METHOD OF TEST FOR WOOL FIBRE DIAMETER BY THE AIR-FLOW APPARATUS

(*Adopted by the I.W.T.O. Technical Committee, Venice, May*, 1960)

Preface

WHEN a current of air is passed through a uniformly arranged mass of fibres packed in a chamber with perforated ends the ratio of air flow (l/min.) to differential pressure (mm. H_2O) is uniquely determined by the total surface area of the fibres, and various constants. This was predicted from the hydrodynamic equations of Kozeny[1] and others.

For fibres of circular or near-circular cross-section and constant density, such as non-medullated wool, the surface area of a given mass of fibres is universely proportional to the average fibre diameter. This principle (the air-flow method) can be utilized to construct apparatus giving an estimate of fibre diameter. Owing to the speed and simplicity of the method it is particularly suitable for quality control in mill testing laboratories.

Since the method is indirect the apparatus must first be calibrated from wools of known fibre diameter. For this purpose eight reference slivers have been provided (Appendix 5).

It has been shown[2] that the estimate of fibre diameter actually given by the air-flow method is $d\ (1 + c^2)$ where d is the average fibre diameter (length biassed) given by the projection microscope and c the fractional coefficient of variation. Since c normally lies within comparatively small limits for unblended slivers it is usual, however, to calibrate the apparatus directly in terms of d.

The method requires that the fibres be reasonably clean and dispersed in a uniform open state such as card slivers or combed slivers. It is thus unsuitable for raw wool unless first scoured and carded. Some types of wool may need special calibrations as described in Appendix 4.

This method of test is based on a previous draft method[3] published by the I.W.T.O. in 1955 and original papers by Anderson[4] and Monfort[5].

1. Scope

The method is applicable to clean, unmedullated wool fibres dispersed in a uniform, open state. It is particularly suitable for combed slivers. The method is also applicable to oil-combed slivers without cleaning, if the oil content is constant and the apparatus suitably calibrated.

The method gives less accuracy for lambswool and wool which is appreciably medullated (see Appendix 4).

2. Definitions

Laboratory sample.—The sample of fibres *conditioned in the laboratory* from which the test specimens are weighed out. In many cases the laboratory sample will consist of one or more short lengths of sliver.

Test specimen.—The weighed amount of fibre which is packed into the constant volume chamber.

3. Principle

A specified weight of fibres to be tested is compressed to a constant volume in a cylindrical chamber with perforated ends to which a flowmeter and a manometer are connected. The fibres are packed in such a way that they lie predominantly at right angles to the axis of the chamber. A regulated current

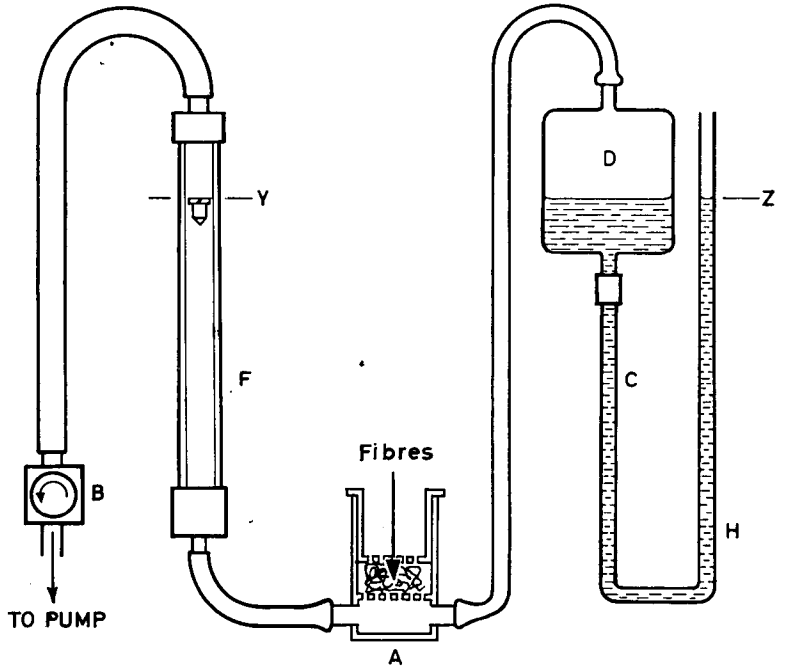

FIG. 1 *General arrangement of apparatus.*

of air is then passed through the compressed fibres and the average fibre diameter read off from a scale on the manometer or the flowmeter.

