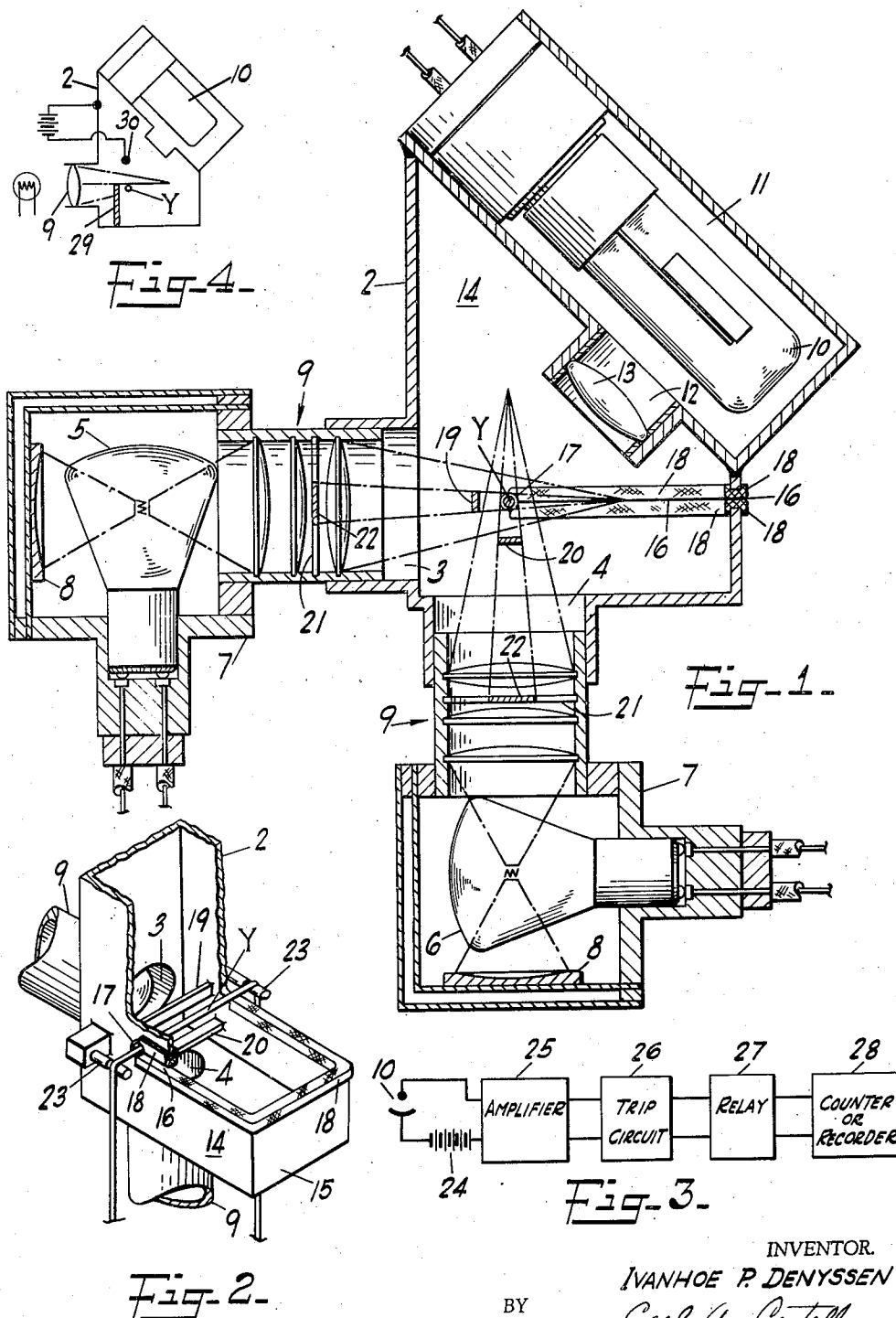


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METHOD AND APPARATUS FOR DETECTING IRREGULARITIES OF
FILAMENTS, YARNS, AND THE LIKE
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METHOD AND APPARATUS FOR DETECTING
IRREGULARITIES OF FILAMENTS, YARNS,
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This invention relates to methods and apparatus for the detection of surface irregularities of objects, such as broken filaments, fuzziness, slubbiness and other irregularities of filaments, yarns and the like.

