EO 05-1-3/18

ROYAL CANADIAN AIR FORCE

# FABRIC COVERING APPLICATION AND REPAIR

(This EO replaces Part 18 of EO 05-1-3)

ISSUED ON AUTHORITY OF THE CHIEF OF THE AIR STAFF

17 NOV 60

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# FABRIC COVERING APPLICATION AND REPAIR

## MATERIALS AND DOPING

GENERAL

1 The materials commonly used in dope and fabric work are listed in Figure 1. In column three of the table, a brief description of the use of each material is given. This description does not cover all of the intended uses of the material; only those related to dope and fabric work. The RCAF have standardized on the use of cellulose nitrate dope for the refinishing of aircraft fabric control surfaces. Components previously refinished with acetate butyrate dope shall be repaired with the same material until they become unserviceable then they shall be refinished with cellulose nitrate dopes.

DOPES AND THINNERS

2 To obtain satisfactory results in thinning dopes, always use the thinners specified because of the incompatibility of certain ingredients used in the make-up of various dopes and thinners. Failure of tautening properties, separation of ingredients, orange peel effect, blushing and other similar dope troubles result from using thinners improperly. In any case, the proper action of the dope is destroyed if it is not thinned with the correct thinner.

FIRE RETARDANT FABRIC

3 To prepare fire retardant fabric, use new fabric of a sufficiently large size to allow for shrinkage. Prepare the fire retardant solution as follows:-

(a) Dissolve 1-1/2 to 2 pounds of C.I.L. CM Fire Retardant Crystals in one gallon of warm water and stir until dissolved.

(b) Immerse fabric until completely saturated, remove and wring completely. Dry at room temperature or not over 180°F.

NOTE

Avoid skin contact with solution. Use an alkaline or acid resistant container and rinse thoroughly after use.

DOPEPROOFING

4 Treat all parts of the structure which come in contact with doped fabric with a protective coating which resists the solvent action of the dope. Use aluminum foil, cellulose tape or sheets as dopeproofing materials. Attach these materials to the surface to be covered with marine glue, shellac or other non-hygroscopic material. Where zinc chromate primer is the finishing material on metal structures, dopeproofing is not required. A slight bleeding of the primer through the first coat of dope may be observed but this is not objectionable.

NOTE

Aluminum, alclad, and stainless steel parts need not be dopeproofed.

## REJUVENATING OLD NITRATE DOPE FILMS

5 Where nitrate dope films become deteriorated and cracked and the condition is not considered serious enough to warrant recovering, it may be improved temporarily with the following mixture:-

(a) Make up the mixture using one fluid ounce of tricresyl phosphate and one ounce of castor oil mixed with one gallon of solution made up of two parts of clear dope and one part of blush retarding thinner.

(b) Remove all the old pigmented coats of dope from the surface to be treated by applying a 50-50 mixture of dope and blush retarding thinner. As soon as the old dope has softened, wipe off or remove by scraping with a dull tool such as a putty knife having rounded corners. Apply a heavy coat of the rejuvenator dope mixture by brush, followed by one spray coat. Finish to match adjacent surfaces. Where excessive quantities of pigmented dope are not present and tautness of the fabric is satisfactory, the application of lightly pigmented rejuvenating mixture over the old dope is satisfactory. Never apply clear dope over this pigmented rejuvenating mixture.

(c) Where there is any question concerning the condition of the fabric, remove and recover the surfaces. Any indication of staining of the fabric at cracks after removal of the dope finish with dope and lacquer is considered as deterioration of fabric, which must be replaced.

## DOPING FOR EMERGENCY REPAIRS

6 In making fabric repairs of an emergency type, it is often necessary to apply dope under conditions which prevent obtaining a satisfactory job. Use blush retarding thinner to alleviate the severity of blushing conditions. In all cases where the job must be performed under unfavorable conditions and which result in an unsatisfactory repair, the repair is to be considered temporary and is to be accomplished properly at the earliest practicable time. Always try to avoid high humidity conditions, strong draughts, moist sea breezes and temperature extremes. Proceed as follows:-

(a) Apply a brush coat of dope, see Figure 1, to the area as a prime coat and allow to dry.

(b) Apply a second coat and apply the patch.

NOTE

Do not use nitrate dope in conjunction with cellulose acetate butyrate dope during repair procedures.

| Fabric Used | Use of Fungicdial Dope | Finishing Dope | |
|---|---|---|---|
| Aircraft Fabric Linen | None | AN-TT-D-514 and AN-TT-D-551 | Cellulose Nitrate Clear Dope<br>Cellulose Nitrate Clear Dope (for) Aluminum |

Figure 1 Table of Dopes Used in Patching

(c) Press the patch firmly into place on the wet dope. Smooth out the fabric and pull as taut as possible. Make certain that all edges are adhering and that no voids or bubbles exist under the lapped area.

NOTE

Apply a coat of dope, if necessary, to that portion of the patch which overlays the old fabric.

(d) Refer to para. 35, following, for finishing procedure.

TESTING OF DOPE FILM FOR FLEXIBILITY

7 To test dope film for flexibility, proceed as follows:-

(a) Cut a 2 x 4 inch sample from the area to be tested. Make the cut along the thread of the fabric. Fold the specimen lengthwise with doped surface outermost and place on the specimen a 2 kilogram (4.4 pound) weight, having a flat circular base about 2 inches in diameter, so that the crease formed will be directly below the diameter of the weight. Allow to remain for 10 seconds, then remove and examine the crease for cracks or breaks in the film.

(b) Fold the strip in a new position which does not intersect the first crease and repeat the test using a 1 kilogram weight.

(c) A dope film which does not crack at the fold under a 1 kilogram weight is considered to have satisfactory flexibility. The presence of a few slight cracks is acceptable provided there are no long sharp cracks with the 2 kilogram weight test which indicates brittleness.

(d) During production of a doped fabric finish, make a fabric covered panel simultaneously with the aircraft part, thus avoiding the necessity of cutting out a section from the structural surface.

(e) Use the flexibility test on doped fabric which has been air dired at 66°C (150°F) for 16 hours.

ALTERNATE PROCEDURE

8 Where the required test equipment is not available or it is not practicable to perform the tests as indicated above, carefully inspect the covering. Give consideration to the age of the covering as indicated by the code markings, loss of tautness and flexibility, excessive patching, general condition of the doped finish, extensive damage and security of attachment. Where the dope film cracks readily under light thumb pressure, make further inspection to determine whether the surface should be recovered or whether redoping will permit further service.