4. Apparatus

4.1. *Note*

Two alternative forms of apparatus are described: " Constant Flow " and " Constant Pressure." Both forms of apparatus have the same arrangement of parts as illustrated in Fig. 1.

The constant flow apparatus utilizes a specimen weight of 1·5 g, the flowmeter is adjusted to a fixed value and the fibre diameter read off from the manometer. The scale is not linear, the distance between successive micron intervals decreasing with diameter.

The constant pressure apparatus utilizes a specimen weight of 2·5 g, the manometer is adjusted to a fixed pressure and the fibre diameter read off from the flowmeter. The constant pressure apparatus gives a nearly linear scale in microns and also, since less accuracy in weighing the specimen is required, has some advantages for mill use.

4.2. *Detailed Parts*

Provide the following parts and arrange them as shown in Fig. 1 :—

(i) Air valve B, giving sufficiently fine control of the air supply, such that the level of the flowmeter or manometer may be quickly adjusted to the working value.

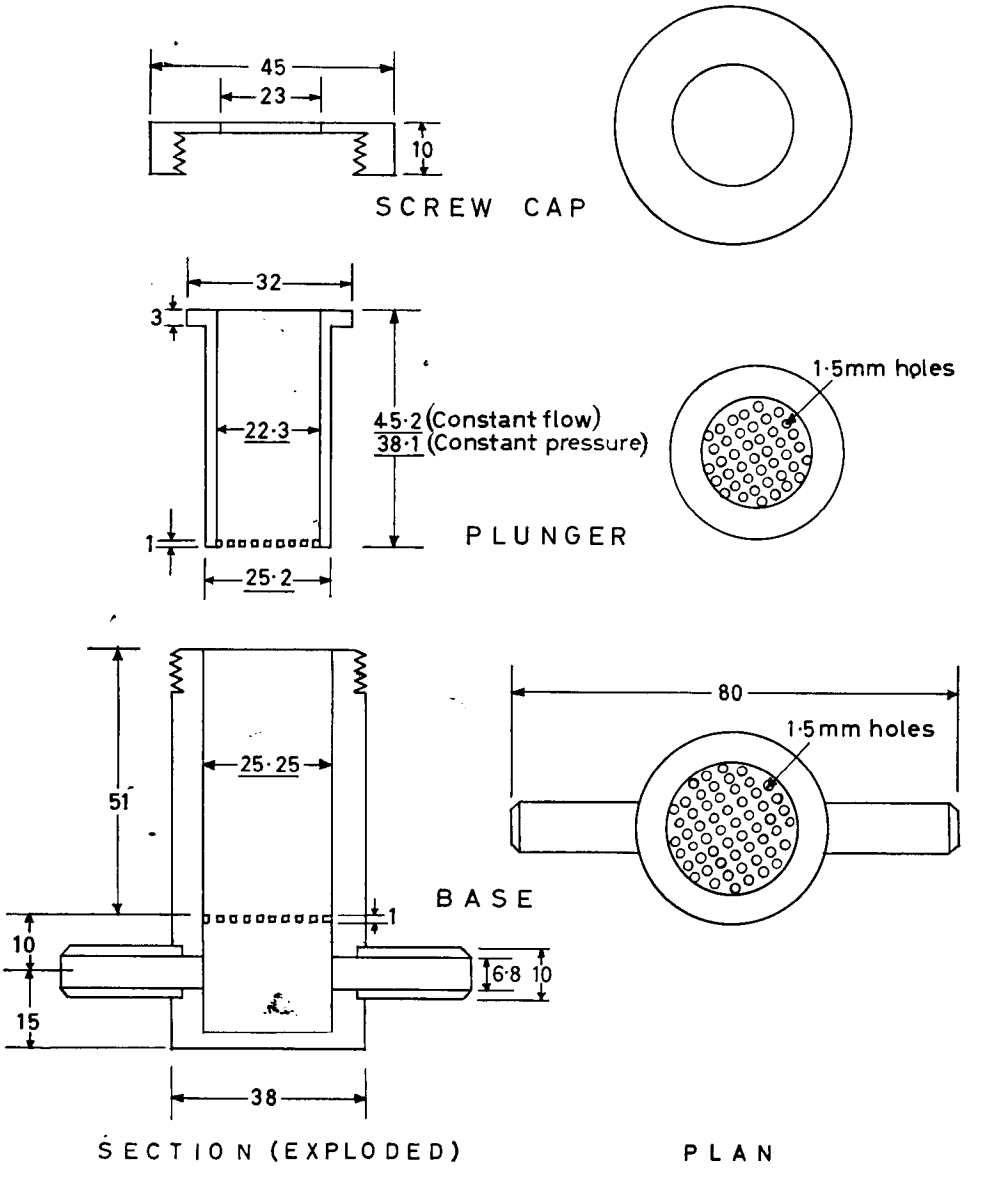

FIG. 2

Suggested dimensions of Constant Volume Chamber A. All dimensions are in millimetres. Important dimensions are underlined.

