[2 D. 101. February, 1923.]
(*Cancelling Air Board Specification D. 101.*)

NOTE.—*The Association desires to call attention to the fact that this Specification is intended to include the technical provisions necessary for the supply of the material herein referred to but does not purport to comprise all the necessary provisions of a contract.*

British Engineering Standards Association.

Incorporated by Royal Charter 1929.

British Standard Specification for Aircraft Material.

PROPERTIES OF AEROPLANE DOPING SCHEME.

1. **Definition.** The term "Aeroplane Doping Scheme" shall denote a method of producing and maintaining on aeroplane fabric a taut, waterproof and airproof surface and of protecting the fabric from the deteriorating effects of light, weather and service conditions.

2. **Classes.** The following classes of Doping Schemes are recognised:—

CLASS A. Using a dope and a protective covering, the dope being transparent to such light as is destructive to fabric and requiring a protective covering.

CLASS B. Using a dope and a transparent finishing varnish, the dope being opaque to such light as is destructive to fabric, but requiring a transparent finishing varnish to protect the dope film from moisture.

CLASS C. Using a dope only, the dope being opaque to such light as is destructive to fabric and being unaffected by moisture.

CLASS D. Any other scheme giving the effect required by this Specification.

3. **Ingredients.** The ingredients of the materials used in the Doping Scheme shall be of such a nature that the materials can be applied easily without injury or discomfort to the workers, and without injury to any part of the aeroplane either during or after application.

4. **Finish.** The Doping Scheme shall be of such a nature that when correctly applied to Standard Linen Aeroplane Fabric (British Standard Specification 4 F. 1) a smooth continuous surface is produced.

5. **Tautening Properties.** The tautening properties of the Doping Scheme when correctly applied, shall be such as to produce on Standard Linen Aeroplane Fabric (British Standard Specification 4 F. 1) mounted on a Standard Test Frame (*see* Appendix I):—

(*a*) A tautness of not less than 2½ lb. per inch and not more than 5 lb. per inch after an exposure of 18 hours at 20° C. to an atmosphere of 66 per cent. humidity.

(*b*) A tautness of not less than 2 lb. per inch after an immediately subsequent exposure of two hours at 20° C. to an atmosphere of 95 per cent. humidity.

The tautness shall be determined eight days after the application of the last coat by the method described in Appendix II.

6. **Elasticity, Brittleness and Adhesion.** Standard Linen Aeroplane Fabric (British Standard Specification 4. F. 1) to which the doping scheme has been applied shall, eight days after the application of the last coat, be subjected to a pressure of one inch of water and the resulting radius of curvature *(x)* measured. The pressure shall then be increased to, and maintained for one minute at 10 inches, and the

radius of curvature (y) again measured. The pressure shall then be reduced to one inch and after 10 minutes the radius of curvature (z) measured once more.

y shall be not less than 35 inches.
z shall not differ from x by more than 10 per cent.

When a bursting pressure is applied, the dope film shall adhere to the fabric and shall not crack before the fabric breaks. A suitable arrangement for carrying out this test is described in Appendix III.

7. **Weight.** The increase in weight produced by the Doping Scheme when correctly applied to Standard Linen Aeroplane Fabric (British Standard Specification 4 F. 1) and determined eight days after the application of the last coat, shall not exceed a total weight of 3·5 ozs. per square yard in an atmosphere of 95 per cent. humidity at 25° C.

8. **Inflammability.** Standard Linen Aeroplane Fabric (British Standard Specification 4 F. 1) to which the Doping Scheme has been correctly applied shall not glow below a temperature of 250° C. (482° F.), when tested by the method described in Appendix IV.

9. **Rate of Burning.** The time taken for flame to travel 18 inches along Standard Linen Aeroplane Fabric (British Standard Specification 4 F. 1) to which the Doping Scheme has been correctly applied shall be determined eight days after the application of the last coat as described in Appendix V. The times obtained shall be:—

(*a*) In still air not less than 15 seconds.
(*b*) In a wind of five miles per hour not less than 10 seconds.
(*c*) In a wind of 20 miles per hour the flame shall be extinguished.