FINISHING PLYWOOD SURFACES

9 For application of sealer and dope to fabric covered plywood surfaces, refer to para. 43, following.

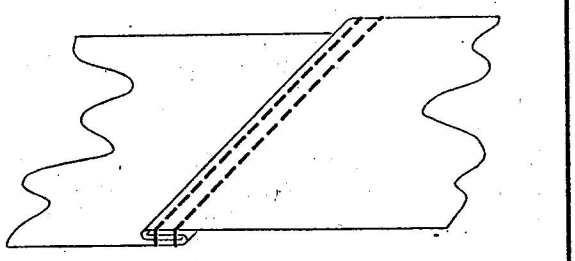
## FABRIC COVERING APPLICATION AND REPAIRS

GENERAL

10 Make repairs to fabric covered surfaces so that the repair procedure will restore the oriiginal strength and tautness of the fabric. Two types of repair are permitted, sewed and unsewed.

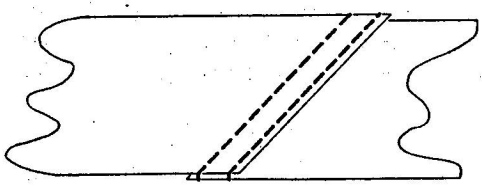
## MACHINE SEWING

11 For all machine-sewed seams use plain lap or folded fell seams with two rows of stitches. For inside seams (not occurring at edges) use type LSc-2 seams, see Figure 2. Use plain lap seam type LSa-2, see Figure 3, only where selvage edges are joined. On seams for closing wing and tail surface coverings use type LSb-2 or LSq-2 or equivalent, see Figures 4 and 5. No raw edges of fabric are exposed on the outer surfaces. Use a two thread loop stitch or double-locked stitch, with eight to ten stitches per inch. Make rows of stitches from 1/4 to 3/8 inch apart placed approximately 1/16 inch from the edge of seam. Run all longitudinal or fore and aft seams parallel to the line of flight. Do not let seams cover a rib or be so placed that the rib lacing will be through or over a seam. The only seam extending along the span of the wing will be at the trailing edge of the wing, except in the case of a tapered wing where an additional seam may be made at the tapered position of the wing at the leading edge. Cover the seams where it is impracticable to avoid a seam at the leading edge. Where widths of fabric are sewed together, use selvage edges in seams as much as possible.



FORM THIS TYPE OF SEAM BY TURNING THE EDGES OF BOTH PLIES OF THE MATERIAL AND LAPPING THEM. UNITE THEM WITH TWO ROWS OF STITCHES WHICH SECURE THE TURNED PORTIONS. CONCEAL THE EDGES OF THE MATERIAL.

Figure 2 Type LSc-2 Seam

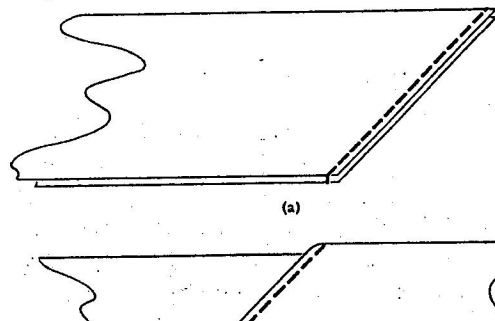


FORM THIS TYPE OF SEAM BY OVERLAPPING TWO OR MORE PLIES OF MATERIAL. UNITE THEM WITH TWO ROWS OF STITCHES.

Figure 3 Type LSa-2 Seam

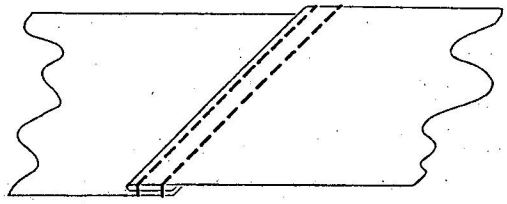
## HAND SEWING OR TACKING OF COVERS

12 Begin hand sewing or tacking where machine sewing stops and continue as necessary. Temporarily tack fabric in place to facilitate hand sewing. Avoid permanent wrapping of metal members to facilitate attachment of fabric covers as such wrappings tend to induce early corrosion of the metal. After hand sewing has been completed, remove the tacks by a straight pull to avoid tearing the fabric. At the points where hand sewing or tacking is necessary, cut the fabric so that it can be doubled under approximately




IN FORMING THIS TYPE OF SEAM THE PLIES OF MATERIAL FIRST ARE SUPERPOSED AND JOINED, AS IN (a). ONE PLY IS THEN TURNED BACK AND STITCHED DOWN WITH ONE ROW OF STITCHES (b).

Figure 4 Type LSq-2 Seam



FORM THIS TYPE OF SEAM BY TURNING THE EDGE OF ONE PLY OF THE MATERIAL AND LAPPING IT OVER ANOTHER PLY. UNITE THEM WITH TWO ROWS OF STITCHES, WHICH ALSO SECURE THE TURNED-UNDER PORTION OF ONE PLY. CONCEAL THE EDGE OF THE MATERIAL ON THE OUTER SURFACE.

Figure 5 Type LSb-2 Seam

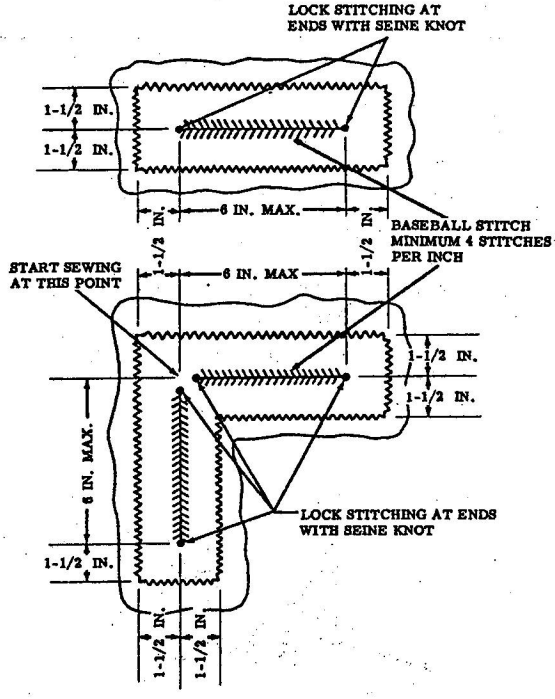



Figure 6 Repair of Tears

1/2 inch. Use a baseball stitch for hand sewing and lock-stitch at intervals of six inches. Finish the seam with a lock-stitch and knot. In hand sewing use a minimum of four stitches per inch, see Figure 6.

SEWING TORN FABRIC

13 When sewing torn fabric together before making the patch, use a baseball stitch with a minimum of four stitches per inch. Fully wax the thread. Make the first stitch a lock-stitch and use a lock-stitch every eight to ten stitches. Finish the sewing with a lock-stitch. Extend the stitches back away from the edge of the tear approximately 1/4 inch, see Figure 6. Cut and apply the patch as described in paras. 32, 33 and 34, following.

NOTE

Maintain sufficient thread tension to draw the torn edges together. Be careful that the stitches do not pull out, since sewing thread pulls through doped fabric very readily.

