IV EXPERIMENTAL PROCEDURE

The experimental procedure has been discussed under the following sections.

4.5.1 Preliminary data of the fabrics used.

4.5.2 General characteristics of the finish used and composition of chemicals used.

4.5.3 Determination of abrasion characteristics on abrasion machines used with method of assessment.

4.5.4 Determination of physical properties.

4.5.1 Preliminary data of the fabrics used.

Fabric code	Fabric Used Name of fabric	%Fibre content	
		C	P
A	Cotton	100	-
B	Blend of Polyester/Cotton	33	67
C	Blend of Polyester/Cotton (Polyester Khadi)	50	50

C = Cotton P = Polyester

Selection of the cotton fabric and the blends of polyester/cotton was based on their utility and suitability as per the climatic condition of the country. Cotton fabric has absorbancy which gives cool effect to the body in warm weather whereas synthetic fibre fabrics have crease resistance/ resilience and strength. Cotton fabrics being poor in these latter properties are improved by blending with synthetic fibres or by application of finishes including acrylic finishes.

Preliminary/..

Preliminary data on the fabrics used on weight per unit area, count and thickness of fabrics were determined as per standard procedures described below:

4.1.1 Determination of fabric weight per unit area

Five specimens of size 5.0 cm x 5.0 cm were cut at random from smooth regular areas of the fabric. Specimens were weighed separately on the analytical balance. An average of five readings was taken and weight per unit area in ounce per square yard (also in grams per square metre) was calculated by using the following formula:

$$\text{Weight (oz/sq yard)} = \frac{W \text{ (gms)} \times 36 \text{(inches)} \times 36 \text{ inches}}{} \times \frac{1}{28.4}$$

$$\text{Weight (gm/sq.m)} = \frac{W = \text{(gm)} \times 100 \text{ (cm)} \times 100 \text{ (cm)}}{5 \text{ (cm)} \times 5 \text{ (cm)}}$$

4.1.2 Determination of thread count of fabrics

The number of threads per inch in warp and weft directions was determined using the Alfred Sutar Counter. An average of five readings was taken and reported in metric system.

4.1.3 Determination of thickness of the fabrics (1)

The compressometer was used to determine the thickness of the fabrics. One sample at a time was placed on the anvil, without tension, the pressure foot was lowered upon the specimen by rotating the knob, until upper dial read 5 (equal to 0.1 lb per square inch pressure), and the reading was recorded from the lower dial. The pressure was then increased/..

increased until the upper dial read 40 (equal to 1 lb per square inch pressure) and reading from lower dial was recorded again. The difference between the two readings gave the thickness of the fabric in inch (x 0.001). An average of five readings was taken as the fabric thickness. This was converted to centimetres and reported to nearest 0.001 cm.

4.2 General characteristics of the finish used and composition of chemicals used.

Acrylamide finish was used as it can be easily polymerised on cellulose. As reported by Mehta (51) it is reactive and both wet and dry crease recovery are obtainable by its application. Acrylamide has the capacity to undergo additional polymerisation to form a linear polymer thousands of units long.

In the present study acrylamide as a monomer was used with suitable catalystic system to facilitate polymerisation of the monomer to cross-link with cellulose. The various systems tried along with acrylamide monomer were:

a. Chloroacetic acid - hydrogen peroxide.

b. Sodium thiosulphate - Ammonium persulphate.

c. Glyoxal - hydrogen peroxide (41).

Finish mixture	Catalyst used with acrylamide	Observation/Time taken for viscosity
a	Acrylamide + Chloroacetic acid + hydrogen peroxide.	- Ve
b	Acrylamide + Sodium thiosulphate + Ammonium persulphate.	+ Ve within 24 hours.
c	Acrylamide + Sodium thiosulphate + Ammonium persulphate + Glyoxal + Hydrogen peroxide.	became viscous within 24 hrs but on heating at 45° to 50°C became viscous in ½ hr.

The data obtained showed that finish mixture 'a' did not show any viscosity. Finish mixtures 'b' and 'c' showed viscosity but time taken was long. Therefore in order to get quick reaction mixture 'c' was prepared at controlled temperature and time as given in the table.

The selection of catalystic system was done by trying out above chemicals as catalysts along with acrylamide in test tubes, and time taken for this paste to turn viscous was noted.

Acrylamide finish was used. Acrylamide is a white crystalline solid with its melting point 84°C - 85°C. It is prepared by the hydrolysis of acrylonitrile (36).

Reaction of acrylamide are largely those expected of the amide group and of the double bond (36). At the amide group, the reaction of acrylamide itself include (a) hydrolysis to acrylic acid (b) dehydration of acrylonitrile (c) alcoholysis to acrylic ester and (d) condensation with aldehydes. At the/..

the double bond, the reactions are addition to hydroxy compounds, amines, ammonia, bisulfate ions etc and diels termed as Alder reactions (36).

Reaction of substituted acrylamide have been studied in less details, but so far as is known, they are parallel to those of the parent compound. Substitution of nitrogen decreases the rate of acid and basic hydrolysis (36).

Chemicals used in the present study are tabulated below:

Table 1 : Chemical Composition of agents in Finish Recipe.

Chemicals gm/100ml		2.5%	5.0%	7.5%	10.0%
Acrylamide	gms.	2.5	5.0	7.5	10.0
Ammonium Persulphate	gms.	0.25	0.50	0.75	1.0
Hydrogen Peroxide (20v)	ml.	1.0	2.0	3.0	4.0
Sodium Thiosulphate	gms.	0.25	0.50	0.75	1.0
Glyoxal (40%)	ml.	1.0	2.0	3.0	4.0
Teepol (1 g/l)	ml.	98.0	96.0	94.0	92.0
Total	ml.	100.0	100.0	100.0	100.0

Acrylamide was used as finishing agent and was prepared in four concentrations i.e. 2.5, 5.0, 7.5 and 10.0%. Ammonium persulphate Hydrogen Peroxide were used as iniciators with glyoxal sodium thiosulphate for the redox system. Their content in the finish was 1.0%.

4.2.1 Procedure for preparation of fabrics for finishing

Scouring Procedure

The fabrics as purchased were scoured in a hot solution about (80°C) containing 2gm/l of soap and 2gm/l of soda ash for 45 minutes with material to liquor ratio 1:30 and were then washed thoroughly and dried.

4.2.2 Procedure for the preparation of finish

Acrylamide was dissolved in Teepol 1 g/l. Glyoxal was added followed by sodium thiosulphate (dissolved in teepol). Hydrogen Peroxide was added following ammonium persulphate which was previously dissolved in teepol. Then whole solution was stirred and kept in hot water bath for 30 minutes at the tempereature of 45°C to 50°C. Then the solution was allowed to cool down. Fabric specimens were padded with this finish. Then fabrics were dried in a warm oven (45°C to 50°C). Percent pick up for cotton fabric A was 110, for blended fabric B (67/33) it was 120 percent and for blended fabric C (50/50) it was 116 percent.

