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Person

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[54] MEASURING LENGTH OF WIRE FABRIC BY COUNTING ONLY STRANDS NORMAL TO DIRECTION OF MOTION

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[52] **U.S. Cl.**.....**250/219 LG**, 235/92 DN, 235/92 V, 250/219 FR, 250/219 WE

[51] **Int. Cl.**.....**G01n 21/30**, G06f 7/38, G06g 7/00

[58] **Field of Search**.....235/92 DN, 92 V; 250/219 WE, 250/219 LG, 219 FR

[56] **References Cited**

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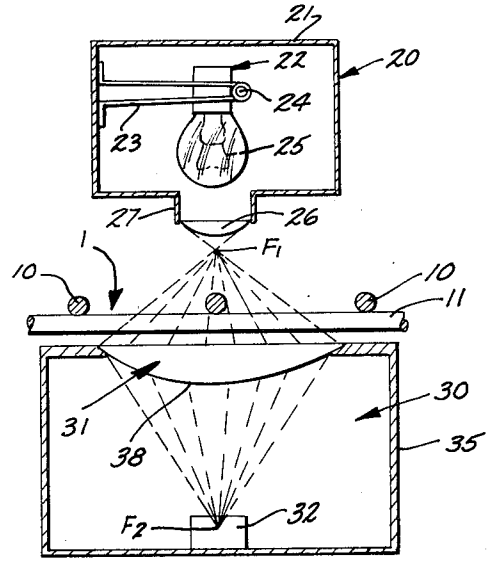
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Attorney—Price, Heneveld, Huizenga & Cooper

[57] **ABSTRACT**

Parallel wire strands of wire fabric having a first set of parallel strands perpendicular to a second set of parallel strands are counted as the fabric is moved through a beam of light. The beam is expanded by a projection lense such that its projection area on the wire fabric includes a dimension parallel to the strands being counted which is greater than the thickness of those wire strands perpendicular to the strands being counted such that only a portion of the beam can be blocked by such a strand. On the opposite side of the fabric, the light is received by a refocusing lense having an elongated receiving surface, oriented parallel to the strands being counted and having a width less than or equal to the thickness of one of the strands being counted. That portion of the light which is received at said receiving surface is refocused by the lense onto a photoelectric cell which thereby detects the passage of one of the strands to be counted as a result of that strand blocking the passage of light to the receiving surface of the receiving lense as it passes.

11 Claims, 6 Drawing Figures



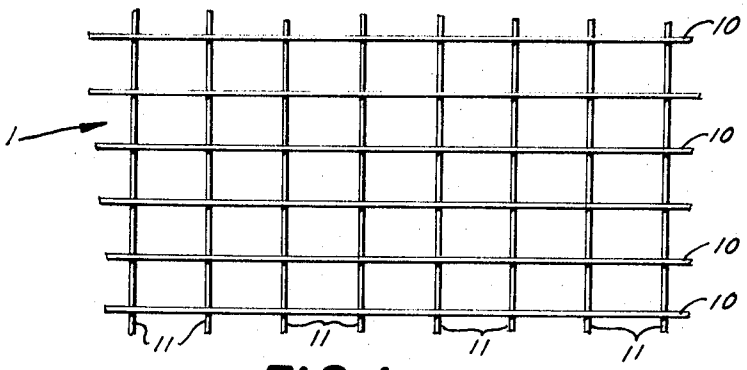


FIG. 1.

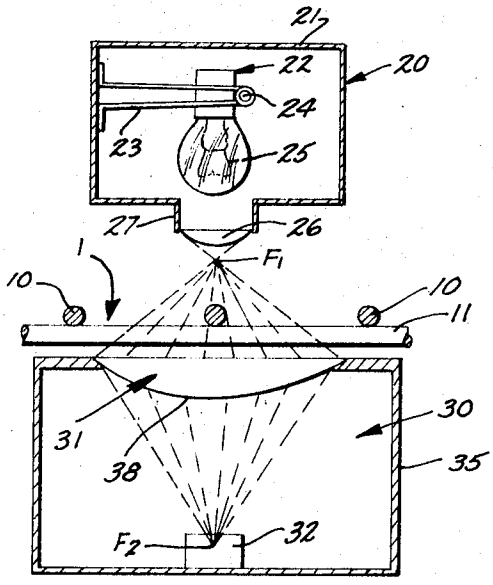


FIG. 2.

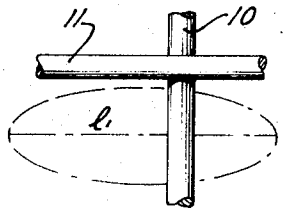


FIG. 3.