LACING KNOT

14 The following method may be used for securing lacing cord at stitching points, see Figure 7.

(a) Loop hitch over needle (B) with right hand.

(b) Pull needle and cord with both hands, leaving enough slack for later insertion of needle.

(c) Hold hauling end (A) with left hand and insert needle with right hand.

(d) Take in remaining slack with left hand, leaving needle in knot.

(e) Shift right hand from butt of needle to point and pull double section of cord through knot, keeping strain on hauling end (A) with left hand during this operation.

(f) Cinch hauling end (A) from left to right until hitch has been pulled tight on rib. Hitch is slightly to right of centre of rib.

(g) Pull needle end of cord completely through with both hands and centre knot.

LACING OF FABRIC TO STRUCTURES

15 Lace fabric coverings to structures for the purpose of maintaining the contour of the air-foil or fuselage, and to prevent lifting and whipping of the fabric in flight. Lacing also provides for better utilization of the fabric strength. Use re-inforcing tape under all lacing.

16 Make the width of the re-inforcing tape equal to the width of the member over which the tape is applied. In some cases where the rib is very wide, it may be necessary to sew together widths of tape to cover the rib. Pass the re-inforcing tape from the trailing edge up to and around the leading edge and back to the trailing edge. Apply moderate tension to the tape and tie the tape at the trailing edge to maintain this tension until the first coat of dope is dry. For lacing fabric to structures use lacing cord. Thoroughly wax the cord by drawing it through a bar of wax at least four or five times. Rewax the cord every five or six lacing points. At the first point of lacing use a slip knot for tying the lacing cord. At all subsequent points, tie the lacing by seine knots as shown in Figure 8. At the end point of lacing secure the lacing cord by a double lock knot.

INTER-RIB BRACING

17 Tie wing ribs, which do not have permanent inter-rib bracing in position by means of cotton tape running parallel to the spars. Apply the tape bracing to both the bottom and top cap-

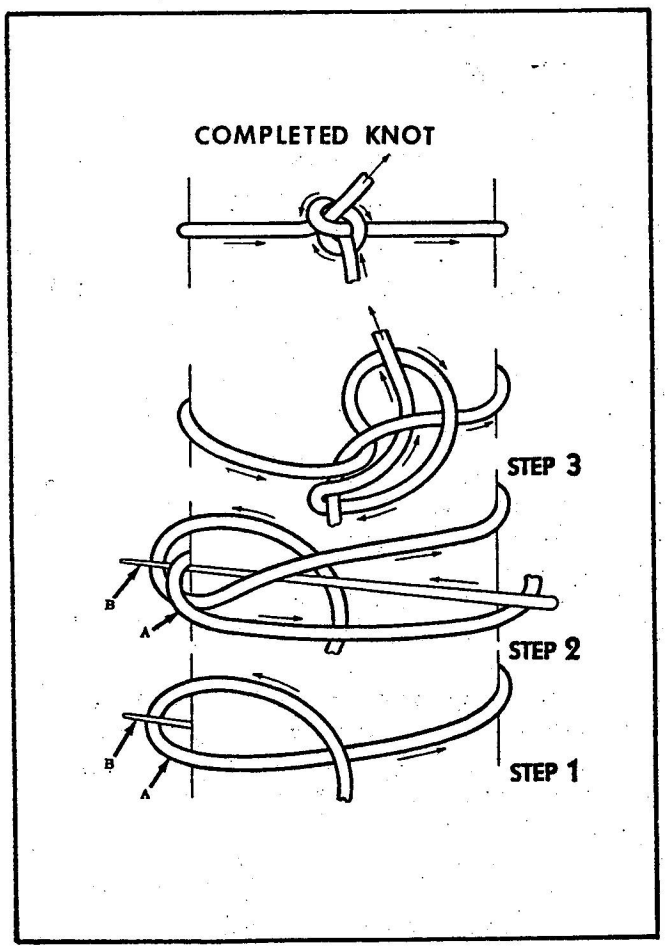



Figure 7 Standard Knot - Rib Lacing

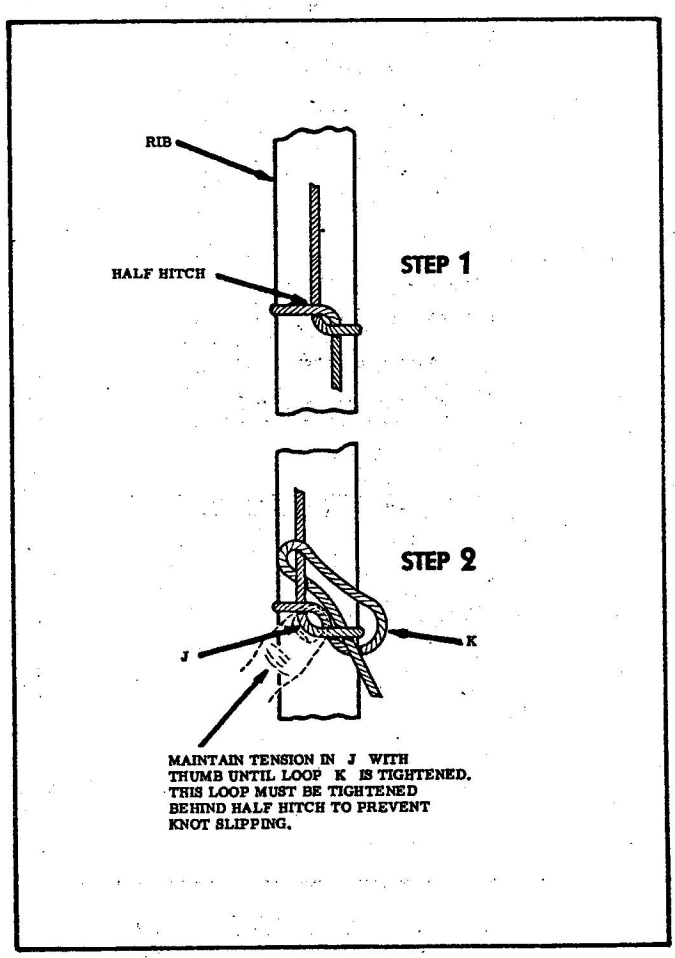



Figure 8 Seine Knot

strips, keeping the tape parallel to the plane of the cover rather than diagonally between the top and bottom capstrips. Apply the tape continuously with one turn around successive capstrips, so that the tape between ribs is separated from the cover by a distance equal to the depth of the capstrip. Tie the turn of tape around each catstrip by means of a short length of lacing cord, see Figure 9.

CHAFE POINTS

18 Cover all points of the structure such as sharp edges, bolt heads and rivets which come in contact with and are likely to chafe or wear the covering, with doped fabric strips or with an adhesive tape. Where adhesive tape is used, cover with a dopeproofing material to prevent the dope from affecting the adhesive. After the cover has been installed re-inforce the chafe points of the fabric by doping on fabric patches. Where a stronger re-inforcement is required, sew a cotton duck patch of suitable size and weight to a fabric patch, then dope in place. Install re-inforcing patches with the second coat of dope. Re-inforce all portions of the fabric pierced by wires, bolts, or other types of projections.

