Fabric testing apparatus (1) comprises a turntable (9) on which the fabric (f) may be positioned, at least one sensing means (21, 24, 28) for making a continuous measurement of the fabric during rotation of the turntable, and computing means for making a continuous measurement of the fabric during rotation of the turntable, and the computing means for calculating a property of the fabric from such measurement.
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The present invention relates to fabric testing apparatus.

It is well known that various tests are carried out on fabrics to measure their properties, e.g. drape, bending stiffness, coefficient of friction. Generally these tests are conducted manually using somewhat time consuming procedures. The measurement of drape may be cited as an example. In a standard test for measurement of drape, a circle of the fabric of standard diameter is positioned on a horizontal circular plate of diameter less than that of the fabric, the centres of the fabric and the plate being coincident. Above the plate is a translucent screen on which is positioned a paper annulus having an inner diameter equal to that of the plate and an outer diameter equal to that of the fabric. The centre of the annulus is coincident with that of the plate (and hence that of the fabric). Light is shone upwardly from beneath the fabric so that its image is projected through the translucent screen onto the paper annulus. A line is then hand drawn onto the annulus around the image of the outer edge of the fabric circle. Next, the annulus is cut around the line. The remaining inner portion of the annulus represents the extent to which the fabric projects laterally beyond the circular plate, i.e. a measure of the drape of the fabric. This inner portion of the annulus is weighed and this weight is used in the calculation of the drape coefficient.

Clearly this is a laborious, error-prone operation.

Furthermore, certain of the tests require more than one sample of the fabric. An example of this is
the bending stiffness test in which is carried out by measuring the length of the rectangular strip of material which will bend under its own weight to a predetermined angle (e.g. 7.10°) below horizontal. For any one fabric, this test must be repeated several times with strips of material each cut along principal directions and 45 bias.

It is an object of the present invention to provide fabric testing apparatus which obviates or mitigates the abovementioned disadvantages.

According to the present invention there is provided fabric testing apparatus comprising a turntable on which the fabric may be positioned, at least one sensing means for making a continuous measurement of the fabric during rotation of the turntable, and computing means for calculating a property of the fabric from such measurement.

The sensing means may, for example, be a line scanning camera used for determining the degree of 'overhang' of the fabric over the turntable, for use in measurements of bending stiffness or drape coefficient. Alternatively, the sensing means may comprise a friction sensing arrangement which generates a torque when in contact with the rotating fabric, such torque being measured by a transducer the output of which is fed to the computer. In a still further modification, the sensing means may comprise a linear transducer for measuring roughness of the fabric as it rotates.

The invention will be further described by way of example only with reference to the accompanying drawings which shows one embodiment of fabric testing apparatus in accordance with the invention.

The illustrated apparatus 1 comprises a base plate 2, an upright 3, and a top plate 4. Mounted on
base plate 2 is a housing 5 incorporating a motor 6 and reduction gearing 7 which together drive a spindle 8 on which is mounted a turntable 9 in the form of a circular (e.g. 18cm diameter), cast iron plate. An upwardly projecting pin 10 is provided at the centre of turntable 9.

A header 11 is mounted on a threaded shaft 12. This shaft 12 locates in a threaded bush 13 provided in top-plate 4 whereby rotation of shaft 12 allows header 11 to be moved upwardly or downwardly, depending on the direction of rotation. During its vertical movement, header 11 is guided by rods 14 which slide through bushes 14a.

Header 11 is comprised of a generally cylindrical hollow body with a circular undersurface 15 with a central aperture 16. Provided around the cylindrical body of the header is flange 17 from which depends an annular flange 18 with an undersurface 19. The undersurfaces 15 and 19 are at the same horizontal level and both surfaces have been ground for smoothness.

Those areas of turntable 9 which locate immediately beneath the smooth undersurface 15 and 19 of header 11 are roughened (e.g. by sandblasting) whereas the remaining areas of turntable 9 are smooth.

A friction measuring arrangement is provided on header 11. This arrangement comprises a U-shaped member having a horizontal arm 21a which extends through aligned, apertures 22 in the body of header 11, and depending limbs 21b each provided at their lower end with stainless steel surface contactors 23. The mid-point of arm 21a is pivotal about a vertical axis, and the arm 21a is associated with a torque transducer (not shown). The output of this transducer is fed to computing means (not shown). Provision is also made for the application of a dead
load W to arm 21a.

Extending through flange 17 is a linear transducer 24 capable of measuring height variations to an accuracy of 1 micron. This transducer 24 is located at a greater distance from the centre of the body of header 11 than the contactors 23 and its output (after rectification) is sent to the computer.

