The present invention relates to an instrument for observing profiles of objects and materials and, in particular, for observing the profiles of shaped or creased objects or materials, such as fabrics. The instrument comprises an extended source (8) of diffused illumination; a platform (4) to support a specimen within the illuminated field; and a lens (5) to bring to focus a shadow image of the specimen and project that image onto a readout screen (6).
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OBSERVING THE PROFILES OF OBJECTS AND MATERIALS

TECHNICAL FIELD

This invention relates to an instrument for observing the profiles of shaped or creased objects and materials. In one particular application the instrument is used to measure the crease angle in materials such as fabrics and yarns. In a further aspect the invention concerns a method for observing the profiles of objects and materials.

Fabric pressing is one of the final processes performed in the manufacture of high quality wool garments and good pressing performance is essential for the production of garments with good appearance. Fabric pressing provides a smooth, crisp appearance to garment panels and also forms sharp, flat seams which do not billow or "blow". In a tailoring industry which is becoming increasingly mechanised, it is commercially important to be able to predict the pressing performance of fabrics so that optimum efficiency can be achieved.

BACKGROUND OF THE INVENTION

It has been shown that the pressing performance of fabrics can be predicted by forming a crease (along a crease axis) in a sample of fabric, and measuring the recovery rate of the crease angle under a standard atmosphere. A low crease recovery angle is a necessary condition for a pressed seam with a good appearance.

In a known device for observing the crease angle, one surface of the creased specimen is laid on a horizontal platform. The crease angle at one end of the specimen is then viewed through a magnifying lens. The angle is compared against a reference line which is rotated to alignment parallel with the edge of the unsupported surface of the specimen. The angle that the line makes with the horizontal direction is then read.
from a circular scale around the rim of the magnifier and is taken to be the crease angle.

Although this device measures crease angles with relatively low precision it is a simple and robust device which provides useful predictions of fabric pressing performance. However, some observers have experienced eye fatigue when using it, possibly due to image distortion by the magnifier or because they must refocus their eyes twice during each measurement, first on the distant image of the crease angle formed by the magnifier and then on the closer circular scale.

An alternative instrument uses an intense beam of light, from a linear array of optical fibres, which is scattered from the creased edge of a specimen. A bright image of the crease angle is then focused onto an array detector in a video camera. The image is then digitised and processed by a computer to provide an accurate measurement of crease angle.

A device of intermediate complexity has been constructed which projects a beam of collimated light along the crease axis of a specimen and onto a screen. However, performance is degraded when the surfaces of the specimen, on either side of the crease axis, are warped, since the warped fabric partially obstructs the light as it passes the specimen.

**SUMMARY OF THE INVENTION**

The present invention provides an instrument for observing the profiles of objects and materials, comprising:

- an extended source of diffused illumination;
- a platform to support a specimen within the illuminated field; and
- a lens to bring to focus a shadow image of the specimen and project that image onto a readout screen.

Such an instrument is simple to operate and may be constructed using optical and electrical components which are commercially available. Furthermore shadowing in the
resulting image is significantly reduced by the use of the extended source of diffused illumination. The extended source will typically have an area at least comparable in size to the specimens to be observed. The emission of light over all forward angles from all points in the source allows an image to be projected with only minor shadowing; for instance in the case of creased fabric specimens, only minor shadowing is seen even when the specimens are severely warped and have small crease angles.

The instrument may further comprise a mechanism to provide for relative movement between the lens and the platform, and permit images from different planes of the specimen to be brought to focus. Preferably the platform is moveable on a linear slide. This allows the front and rear crease angles of fabric specimens to be measured without turning the specimen end to end, simply by altering the plane at which the lens is focused.

The platform may be constructed from a series of thin, upright, spaced-apart and transparent sheets, which may be transverse to an axis passing from the light source to the lens. Such a platform allows a creased specimen to be supported in a manner which does not distort the crease angle, and at the same time allows an unobstructed image of the crease to be projected when one surface of the specimen is laid on the platform. The weight of the unsupported arm produces a negligible change in crease angle, and unlike a system in which the specimen is placed on a platform in the form of an inverted 'V' the support does not become unstable for small crease angles.

The lens should have a large aperture to receive light from the extended source, and may advantageously be corrected for spherical aberration, because of the large angular divergence of light rays entering the lens.