USE OF ANTI-TEAR STRIPS

19 On aircraft with a maximum permissible speed in excess of 250 mph, use anti-tear strips under the re-inforcing tape on the upper surface of wings, and on the bottom surface of that part of the wing in the slip-stream. Outside the slip-stream, the use of anti-tear strips is optional on the bottom surface of the wing. Where the anti-tear is used on both the top and bottom surfaces, pass the strip continuously up to and around the leading edges and back to the trailing edge. Where the strip is used only on the top surface, carry up to and around the leading edge and back on the lower surface as far aft as the front spar.

20 Cut anti-tear strips from the same material as used for the covering. Cut wide enough to extend beyond the re-inforcing tape on each side so as to engage the lacing cord. Attach the strips by applying dope to that part of the fabric to be covered by the strip, laying on the anti-tear strip and applying dope freely over the strip.

INSPECTION OPENINGS

21 When applying fabric coverings, make provision for inspectionof interior points of the structure. On metal frames, sew flaps with provisions for lacing or interlocking fasteners to fabric patches and then dope to the covering at the points where inspection openings are required.

METAL FRAMES

22 Where metal frames are used for inspection openings, attach doors to frames with cowl fasteners or flush type screws driven into self-locking nuts attached to the frames. Sew the frame securely to the fabric patch with the fabric extending at least two inches beyond all sides to provide sufficient dope adhesion of the patch to the cover.

PROTECTING SLIDE FASTENERS

23 To prevent failure of slide fasteners due to the effects of oil and weather, cover the entire length of fastener with doped-on surface tape. In applying tape, take care that the dope is kept away from the metal scoops or teeth of the fastener, since dope clogs the fastener and prevents operation. Apply a strip of cellulose tape, wide enough to cover the metal parts of the fastener, prior to doping-on the surface tape.

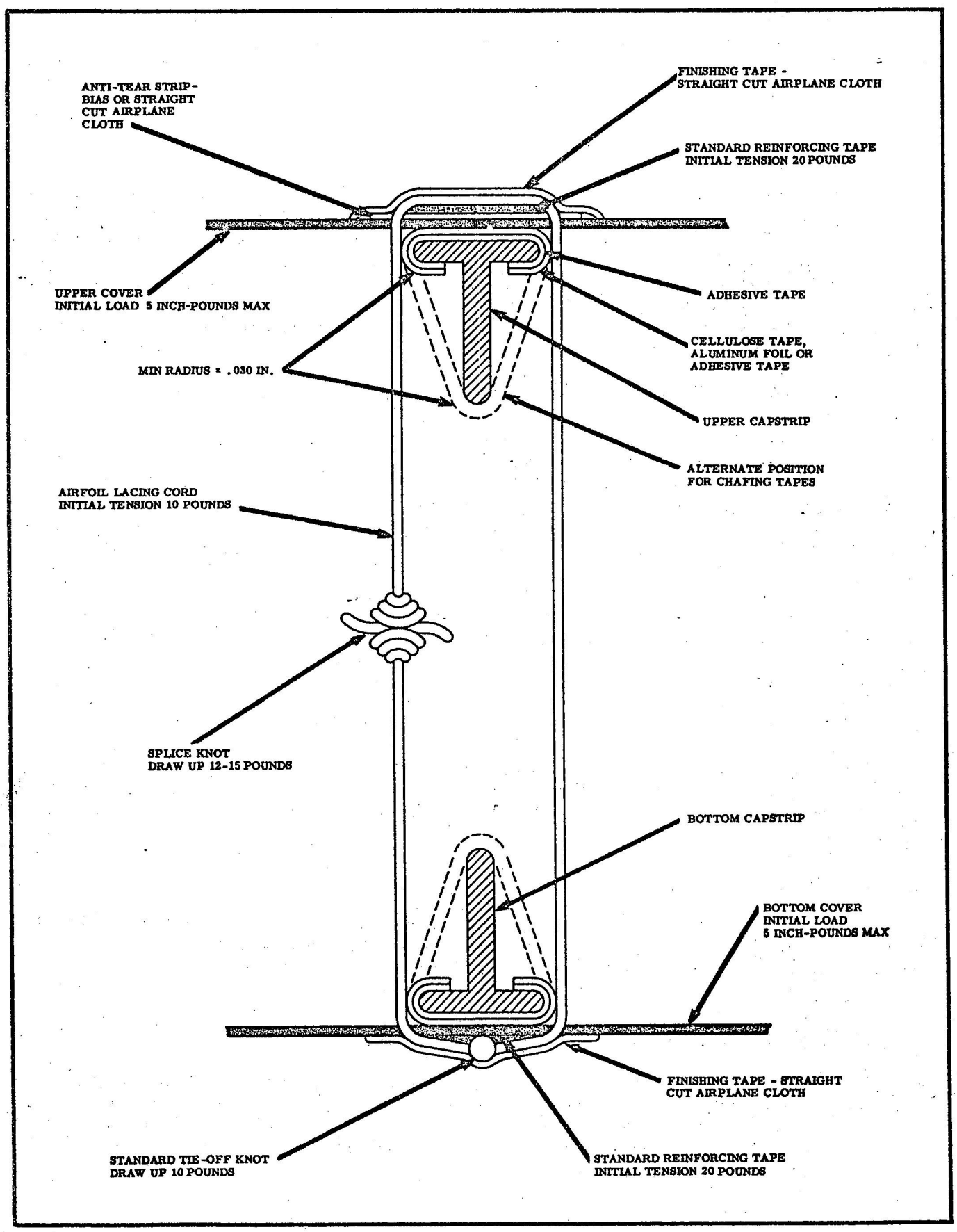



Figure 9 Cover to Cover Non-Flush Type Rib Lacing

**CAUTION**

Do not use oil or grease as a lubricant for slide fasteners, as such materials eventually cause failure of the fastener. The only recommended lubricants for slide fasteners are beeswax or a solution of paraffin dissolved in benzine. In the preparation of the paraffin-benzine solution, the operation should be performed under good ventilation, and the benzine kept away from any open flame or source of ignition.

## STATIC UNBALANCE

24 Make repairs to fabric covered control surfaces in the same manner as other fabric repairs. Inspect for static unbalance created by the repair. The static unbalance of a control surface is defined as the product of the weight of the surface and the chordwise distance between the hinge line and the centre of gravity of the surface. The centre of gravity is a point on the surface about which the surface is balanced with respect to gravity, that is, if the surface were suspended at the centre of gravity, the plane of the surface would remain in any position in which it was initially located.

