has been used on the above description but this is intended to include the cellulose adhesives that some manufacturers use for this initial stick-down.

The filler dopes are now brushed into the fabric. The object is to tighten the fabric and to 'body it up' until a smooth surface is obtained in which the original fibres of the fabric have disappeared. A number of coats will be needed, perhaps four or more, but the finish will be improved if a light rub down with fine abrasive paper is given between the coats. Alternatively a rub over with a pad soaked in thinners will smooth out the surface. When bodied up, one coat of an aluminium dope should be applied as this forms an excellent barrier to the various forms of light, ultra violet and otherwise, which tend to destroy the life of the fabric.

Finally the finish colour may be applied. This is usually in the form of an undercoat and a top coat, the latter simply being a gloss coat with a little pigment in it.

The first coats, the stick-down of clear dope, and the first few coats of the filler dopes must be brushed in. The later coats may be sprayed, and the best finish is always obtained if the final coats of finish dope are sprayed.

Manufacturers of dope normally supply schemes for using their dopes and the above is only a rough outline of the sort of scheme to expect. Some recommend the use of clear dope as a filler, and this is a good plan from some angles. It is lighter in weight than red or grey pigmented dopes, but it is not perhaps quite so good in stopping the ultra violet light.

The aim of all repair work should be to restore the glider to the original state as far as is possible. To this end try to copy as closely as you can the original doping scheme.

General Notes on Doping

Never forget that all dopes are highly inflammable. Treat them as though they were petrol, and indeed, the vapours from dopes are as explosive in the right conditions as petrol vapours. Also avoid as far as possible inhaling the vapours. Wear a mask of an approved type when spraying or using dope, otherwise the result may well be a most unpleasant headache. Drinking milk after a doping is a good antidote to the effects of the vapours.

A good surface finish is important on gliders, more so than on most aeroplanes. It is particularly important around the leading edge area of wings.

The above remarks assume that the finish is of Cellulose, or Synthetic Cellulose base.

There are other finishes, such as Polyurethane, and these require special treatment. Doubtless the future will bring yet others, but in these cases the manufacturers should be consulted.

Difficulty is often found in sticking fabric patches to these special finishes, but as a general rule, it can be taken that the finish, if not of cellulose, will have to be scraped or rubbed down until the surface of the dope is exposed. If this is not done the doped patch will probably not stick.

Chapter 2.2
FABRIC REPAIRS

Fabrics used on gliders are usually one of two specifications. The first, DTD 343, commonly known as 'Madapollam', is used for unsupported surfaces, and also for covering plywood. The other commonly used material is DTD 575, which is slightly heavier than the DTD 343 and is of a closer weave. Both these materials are cotton fabrics.

Sometimes lighter fabrics still are used for covering plywood, as in this application the fabric is merely a vehicle for the dope and its strength is of no consequence at all.

The covering of components is dealt with in the next Chapter: in this one we are concerned with repairs to the fabric of gliders.

First, in the case of any repair, determine what the material of the fabric is. Then try as far as possible to repair the damage to the fabric with the same material.

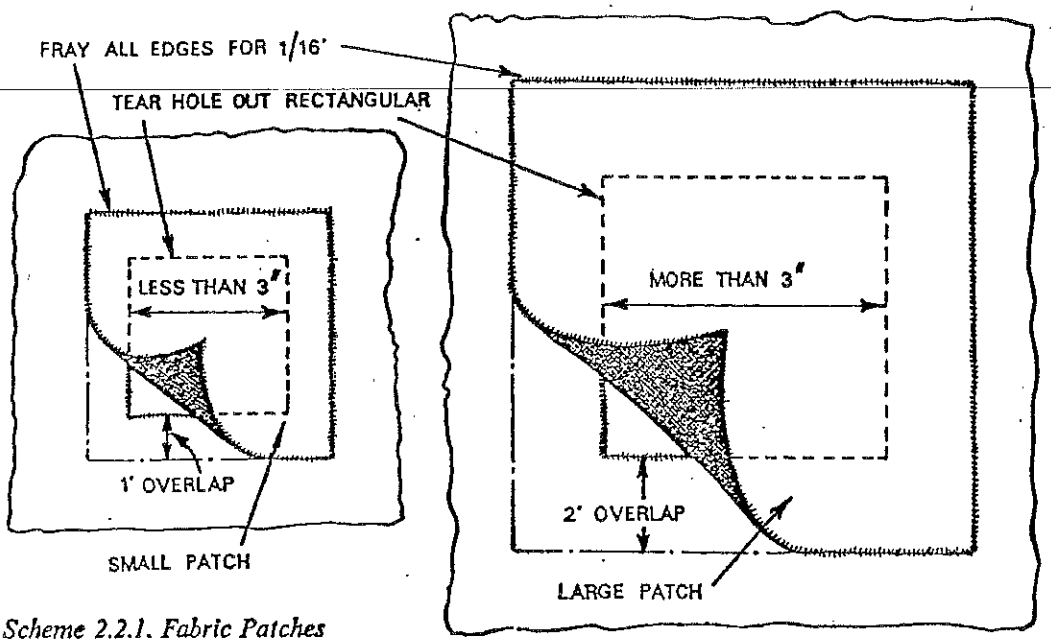
Do not try to repair straight or 'L' shaped tears in fabric. In these cases rip the damage out to a rectangular shape and patch with new fabric.