10. **Properties for Comparison with Standard Reference Materials.** The Doping Scheme shall be not inferior to that consisting of the Standard Reference Dope and Protective Covering (British Standard Specification No. 83) in respect of the following properties, the comparison being carried out on Standard Test Frames prepared as described in Appendix I:—

(*a*) Resistance to the action of fresh water, sea water, lubricating oils, and petrol.
(*b*) Tensile strength and durability (*see* Appendix VI).

11. **Keeping Qualities.** The Doping Scheme shall satisfy the clauses 3 to 10 inclusive of this Specification after storage of the materials comprising the scheme, in suitable containers, for at least three months from the date of manufacture.

APPENDIX I.

Method of Preparing Standard Test Frames.

Strong rectangular wooden frames, preferably reinforced with metal to prevent warping, not less than 10 inches by 10 inches internal measurement, and having a single hole (D) $\frac{3}{16}$ inch diameter through one of the sides (*see* Fig. 1) shall be covered on one face with Standard Linen Aeroplane Fabric (British Standard Specification 4 F. 1) under a tension approximating to two lb. per inch warp and one lb. per inch weft, the warp and weft threads being parallel to the sides of the frame. The materials shall be applied in the following quantities, the weight in each case representing the added weight per square yard when dry, that is, not less than eight days after the application of the last coat.

Class A. The quantities of dope and protective covering specified by the maker. Should the maker of the dope supply no special protective covering, the quantity of dope specified by the maker, but not more than two ozs. shall be covered with one oz. of Standard Reference Protective Covering (British Standard Specification No. 83).

Class B. The quantities of dope and finishing varnish specified by the maker. Should the maker of the dope supply no finishing varnish, the quantity of dope specified by the maker, but not more than two ozs. shall be covered with one oz. of transparent Nitro-Cellulose Varnish V. 114 (British Standard Specification 2 D. 103).

Class C. The quantity of dope specified by the maker.

Number of Test Frames Required. Four Standard Test Frames and three larger frames at least will be required to carry out the tests specified, *i.e.* :—

One frame for testing finish, tautness, weight and inflammability.

Two frames for testing durability and tautness.

One frame for testing elasticity, brittleness and adhesion.

Three larger frames for testing rate of burning.

For the purpose of comparison, two frames will also be required for the Standard Reference Materials (British Standard Specification No. 83).

APPENDIX II.

Method of Measuring Tautness.

The tautness of the doped fabric shall be defined as the evaluation of the expression $T = \frac{RP}{2}$, where R is the radius of curvature resulting from a difference of pressure P between the upper and lower surfaces. R shall be measured in inches and P shall be equal to one inch of water (0·0362 lb. per square inch). The radius of curvature R of the surface may be measured by any suitable means. A convenient type of spherometer is shown in Fig. 2 and consists of an aluminium ring (C) approximately six inches diameter, bevelled at the face so as to present a well defined circle of contact with the doped fabric. The ring must be as light as possible, and may be turned up from a casting or may take the form of a spinning. An aluminium bracket (B) with a boss at its centre is rigidly fastened to the top of the ring, the hole in the centre of the boss being concentric with the outer circumference of the ring. The hole in the boss is reamered out to be a "push fit" for the stem of an Ames dial (A) graduated in $\frac{1}{1000}$ inch.

The Ames dial as supplied by the makers is not suitable for use with this spherometer as its weight is too great, and the effort required to move the plunger is excessive. These difficulties may be overcome by removing the heavy iron back plate, and the spiral tension spring used to control the movements of the plunger. The plunger must also be removed and be carefully cleaned. If necessary, it is rubbed down with fine emery cloth until it will slide easily under its own weight through its tubular guide. It is essential that no oil should be used between the plunger and its guide. When re-assembling the parts care must be taken that the small hair spring, used to take up backlash, is properly fixed. The iron back is replaced by a thin disc of celluloid or mica. The zero reading of the dial is ascertained by placing a straight edge across the ring and plunger, or by placing the instrument on a flat metal surface.