It has heretofore been suggested to employ photocells for detecting irregularities in filamentous structures, such as yarns of artificial and natural filaments or fibers. In all of such methods, either of two procedures have been employed. In one case, the yarn has been passed transversely through a light beam directed to the photocell so that any irregularities either reduce or increase the light falling upon the cell by variation in light transmission. In the other case a light beam is passed upon the traveling yarn in such a manner that the portion of the beam reflected by the yarn reaches the photocell and so that irregularities vary the amount of light reflected to the photocell.

In accordance with the present invention, a light beam is directed so that it normally can not reach the photocell and the yarn travels within the field of the cell through a shadowed region of the light beam. The shadowed region of the beam is controlled so that the yarn normally travels in the dark. However, irregularities projecting from the yarn extend out of the shadow into the beam and reflect light to the cell. Thus the cell is always in the dark except when yarn irregularities pass. This circumstance results in numerous advantages. Since the cell is normally in the dark, it uses substantially no power except when irregularities pass. This increases the life of the cell and prevents loss of sensitivity. Both the life of the cell and sensitivity of the cell suffer seriously when the cell is constantly receiving light either by transmission or by reflection. Furthermore, the cell is more sensitive to changes from a dark condition than to changes from an illuminated condition, especially at high light intensities. For example, where an irregularity occurs which would effect an increase in the intensity of 20% by the prior art reflection method (or a decrease of 20% by the prior art transmission method) a corresponding variation when operating in accordance with the present invention would effect an infinitely large change. When operating in accordance with the invention, the light sources may be increased in intensity and such increase is fully available to increase the sensitivity of the cell whereas an increase in the intensity of light in accordance with the prior art method would still leave only a proportionate (in the example stated above

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only 20%) improvement in sensitivity. In addition, an increase in light intensity in the arrangement of the present invention does not greatly reduce the life of the cell or reduce the sensitivity because the increased intensity of light is reflected only by the irregularities in the yarn. However, the employment of increased intensities in the arrangements of the prior art leads to rapid burning out of the cell and temporary "paralysis" or loss in sensitivity thereof.

In the drawing, illustrative of the invention, Figure 1 is a cross-sectional view of the invention,

Figure 2 is a perspective view with portions removed,

Figure 3 is a diagrammatic representation of a suitable circuit, and

Figure 4 is a modification.

As shown in the drawing, the apparatus comprises a housing 2 having two openings 3 and 4 set in adjacent walls near one corner which openings communicate with suitable light sources 5 and 6. The light sources may be provided with suitably ventilated housings 7 provided with reflectors 8 and condensing lens systems 9. A photocell 10 may be mounted within a chamber 11 having a window 12 which may be provided with a lens 13, if desired, directed generally toward the corner of the housing 2 between the two openings 3 and 4 to the light sources. The two side walls 14 and the end wall 15 of the housing 2 are provided with a continuous slot 16 extending to openings 17 in the side walls 14 through which the yarn Y is to travel. A light-sealing fabric 18, such as a velvet, may be secured about the edges of the walls where it is slotted, or the edges of the slot may be labyrinthine in character, to reduce entrance of light into the housing 2. The slot 16 permits the insertion of the yarn transversely of the housing into the holes 17 in the side walls 14 thereof to facilitate lacing. The holes 17 in the side walls of the housing are preferably just slightly larger in diameter than the filament or the yarn-like structure which is to be inspected. Shadow-casting strips 19 and 20 are secured within the housing 2 so that they extend across the path of the light and cast a shadow upon the yarn or obturate or occultate it. As shown in Figure 1, these strips 19 and 20 extend at right angles to the plane of the drawing. Where a cylindrical lens system is to be used for the condensers 9, a shadow-casting occultating strip of rectangular shape would be fully adequate to maintain the yarn in shadow, both strips 19 and 20 being disposed in a direc-