In many cases it will be easier to cut back to the surrounding structure and replace the panel of fabric. Where the panel is small this is always the best plan. When cutting away fabric, care must be taken to ensure that the underlying structure is not damaged by the knife. Particularly is this care necessary when cutting away fabric that is doped down on to ply. Gaboon ply is very soft and very easily cut by a trimming knife or chisel, and if you do cut it, you will have to replace the ply as well as the fabric.

Owing to the low wing loadings on gliders, no sewing of patches is necessary. This, of course, makes fabric work on gliders far simpler than on powered aeroplanes.

Virtually the only repair to fabric on gliders is the simple patch. On small patches, say up to 3 ins. square, allow an overlap of 1 in. all round: for larger patches than this, allow an overlap of 2 ins.

See illustration 2.2.1 and go ahead as follows: Having opened out the damage to



Scheme 2.2.1. Fabric Patches

a rectangular shape, make sure that there is no damage to the structure of the component and that there is no foreign body left in the interior. Prepare a patch of the same material as the original fabric. Now soften with clear dope the surrounding edges of the hole and attach one edge of the patch, arranging the overlap correctly, and brushing through with clear dope on to the softened surface beneath, and rubbing the dope through with a pad of fabric, until the fabric is quite smoothed out and no air bubbles remain. With patches of any considerable size, it is an advantage to allow one edge to dry before tackling the next.

By this means it is possible to pull the fabric tight when doping down the next edge. Proceed around the patch until all the edges are stuck down. Some people prefer to stick one edge and then the opposite one, while others like to attack an adjacent edge. Whichever method is employed does not matter much, but generally it is easiest to leave until last any edge that has some support underneath it, such as a rib boom or the leading edge ply of a wing. The reason for this is that it is easier to draw a patch tight on the last edge if there is support below to press on.

When softening the edges with clear dope, make sure that the surfaces are not contaminated with polishes, etc. as these will prevent the proper adhesion of the patch. If polishes are present then these must be removed before attempting to soften the dope.

The patch is now attached all the way round. Do *not* dope the centre of the patch until you have brushed in two coats of clear dope to stick the edges and these two coats have dried. Now dope up the centre of the patch, following as closely as possible the original doping scheme. The aim is to reproduce the original finish as nearly as you can.

Most books on fabric repair work recommend that the edges of patches should be pinked. If you like using pinked patches and have a pair of pinking shears, go ahead and use them. However, just as good results, if not better, can be obtained by carefully fraying the edges of any fabric patch for about $\frac{1}{4}$ in. When doping down, brush out these frayed edges and when the coats of dope are dry, rub down between coats with fine wet and dry paper to eliminate the fabric edge. If this is done carefully it is quite simple to make the patch disappear entirely in the finishing coats. It is, however, much more difficult to make a pinked edge patch disappear.

Ensure that fabric to be used for any sort of aircraft use is kept dry, and free from any sort of contamination. Damp fabric will not tauten up properly when doped and you will waste not only the fabric but the dope as well, since the whole lot will have to come off and you will have to start again. If you are working in the Summer months you can often air the fabric by draping it over trestles in the sun for an hour or so before doping it on.

If any of your patches go across wooden members, then you must ensure that the patch is properly stuck to the member in question. To do this clean down the wood and brush on two coats of clear dope or the adhesive if you prefer to use this. Allow these to dry before attaching the patch. When fixing the patch, brush through the dope or adhesive for two coats, rubbing through as well with a fabric pad. This will guarantee proper penetration of the dope and good adhesion of the fabric.