(ii) Suction pump of a type providing a smooth output of at least 30 l/min. at 200 mm. H_2O and little fluctuation of the float of the flowmeter. A filter to trap any loose fibres may be inserted between the pump and the air valve B.

(iii) Constant volume chamber A of brass, hardened steel, or any other suitable metal, suggested dimensions of which are given in Fig. 2. This consists of the following three parts: the *base* into which the fibres are packed, the *plunger* which compresses the fibres, and the *screw cap* which clamps the plunger to the base. The finish should be smooth so that the plunger slides easily into the base without trapping fibres.

(iv) A manometer reservoir D, with fluid as specified in Table I, mounted at sufficient height to give a clear working distance ZH of 350 mm. in the glass limb of the manometer.

The manometer is made of glass tube of internal diameter at least 5 mm. to reduce surface tension effects. In both cases a small amount of dye may be added to the manometer fluid, and where this is distilled water there should be added a small trace of chromic acid to give a clear meniscus. A millimetre scale is fixed behind ZH as described in Appendix 1, Section 3.1.

TABLE I
Manometer and Flowmeter Details

	Constant Flow	Constant Pressure
Minimum diameter of reservoir ..	150 mm.	60 mm.
Manometer fluid	n-propyl alcohol	Distilled water
Working range of flowmeter	10–20 litres/min.	5–25 litres/min.

(v) A flowmeter as specified in Table I.

(vi) Rubber tube connecting the manometer reservoir D to the chamber A, which should be pressure tubing of small internal diameter to avoid constriction at the bends. A rubber or plastic tube from A to the flowmeter F, which should be of internal diameter not less than 6 mm., should be as short as possible and should not be twisted or kinked between calibration of the apparatus and its subsequent use.

4.3. *Balance*

Provide a balance capable of weighing the specimen to an accuracy of $\pm$ 2 mg for the constant flow method or $\pm$ 4 mg for the constant pressure method.

5. Conditioning and Testing Atmosphere

5.1.

Whenever possible condition the laboratory sample to equilibrium and test in the I.S.O. atmosphere for testing: 65 per cent $\pm$ 2 per cent R.H. and 20° $\pm$ 2°C.

5.2.

If tests are not carried out in the I.S.O. atmosphere for testing, condition the laboratory sample to equilibrium near the apparatus and note the relative humidity of the atmosphere at the time of test. Then correct the final results by the factors given in Appendix 3.

Note.—A source of error may occur if the moisture content of the specimen changes during test. This may happen if the laboratory sample is allowed insufficient time to attain moisture equilibrium with the testing atmosphere. The minimum time required to ensure conditioning to equilibrium a length of sliver in an opened-out state in a well ventilated room is about 60 minutes.

6. Test Specimens

6.1. *Cleaning*

In general the laboratory sample should be about 8 g and should first be de-greased by rinsing well in two baths each of about 200 c.c. of petroleum ether before conditioning.

If the laboratory sample is known to be dry combed with fatty matter content below 1% the test specimens may be taken from it without cleaning.

If the laboratory sample is known to be oil combed with fatty matter content between 3 per cent and 4 per cent the test specimens may be taken from it without cleaning provided the apparatus has been calibrated from oil-combed slivers.

6.2. *Number of Specimens*

Unless otherwise specified, test a minimum of two specimens for fibre diameter below 30 microns and a minimum of three specimens for fibre diameter above 30 microns.

6.3. *Selection*

Take the specimens from different places in the laboratory sample. In the case of balls of sliver the laboratory sample should be made up of pieces of sliver from both inside and outside the ball.

6.4. *Specimen Weight*

For the constant flow method the specimen weight is $1{\cdot}5$ g $\pm$ 2 mg For the constant pressure method the specimen weight is $2{\cdot}5$ g $\pm$ 4 mg.

6.5. *Preparation*

For slivers with cut ends, cut off with scissors a length to give as nearly as possible the specimen weight, then make up to the exact weight by adding shorter cut lengths or portions thereof.

For slivers with pulled ends, remove and discard about five hand draws, then weigh out the specimens by taking several successive hand draws.