In order to carry out the determination of tautness the under-side of the frame is covered with a more or less air-tight back, such as doped fabric, and the frame connected through the hole in its side to any suitable arrangement, such as a water pump, for reducing the pressure inside the frame, so that a difference of pressure of one inch is obtained between the inside and outside of the frame. A convenient method of maintaining a constant pressure difference is by means of a Mariotte bottle (*see* Fig. 3). The radius of curvature of the fabric on the frame shall then be measured by means of a spherometer such as that described above.

In order to calculate R and T from the depression recorded on the Ames dial, let :—

x = diameter of aluminium ring, and

y = depression of plunger, then

$$R = \frac{x^2}{8y}$$

for example :—

If $x = 6$ and $y = \frac{60}{1000}$ inch,

then $R = 75$

and $T = \frac{75 \times 0{\cdot}0362}{2} = 1{\cdot}3$ lb./inch.

APPENDIX III.

Method of Testing Elasticity, Brittleness and Adhesion.

The Elasticity Meter (Fig. 6) consists of a cylindrical brass pressure vessel A, seven inches in internal diameter, the top of which is closed by a thin sheet of rubber, upon which a fibre ring B can be firmly clamped. The tests shall be carried out as follows :—

Elasticity. The Standard Linen Aeroplane Fabric (British Standard Specification 4 F. 1) to which the doping scheme has been correctly applied, shall be affixed by means of dope to the fibre ring B. After allowing to dry for two hours, the frame shall be cut away from the ring, and the ring and fabric clamped in the Elasticity Meter.

A pressure equal to one inch of water shall be allowed to act upon the doped fabric for one minute, after which the radius of curvature X shall be measured. This may be done by means of any suitable spherometer, *e.g.*, the instrument described in Appendix II.

The pressure shall then be increased to 10 inches of water and allowed to act for one minute, at the end of which period the radius of curvature Y shall be measured.

The pressure shall then be reduced to one inch, and after 10 minutes the radius of curvature Z measured once more. The release vale shall then be opened. After 10 minutes, the pressure of one inch of water shall be again applied for one minute, and the radius of curvature once more measured.

Brittleness and Adhesion. The pressure shall then be increased at the rate of three lb. per square inch per minute until the specimen bursts.

The temperature shall be between 15° C. and 20° C., and the relative humidity between 60 per cent. and 70 per cent. during the tests.

APPENDIX IV.
Method of Testing Inflammability.

The apparatus (*see* Fig. 4) consists of a sheet steel vessel with bottom inlet tube for air supply. The whole is immersed in molten solder to just above the level of the shoulder. Air is supplied at the rate of two or three litres per minute. The temperature of the solder is maintained at 250° C. (482° F.).

Four pieces of the doped fabric each one cm. square, are then dropped into the vessel. No glowing or flaming of the doped fabric shall take place within two minutes.

The test shall be carried out five times in all, the residues being removed after every second test by blowing through the open top.

The behaviour of the doped fabric in the vessel may be conveniently observed by means of an inclined mirror placed some distance above the top of the vessel.

APPENDIX V.
Method of Measuring Rate of Burning.

The rate of burning shall be measured as follows:—

A piece of Standard Linen Aeroplane Fabric (British Standard Specification 4 F. 1) to which the Doping Scheme has been correctly applied, shall be fixed to a frame of inside dimensions not less than 24 inches by 12 inches, made of one inch by one inch material.

For tests (*a*) and (*b*) two lines shall be drawn on, and also a slit cut across the fabric, parallel to the short sides, and distant four inches, twenty-two inches and one inch respectively, from the front inside edge of the frame.

The frame shall be supported at its corners at its lower edge (*i.e.*, edge nearest the slit) nine inches from the table and the long sides inclined upwards at 15 degrees to the horizontal (*see* Fig. 5) for the two tests (*a*) and (*b*) described below.

For test (*c*) the slit shall be across the centre of the fabric and the lines three inches on either side of it.