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tion parallel to the axis of the cylindrical lens system 9 with which each cooperates. However, where spherical lenses are employed or where poorly corrected lenses are employed, as shown in the drawing, it may be advisable to employ an auxiliary stop or diaphragm 21 placed at the lens aperture in each condensing system 9. The occultating band 22 of the stop may have any desired shape necessary to correct for aberrations in order to produce a shadow having substantially parallel sides at any plane of intersection transverse of the light beam beyond the condensers 9.

As shown more particularly in Figure 2, a couple of grooved thread guides 23 are positioned just outside the housing adjacent the holes 17 through which the yarn is intended to pass. The guides 23 serve to steady the yarn or thread as it passes through the housing.

It will be seen from a study of the drawing that the yarn ordinarily proceeds through a shadow and since the interior of the housing and the occulting strips 19 and 20 are blackened, the photocell 10 is completely in the dark except when irregularities which project from the yarn pass.

If desired, one or the other of the light sources 6 may be omitted. Preferably, however, both are used. Any type of photocell may be used and it may be connected in known fashion to an amplifier which in turn may be connected with an indicator or recorder. As shown in Figure 3, the photocell 10 in series with an outside source of potential 24 is connected to an amplifier 25 which operates a trip circuit 26. The impulse received by the trip circuit, which is in reality a delay circuit, actuates a relay 27 and stops the flow of current after sufficient time has elapsed for the mechanical parts of the magnetic counter or recorder 28 to operate in response to the relay 27. Preferably a vacuum phototube of the photo-emissive type connected in series with a source of potential is used. A phototube of the multiplier type using secondary emissions is exceptionally satisfactory in this connection.

In Figure 4, a modified arrangement is shown in which a single light beam is used. Instead of a strip for occulting the yarn Y, it is passed just behind the edge of a plate 29 so that it is just completely shaded thereby. To assure the orientation of loose filaments or filament ends into the light beam, a wire 30 which extends parallel to the yarn Y in a position above the plate 29 outside the light beam and is insulated from the housing, is charged electrically with respect to the housing and yarn. For example, the wire 30 may be connected to one pole, preferably the positive terminal, of a source of potential and the housing 2 or one of the yarn guides 23 is connected to ground or to the other terminal.

The illuminating systems may be so designed as to provide for illuminating the region within the housing for any length or distance along the traveling filaments. Thus an irregularity may be caused to reflect light to the photocell for a greater length of time for a given rate of travel of the yarn merely by increasing the width of the light band in the direction of travel of the yarn. For this purpose, cylindrical lenses are of particular advantage since they would be arranged with their axes parallel to the direction of travel of the yarn through the housing and to surround the yarn with an envelope of light of greater length longitudinally of the traveling yarn by cylindrical lenses would not involve special grinding procedures or extremely large diameter spherical

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lenses. Thus, where it is desired to make an inspection of the yarn at a high speed of travel to the device, any loss in sensitivity that might result from the increased speed can be compensated for by merely making a longer envelope of light along the traveling yarn.

While the yarn is shown proceeding about guides 23 outside openings 17 of the light-tight housing, a supply bobbin and a take-up device may be arranged within the housing in which case openings 17 may be omitted and the guides 23 may be positioned inside the housing in appropriate relation to the occulting strips 19 and 20.

The device may be used for inspecting textile fibers, filaments, twisted or untwisted filamentary bundles, such as yarns, yarn-like structures and also for inspecting metal wires, twisted strands of wires, cords and so on. In the claims, the word "strand" is intended to be generic to individual filaments or multiple filament bundles whether twisted or untwisted.

While preferred embodiments of the invention have been disclosed, it is to be understood that changes and variations may be made without departing from the spirit and scope of the invention as defined by the appended claims.