4.3 Determination of resistance to abrasion characteristics and method of assessment

Samples were determined for resistance to flat, rotary impact and wet impact abrasion by using following machines.

4.3.1 Martindal's Abrasion Tester

4.3.2 Accelorotor Abrasion Tester

4.3.3 WIRA Dynamic Loading Machine, and

4.3.4 Impact Abrasion Tester (Fabricated in the department)

/..

1. Martindale abrasion tester

4.3.1 The Martindal's Abrasion Tester B.S.11.1974(7)

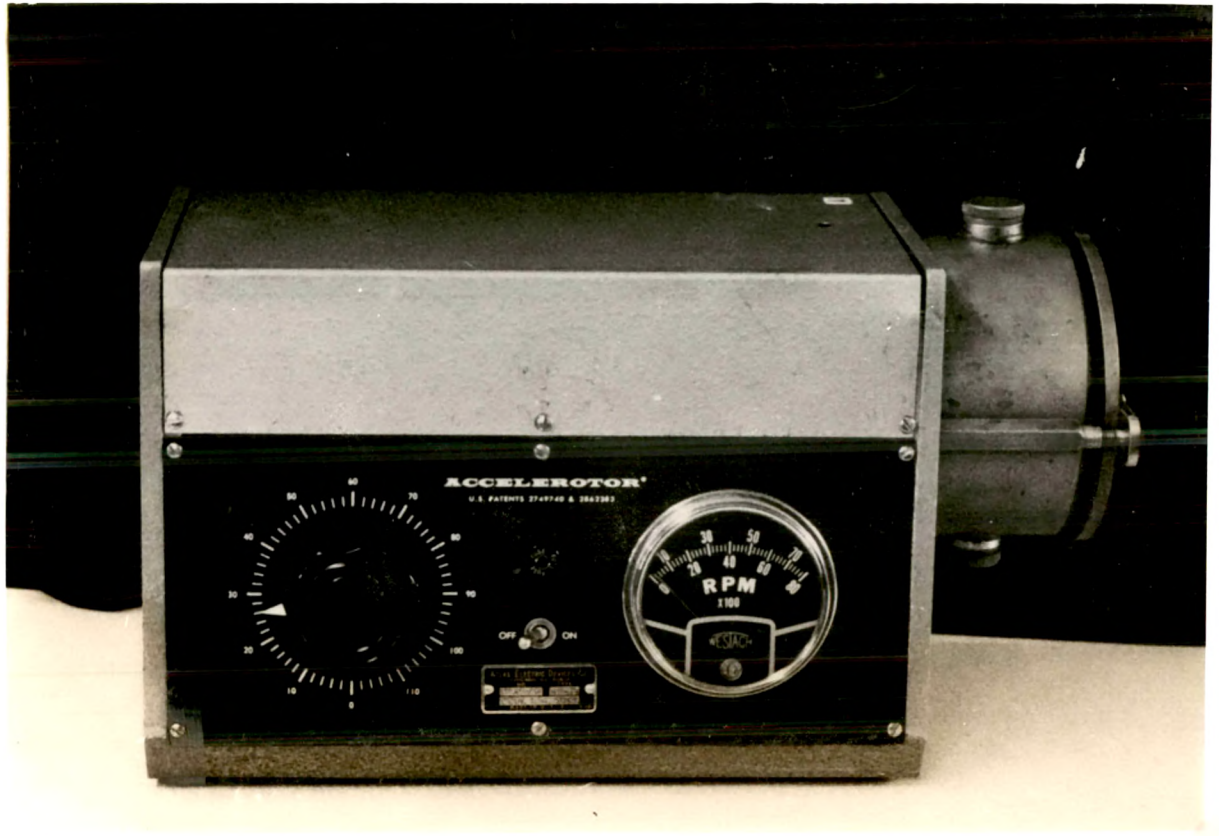
The normal sample holders are replaced with light-weight square holders which are keyed so that they may have vertical movement but cannot turn on their axes. The samples are given a multi-directional movement and are rubbed against a standard fabric. In the present study samples were rubbed against emery cloth, under the pressure of 500 gms.

Conditioned samples size 7 x 7 inch were cut from untreated and treated fabrics and were mounted on each of the four tables. The surface was flattened and frame was tightened up evenly, using diagonally opposite screws in sequence. Emery cloth was used as abradant. Circles of 38mm diamters cut and inserted facing down wards centrally in the ring. Metal insert was placed carefully on top of the abradant, so that its hollowed side faced upwards and pressed down. This abradant holder was inserted through the top place and weight 500gms was clamped to it, and the machine was switched on. Samples were abraded for 500, 1000, 1500 and 2000 rubs and used for their strength estimation.

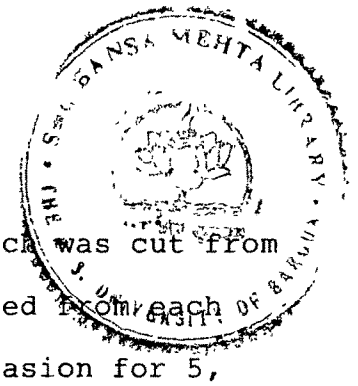
To keep the uniformity in the method of assessment for the abrasion damage in the fabric, strength loss was the main criterion for all the abrasion tests in estimating the resistance to abrasion for all fabrics.

4.3.2 Determination of Rotary Abrasion on Accelorotor abrasion tester

Conditioned/..