A mirror may be angled between the lens and the image screen to allow the image screen to be placed at a convenient viewing angle on the instrument.
The readout screen will typically be diffuse, and in a preferred form will be rotatable and marked with a series of parallel grid lines. An angular scale may be marked around the edge of the screen. If the scale is also rotatable it may be rotated with the screen to align with the edge of one surface of a creased specimen. The screen may then be rotated without rotating the scale to align with the edge of the other surface, at which time the crease angle may be measured directly from the scale.

In a further aspect the invention provides a method for observing the profiles of objects and materials, comprising the steps of:

illuminating a specimen with diffused illumination;

and

focussing a shadow image of the specimen onto a readout screen.

The focal plane may be altered to bring to focus a shadow image from different parts of the specimen.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

figure 1 is a pictorial view of an instrument for observing the profile of objects and materials, embodying the present invention;

figure 2 is an elevational view of the instrument of figure 1;

figure 3(a) and 3(b) show respectively an elevational and a cross-sectional view of a readout screen embodying preferred features of the present invention;

figure 4 is a schematic illustration of the instrument of figures 1 and 2;

figure 5(a) shows the effect of illuminating a specimen with collimated light, and figure 5(b) shows the effect of illuminating a specimen with a diffused light source;
figure 6(a) shows the effect of illuminating a specimen on a transparent platform, and figure 6(b) shows the effects of illuminating a specimen on a platform according to a preferred feature of the present invention;

figure 7(a) shows a readout from an instrument embodying the present invention, from the front of the specimen, and figure 7(b) from the rear of the same specimen;

figure 8(a) shows a readout from an instrument embodying the present invention, from the front of the specimen, and figure 8(b) from the rear of the same specimen;

figure 9(a) shows a readout from an instrument embodying the present invention from the front of the specimen, and figure 9(b) from the rear of the same specimen; and

figure 10(a) shows a readout from an instrument embodying the present invention from the front of the specimen, and figure 10(b) from the rear of the same specimen.

The same reference numerals have been used throughout the drawings to refer to corresponding features.

BEST MODE OF THE INVENTION

Referring now to Figures 1 and 2, instrument 1 can be seen to comprise a housing 2 in which is mounted a light source 3, a specimen platform 4, a lens 5, and a readout arrangement 6.

Light source 3 comprises a 20 watt tungsten halogen lamp 7 which is separated from diffusely transmitting screen 8 by a glass heat filter 9. A fan (not shown) is mounted on the back panel of the housing 2 to circulate cooling air past the heat filter 9, and the lamp 7. In use, light emitted from the source 3 is collimated by a reflector 10 and directed onto the diffusely transmitting screen 8, to form an illuminated disc which acts as an
extended source of diffused light with approximately uniform density. Diffusing screen 8 is formed by sandwiching a sheet of translucent drafting paper between two clear glass or polycarbonate plates; polycarbonate is preferred. The screen is mounted on the upstream end of specimen platform 4.

Specimen platform 4 comprises five equi-spaced glass or polycarbonate plates 11 (polycarbonate is preferred), whose surfaces lie in planes normal to the axis 12 of the instrument.

A large aperture, F/1.4, 50 mm, photographic lens 13 is positioned to focus in a plane transverse to instrument axis 12 in the region of platform 4.

Light passing through the lens is reflected from the front surface of a plane mirror 15 inclined at 45° to the instrument axis 12, and images on a diffuse readout screen 16 mounted at 45° to the horizontal on the front of the instrument housing.

The readout screen 16 contains a diffuser in the form of a translucent sheet of drafting paper 17 with a grid of equally spaced parallel lines drawn on it as shown on figure 3. The paper 17 is sandwiched between two clear glass plates 18 and 19. The screen 16 may be rotated by an observer to bring the grid into alignment with features of the image. The orientation of the grid may then be read from a circular scale 20 around the circumference of the viewing screen. The scale 20 may also be rotated by the operator to assist in taking a readout. The viewing screen and the scale may be fixed in relation to each other with the grid aligned with the 0°- 0° direction on the circular scale by the engagement of a spring loaded ball 21 with a detent in the ring supporting the viewing screen.

Referring now to figure 4 the operation of the instrument with a crease specimen will be described. A crease specimen 22 is placed on platform 4 with its crease axis 23 aligned with the axis of the instrument. Diffused light is emitted from the extended area of the
diffusing screen 8 to illuminate the specimen, and form a shadow image of the crease. Focusing lens 13 brings one transverse slice of the shadow image into focus and projects it via mirror 15 onto readout screen 16.