I claim:

1. The method of detecting irregularities in strands comprising the steps of passing the strand through an obturated region within a light beam which is directed to pass by without entering a light responsive member, said obturated region having an imaginary bounding surface adjacent to the periphery of the strand so that only irregularities of a predetermined magnitude may project through that surface into the beam and cause light to affect the light-responsive member, and detecting the light responses of the member.

2. The method of detecting irregularities in strands comprising the steps of passing the strands through an obturated region within a light beam which is directed to pass by without entering a light responsive member, said obturated region having at least two imaginary bounding surfaces adjacent to the periphery of the strand so that only irregularities of a predetermined magnitude may project through those surfaces into the beam and cause light to affect the light-responsive member, and detecting the light responses of the member.

3. The method of detecting irregularities in strands comprising the steps of passing the strands through an obturated region within a light beam which is directed to pass by without entering a light responsive member, said obturated region having at least four imaginary bounding surfaces adjacent to the periphery of the strand so that only irregularities of a predetermined magnitude may project through those surfaces into the beam and cause light to affect the light-responsive member, and detecting the light responses of the member.

4. In apparatus for inspecting strands, a housing, means for guiding a traveling strand through a path within the housing, light-responsive means associated with the housing and having a light-receiving entrance directed to communicate with the vicinity of at least a portion of said path, light means, means associated with the housing for directing a beam of light from the light means across said path at a sufficient angle to the direction from the path to the entrance of the light-responsive means that such light normally passes

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by, without entering, the light-responsive means, and means for obturating a portion of the light beam to place in shadow at least that portion of the path of the strand with which the light-responsive means communicate so that only irregularities of a predetermined magnitude project out of the shadow into the beam.

5. In apparatus for inspecting strands, a housing, apertures in opposite walls thereof to permit passage of a strand therethrough, light-responsive means in the housing having a light-receiving entrance directed to communicate with the vicinity of at least a portion of the space between said apertures, light means, means associated with the housing for directing a beam of light from the light means across said portion of the space extending between the apertures in the housing at a sufficient angle to the direction from said portion of the space between the apertures to said entrance that such light normally passes by, without entering, the light-responsive means, and means for obturating within the light beam a transverse portion thereof in alignment with the apertures to place the path of the strand in shadow so that only irregularities of a predetermined magnitude project out of the shadow into the beam.

6. In apparatus for inspecting strands, a housing, means for guiding a traveling strand through a path within the housing, light-responsive means associated with the housing and having a light-receiving entrance directed to communicate with the vicinity of at least a portion of said path, a plurality of light sources, means for directing a light beam from each source at an angle to the other across said path at a sufficient angle to the direction from the path to the entrance of the light-responsive means that such light normally passes by, without entering, the light-responsive means, and a member in each of the light beams arranged to extend substantially entirely there-

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through in a direction substantially parallel to the strand to place in shadow the transverse region common to the beams adapted to be occupied by the traveling strand so that only irregularities of a predetermined magnitude project out of the shadow into the beams.

7. The method of detecting surface irregularities projecting from an object having indefinite length comprising the steps of passing the object longitudinally through an obturated region within a light beam which is directed to pass by without entering a light-responsive member, said obturated region having an imaginary bounding surface adjacent to the periphery of the object so that only irregularities of a predetermined magnitude may project through said bounding surface into the beam and cause light to affect the light-responsive member, and detecting the light responses of the member.

8. In apparatus for inspecting objects having indefinite length for surface irregularities, a housing, means for guiding a longitudinally traveling object through a path within the housing, light-responsive means associated with the housing and having a light-receiving entrance directed to communicate with the vicinity of at least a portion of said path, light means, means associated with the housing for directing a beam of light from the light means across said path at a sufficient angle to the direction from the path to the entrance of the light-responsive means that such light normally passes by, without entering, the light-responsive means, and means for obturating a portion of the light beam to place in shadow at least that portion of the path of the object with which the light-responsive means communicate so that only irregularities of a predetermined magnitude project out of the shadow into the beam.

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