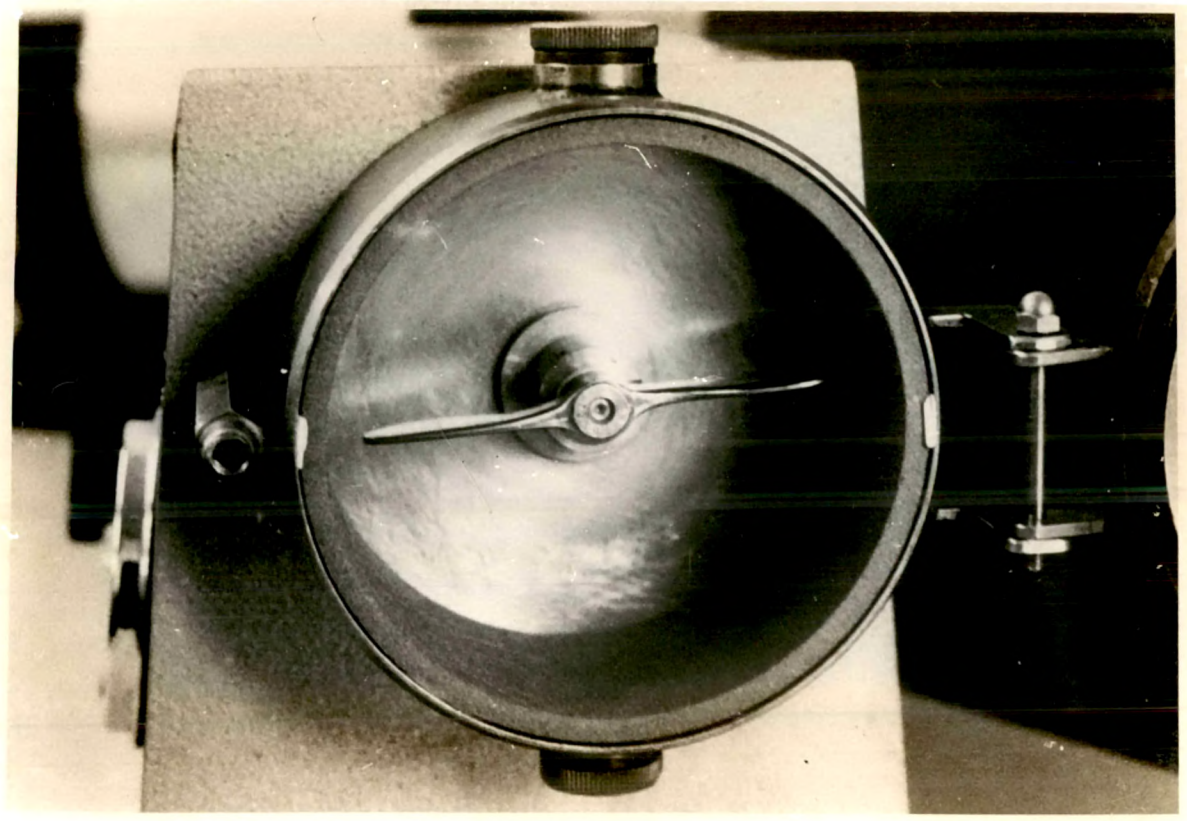
2. Accelerator



Conditioned sample size 7 inch x 1.5 inch was cut from untreated and treated fabrics and was revelled from each side by 0.5 inch and subjected to rotary abrasion for 5, 10 and 15 minutes against metal abradant at 300 rpm.

Each sample was placed in the accelorotor abrasion machine (Dia 2a). An accelerotor applies an abrasive force by using a whirling impeller. The impeller is a two-bladed unit of an elongated S shape; 4½ inches long and mounted on a central shaft inside a cylindrical chamber. This chamber is 5½ inch diameter and 2 inch deep, its inside surface being lined with the selected abrasive backed by foam rubber. The sample is whisked and tumbled about inside the chamber and hence suffers abrasion damage. This has been reported by Booth (5). It is the only abrasion tester that does not hold the fabric sample under tension while it is being abraded, instead it allows the fabric to bend, flex and try to move away from the impeller and so the sample is abraded uniformly from front and back surfaces.

Evaluation is made on the basis of weight loss of sample or strength loss of sample broken at the abraded edge, or on the basis of change in other properties such as air permeability, light transmission, visual appearance, hand etc. depending on the type of fabric and its intended end use. Generally flat woven fabrics should be tested by the grab breaking strength loss method, while tuffed and other three dimentional fabrics should be tested by the weight loss method. In the present study, to keep uniformity with/..



2a. Front view of Accelerator

with other methods strength loss was estimated.

4.3.3 Determination of impact abrasion on WIRA Dynamic Loading Machine

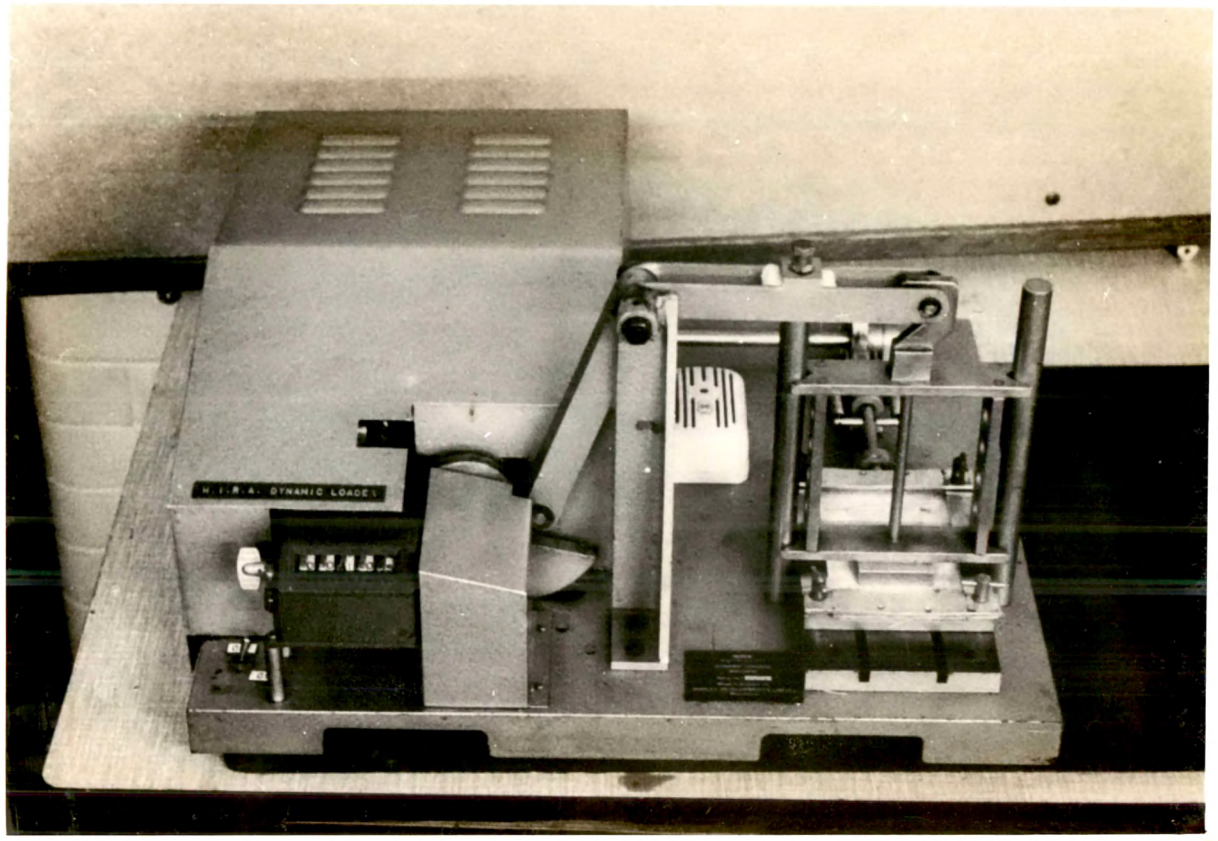
Sample size 7 inch x 2 inch in warp direction (7 inch in warp) was cut from untreated and treated fabrics and was subjected to impact abrasion on WIRA Dynamic Loading Machine (Dia. 3) following B.S. Method 4052 (7).