It has been verified that both these methods of sampling give the same results if carried out properly.

7. Test Procedure

7.1.

Ensure that the meniscus of the manometer is at the zero mark and if required carry out an orifice plate check as detailed in Appendix 1.

7.2.

Pull out the weighed test specimen into a long thin sliver and feed it evenly into the constant volume chamber, packing the fibres down with a smooth rod from time to time. Insert the plunger and screw down the cap to the furthermost extent so that the lip of the plunger is in contact with the base.

7.3.

7.3.1.

For constant flow method adjust the air valve until the top of the float of the flowmeter coincides with the reference mark Y and note the fluid level of the manometer to the nearest millimetre or $0{\cdot}1$ micron.

7.3.2.

For constant pressure method adjust the air valve until the fluid level of the manometer coincides with the 18 cm. reference mark H and note the position of the float of the flowmeter to the nearest millimetre or 0·1 micron.

7.4.

Remove the specimen from the constant volume chamber, tease out the fibres by hand, repack in the constant volume chamber without loss of fibre, insert the plunger and screw down the cap.

Note the reading as before.

7.5.

Repeat 7.4 so that a total of three readings on each test specimen is obtained.

8. Calculation and Report of Results

Calculate the average of the three readings for each specimen and report the result for each specimen to the nearest 0·1 micron.

State whether the sample was tested as received without cleaning, or after cleaning in petroleum ether.

State the relative humidity and temperature of the conditioning and testing atmosphere and whether the result has been corrected for relative humidity.

APPENDIX 1

Calibration of Apparatus

1. Leakage Test

After assembling the apparatus as in Fig. 1 remove the cap and plunger from the constant volume chamber A and insert a rubber stopper. By means of a Hoffman clip close the rubber tube between A and F after introducing a pressure difference causing the meniscus in the manometer to alter by about 15 cm. Note the position of the meniscus periodically for several minutes. If it changes the apparatus should be examined for leaks.

2. Samples of Sliver

Obtain sufficient of the 1959 reference slivers (Appendix 5) for a calibration. In requesting these state (*a*) the test specimen weight of your apparatus (whether 1·5 g or 2·5 g), and (*b*) whether oil-combed or dry-combed samples are required. Sufficient of each sliver is normally supplied for four specimens.

3. Graduating the Scale

3.1. *Constant Flow Apparatus*

Make a horizontal mark Y (Fig. 1) near the top of the flowmeter scale, avoiding any position giving marked fluctuation of the float. Fix a scale graduated in mm. behind the manometer and adjust the zero mark to coincide with the meniscus of the liquid. Then condition and weigh out 1·5 g specimens of each sample of reference sliver and test according to the procedure described in Sections 6.4 and 7 of the Method of Test, noting the distance in millimetres below the zero to which the meniscus falls. Do *not* clean the slivers before test. Test three specimens from each of the eight reference slivers in this way and calculate the average of the nine readings for each reference sliver.

Plot the average depression h in mm. of the manometer meniscus against the known value of fibre diameter d, and after inspection to ensure that the points lie about a smooth curve, fit a relation by least squares as given below.

From this relation a conversion table may be prepared in microns, or a scale may be graduated in microns and fixed behind the manometer.

The relation between d and h is of the form $hd^b = \text{constant}$ and it is thus necessary to take logarithms to obtain a linear relation.

Let $X = \log d$ and $Y = \log h$.

For each of the n lots of sliver used for standardization we obtain two values X_i and Y_i.

First calculate the following quantities:—

$$\Sigma X = X_1 + X_2 + \ldots + X_n \qquad \Sigma Y = Y_1 + Y_2 + \ldots + Y_n$$

$$\Sigma Y^2 = Y^2{}_1 + Y^2{}_2 + \ldots + Y^2{}_n$$

$$\Sigma XY = X_1Y_1 + X_2Y_2 + \ldots + X_nY_n$$

$$\Sigma y^2 = \Sigma Y^2 - (\Sigma Y)^2/n$$

$$\Sigma xy = \Sigma XY - (\Sigma X\, \Sigma Y)/n$$

$$b = \Sigma xy / \Sigma y^2$$

The regression equation of X and Y which applies to the apparatus is then:—

$$X = \Sigma X/n + b\,(Y - \Sigma Y/n) \ldots\ldots (1)$$

Finally construct a table relating h to d by taking values of h at 5 mm. intervals, finding log h, substituting in equation (1) to obtain X and so tabulating d = antilog X for each value of h.