Do remember it is important that fabric should stick to the structure of the aircraft. It is only by careful attention to this that we are able to dispense with stringing the fabric to the ribs, etc. On certain older aircraft, Grunau Babies for instance, you will find that there is a certain amount of stringing of the underside of the wing fabric to the lower rib booms. Where you find this you must copy the scheme again in your repair, using the same type of thread for the stringing and the same stitch pitch. The reason for this use of stringing is that these machines had very cambered under-surfaces and the stringing is an insurance against the fabric separating from the lower rib booms.

General Notes on Fabric Repairs

Always allow a generous overlap rather than the other way round. Do make sure that the edges are properly stuck down with two coats of clear dope or adhesive and that these are dry before you start doping up the middle of the patch. Do rub through well when sticking the edges of the patch to eliminate all air bubbles and wrinkles. When

doping up the whole patch, do give a good rubbing down with wet and dry paper between coats to get a good finish, and if you will work on the frayed edges with the abrasive paper, you can get the final result to be invisible as a repair.

Chapter 2.3
RE-COVERING COMPONENTS

Although this Chapter is entitled 'Re-covering Components', it includes the covering of new components.

Fabric covering falls into two categories: first the fabric covering of plywood parts of an airframe to protect it from the weather and to give a good finish, and second the fabric-ing of wings and other parts where the fabric carries air loads and is unsupported over large areas.

Fabric Covering of Plywood

The fabric used in this case is usually DTD 343 (Madapollam), but may be an even lighter fabric. Since the fabric carries no loads but is being used merely as a protective coating and as a vehicle for the dope, any suitable fabric may be used, but it will be found to be a false economy to use anything with too open a weave as this will mean that a great deal of dope will have to be used to get anything like a good finish. The component must be cleaned down smooth and then given two coats of clear dope, or if you prefer using it, one of the special adhesives made for this job. The purpose of these coats is to ensure that there is plenty of dope under the fabric to stick it to the ply when the fabric is applied. Now stretch the fabric tightly over the component and hold it in place. The easy way to do this is to use drawing pins or if you have one, a one-handed tacker. Before you start doping it on, run a hand all over the surface to make sure that there are no lumps of dirt under the fabric as these will spoil the finish later on. Surfaces that have curvature in two planes will probably have to be done in more than one piece, but it is surprising how much the fabric will stretch round double curvature if carefully pulled into shape.

When you are satisfied with the smoothness of the fabric, start brushing clear dope, thinned as necessary, into the fabric and make sure that it does go right through. It is a help in this direction if you follow up the brush with a pad of scrap fabric rubbing the dope well into the weave and making certain that there are no air bubbles or dry spots in it. Give two coats of the clear dope and allow to dry between each coat. Then go ahead with the filler or red dope to fill the weave and get a good surface for the finish colour. The finish is enormously improved if you rub down the surface between coats with a fine wet and dry paper or fine glasspaper. Before the finish dope goes on, it is a very good plan to give the fabric one coat of aluminium dope. Not only does this help to protect the fabric from attack by ultra violet light, but it does also act as a barrier to stop colours of the undercoats creeping through to spoil the finish colours Red dope seems to creep through on to the lighter finishes in a surprising way.

Half the battle in this sort of work is the proper rubbing through of the dope with the pad and the job is made much simpler if two people can work together at it, one doing the doping and one rubbing through. If you have to make joins, you have a choice of making very careful butt joints and then covering the joint with a strip pinked or frayed, or making an overlap of about ½ in. Careful rubbing down with abrasive paper during the building-up with dope process will make both these joints almost invisible in the finish.

Fabric Covering of Unsupported Surfaces

In this case the job is a little different from the foregoing. The fabric must here be considered part of the structure of the aircraft and therefore only approved stuff may be used. DTD 343, Madapollam, is used on many machines and is very satisfactory. A slightly heavier and closer weave material is sometimes used, to Specification DTD

575, and this is somewhat stronger than the Madapollam and seems to last longer between re-covers. Which you use is a matter of choice. If the machine is a little tight on all up weight then the DTD 343 would be the one to use as the resulting empty weight will be less. If there is ample payload in the glider in question and it may have to be used in rough conditions of weather or storage then the DTD 575 is clearly the choice. Make sure that you do get a Release Note with your fabric and quote the number in the log book of the glider.