Sample was mounted on the steelplate with the warp direction at right angles to the direction of the travel of the plate, taking special care that backing was held flat to the plate and was not buckled. Then sample was subjected to 25, 50, 100, 200, 500 and 1000 impacts under the pressure of 1279 ± 13 gms.

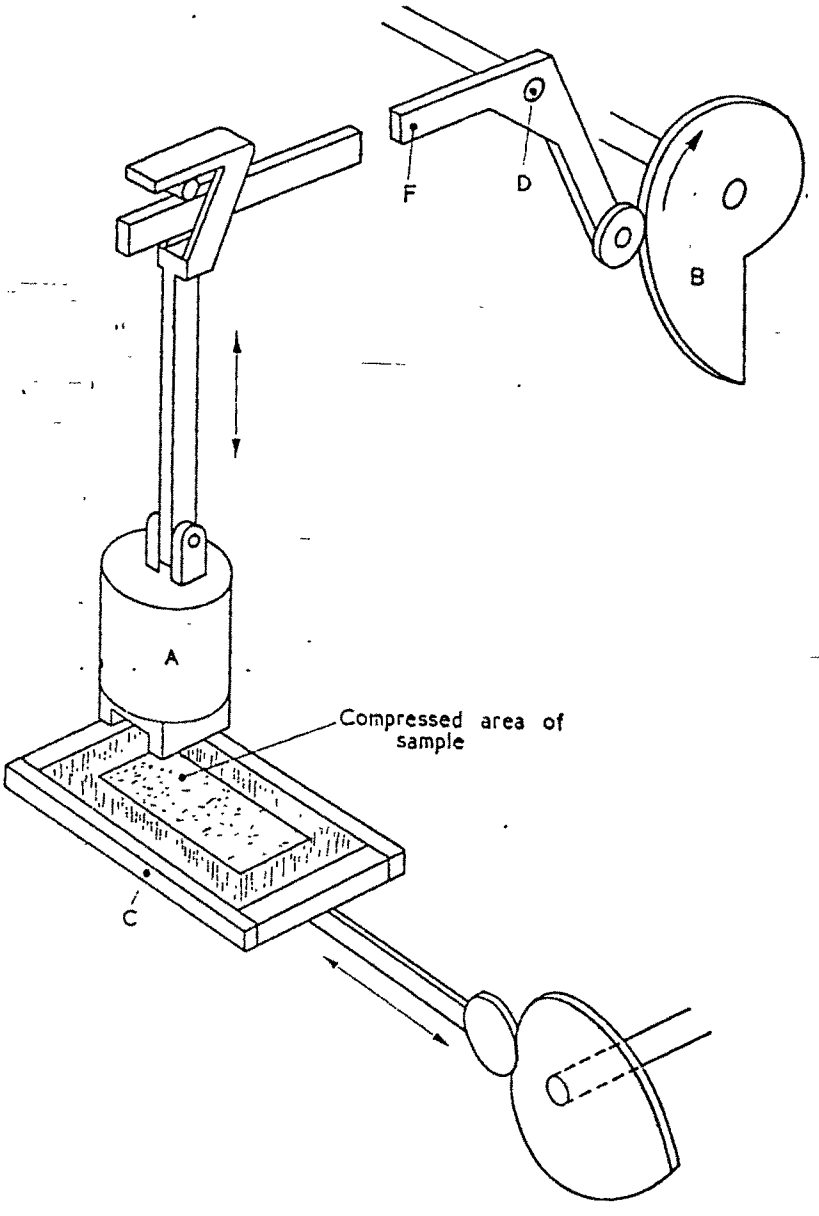
Dynamic Loading Machine, with the general principle as shown in dia. 3a fulfil the following requirements:

A metal piece, A, has a plate with two steel feet (2 inch x 1/4 inch and 3/8 inch in depth) of rectangular cross section attached to its underside 1½ inch apart. The calm B is shaped such that cantilever F, pivoting at, D, firstly raises the metal piece and then allows it to fall freely from a height of 63.5cm on to the specimen approximately every 4.3 seconds. Each fall of the metal piece corresponds to one impact. The specimen is clamped to a steel plate 0.6 inches long and 5 inches wide, by means of two 6 inch long and ½ inch wide steel bars at the sides screwed at the ends to the base plate.

The/..



3. WIRA Dynamic Loading Machine



3a. Principles of dynamic loading machine

The base plate is slowly traversed in such a way that there is 1/8 in. movement between each drop of the weight there is thus a half overlap by the steel feet at each impact. A complete traverse, forwards and backwards, is made for 25 impacts which produces a uniformly compressed area of 2 inch wide by 3½ inch long.

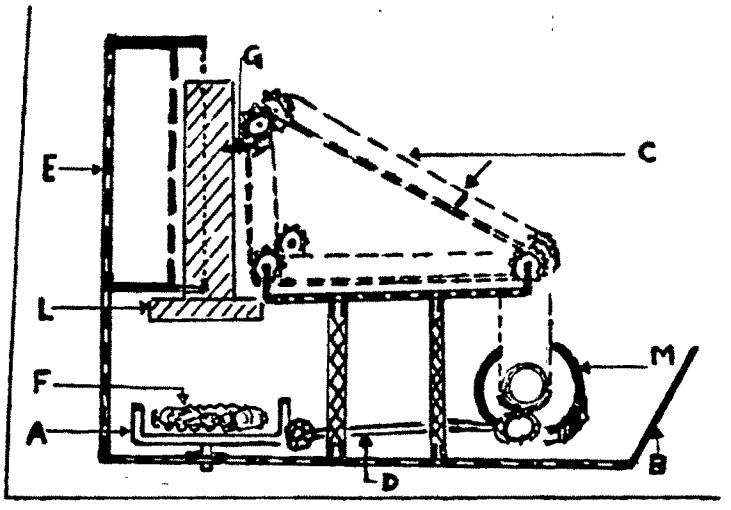
Normally, the carpet samples are tested in this machine for thickness immediately after 50, 100, 200, 500 and 1000 impacts. For the present study, this machine was used as impact abrasion tester, so strength loss of fabrics was estimated after numbers of impact. This was also to keep uniformity.

4.3.4 Determination of dry-wet impact abrasion on impact abrasion tester.

Sample size 6 x 6 inch were cut in warp direction from untreated and treated fabrics and were subjected to dry-wet impact abrasion on impact abrasion tester samples were wet with water and padded on padding mangle with about 150% pick up. Samples were given 50, 100, 200, 500 and 1000 impacts against wooden base lined with scoured muslin cloth. Four dry and wet dummy pieces were placed below each sample, for dry and wet impact abrasion respectively. They were rotated after each sample was taken out for assessment.