Mounted on upright 3 is a vertically movable support plate 25. This plate is in the form of a major sector of a circle with its straight edge (i.e. that edge defining the chord of the circle) being depicted as 26 in the drawing, this edge 26 extending perpendicular to the plane of the paper as shown in the drawing. The diameter of this sector of the circle is greater than the diameter of the fabric sample. Plate 25 has a central circular aperture 27 of diameter just greater than that of turntable 9 whereby plate 25 may, at its upper position as illustrated in Fig. 1, locate around turntable 9.

A conventional line scan camera 28 is mounted on the top plate 4 above an aperture 28 and provided on the base plate 2 is an arcuate reflective plate 29. Information from the camera is supplied to the computer.

The computer is programmed to receive signals from the torque transducer (not shown), linear transducer 24, and line scan camera 28 and to calculate from these signals the fabric properties which each of these components is designed to measure.

The manner in which the illustrated apparatus is used for effecting measurements on a fabric will now be described.

The illustrated apparatus is designed to measure the surface properties, i.e. the geometrical roughness and the coefficient of friction, and the bending stiffness along different directions of fabric.
samples F, using one sample only. Thus apparatus may also be used for measuring drape coefficient. The samples F are located in position by raising header 11 (and thus friction measuring assembly 21 and transducer 24), and locating the sample over pin 10. Header 11 may now be lowered and rests on sample F under its own weight.

The samples F are shown as circular. The samples may be of any size but for the bending stiffness and drape coefficient measurements should be of the same size as the standard drape samples, i.e. 24 cm, 30 cm or 36 cm diameter.

At the outset, all the given constants of the system such as sample size, applied force W and the size of the ball at the end of the linear transducer 24 can be entered into the computer. Additionally the initial measurement of linear transducer 24 and the torque transducer are also recorded by the computer.

Motor 6 is now operated and gearing 7 causes turntable 9 to rotate at 1 rpm. Approximately 10-15 seconds are allowed for the rotation to become steady after which the various measurements may be made (as detailed below). It should be noted that the roughened areas A of turntable 9 cause the sample F to rotate with the turntable against the smooth undersurfaces 15 and 19 of header 11.

Roughness Measurement

The linear transducer (electronic dial gauge) 24 is capable of measuring the variation of the height to accuracy of 1 micron. After measurement of the initial value and rotating the sample it gives outputs linearly proportional to the thickness of the sample F at different locations along a circular track. The output from this transducer is rectified
and fed to the computer which is programmed to calculate the surface roughness.

Friction Measurement

The two contactors 23 are 180° apart in contact with the sample F while it rotates. These contactors are placed on a different track from the path covered by the linear transducer 24 measuring the roughness. The twisting moment developed by the friction force shown by the double headed arrow X in the drawing is applied to the torque transducer, the output of which is amplified and input to the computer. The contact pressure between the contactor 23 and the sample can be varied by changing the dead load W.

Measurement of bending stiffness

The bending stiffness as defined for single curvature deformation is the slope of moment-curvature diagram which according to Kawabata is almost a constant over a wide range of curvatures, -2.5cm⁻¹ to +2.5cm⁻¹.

The conventional method of obtaining the bending stiffness of fabrics is measurement of the bending length, the length of a rectangular strip of material that will bend under its own weight to an angle 7.1°, and using the equation relating the bending stiffness to the bending length and the weight per unit area of the fabric.

With regard to negligible deflection caused by shear across the cross section of the fabric, (for an isotropic continuous strip the ratio shear deflection/bending deflection is \((h/L)^2\) where h is the thickness and L is the length of the strip of the material). The bending stiffness measured by this method is quite reliable.

The line scan camera 28 serves to sense the projected length l of a cantilever of the fabric,
i.e. scan across the width of reflective plate 29. The variation in reflectio caused by a sector of the circle supported along the cord 26 of support plate 25. More particularly, there is a variation in light intensity as between light reflected back to the camera 28 from plate 29 and that reflected from fabric F. The position at which this change of intensity occurs as the camera scans across the width of plate 29 is sensed by the computer which is thus able to calculate the extent to which the fabric overhangs beyond turntable 9. The computer is than able to calculate the bending stiffness from the measurements made.

Measurement of Drape Coefficient

When the support plate 25 is lowered, the sample F is free to drape and deform in double curvature fields. By using camera 28 it is possible to sense the projected length at regular intervals (as effected extremely rapidly by the line scan camera 27 as turntable 9 rotates). Repeated measurement of 1 allows calculation of the projected area of the draped sample corresponding to the area of the shade in conventional test method. The ratio (100 x shaded area/sample area) gives the % of drape coefficient accurately without any need of cutting and weighing papers which introduces the experimental errors.

Analysis of the Recorded Signals

The computer records up to 600 readings of each signal, i.e. amplified voltage outputs of the linear transducer 24 and the torque transducer and the binary output of the camera, during a full revolution. Using the conversion factors, the required values of the geometrical roughness, coefficient of friction, the bending stiffness and the drape coefficient can be calculated.
8.