3.2. *Constant Pressure Apparatus*

Make a horizontal mark at a distance corresponding to 180 mm. water pressure from the zero mark Z of the manometer. Fix a scale graduated in mm. behind the flowmeter F so that the zero of this scale coincides with a file mark (zero) made near the bottom of the flowmeter. Condition and weigh out 2·5 g specimens of each sample of reference sliver according to the procedure described in sections 5 and 6 of the Method of Test, noting the distance y in millimetres of the float of the flowmeter from zero. Do *not* clean the slivers before test. Test three specimens from each of eight reference slivers in this way and calculate the average of the nine readings for each reference sliver.

Plot the average reading in millimetres, y_1, y_2, etc., against the known values of fibre diameter d_1, d_2, etc. The result will be a nearly linear relation. Fit a second degree regression line of y on d. This is done by finding the coefficients a, b, c in the equation :—

$$y = a + bd + cd^2 \ldots\ldots\ldots (1)$$

by solving the equations :—

$$\Sigma y = 8a + b\Sigma d + c\Sigma d^2$$

$$\Sigma dy = a\Sigma d + b\Sigma d^2 + c\Sigma d^3$$

$$\Sigma d^2y = a\Sigma d^2 + b\Sigma d^3 + c\Sigma d^4$$

The equation (1) is then used to graduate a scale in microns which may be fixed behind the flowmeter.

3.3. *Orifice Plate Checks*

To make regular daily checks that the apparatus is in good order the use of two orifice plates is recommended. These consist of aluminium discs the same diameter as the inside of the constant volume chamber, each with a central hole. The discs have a rim which in use rests on the annular top of the constant volume chamber. The diameter of the central hole in one disc is chosen to give a reading of about one-third of the available scale on the manometer (constant

flow method) or flowmeter (constant pressure method) when clamped and used in the apparatus under working conditions, with no fibres in the chamber. The diameter of the central hole in the second disc is similarly chosen to give a reading about two-thirds of the available scale.

About once a day the orifice plates are clamped in the apparatus so that air enters through the central hole only and the readings noted. Variations in the readings given by the scale should not exceed 2 mm. and 4 mm. respectively for the two orifice plates. This provides a useful and quick check on the functioning of the apparatus particularly as regards the presence of air bubbles in the manometer system.

APPENDIX 2

Reproducibility of Results

It is desirable that the persons to whom a test result is communicated should have some idea of the appropriate confidence limits of each average reading reported. Confidence limits will depend amongst other things on the number of tests, the variability of the material, experimental error, differences between apparatus and the probability level assumed. There are two important cases about which information is available at present. This information, which is summarized below, should be regarded as illustrative and as only applying to the particular material tested. The original papers should be consulted for further details.

" Within Sample " Confidence Limits

Suppose about 1 metre of a sliver is received for test and n test specimens are weighed out and tested, three readings being taken on each in accordance with standard procedure. A total of 3n readings would be obtained and since the variance due to repacking is normally about the same as that between different weighings[4] the 95 per cent. confidence limits of the average readings are given by:—

$$\pm 1 \cdot 96\sigma / \sqrt{3n}$$

where σ is the standard deviation of the 3n readings. From the work of various authors it appears that the value of σ is about 0·2 microns at 20 microns, rising to about 0·4 microns at 30 microns.

"Between Apparatus" Confidence Limits

Some results have been given by Monfort[6] of the confidence limits taking into account the variability between 16 different laboratories when all their instruments have been calibrated by the same four reference slivers. Monfort gives the following confidence limits which apply to a determination carried out by the usual method on two test specimens in any one of the 16 laboratories.

Average (microns)	95% Confidence Limits (microns)
20	± 0·18
25	± 0·29
30	± 0·42
35	± 0·59

Variability Within Lots During Processing

Strictly speaking, the variability within lots is not concerned with the reproducibility of the Method of Test. It is sometimes necessary, however, to take variability within lots into account when comparing results obtained in different laboratories, since the laboratory samples may have been taken at different times from different portions of a non-homogeneous lot. Monfort[7] and Mazingue and Van Overbeke[8] have given results for variations in apparent fibre diameter during processing and have shown that significant differences may occur.

APPENDIX 3

Correction for Relative Humidity

As explained in section 5 of the Method of Test the standard conditions for testing are 65 per cent R.H. and 20°C. If tests are carried out in non-standard atmosphere of known relative humidity the results in microns may be corrected by the following factors, which have been shown[9] to apply to fibre diameters between 19 and 37 microns.