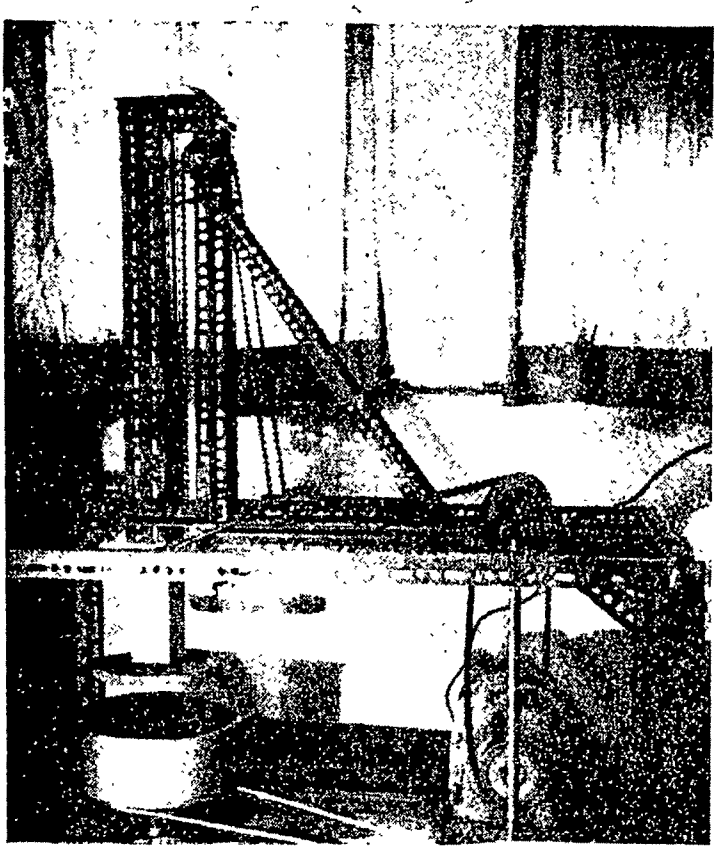
Impact abrasion tester

The abrasion caused by dhobiwash includes wear from pull/...



A=Container (8" dia)
B=Base
C=Driving Chain
D=Supplementary Drive
F=Fabric Speciman
L=Load (6" dia)
M=Motor (Gear type)
E=Suport - Bearing for load
G=Lifting mechanism

4. Mechanism of chain drive machine



4a. Impact abrasion tester

pull-push of fibres, impact abrasion due to impact of wooden mallet and the rubbing abrasion caused by the cement/hard stone used as base for washing. It can be said that this wash involves rapid wear but not the accelerated type wear caused by machines having rubbing part moved at high speed.

As shown in diagram 4a,b a fabric sample (F) was placed in the container (A), which was rotated by a suitable mechanism (D). The abrasion of the fabric sample was caused by some frictional contact of the load mechanism, as well as by force caused by impact when the load (1100 gm) was raised and dropped from height (23cm) on the specimen (F). For upward movement of the load, a double cycle chain with a suitable attachment, marked as (C) was used: the chain mechanism gets its drive in turn from a geared motor (M), the down ward movement of the load is by itself. Gravity fall that is when it gets detached from the attachment of the double chain and so this is caused by impact.

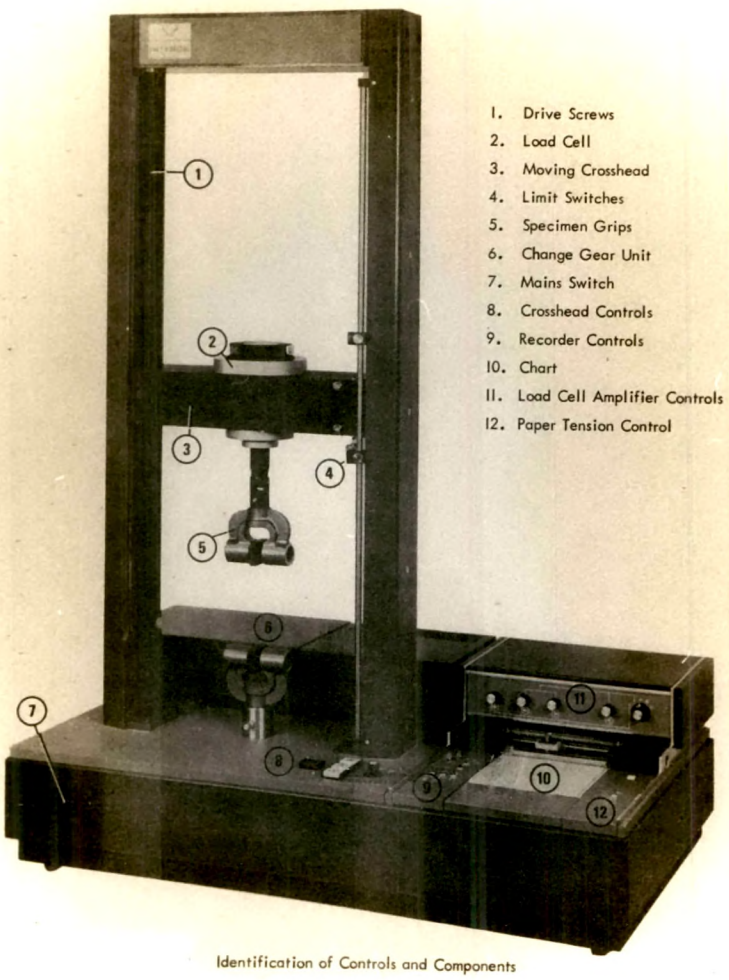
Thus flexing, rubbing, stretching, squeezing and other mechanical forces, are calculated from load and height and the number of such impacts so as to cause wear which can be assessed separately and compared.

Percentage pick up for fabric A, B and C were 140, 150 and 165 respectively, using load of 2.225 kg.

4.4 Determination of physical properties of fabrics

The following physical properties of the fabrics were determined:

4.4.1/..



Identification of Controls and Components

5. Identification of controls and component (INSTRON)

4.4.1 Determination of Tensile strength and elongation of fabrics (2)

Tensile strength and elongation of the fabrics were determined on Instron tensile testing machine. The Instron is an American made instrument which uses the bonded - wire type of strain - gauge. A general view of the table model is given in Fig. 5. In order to acceommodate a wide variety of specimens, several interchangeable load cells containing the strain gauges are used. In this way a range from 2 to 100,000 g is possible. The load cell is located centrally in the fixed crosshead. The upper jaw is suspended from the cell through a universal coupling. The lower jaw is mounted on the traversing crosshead which is driven upwards and downwards by screwed rods on each side. A range of gear-changes enables the speed of the crosshead (i.e. the rate of extension of the specimen) to be varied in steps from 0.02 to 50 in/min. On the bottom panel of the crosshead assembly the controls which govern the movement of the crosshead can be seen.

The load cell output is fed by cable to the control cabinate which houses the various electronic circuits and the pen recording equipment, the main controls for load range selection, calibration etc. are mounted on the front panel below the recording chart.