## FINDING CENTRE OF GRAVITY OF SURFACE

25 Since it is not convenient to find the centre of gravity of a surface directly, the following procedure is used to measure the static unbalance:-

(a) Support the surface at its hinge line on supports which impose negligible restraint to rotation of the surface about its hinge line. Make supports so that the hinge line is level, see Figure 10.

(b) Apply a force to the surface near the leading or trailing edge so that the chordline of the surface is approximately level. For symmetrical sections, take the chordline as the line from the centre of the leading edge to the centre of the trailing edge. For sections which have a flat lower surface and a curved upper surface, take the lower surface as the chordline. For other sections, a line between the two mentioned above is used.

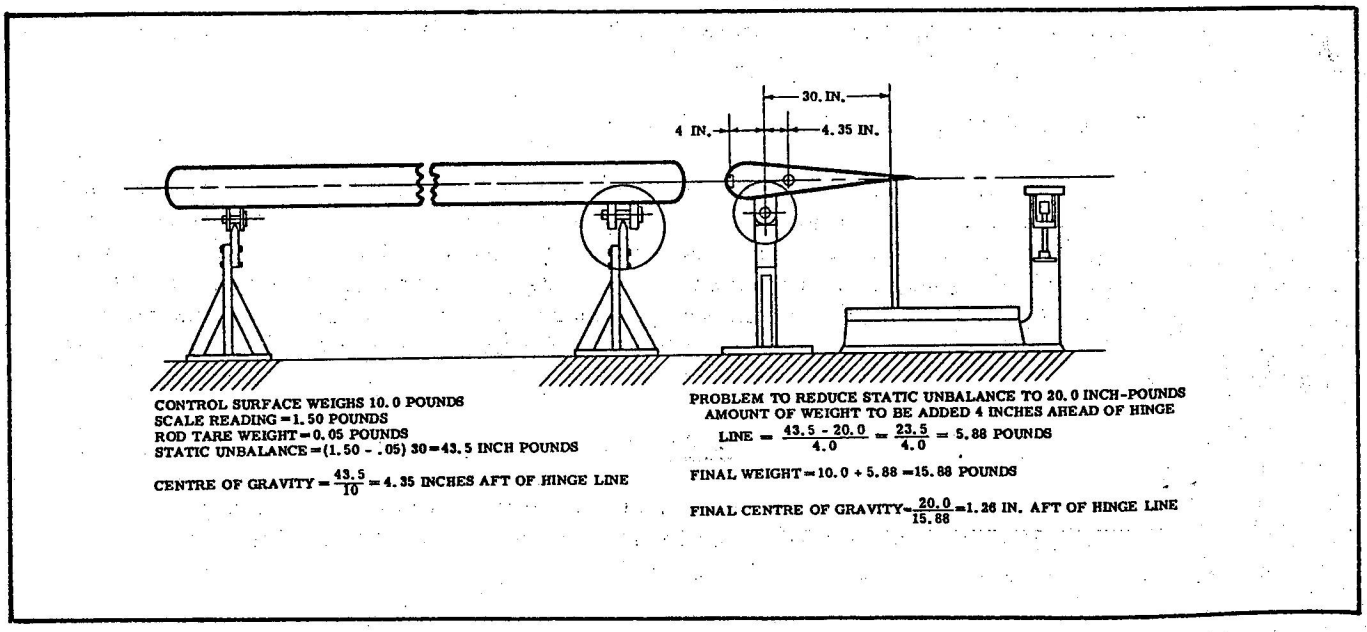



Figure 10 Static Unbalance Measurement of Control Surfaces

(c) Calculate static unbalance and correct as indicated in Figure 9.

## REPAIRING FABRIC WHEN DAMAGE IS EXTENSIVE

26 Where the damage to the fabric covering extends across a rib or other supporting structure of a wing or is over 16 inches, do not patch but recover the damaged area. Also recover where coverings are old and deteriorated, refer to paras. 38 and 39 following.

## CUTTING OF FABRIC FOR COVERS

27 In fabricating fabric coverings for airfoils, cut the fabric in sufficient lengths to pass completely around the frame, starting at the trailing edge, passing up to and around the leading edge, and returning to the trailing edge. Machine sew the covering wherever possible and complete installation by hand sewing or tacking.

## ENVELOPE METHOD OF COVERING

28 Sew together widths of fabric cut to specific dimensions to fit the airframe and then machine sew to form an envelope. Pull and draw envelope over the frame. Machine sew the trailing and outer edges of the covering, unless the frame is not suitably shaped for such sewing, in which case hand sew. Alternately, make up the cover as a sleeve by sewing the trailing edge only, then finish by hand sewing.

## BLANKET METHOD OF COVERING

29 Sew together widths of fabric of sufficient length to form a blanket covering for all surfaces of the frame, with the blanket installed on the airframe by hand sewing, using a baseball stitch. On wooden frames, temporarily tack the covering to the frame to facilitate sewing. On metal frames, use friction or other types of tape temporarily wrapped around members with the covering pinned in place to facilitate sewing.

**CAUTION**

Do not use permanent wrapping of members to facilitate sewing as the wrapping absorbs moisture and causes corrosion.

## GENERAL PRECAUTIONS WHEN INSTALLING COVERS

30 Design and apply the covering, whether envelope, blanket, or sleeve type, in a manner that will ensure that the fabric has proper and equal tension over all parts of the surface. In order to stress each system of threads, apply tension to the cover in all directions. Ensure that excessive tension is not applied to the covering, resulting in warping the structure when dope is applied to the covering. The fabric covering, when correctly designed and installed under the proper condition, is free of all wrinkles and has sufficient tension to prevent sagging of the fabric.

**NOTE**

Changes in temperature and humidity cause changes in the tension of the fabric covering. If temperature and humidity conditions are not controlled during sewing and covering operations, a poor job will result.

## INSTALLING COVERS

31 To cover a structure with fabric, proceed as follows:-

(a) Support the structure to be covered on suitable stands.

(b) Cover all parts of the structure which are likely to chafe the fabric covering with fabric or adhesive tape. Dopeproof the structure where required. If a plywood surface is being covered, prepare by cleaning, applying sealer, and two coats of dope.

(c) Prepare covering by sewing together widths of fabric, and sew in a manner to form an envelope or sleeve, or apply as a blanket covering.

(d) Pull the cover over the frame. Apply tension to the fabric in all directions and temporarily pin or tack in place to facilitate hand sewing. Complete the installation of the cover by sewing or tacking. Where mechanical fabric attachments are provided, install these.

(e) Apply anti-tear strips to fabric where required.

(f) Install re-inforcing tape and lace to the structure, or install mechanical types of attachments where provided. After re-inforcing tape has been laced to the structure, do no further work until after the first coat of dope has been applied.

(g) Install face tape, fabric re-inforcements and inspection openings with the second coat of dope.