Relative Humidity per cent	Multiplier to convert to 65 per cent R.H.
40	1·022
45	1·019
50	1·015
55	1·010
60	1·005
65	1·000
70	0·995
75	0·988
80	0·980
85	0·969

APPENDIX 4

Special Types of Wool

1. Noils

It has been shown by Anderson[10] that in general the air-flow method is applicable to noils. Particular care should be taken, however, when testing noils to remove all vegetable matter and to de-grease the laboratory sample with petroleum ether before weighing out the specimens. Representative laboratory samples should be made up by taking bunches of fibres from several places in the bulk.

2. Lambswool

Robinet and Franck[11] have tested samples of lambswool and found that the estimates of diameter obtained by the air-flow method were systematically lower than those given by the projection microscope, the apparatus having been calibrated from slivers of ordinary wool.

The maximum difference they obtained in estimated fibre diameter by the two methods was 6·7 per cent.

3. Medullated Wool

The theory of the air-flow method assumes the fibres have a constant over-all density, so that a fixed weight of fibres of the same average diameter will always give the same amount of fibre surface. Highly medullated fibres may have an appreciably lower fibre density than the accepted value of 1·30–1·31 for solid wool fibres. An air-flow test carried out on such medullated fibres will give a reading *lower* than the fibre diameter as measured on a projection microscope. This error may be of significance for fibres coarser than about 35 microns. The effect is illustrated from the following data taken from a paper by Richards[12].

Density g/c.c.	1·31	1·29	1·27	1·25
Apparent fibre diameter (air-flow) μ	35·0	34·2	33·2	32·3

4. Dyed Fibres

Differences in apparent fibre diameter between undyed slivers and dyed slivers have been reported by Robinet and Monfort [13] when tested by the air-flow method, the dyed fibres giving higher values. The effect is likely to be of significance only for heavier shades, e.g. chrome black where the difference may be up to about 0·8 microns.

APPENDIX 5

Reference slivers for calibration

For calibration of the air-flow apparatus as described in Appendix 1, laboratory samples of eight references slivers are available. The fibre diameter of each sliver has been measured by the projection microscope in several laboratories and is known accurately.

The slivers are available in two forms:—

(1) Dry-combed, fatty matter content less than 1 per cent.
(2) Oil-combed, fatty matter content between 3 per cent and 4 per cent.

A set of eight reference slivers can be obtained by appropriate laboratories on application to:

Dr. E. G. Carter,
Scientific Adviser,
International Wool Secretariat,
Dorland House,
18-20 Regent Street,
London, S.W.1, England.

All such applications should state: (1) whether oil-combed or dry-combed slivers are required, and (2) whether specimen weights of 1·5 g or 2·5 g are in use.

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METHOD OF TEST FOR WOOL FIBRE LENGTH USING A SINGLE FIBRE LENGTH MEASURING MACHINE

(Adopted by the I.W.T.O. Technical Committee, Venice, May, 1960)

SAMPLING

THE following is a description of suitable sampling methods for fibres prior to measurement using the W.I.R.A. Fibre Length Machine.* The methods are suitable for wool and many other fibres processed on the worsted and woollen systems. The following general apparatus is required for the sampling methods described.

1. Sampling Methods for Loose Fibres (e.g. raw wool, noil)

The whole available bulk is spread out on the floor or on a large table and about 40 handfuls are taken. Each handful is taken from different regions about equally spaced throughout the bulk. One of the handfuls is then divided carefully into two, and half rejected. The retained half is again divided into two, and half rejected. This procedure is continued until about (say) 20 fibres are left; only a little experience is necessary to decide from the size of the tuft when this number of fibres remains. The choice of which half to reject should be made at random with tables of random numbers. If these are not available, it is best to reject the half remaining in the left and right hands alternately. At each stage care should be taken to avoid fibre breakage, e.g. a single lock should be divided into two lengthwise.

Each of the handfuls is reduced in this way, the 40 remaining groups of fibres being stored separately on a large velvet-covered board and covered with glass plates. The groups of 20 or so fibres are then transferred separately as required to a small velvet-covered board, and all are measured for length according to the specified method.

If the wool is a large amount contained in a bin from which it will be removed in skeps for scouring, it is best to carry out the sampling whilst it is being moved. From each skep (or every second or third skep) a handful is taken as it is being filled, and if the number of handfuls thus taken is rather more than is required, this may be reduced afterwards by discarding, say, every third handful taken. The handfuls are then assembled and each reduced to about 20 fibres as described.