(*a*) *Rate of Burning in Still Air.* The frame being shielded from draughts, the doped surface shall be ignited along the length of the slit. The time taken for the flame to travel between the two lines shall be noted.

(*b*) *Rate of Burning in a Wind of five miles per hour.* A suitable fan, the diameter of which shall not be less than 12 inches, shall be placed with its centre on a level with the lower end (front) of the frame, in such a way as to produce a horizontal wind of five miles per hour at the front of the frame. The doped fabric shall be ignited as in (*a*) and the fan switched on as the flame passes the lower line. The time taken for the flame to travel between the two lines shall be noted.

(*c*) *Behaviour in a Wind of twenty miles per hour.* The frame shall be inclined at four degrees to the horizontal and ignited along both edges of the slit. After it has been allowed to burn for three inches it shall be exposed to horizontal wind of twenty miles per hour, acting in the same direction as in flight.

APPENDIX VI.
Method of Applying Durability and Tautness Tests.

Standard test frames shall be prepared as described in Appendix I:—

(*a*) Two frames with the Doping Scheme under test.

(*b*) Two frames with the Standard Reference Dope and Standard Reference Protective Covering applied in the proportion of two ozs. per square yard of dope and one oz. per square yard of protective covering.

The backs of the test frames shall be suitably protected with a covering of waterproof material.

The tensile strength of the fabric on one side of each of the differently treated frames shall be determined when the doped fabric is dry, that is, not less than eight days after the application of the last coat.

The tensile strength shall be determined as follows:—

Six specimens, one inch wide, and sufficiently long to allow seven inches between the jaws of a suitable testing machine, shall be cut in the warp direction from the fabric on each of the frames. All specimens shall then be subjected to the same humidity conditions for 18 hours immediately preceding the test. At the end of this period the tensile strength shall be determined.

The relative tautness of the fabric on the remaining frames shall be determined either as described in Appendix II, or by means of any suitable form of commercial instrument giving comparative readings.

The frame shall then be freely exposed in the open, facing the sun, at an angle corresponding to maximum sunlight. An exposure of six months shall be given, the period to include at least two of the months from May to August inclusive. During the exposure, the frames shall be examined at intervals for adhesion of the dope, cracks, etc., and the general behaviour in wet and dry weather shall be noted. Comparative tautness tests shall also be made at intervals in both wet and dry weather.

After exposure for the specified period, the tensile strength of the doped fabrics shall be determined as described above.

This Specification was adopted by the Sectional Aircraft Committee on 8th February, 1923, and approved on behalf of the Main Committee on 20th February, 1923.

NOTE.

In order to keep abreast of progress in the Industries concerned, the British Standard Specifications are subjected to periodical review.

Suggestions for improvements, addressed to the Director of the British Engineering Standards Association, 28 Victoria Street, London, S.W., 1, will be welcomed at all times. They will be recorded and in due course brought to the notice of the Committees charged with the revision of the Specifications to which they refer.

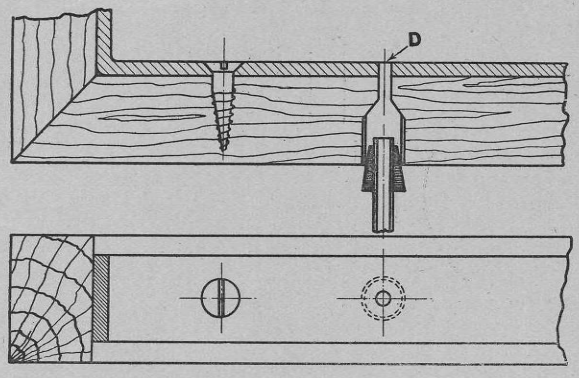
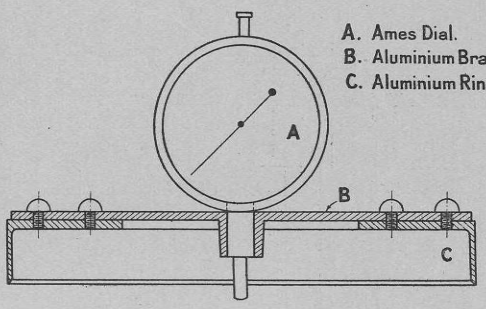


Fig. 1. Section of Frame used for measurement of Tautness.