Clean down the component and give it two coats of clear dope over all the surfaces where the fabric is to stick. Now stretch the fabric tightly over the component and pin it in place with drawing pins or by the use of a one-handed tacker. Where the fabric is attached to a ply leading edge or spar, arrange it so that you have at least 1 in. lap on the spar.

Taking for example the job of covering the top surface of a wing, say a T.21B, it is easiest to dope along the spar edge first and allow this to dry. Follow the dope brush immediately with a rubbing pad to ensure proper penetration of the dope. Once this edge has stuck, the fabric can be re-tensioned if necessary and then the trailing edge can be doped down, rubbing through as before. Lap the fabric round the trailing edge member and trim off. Now continue the doping down, this time along the top boom of each rib and round the tip lamination and along the root box. Allow all this to dry and then give a second coat of dope over all the places where the first coat went. Allow this to dry thoroughly.

You have now got the fabric nicely attached to the structure and you can start to tauten it and fill it in. Depending on the scheme that you prefer, this can be done with clear dope (tautening) or red dope (tautening). Most dopes can be obtained in High, Medium or Low tautening forms, and for glider use the Medium seems to be about the right strength. The Low tautening is useful for sticking fabric to plywood or for the initial stick down coats to ribs, etc., but the Medium seems to work just as well. The low tautening dopes are not so good for building up the finish and filling the weave, unless you are working in a very hot climate. The High tautening dopes should be used with care, as they do tend to pull the light structures that we use on gliders out of shape if used rashly, but they can be very useful for patching, particularly in Winter.

The fabric will take some three or four coats of tautening dope before the weave is buried and you have a smooth surface. As before you can improve the surface enormously by careful rubbing down with abrasive paper between each coat. Before the finish colour coats go on, give one coat of aluminium dope to seal the fabric against the attack of ultra violet light and to stop the colours of the undercoats creeping up into the finish colours.

In the above example we considered the covering of the top surface of a wing. The under surface is a little more complicated as we frequently have a bit of undercamber to deal with and this makes the job of sticking the fabric to the ribs a little more tricky, as it naturally tries to pull away from the ribs as the fabric tautens. The secret here is to stick the fabric down all the way round the outside first with two coats of dope and let it dry. Then and only then load the unsupported areas of fabric with any suitable weights so that the fabric is held down on to the rib booms and then dope and rub through in the ordinary way. When two coats have been applied and rubbed through, the fabric will be found to have stuck firmly to the ribs. Then you can remove the weights. Suitable weights can be made from pieces of ply loaded with 'G' cramps or any workshop tools of a convenient weight. It is worth leaving the job for some hours or even overnight for the stickdown to harden off. Once this has hardened off you can go ahead and dope up the unsupported surfaces with red or filler dope, but for the first coat it is wise to avoid doping the portions that have already been doped.

The stickdown coats and the first coat must be brushed in. The later coats may be sprayed if desired, but it is better to keep the spray gun for the finish coats.

General Notes on Covering

The fabric must be dry and if there is any doubt about this it is a good plan to air the fabric for an hour or so in the sun. If you try to use damp fabric you may waste the fabric and the dope and have to take the whole lot off and start again. If there is any stringing of the fabric on the underside repeat this when you re-cover. You may find on some older machines that there is a doped strip on the lower booms of each rib to prevent chafing when stringing the booms and this should be renewed.

Do not be discouraged if the job looks awful after the first coat. Fabric goes on tautening for some days after the dope has apparently dried off and it is amazing how puckers will pull out given a little time.

The manufacturers of dopes will be found to be very helpful in case of any troubles and it is wise to follow their approved doping schemes. As regards the choice of dopes, using clear dope throughout for the filling and tautening does give a lighter result. However, unless weight is of paramount importance, red dope does seem to protect the fabric better and makes a longer lasting job. It also fills the weave rather more quickly and gives a smoother finish. Filler dopes do the same job of course.

If a really high finish is required this can be obtained only by hard work, rubbing down each coat thoroughly and finally polishing with one of the special polishes made for the job, such as Hendon Polish. Dopes from different manufacturers may have different chemical properties so, to avoid trouble, stick to the same make of dope for the whole machine. You will find the type of dope used quoted in the log book, in the pages at the front of the book, and when you re-cover fill this page with the details of what you have used on the job. This will save somebody a lot of trouble later on.