UNSEWED PATCH UNDER SIX INCHES

32 Repair of holes in fabric up to six inches may be made without stitching the new fabric to the old, providing the patch falls entirely within the supporting members. When patches are made to areas from four to six inches in greatest dimensions, the distance of the patch from the structural members should not be less than 2-1/2 inches. For damaged areas smaller than four inches in greatest dimension, the distance of the patch must not be less than 1-1/2 inches from the structural members or ribs. Make overlap of the fabric a full 1-1/2 to 2 inches in all directions from a break or tear. Patches for holes up to six inches in size should have pinked edges.

PREPARING THE PATCH

33 Prepare the patch as follows:-

(a) If the damage is such that it will not permit sewing the edges of the tear together, cut out the damaged section.

(b) Trim to a smooth contour around the edge of the opening, either round or oval-shaped. When cutting the fabric, avoid making sharp corners.

| Dope | Removal Agent |
|---|---|
| MIL-D-5552A or 1-GP-31 Cellulose Nitrate Clear Dope (For) Aluminum | 1-GP-50B Cellulose Nitrate Dope and Lacquer Thinner |

Figure 11 Dope Removing Agents

(c) Thoroughly clean the area over which the patch is to be applied, see Figure 11 for dope removing agents.

(d) Wash off the area with dry cleaning solvent. Clean uniformly and remove all lacquer and layers of pigmented dope previously applied to the area. Produce a surface that is smooth and free from blemishes. Ensure that the cleaning agent does not drip onto any other portion of the surface or drip through the injury.

NSTALLING THE UNSEWED PATCH

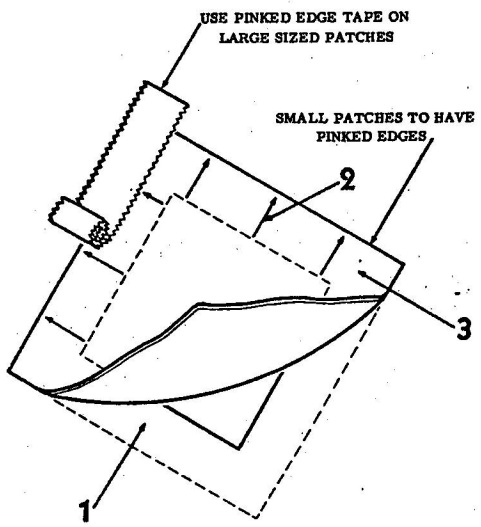
34 For installation procedure, see Figure 12.

FINISHING PROCEDURE

35 Finish as follows:-

a) After the patch has been placed in position, apply a coat of dope, see Figure 1.

b) After the first coat has dried, apply a second and a third coat.




**STEPS**

1 APPLY DOPE TO AREA OF OLD FABRIC TO BE COVERED BY THE PATCH.

2 PUT PATCH IN PLACE, SMOOTH OUT, AND STRETCH TAUT; DOPE THAT PART OF PATCH WHICH LAPS THE OLD FABRIC.

3 AFTER DOPE ON EDGES OF PATCH HAS DRIED, APPLY SUCCESSIVE COATS OF DOPE OVER ENTIRE PATCH AREA.

4 ON LARGE-SIZED PATCHES, DOPE MAY BE APPLIED ALONG TWO EDGES OF PATCH FIRST; AFTER THIS HAS DRIED, APPLY DOPE TO THE REMAINING EDGES, STRETCH THE FABRIC TAUT, AND LAY PATCH IN PLACE. AFTER DOPED EDGES HAVE DRIED, APPLY SUCCESSIVE COATS OF DOPE OVER ENTIRE PATCH AREA TO FINISH.

Figure 12 Patch Repair Procedure

NOTE

Sand between each coat with No. 7/0 sand paper or rub with doped canvas rubbing pads. Exercise care to avoid weakening the fibres of the fabric by unnecessary sanding.

(c) Apply two coats of cellulose nitrate clear dope for aluminum, when required, see Figure 12, allowing time to dry between each coat until the patch has blended completely into the surrounding surface. These pigmented coats may be sprayed, in which case three coats should be applied.

UNSEWED PATCH OVER SIX INCHES

36 The procedure will be the same as that for making unsewed patches under six inches except that the distance of the patch from the rib or structural member must not be less than 2-1/2 inches and the patch does not have pinked edges. The edges of the patch, however, should be finished with pinked edge tape. The overlap of the patch must be two inches for holes from six to eight inches in greatest dimension and one-fourth the size of the hole for holes eight to sixteen inches in greatest dimension.

(a) Apply the dope, see Figure 1, along the two edges of the opening. Place the patch and allow the dope to dry. Apply the dope to the remaining edges and stretch the fabric as taut as possible, sealing the patch into position. Allow the dope to dry.

(b) After drying, apply a second coat of dope to the edges of the patch. Allow the dope to dry.

(c) Install surface tape over the patched edges with the third coat of dope.

(d) Finish with regular finishing procedure, refer to para. 35, preceding.

SEWED-IN REPAIR PATCH

37 To apply a sewed-in patch, proceed as follows:-

(a) Expose all damaged parts. Repair structural damage in interior.

(b) Sew tear with baseball stitch.

(c) Tack down re-inforcing tape.

(d) Cut patches to shape with pinking shears. Cut fabric 1 inch larger than the opening, see Figure 1, for dopes and fabrics.

NOTE

If the damage is such that it will not permit sewing the edges of the tear together, cut out the damaged section, making a rounded or oval-shaped opening. Avoid making sharp corners.

(e) Clean the area of the old fabric to be doped, refer to para. 33, preceding.

(f) Turn under the edges of the patch 1/2 inch and sew them to the edges of the opening.

NOTE

Before sewing, fasten the patch to the corners with a few temporary stitches to facilitate sewing the seams.

(g) After sewing is completed, apply a coat of cellulose nitrate clear dope, to the patch.

(h) Apply a second coat of dope and apply surface tape over the seams.

(j) Finish with the regular procedure, refer to para. 35, preceding.

REPAIR BY SEWING-IN REPAIR PANEL

38 When the damage is over 16 inches in length or over half of the bay or section is damaged, make the repair by sewing in a new panel. Sew the new fabric to the old cover at a point beyond the ribs adjacent to the damage and extending from the trailing edge up to and around the leading edge. Lace the new cover to the ribs over the old re-inforcing tape and lacing, which is not removed. Proceed as follows:-

(a) Remove the surface tape from the ribs adjacent to the damaged area and from the trailing and leading edge of the section being repaired. Leave the old re-inforcing tape in place.

(b) Cut the fabric along a line approximately one inch from the centre of the ribs on the sides nearest to the injury. Continue the cuts to remove the damaged section.

(c) Cut a fabric panel of a sufficient length to extend from the trailing edge over the upper surface of the wing up to and around the leading edge. Return the fabric on the under side of the leading edge approximately to the front beam. Cut the panel of sufficient width to extend approximately three inches beyond the ribs adjacent to the damage.

(d) Clean the area of the old fabric that is to be covered by the panel.