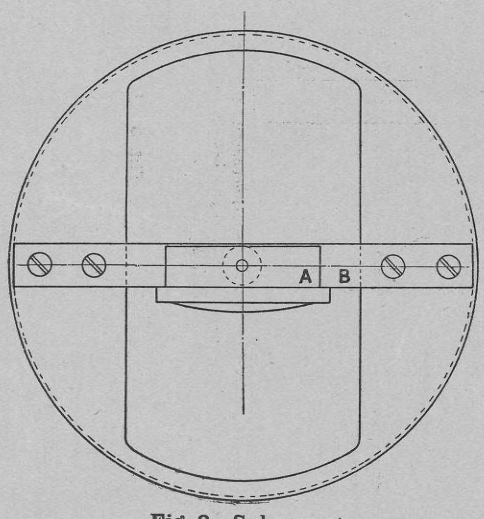


Fig. 2. Spherometer.

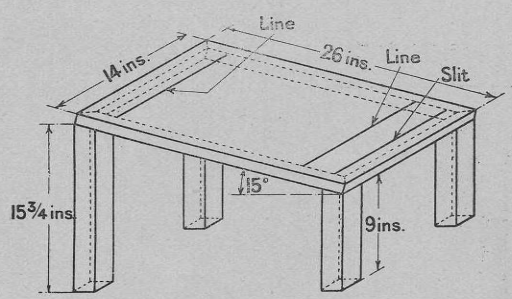


Fig. 5. Frame for measuring Rate of Burning.

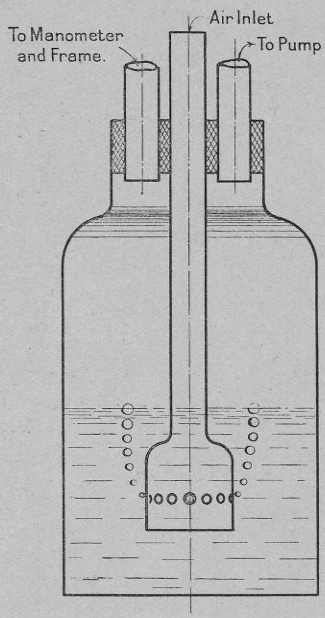
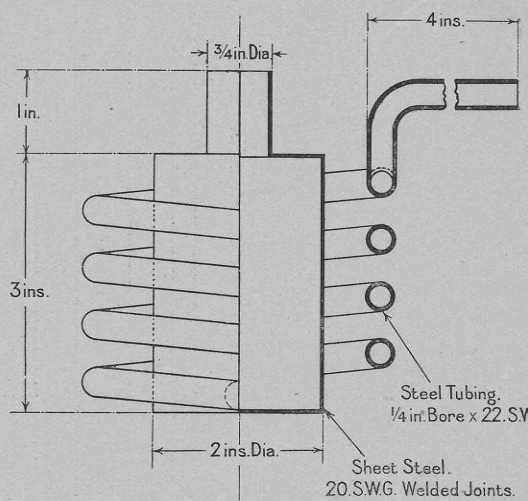


Fig. 3. Marriotte Bottle.