Because the fabric specimen has warped surfaces, the crease angle will in general vary along the crease axis and for this reason it is proposed to measure the crease angle at both ends of the specimen. The platform 4 is mounted on a linear slide to enable linear movement of the specimen relative to the fixed lens 13, as indicated by "arrow" 14 in figures 1 and 2. The specimen can therefore be moved towards and away from the lens 13 to enable an image of the rear of the crease to be obtained, an image of some intermediate point within the specimen, or an image of the front of the crease. This enables the lens to be able to focus on the front or rear crease angle and image them onto the readout screen with a magnification of X 3 or X 3.5, respectively. The instrument is arranged with the viewing screen tilted at 45° to the horizontal to provide for ease of viewing for the operator, and has adjustable brightness to improve operator comfort.

Operators, who will be experienced in viewing the shadow image which is projected from creases, may use the scale in two different ways in order to record the result: First, the circular scale may remain fixed relative to the front panel while the readout screen is rotated to align one of the grid lines as closely as possible with one surface of the folded specimen. The screen is then rotated to align it with the other surface of the specimen. The orientations of each arm are read in succession from the scale, and are subtracted from each other to give the crease angle.

Alternatively, the circular scale and the readout screen are rotated relative to each other to align the grid with the 0°- 0° direction on the circular scale, which operation is assisted by the spring loaded ball which engages a detent in the ring supporting the screen.
The screen and the scale are then rotated as one unit until one of the grid lines is aligned with the edge of one surface of the specimen. The scale is then clamped in position with friction pads, and the screen is rotated until one of the grid lines is aligned with the edge of the second surface of the crease. The crease angle may now be read directly from the circular scale.

Before illustrating some particular examples of results obtained using the instrument, some effects of the preferred embodiment will be described with respect to figures 5 and 6.

Cloth specimens are made to have a crease axis dividing the specimen into first and second surfaces generally arranged in a V-shaped configuration, with the apex of the V at the crease axis. If the two surfaces are planar, then the crease angle will remain constant along the entire length of the crease axis. However, if one or both surfaces are warped the crease angle will vary along the crease axis. It is this variation which leads to a number of difficulties in the measurement of crease angle, and also leads to the requirement to measure the crease angle at both ends of the specimen and average the readings in order to obtain a useable statistic.

Figure 5(a) shows the effect of using collimated light and this is compared with the effect of using a diffused light source according to the present invention shown in figure 5(b). Referring first to figure 5(a), section B-B' represents a specimen shown end-on when the lower surface 26 is laid on a flat horizontal surface. The front end of warped surface 26 touches the horizontal surface, while the rear end is raised up causing a shadow 28 when illuminated from a light source in front of the specimen. A similar shadow 27 is formed under the upper surface 25. Light from a collimated light source is obstructed by the specimen causing the shadows to be large and severe. By contrast in figure 5(b) the extended source of diffused light is able to illuminate the upper
side of both surfaces, and the lower side of the upper surface. If light is able to pass onto the underside of the lower surface this is also able to be illuminated by the diffused light source, as a result the shadowing effects are much less severe.

In figure 6(a) a severe shadow is seen under the lower surface of the specimen. Such a shadow may arise when the platform is opaque, but will also arise when a solid transparent platform is used due to internal reflection at the upper surface of the platform. This shadow can be significantly ameliorated by the use of thin, spaced-apart transverse plates as shown in figure 6(b). These plates will internally reflect only about 20% of the light reflected in figure 6(a), and allow sufficient light to pass on to the underside of the lower surface to destroy the shadow in that region thus improving the resulting shadow image.

**EXAMPLES**

Fabric specimens may be prepared for crease angle measurements according to the following procedure:

conditioning the fabric samples in a standard atmosphere (20 ± 2°C, 65 ± 2% rh) for at least 16 hours prior to cutting;

cutting specimens 20 mm x 40 mm from each sample in both warp and weft directions; three specimens being cut from each direction;

folding the specimens in half so that the fold is parallel to the shorter side and then securing the fold with a staple;

pressing creases into all six specimens in one operation;

during the pressing operation the temperature of the compressed specimen must be raised to above 90°C at constant regain and then lowered to 40°C before release;

after pressing returning the specimens to the standard atmosphere and cutting a line 10 mm from the crease and parallel to it;
passing a piece of paper or thin card between the arms of each crease specimen to ensure that no fibres are tangled;

placing the crease specimens onto a flat surface in the standard atmosphere and allowing them to recover for 24 hours.