(e) Put the panel in place, stretch taut, and pin. After the panel is pinned in place, fold under the trailing and leading edge of the panel 1/2 inch and sew to the old fabric. Fold the side edges of the panel under 1/2 inch and sew them to the old cover.

(f) After completion of the sewing, place re-inforcing tape over the ribs under moderate tension and lace down in accordance with Figure 9. Remove the temporary pinning.

(g) Give the panel a coat of clear dope and allow to dry. Install surface tape with the second coat of dope, over the re-inforcing tape and over the edges of the panel.

(h) Finish using regular doping procedure, refer to para. 35, preceding.

SEWING-IN REPAIR PANEL - FLUSH TYPE COVER FASTENING

39 Where the cover is fastened to ribs with flush type re-inforcement, remove re-inforcement and then sew the repair panel to the old cover as specified in para. 38, preceding. Have the repair fabric extend beyond the ribs to approximately the centre of the sections adjacent to the damage. Some of the tautness of the cover will be lost by removal of the re-inforcements, but the added doping area will restore tautness. After the cover is in place, install the re-inforcements and finish the repair as outlined in para. 38, preceding.

REPAIRS TO LOOSENED FABRIC TAPE

40 Repair fabric tape over joints in the plywood or over fabric seams by removing all tape within the loosened area, using thinner to facilitate removal and prevent harming the wood surface. Then proceed as follows:-

(a) Remove the finish from the remaining tape to a point two inches back from where the loosened tape was removed. Remove the finish from the wood in an area approximately two inches on either side of where the tape was located, leaving a feathered edge on the remaining finish.

(b) Apply one brush coat of clear dope to the wood and allow to dry for 45 minutes. Remove all dope lapped over the edges of the original finish by wiping with a cloth before the dope has dried.

(c) Apply a second coat of clear dope, also covering the two inches of old tape from which the finish has been removed. While still wet, apply a strip of pinked fabric equal in width to the original strip and sufficiently long to cover the two inches on the original fabrication. Work out all air bubbles by brushing to ensure maximum adhesion. Allow to dry for 45 minutes and re-finish as necessary.

## REPAIRS TO FABRIC-COVERED PLYWOOD SURFACES

GENERAL

41 Before applying fabric to plywood surfaces, prepare the surface for covering by cleaning and application of sealer and dope.

CLEANING

42 Plywood surfaces, prior to application of sealer, must be free from excess glue extruded a distance greater than 1/8 inch beyond glue joints. Sand all surface areas which have been smeared with glue in order to expose a clean wood surface. Remove loose deposits such as dust, wood chips and sawdust by wiping with dry cloths or other suitable means. Remove oil or grease spots by carefully washing with naphtha in such a manner as to prevent the spread of oil or grease.

APPLICATION OF SEALER AND DOPE

43 The specified minimum protective finish for exterior fabric-covered plywood is one brush coat or two dip coats (wiped) of sealer, thinned to 30% non-volatile content, and two brush coats of clear dope. Apply the sealer and allow to dry for two to four hours, then apply two brush coats of clear dope. Allow the first coat of dope to dry for approximately 45 minutes before applying the second coat. After the second coat of dope has dried, the surface will be ready for covering.

PROCEDURE

44 Repair the damage to fabric covering on plywood by cutting out the damaged section of fabric and applying a fabric patch of the same size and shape. Finish the edges of the patch with pinked tape. Proceed as follows:-

(a) Cut the fabric to form a regularly shaped opening. After the damaged section of fabric is removed, clean the surface of the plywood and smooth out any rough spots. Clean the area of the old fabric, which is to be lapped by the pinked edge finishing tape, using dope or thinner.

(b) Apply two coats of clear dope to the surface of the plywood and that part of the old fabric to be covered by the tape, allowing 45 minutes between coats.

(c) After applying the second coat, lay the patch in the wet dope and dope over the patch area. Brush sufficiently to work out all air bubbles and to ensure maximum adherence.

(d) Allow this coat to dry, apply dope to pinked tape and finish with three additional coats of clear dope. Follow by aluminum dope or other finish as required.

REPAIRS TO SMALL LOOSENED AREAS

45 Wash off the dope on the loosened fabric by repeated application of cellulose nitrate thinner, or cellulose acetate butyrate dope thinner, whichever is applicable. Follow by scraping, then wipe with thinner. Proceed as follows:-

(a) Beginning approximately in the centre of the loosened area, carefully cut the fabric towards the securely cemented area so that the cuts form a cross. Lay each quarter of fabric back away from the wood surface.

(b) Apply one brush coat of clear dope to the entire exposed wood area and allow to dry 45 minutes.

(c) Taking each quarter of fabric in sequence, apply a brush coat on the wood beneath it and press the fabric into the wet dope. Apply sufficient dope to ensure the wetting of all loosened fabric up to the line where cloth is satisfactorily attached. When all four quarters have been properly cemented in place, allow the dope to dry for 45 minutes and apply a brush coat of clear dope over the entire repair area. Allow this coat to dry for 45 minutes.

(d) Cement pinked tape over the cuts and apply clear dope over the tape and the entire repair area. Allow the dope to dry for 45 minutes, then scuff lightly with fine sandpaper. If the area is small, apply a circular pinked-edge patch over the cuts instead of taping.

(e) Spray or brush on two coat of clear dope. Allow each coat to dry for 45 minutes.

(f) Spray two coats of aluminized dope or pigmented dope to match the colour of adjacent areas.

REPAIRS TO LARGE LOOSENED AREAS

46 Proceed as follows:-

(a) Remove the loosened fabric and cut back a little into the securely cemented fabric. Cut out the fabric in straight lines to conform to the taping pattern in adjacent areas.

(b) Apply two coats of clear dope to the bared wood areas.

(c) Cement in place a piece of new cloth cut with straight edges to fit the opening.

(d) Apply a coat of clear dope to the area and allow to dry for 45 minutes.

(e) Cement pinked-edge surface tape, not less than two inches in width, over the cuts and the adjacent mating areas. Apply clear dope over the tape and the entire repair area. Allow the dope to dry for 45 minutes, then scuff lightly with fine sandpaper.

(f) Spray or brush on two coats of clear dope and allow each coat to dry for 45 minutes.

(g) Spray two coats of aluminized dope or pigmented dope to match the colour of adjacent areas.