2. Sampling Method for Slivers (e.g. card sliver, top)—Random Draw Method

A grip, suitable for taking a draw of fibres from a sliver, is required for this method. This can be made from the type of letter clip shown in Fig. I, which is about 6 inches wide. The straight edge A of the clip is, if necessary, ground to be parallel to the bent edge B. A thin strip of leather is then cemented in the groove of the bent edge B so that the clip so modified will hold single wool fibres firmly at all points along its edge.

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* Any similar apparatus giving the same results may be used.

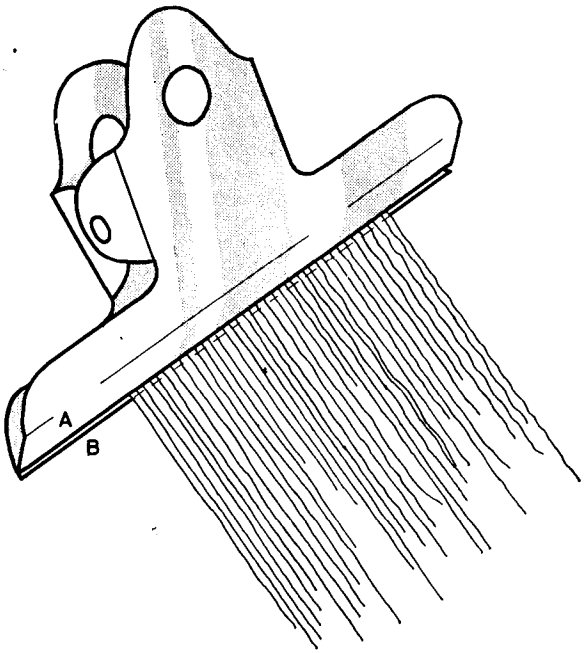

FIG. 1.

Grip for taking fibre draws.

The sliver to be sampled is held firmly in the right hand near to a free end and then gripped at a distance of about 30 cm. by the left hand. The sliver is then gently parted by separating both hands and the shorter piece discarded. The remaining piece is then placed along the centres of two velvet boards placed edge to edge with the parted end near the front of the first board, as shown in Fig. 2. A weighted glass or perspex plate is placed on the sliver near the back edge of the second board to prevent the sliver moving.

The grip with leather-lined jaws is then used to remove and discard a 2 mm. fringe of fibres.† The procedure is repeated, removing and discarding successive 2 mm. fringes of fibres for a distance about equal to that of the longest fibre in the sliver, which for a 64s top is generally about 20 cm. The sliver end has now been " normalized " and any succeeding draw of fibre ends will be a representative sample. It is best to choose the actual draw at random out of the succeeding 10 draws. A second draw may be chosen at random from the same " normalized " end if required. The selected draw of fibres is then transferred to a small velvet board and covered with a small transparent plate and all the fibres measured according to the specified method.

† This distance, which is the length of fibre in the grip, may be gauged at first by marking a number of parallel lines on a paper and placing them under the parted end. After a little practice it is quite safe to estimate the distance by eye.

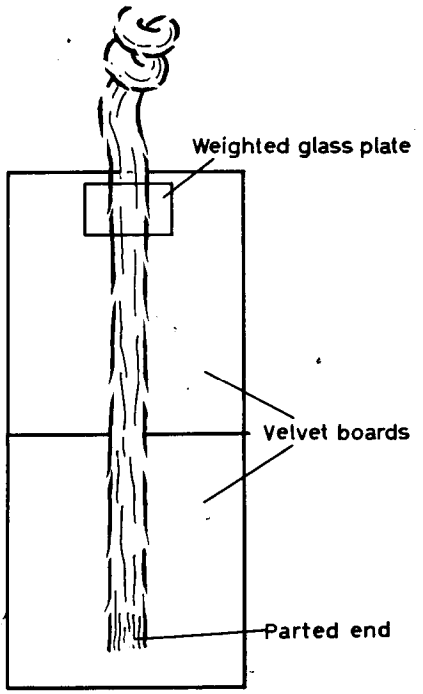

FIG. 2.

Random draw method.

It is permissible to reduce the size of the last 10 draws by taking them from a 1 mm, fringe if only a moderate sized sample is required. The number of fibres in a 1 mm. draw will vary according to the fibre length and diameter, but for an average 60s top will lie between 250 and 400.

3. Sampling Method for Yarns—Cut Square Method

A length of the yarn is cut from the sample under test, untwisted by hand and laid down centrally on a small velvet board and covered by a small transparent plate. The yarn is then cut about $\frac{1}{2}$ cm. from the front edge of the plate as shown in Fig. 3.