Sample/..

Sample size 7 inch x 1.5 inch was cut from untreated and treated fabrics. Sample was also cut from unabraded and abraded fabrics. Sample was ravelled from both the sides till the size remained 1" inch. The sample was clamped between the jaws which had a distance of 3 inches. The machine was operated the upper jaw moved upward at the speed of 100 mm/min. It was allowed to move up till the fabric sample broke and at that time reading was taken for load at break and so also it was observed on the chart which was moving at the speed of 200 mm/min. Extension at break was also noted and recorded. An average of five readings was taken.

Percentage tensile strength and percentage elongation were calculated by using the following formulae.

$\frac{W}{0} \frac{100}{}$ = % tensile strength

Whereas W = strength of abraded sample

0 = strength of original sample

$\frac{N}{0}$ x 100 = % elongation

Whereas N = Change in length of abraded sample

0 = Length of original sample

Experimental work was continued in Clothing and Textiles Department. Some of the physical properties were determined as per the availability of instrument. Here Scot J Tester was used for tensile strength determination following the similar procedure for two fabrics A and C. But for B fabric/...

fabric sample size was reduced to ½ inches to get tensile strength in the range (whereas in U.K. Instron was used for tensile strength testing).

4.4.2 Determination of Tearing strength

Tearing strength was determined by the Elemendorf tearing strength tester manufactured by Thwing Albert Instrument Co., Philadelphia, U.S.A. following CCC T 191 B method 5132. (8)

From the untreated and treated fabrics sample measuring 3 inch x 2.1 inch was cut. Each sample was laid securely between two clamps and a slit of 1.692 inch was made in the lower edge of sample by using the knife blade. The sector was released to fall, thus moving the pendulum clamp away from the specimen. The force required to tear the sample was read from the scale. The results were then calculated by multiplying factor which gave the force in grams required to tear the sample. An average of five readings was taken.

Percentage tearing strength was also calculated by using the following formula:

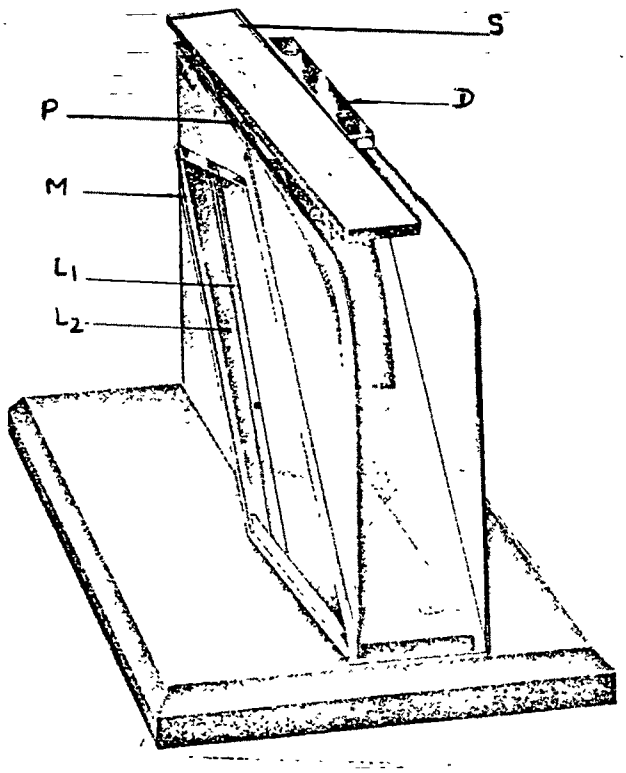
$$\frac{AB}{0} \times 100$$

Whereas 0 = strength of original fabric (untreated)

AB = Strength of Treated fabrics at different concentrations.

4.4.3 Determination of stiffness of fabric

Stiffness of the fabric was determined on the "Shirley" stiffness/..