Except for the latter which is an overall property of the sample, the other values can be used for any type of statistical analysis such as calculation of average mean, the polar plots etc., by the same computer after taking the readings which takes one minute only for each side of the sample. The total hand value which is greatly dependent on the bending and surface properties (in addition to the areal density and the thickness which are easy to measure) can be estimated by using a proper regression equation.

The same sample can be used for measurement of the properties of the other side of the sample.

Additional Features

The header 11 can support many types of contactors to be placed on the rotating sample and cause abrasion, shine, peeling etc. At the same time the linear transducer and the friction tester can detect any change in the roughness or coefficient of friction as the time goes on. By placing the tester in an environmental chamber of controlled humidity or (and) temperature, variation of bending stiffness and drape as well as variation of the surface properties can be measured as a function of the time. As a further feature, the apparatus may be used to test the abrasion resistance of a sample F by use of electrical contacts for detecting when the fabric has been worn through.

It will of course be appreciated that the abovedescribed measurements of roughness and friction may be repeated on the same fabric sample F by remounting the sample over pin 10 at different positions.

A number of modifications may be made to the illustrated embodiment for example, arcuate plate 29
may be replaced by a light source and a line scan detector used instead of camera 28. Alternatively, contactors 23 need not be of stainless steel and can be of any material against which it is desired to measure the friction of sample f (e.g. this could have a fabric surface).

Although sample F has been illustrated as being circular, any other shape may be used if it is simply desired to measure the surface properties (e.g. roughness and friction).
CLAIMS

1. Fabric testing apparatus comprising a turntable on which the fabric may be positioned, at least one sensing means for making a continuous measurement of the fabric during rotation of the turntable, and computing means for calculating a property of the fabric from such measurement.

2. Fabric testing apparatus as claimed in Claim 1 comprising as a sensing means a line scanning camera for determining the degree of overhang of the fabric over the turntable.

3. Fabric testing apparatus as claimed in Claim 1 or 2 comprising as a sensing means a friction sensing means which generates a torque when in contact with the rotating fabric, said friction sensing means being associated with a transducer for measuring said torque.

4. Fabric testing apparatus as claimed in any one of Claims 1 to 3 comprising as a sensing means a linear transducer for measuring roughness of the fabric as it rotates.

5. Fabric sensing apparatus as claimed in Claim 1 comprising a head mounted for vertical movement above the turntable so as to be capable of sandwiching fabric between itself and the turntable, said head having at least one undersurface portion for contacting fabric on the turntable, said head being associated with at least one of linear transducer for measuring surface roughness and/or friction sensing means for generating a torque when in contact with rotating fabric.

6. Fabric sensing apparatus as claimed in Claim 5 which is associated with said friction sensing means which comprises a U-shaped member pivotal about a central vertical axis and having depending limbs.
provided at their free ends with surface contactors for contacting the fabric.

7. Fabric sensing apparatus as claimed in Claim 5 or 6 provided with said linear transducer.

8. Fabric testing apparatus as claimed in any one of Claims 5 to 7 wherein the head has a central undersurface section and an outer annular undersurface section contacting for the fabric.

9. Fabric testing apparatus as claimed in Claim 8 when said undersurface sections are smooth and overlie roughened areas of the turntable.

10. Fabric testing apparatus as claimed in any one of Claims 1 or 3 to 9 comprising a vertically movable, fabric support member which may be positioned around the turntable, said fabric support member having a straight edge over which fabric may drape, and further comprising means for determining the overhang of said fabric over the edge.

11. Fabric testing apparatus as claimed in Claim 10 wherein said means for determining the overhang is a line scan camera.

12. Fabric testing apparatus as claimed in Claim 11 comprising a reflective surface for reflecting light towards the line scan camera.
INTERNATIONAL SEARCH REPORT

International Application No PCT/GB88/00620

I. CLASSIFICATION OF SUBJECT MATTER
(A few classification symbols apply; indicate all)

According to International Patent Classification (IPC) or to both National Classification and IPC

G 01 N 33/36

II. FIELDS SEARCHED

Minimum Documentation Searched

Classification System Classification Symbols

IPC 4 G 01 N 33/36, 19/00, /02

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched

III. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>Textiltechnik 35 (1985) 2 pages 96-99, Prüfgerät zur Bestimmung der Ebenflächigkeit textiler Flächengebilde, H Perner, P Thiem, P Raue, H Fuchs</td>
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IV. CERTIFICATION

Date of the Actual Completion of the International Search 12 October 1988

Date of Mailing of this International Search Report 25 NOV 1988

International Searching Authority

EUROPEAN PATENT OFFICE

Signature of Authorized Officer

P C G VAN DER PUTTEN

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