The fibres that project in front of the plate are removed one by one with a pair of forceps, right back to the edge of the plate. This procedure is termed "squaring." The plate is then moved back a few millimetres, exposing a band of fibre ends which are removed one by one and measured according to the specified method. The plate is moved back again when all the exposed fibres have been measured until a total of about 50 fibres has been taken.

In all cases, however, once the plate has been moved back, all the available fibres whose ends project must be taken. The length of yarn is then discarded and another taken from the sample, squared and about 50 fibres measured. The required number of fibres is obtained by repeating this procedure on fresh lengths of yarn chosen at random from the bulk available.

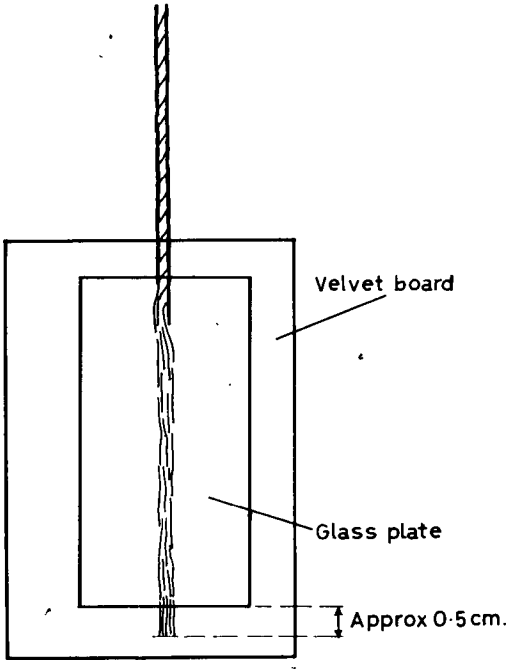

FIG. 3.

Cut square method.

4. Number of Fibres

The number of fibres in the sample will depend on the accuracy required. A guide to this number may be obtained from Table I, which gives the number of fibres required for various confidence limits, calculated from typical values of the coefficient of variation percentage of fibre length.

TABLE I

Approximate Number of Fibres required for various Confidence Limits‡

Material	Confidence Limits as Percentage of Average Fibre Length		
	10%	5%	3%
Raw wool; scoured wool	60	250	700
Card sliver; noil.. ..	150	600	1,700
Top; yarn (worsted) ..	90	360	1,700
Slubbing; yarn (woollen)	290	1,160	3,200

‡ Calculated for probability of 95 per cent.

MEASUREMENT

1. Scope

This method is suitable for wool in any form, and also for many man-made fibres processed on the worsted or woollen systems.

2. Principle

A numerical sample is taken, the length of each fibre measured under controlled tension on a W.I.R.A. Fibre Length Machine and the lengths classified in $\frac{1}{2}$ cm. groups. The frequency distribution of fibre lengths is then read off from the counters of the machine.

3. Apparatus

(*a*) W.I.R.A. Fibre Length Machine, the main features of which include means for automatically measuring fibre length under controlled tension, means for automatically classifying the fibre lengths in $\frac{1}{2}$ cm. groups and means for registering the number of fibres in each $\frac{1}{2}$ cm. group. Any similar apparatus giving the same results may be used.

(*b*) Two pairs of pointed forceps with ground ends.

(*c*) Short black scale with two white marks spaced 0·5 cm., for classifying very short fibres.

4. Conditioning and Testing Atmosphere

The fibres to be measured should be conditioned and tested in an atmosphere within the range 50–70 per cent. R.H.

5. Test Procedure

5.1. *Machine calibration*

Switch on the W.I.R.A. Fibre Length Machine and carry out the following calibration check.

Depress the operating key as far as it will go, check that the fibre detector wire falls into the space between the anvil and the fibre support and that its end just dips into the mercury, thus actuating the stop motion and stopping the traverse screw. If the detector wire does not fall into its correct place, adjust its *lateral* position by carefully bending it with a dissecting needle at a point near its fixed end. Check also that the detector wire lies parallel to the pressure plate when in the raised position and about $\frac{1}{2}$ mm. below it. If it does not do so, adjust its *vertical* position by bending with a dissecting needle near its fixed end.

By means of the forceps select a trial fibre and measure in the way described in section 5.2., noticing whether the screw is stopped immediately the fibre end slips clear of the anvil. *If it does not do so adjust the level of the mercury until the screw is being stopped satisfactorily on release of a fibre.*