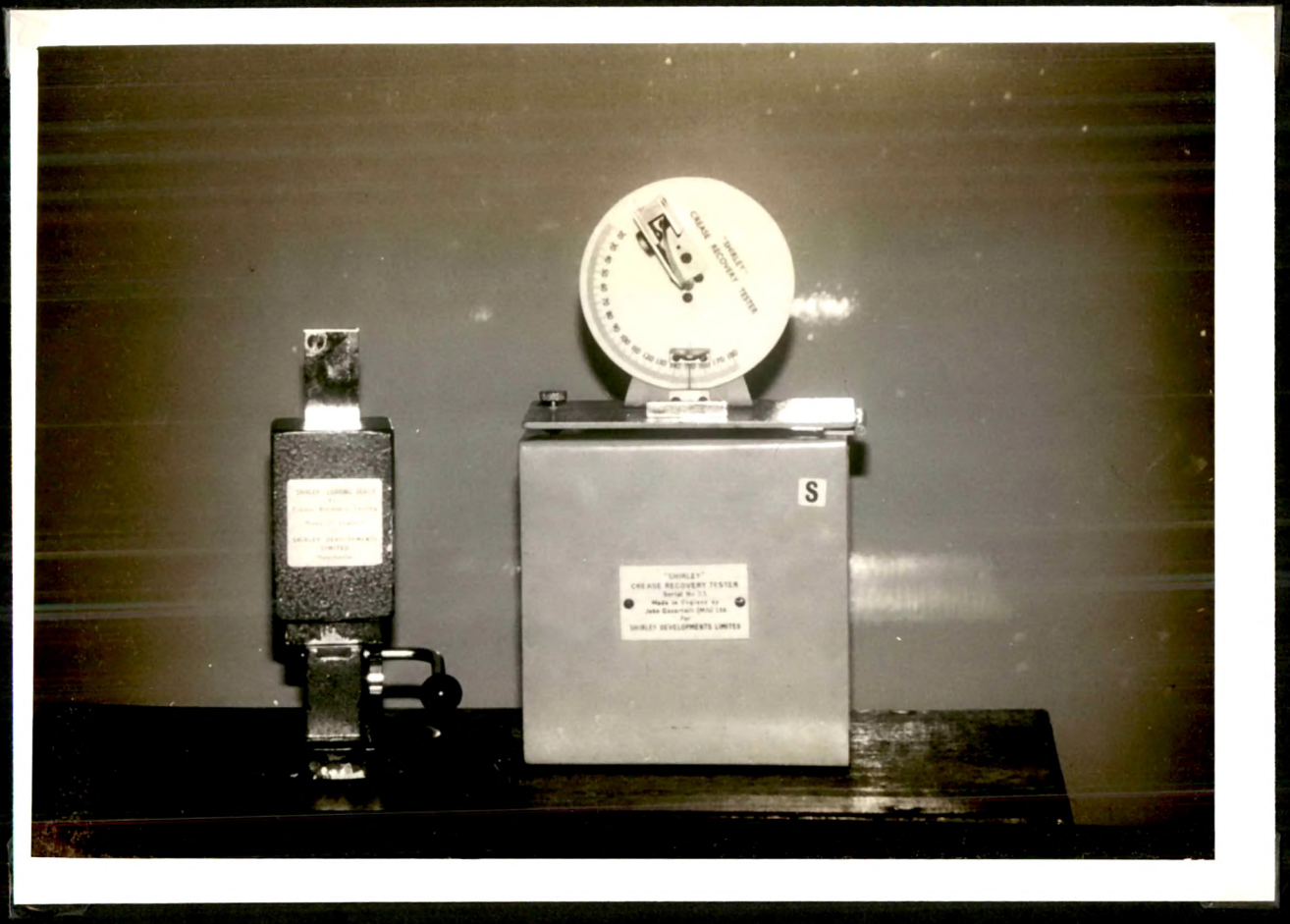


6. The Shirley stiffness tester

stiffness tester as per B.S. 1051. (Dia. 6). The essential features of the instrument (which is a fixed angle flexometer) are as follows. The slide S is graduated in bending length (c) in centimetres and when the front edge of the slide is coincident with the front edge of the horizontal platform P the zero of the scale coincides with a datum line D on the instrument. On each of the transparent plastic slide pieces of the instrument are scribed two signting lines L_1L_2 seen by reflection in the mirror M. Both these lines pass through the line of the upper forward edge of the platform and lie 41.5° below the horizontal. The under surface of S is covered with rubber so that when it lies on a cloth sample resting on the polished surface of P, movement of S carries the specimen with it.

Samples of untreated and treated fabrics were cut using the slide S as a template measuring 8 inch x 1 inch in warp direction. A clean cut was made with razor and the edges were not trimmed.

Instrument was placed on a level table with the mirror towards the observer. The sample was placed lengthwise on the platform P with one end coincident with the front upper edge of the platform. The slide S is placed on the sample so that the zero of the scale was in line with the mark D. The slide was then pushed forward, carrying the specimen with it until by looking in the mirror M it was seen that the end edge of the sample was in line with the two scribed lines L_1 and L_2 (To do this it is of course necessary/..



7. The Shirley crease recovery tester

necessary to adopt a viewing position such as that the reflections of L_1 and L_2 coincide). If the sample twists the mid-point of the end is aligned with L_1 and L_2.

The same operation was repeated with the other side of the sample up and again at the other end of the sample first with the original face up and then with the sample turned over. Reading from the scale S was recorded since the scale S was calculated directly, in bending length in centimetres the mean of four readings gave the bending length of the sample. Average was taken out and reported in results.

4.4.4 Determination of wrinkle recovery of fabrics

Wrinkle recovery of the untreated and treated fabrics was determined by using the "Shirley" crease recovery tester as per B.S. 3086 (given in Dia. 7).

The instrument provides a simple but accurate way of measuring the capacity of a fabric to recover from creasing in a given time. It enables the different factors governing crease recovery properties to be assessed and is of particular value as a quality control instrument where fabrics are undergoing the "Crease resist" process - the effectiveness of the process can be carefully measured and compared with any standards which may be available. The instrument consists of a circular dial which carries the clamp for holding the specimen. Directly under the centre of the dial/..

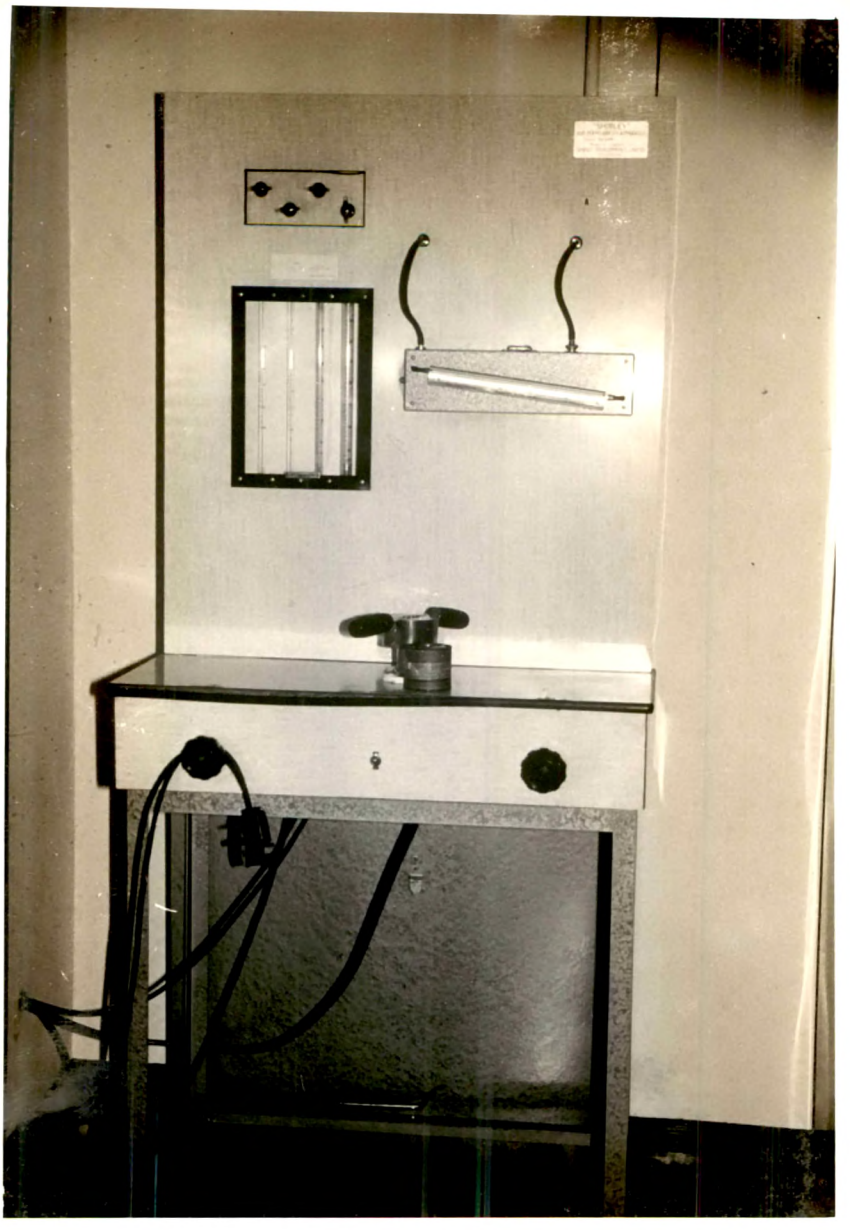
dial is a knife edge and an index line for measuring the recovery angle. The scale of the instrument is engraved on the dial.

A sample was cut from untreated and treated fabrics with a template 2 inch x 1 inch. It was carefully creased under pressure of 2kg for 1 minute. The specimen was then transferred to the fabric clamp on the instrument and allowed to recover from the crease. As it recovered, the dial of the instrument was rotated to keep this free edge of the specimen in line with the knife edge and at the end period (after 5 minutes) the recovery angle in degrees was read on the engraved scale. This was done for both the surfaces of fabric. An average of five readings was taken.