MATERIAL SPECIFICATIONS

47 For table showing materials, specifications, see Figure 13.

| Material | Specification | | Remarks |
|---|---|---|---|
| | RCAF Ref. | Procurement | |
| Acetone | 33C/725 | 15-GP-50 | Used for cleaning fabric before patching. |
| Aluminum, Foil | | AN-A-20 | For use in protecting structural parts and finishes against dope in the covering of airplane wings, etc. |
| Aluminum, Pigment Paste, Aircraft | 33A/349, 350 | 1-GP-24a Type 2 | Used in the preparation of aluminized dope, lacquer and enamel. |
| Beeswax, Technical Grade | 33C/5 | C-30-536 | Used for waxing lacing cord and hand sewing thread. |
| Castor Oil | | AN-JJ-O-316 | Used as plasticizer in dopes. |
| Cellulose Tape or Sheet | 33G/63, 67 | L-T-101 Type 1 | Type II for use in protecting structural parts and finishes against dope in the covering of airplane wings, etc. |
| Aircraft Fabric Linen | 32B/305 | MIL-C-5646C | For use as a covering for the wings, control surfaces and fuselages of aircraft. |
| Cloth, for Plywood Covering | 32B/305 | MIL-C-5646C | For application to plywood skin surfaces only, where the design is such that no portion of the loading is carried by the fabric. |
| Cord, Braided, Cotton | 32B/382 | MIL-C-5648A | Used for lacing fabric on airplane fuselages and wings. |
| Cord, Lacing, (Airfoil) Linen and Linen Hemp | | MIL-T-6779 | Use type II, 11-ply, polished, RH twist, for lacing fabric to structures. |
| Dope, Cellulose Nitrate, Clear | 33A/420, 421 | 1-GP-31 MIL-D-5553A | For use as an undercoat on aircraft fabric surfaces and for making repairs to doped fabric surfaces. For thinning, use thinner 1-GP-506. |

Figure 13 (Sheet 1 of 4) Table of Material Specifications

| Material | Specification | | Remarks |
|---|---|---|---|
| | RCAF Ref. | Procurement | |
| Dope, Cellulose Nitrate, Clear For Aluminum | 33A/420, 421 | 1-GP-31 MIL-D-5552A | For use as a vehicle for aluminum paste in the preparation of aluminized dope for aircraft fabric surfaces. For the preparation of aluminum dope, add approximately 6 ounces of aluminum paste, RCAF Ref. 33A/349, to 1 pint of the dope and mix thoroughly, then add sufficient dope to make 1 gallon of the aluminized dope. For thinning, use thinner 1-GP-50B as required. Apply only over 1-GP-31 dope. |
| Dope, Cellulose Nitrate, Pigmented Camouflage | 33A/NIC | MIL-D-5555 | For use on aircraft fabric surfaces doped with 33A/420, for obtaining camouflage finish. For thinning, use thinner 1-GP-506. For brush application, use not more than one part of thinner to four parts of dope. For spray application, use not more than one part of thinner to one part of dope. |
| Dope, Cellulose Nitrate, Pigmented | 33A/ | 1-GP-31 MIL-D-5554 | For use on aircraft fabric surfaces dopes with 33A/470 for obtaining coloured glossy dope finish. For thinning, use thinner 1-GP-50C. For brush application, use not more than one part of thinner to four parts of dope. For spray application, use not more than one part of thinner to one part of dope. |
| Cloth, Cotton Unbleached | 32B/343 | 4-GP-42 | 12-ounce duck used to make up fabric re-inforcements. |
| Eyelets, Brass | 29/ | | For making up inspection openings. |
| Glue, Aviation Marine, Waterproof | 33G/NIC | | Used for fastening aluminum foil to structural parts as a portection against dope. |
| Grommets, Drain Plastic | 28/ | | Installed at low points of structure to provide for drainage and ventilation. The No. 4 grommet is shielded. |
| Grommets, Brass | 28/ | | Installed at low points of structure to provide for drainage and ventilation. Use No. 2 on wings and fuselages, No. 1 on airfoils in empennage unit. |

Figure 13 (Sheet 2 of 4) Table of Material Specifications

| Material | Specification | | Remarks |
|---|---|---|---|
| | RCAF Ref. | Procurement | |
| Thinner | 33A/119 | 1-GP-70a | Used to clean oil and grease from wood surfaces, used also for thinning various varnishes and enamels. |
| Paper, Abrasive, Artificial, Waterproof | 29/1868-67 | FED-PP-101-1 | Used for sanding doped surfaces. |
| Plastic Coating Compound Strippable | 33G/52 | MIL-C-6799A | Used as a masking material for windows and other surfaces on which the adhesion of dope or paint is not desired. |
| Primer, Zinc Chromate | 33A/529 | 1-GP-132 | Used to protect metal surfaces from corrosion, and to provide improved adhesion of finished coats. Thin with 33A/467 Thinner. |
| Slide Fasteners | 29/ | VF-106 | Use grade II, semi-automatic locking for making up inspection openings. |
| Naptha Cleaner | 33C/182 | 3-GP-8 | For use when cleaning fabric before patching. |
| Tacks | 29/ | | Used for installing fabric to wood structures. For permanent tacking, use Monel metal, tinned iron or brass. No. 18 BWG gauge x 3/8 to 1/2 inch long. Where tack will pass through member, use shorter tack. Copper tacks may be used for temporary tacking. |
| Tape, Cotton, Re-inforcing | 32B/16 | 3-F-47 | Tape used as re-inforcing tape on fabric and under lacing cords of airfoil sections and for inter-rib bracing. |
| Tape, Masking (Paper-backed) | 33G/99, 100, 101 | UU-T-106A | Used as a masking material to protect parts from dope during finishing of aircraft. |
| Tape, Non-hygroscopic Adhesive | 33G/ | | May be used to cover edges which are likely to wear fabric covering. |
| Tape, Surface | 32B/444-446 | DTD 540 | Used as a finishing tape over lacing, sewing, etc. |

Figure 13 (Sheet 3 of 4) Table of Material Specifications

| Material | Specification | | Remarks |
|---|---|---|---|
| | RCAF Ref. | Procurement | |
| Thinner, Cellulose Nitrate Dope and Lacquer | 33A/466 | 1-GP-50b | Used in thinning cellulose nitrate dopes and lacquers. |
| Thinner, Cellulose Nitrate Dope and Lacquer, Blush | 33A/533 | 1-GP-13b | Used as a blush retarding thinner in cellulose nitrate dopes and lacquers. |
| Thinner | 33A/98 | 1-GP-4a | Used for thinning spar varnish. |
| Thread, Cotton | 32B/ | | For hand sewing, use size 10/3 ply. For machine sewing of fabric, use size 16/4 to 20/4 ply. Use fully waxed thread for hand sewing. |
| Thread, Hand Sewing. Linen and Linen Hemp | 32B/ | | |
| Thread, Hand Sewing and Lacing Cord, Cotton | 32B/ | | |
| Toluene | 33A/467 | TT-T-548A | Used for thinning zinc chromate primer. |
| Tricresyl Phosphate | 34A/227 | TT-T-656a | Used as a plasticizer in dopes. |
| Varnish, Spar, Glyceryl Phthalate | 33A/75 | 1-GP-99 | Used as a sealer on fabric covered plywood surfaces prior to application of dope and fabric. Thin with Thinner 33A/98. |

Figure 13 (Sheet 4 of 4) Table of Material Specifications