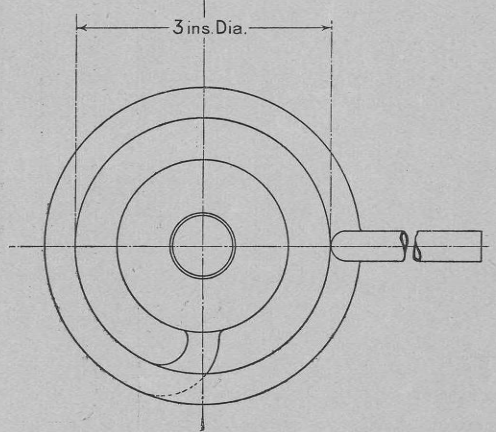
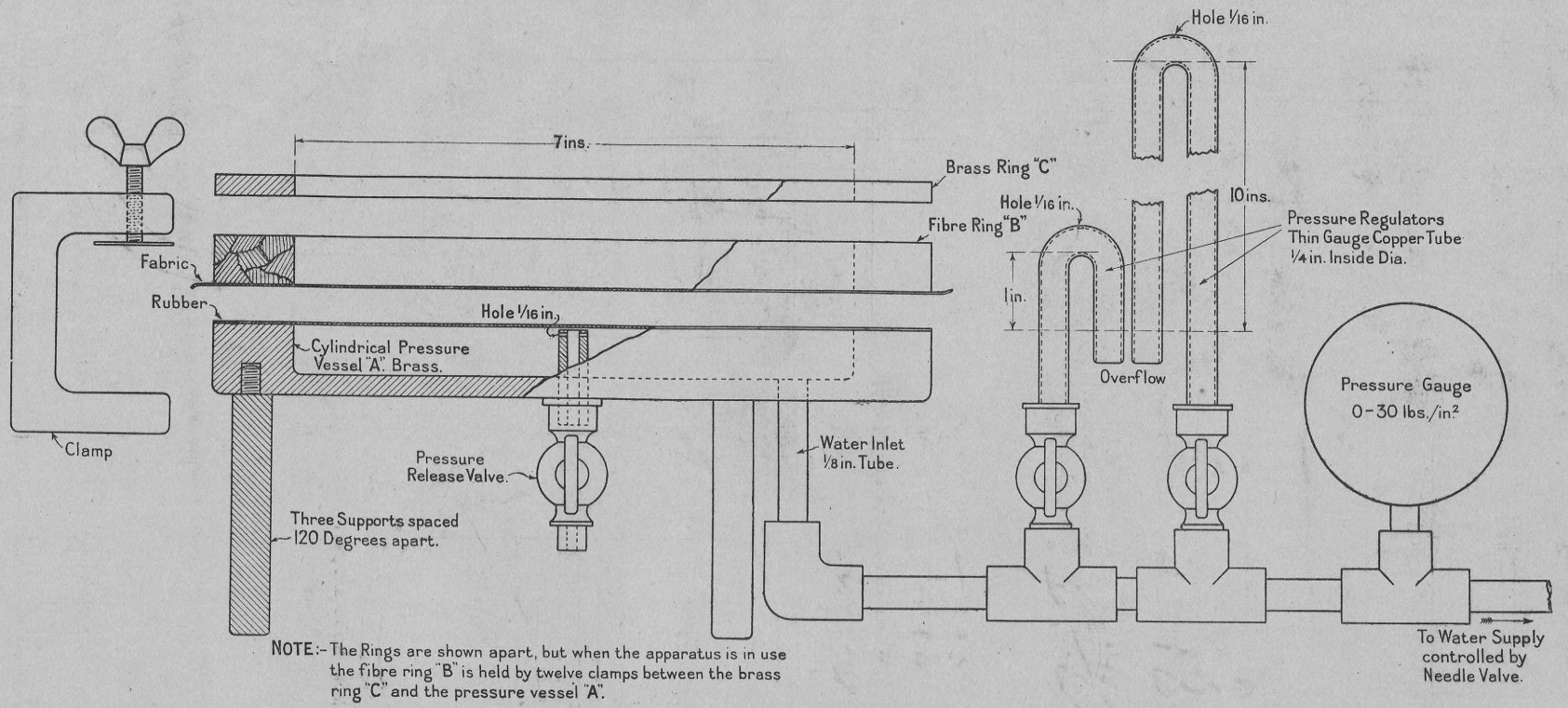


Fig. 4. Apparatus for Testing Inflammability.



NOTE:- The Rings are shown apart, but when the apparatus is in use the fibre ring "B" is held by twelve clamps between the brass ring "C" and the pressure vessel "A".

Fig. 6. Elasticity Meter.

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