4.4.5 Determination of air permeability of fabrics

Air permeability of the fabrics was determined on Shirley air permeability tester as per B.S. 3217 (1960).

The apparatus is illustrated in dia. 8 and shown diagramatically in dia. 8 a and b. Air, at 20+2°C and 65+2 percent relative humidity, was drawn through the test specimen by means of a suction pump A, the rate of flow being controlled by the by-pass valve B and the series value C. The rate of flow of air is adjusted until the required pressure drop across the fabric is indicated on an inclined manometer D, graduated from 0-25 mm head of water. E is a reservoir which smooths out any disturbances due to the varying velocities of the streams of air drawn through the various pattis by the pump. A safety valve F is/..



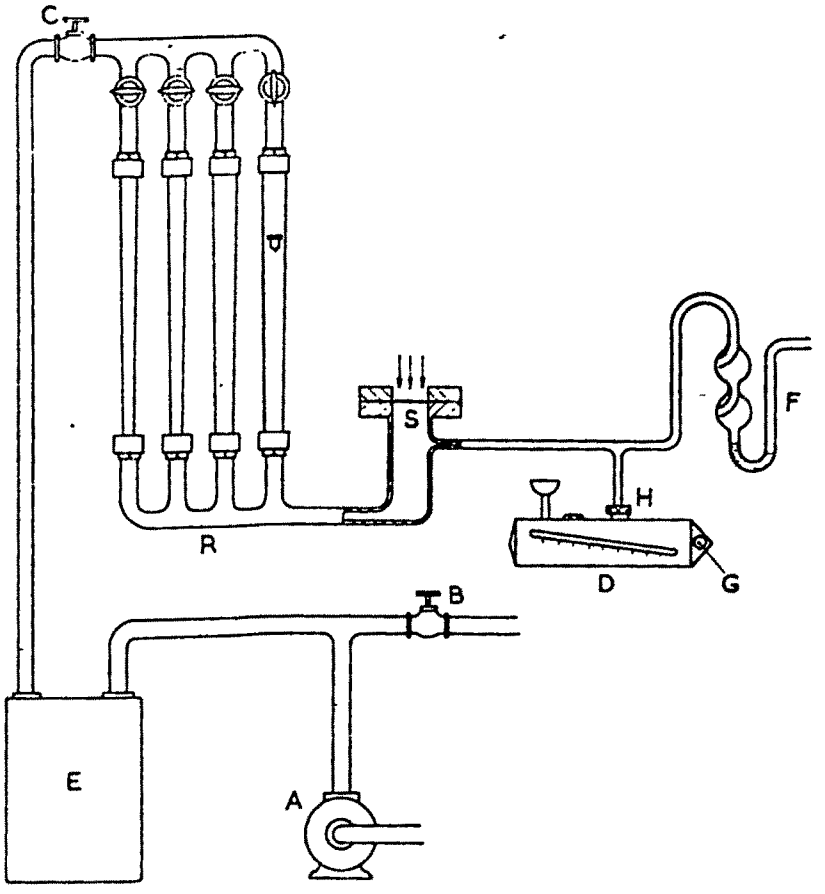
8. The Shirley air permeability tester

in the form of a V-tube containing di-butylphthalate, protects the inclined monometer if the pressure drop is allowed to exceed the range of the manometer.

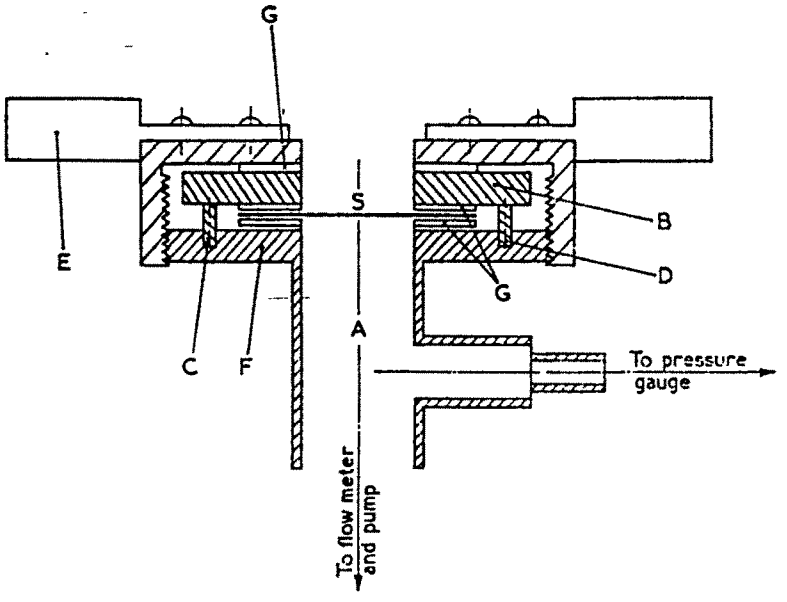
When required pressure drop is attained, the rate of flow of air is read off at one of the four Rotameters and selected according to the permeability of the test sample. The Rotameters are calibrated at 20°C and 760mmHg to indicate air flow in cubic centimetres per second and cover the following range R_1 0.05 - 0.5, R_2 0.5 - 3.5, R_3 3 - 35, R_4 30 - 350.

The specimen under test is held in specimen holder shown in dia. 8b. It consists of an orifice A, 1 inch in diameter in a metal flange F which is threaded externally to take the winged top clamp E, an annular metal disc B of internal diameter 1 inch fits over the flange and is located by pins C fitting into holes D in the flange so that the aperture in it registers with the orifice. Rubber gaskets C, 2 inches in diameter and having a central hole 1 inch in diameter prevent leakage of air outside the perimeter of the test area.

Sample size 5cm in diameter from untreated and treated fabrics was cut. Each sample was placed over the orifice, fitting the annual disc in position loacing the pin in the flange, and the top clamp was screwed down with R_4 upon and the other rotometer closed valve B (that is the valve on the sight of the front panel of the instrument (dia 8b)/...



8b. Front panel showing valves



8a. Sample holder

(dia. 8b). Closed, the pump was started by operating the push switch. Valve C was opened slowly until a pressure drop of 1mm of water was indicated on the inclined monometer vertical part of the meniscus of the inclined monomoter was read on this occasion. Valve C was closed.

When the required drop was attained and the liquid level of the inclined monometer was steady, then the reading was taken for the rate of air from the top of the rotameter float. An average of five readings was taken and average rate of flow in cubic cenitmetres per second through the test area of $5.07cm^2$ was calculated, the volume of air in cubic centimetres passed per second through $1cm^2$ of the fabric at pressure difference of 1mm head of water was expressed by dividing the mean flow in cubic centimetres per second by 5.07.