A specimen of creased yarn can be obtained from a creased fabric specimen simply by extracting a length of the yarn from a creased edge with a pair of tweezers.

Figures 7 to 10 show a series of photographs which are taken to illustrate the images obtained using a variety of creased fabrics and yarn specimens. The scale of each image is defined by a vertical bar which represents a length of 10 mm.

In figure 7 the images are formed by fabric specimen with curved surfaces and a small crease angle; figure 7(a) is the front crease angle and figure 7(b) the rear crease angle.

In figure 8 the images are formed by a fabric specimen with approximately planar surfaces and a medium crease angle; figure 8(a) is the front crease angle and figure 8(b) is the rear crease angle.

In figure 9 the images are formed by a fabric specimen with warped surfaces and a larger crease angle; figure 9(a) shows the front crease angle and figure 9(b) the rear crease angle.

Figure 10 shows the images formed by yarn specimens with large and small crease angles; figure 10(a) shows a large crease angle and figure 10(b) a small crease angle.

Although some degree of shadowing is apparent in all the fabric images, it should be noted that there is always one sharply defined shadow edge on each crease arm which can be used to define the crease angle. It should also be pointed out that direct observation of the viewing screen produces visual images which contain significantly less shadowing than the images which are reproduced in the above figures. This is due mainly to the highly non-linear response of an observer's eye to
changes in brightness and also, to a lesser extent, the limitations in the photographic recording process.

Although the invention has been described with reference to particular examples and embodiments, it should be appreciated that it may be embodied in many other forms. For instance, a lamp and optical fibre bundle may be employed to guide light.

It should also be appreciated that it is not essential for the platform to be mounted in a manner which allows it to be advanced and retracted, since it is relative movement between the specimen and the lens which allows images in different planes to be projected. An alternative is to mount the focussing lens in a manner which allows it to be advanced and retracted.

It should be noted that the device can be used to measure crease angles ranging from 0° to 180° in fabric and yarn, it can also be used in test methods for assessing wrinkle recovery and permanent setting. It may also have broader application to other types of material and objects.
THE CLAIMS

1. An instrument for observing the profiles of objects and materials, comprising:
   an extended source of diffused illumination;
   a platform to support a specimen within the illuminated field; and
   a lens to bring to focus a shadow image of the specimen and project that image onto a readout screen.

2. An instrument for observing the profiles of objects and materials according to claim 1, further comprising a mechanism to provide for relative movement between the lens and the platform.

3. An instrument for observing the profiles of objects and materials according to claim 2, wherein the platform is moveable on a linear slide.

4. An instrument for observing the profiles of objects and materials according to any preceding claim, wherein the platform is constructed from a series of thin, upright, spaced-apart and transparent sheets, transverse to an axis passing from the light source to the lens.

5. An instrument for observing the profiles of objects and materials according to any preceding claim, wherein the lens has a large aperture to receive light from the extended source.

6. An instrument for observing the profiles of objects and materials according to any preceding claim, wherein the lens is corrected for spherical aberration.
7. An instrument for observing the profiles of objects and materials according to any preceding claim, wherein a mirror is angled between the lens and the readout screen.

8. An instrument for observing the profiles of objects and materials according to any preceding claim, wherein the readout screen is marked with a series of parallel grid lines.

9. An instrument for observing the profiles of objects and materials according to claim 8, wherein an angular scale is marked around the edge of the screen.

10. An instrument for observing the profiles of objects and materials according to claim 9, wherein the angular scale is rotatable with respect to the screen.

11. A method for observing the profiles of objects and materials, comprising the steps of:
    illuminating a specimen with diffused illumination;
    and
    focussing a shadow image of the specimen onto a readout screen.

12. A method according to claim 11, comprising the further step of altering the focal plane to bring to focus a shadow image from a selected part of the specimen.
FIG. 5 (a) 

FIG. 5 (b)
**FIG. 8(a)**

**FIG. 8(b)**
FIG. 9(a)

FIG. 9(b)
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.5 G01B 11/24, 11/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC G01B 11/24, 11/26

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

AU: IPC as above

Electronic data base consulted during the international search (name of data base, and where practicable, search terms used)

DERWENT ) 1. Illuminate, light, radiate, shine, brighten, irradiate.

JAPIO ) 2. Diffuse, disperse, scatter, spread.

) 3. Lens.

) 4. Readout screen.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle of theory underlying the invention

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Date of the actual completion of the international search 2 August 1994 (02.08.94)

Date of mailing of the international search report 11 August 1994 (11.08.94)

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