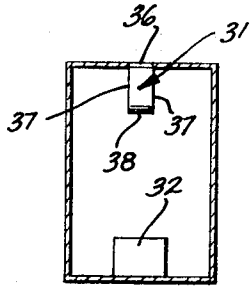


FIG. 4.

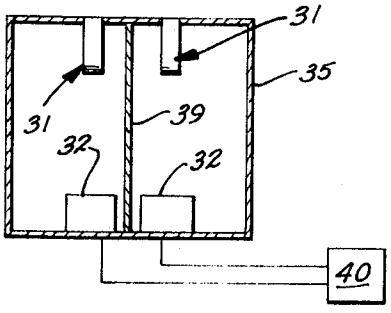


FIG. 6.

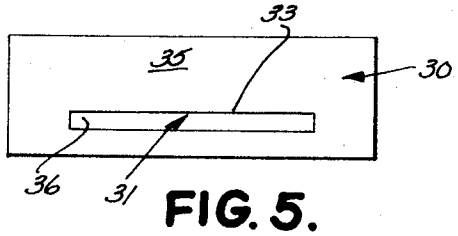


FIG. 5.

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MEASURING LENGTH OF WIRE FABRIC BY COUNTING ONLY STRANDS NORMAL TO DIRECTION OF MOTION

BACKGROUND

This invention relates to a method and an apparatus for measuring lengths of wire fabric. It is particularly useful in the concrete pipe industry, where wire fabric is used to roll reinforcing cages for the pipe. Such fabric has perpendicular sets of parallel strands of wires. FIG. 1 shows such fabric having a first set of parallel strands **10** perpendicular to a second set of parallel strands **11**. In the concrete pipe industry, such wire fabric comes on large rolls and portions thereof must be measured and cut for rolling into reinforcing cages.

One way of measuring length of such fabric is to count the number of parallel strands passing a given point. Because the parallel strands are positioned at generally uniform intervals, one can determine the length of a segment of fabric by counting the number of parallel strands from an initial strand and then multiplying that number by the distance between strands.

However, counting the parallel strands in a high speed cutting and rolling operation poses some difficult problems. Light beams and photoelectric cells have been used for this purpose. The fabric is unrolled and pulled past such an apparatus, and the parallel strands in a given set of strands are used to block the beam of light. However, if the light beam and cell are being used to count the wire strands **11** (FIG. 1), they must be very carefully oriented between a pair of adjacent first set parallel strands **10**. If not, a single first set strand **10** will completely block the beam of light at all times and will thereby render impossible an accurate count of strands **11**. Furthermore, once the light beam and photoelectric cell are properly positioned, one must be very careful to unroll the fabric in a purely linear fashion such that a first set strand **10** does not occasionally stray across the path of the light beam. Such control is practically impossible in most circumstances.

In the present invention, the beam of light is expanded such that only a portion thereof can be blocked by a first set strand **10**. The invention can be illustrated specifically by counting the second set strands **11** of fabric **1**. The fabric is moved in a direction parallel to the first set strands **10**. A beam of radiated energy is projected across the moving fabric and is expanded such that the cross section of the beam, when it reaches the fabric, has a dimension, generally parallel to the second set strands **11**, which is greater than the thickness of each of the first set strands **10**. This expanded beam is received on the opposite side of the fabric at an elongated surface which is oriented generally parallel to the second set strands **11** being counted and which has a width which is equal to or less than the thickness of the second set strands **11** such that the passage of a second set strand **11** will substantially block off the passage of radiated energy to the elongated surface. The passage of a second set strand **11** is then registered each time substantially no energy is received at the elongated surface. The passage of a first set strand **10**, perpendicular to a second set strand **11**, cannot be registered since it cannot substantially block the passage to light to the elongated surface. Thus, when wire strands of the fabric are being counted in accordance with this method, it is irrelevant that a strand of wire perpendicular to the wires being counted may pass through the projected beam of radiated energy.

It is also an object of this invention to reconcentrate the expanded beam onto the surface of an energy detecting cell. Thus, the energy is concentrated when projected and is concentrated when detected. This minimizes the effects of ambient conditions in the environment. This reconcentrating step thus improves the efficiency of the method.

A counting apparatus which may be used to practice this method includes a means for projecting a beam of radiated energy having a cross-sectional dimension at the fabric, parallel to second set strands **11**, which is greater than the width of first set strands **10**. Means are provided for receiving and reconcentrating that portion of the beam of radiated energy

having an elongated cross section which has a width dimension equal to or less than the thickness of one of a second set strand **11**. Detecting means are positioned in the path of the radiated beam at that point at which the beam is substantially reconcentrated by the receiving and reconcentrating means. Thus, the radiated energy is emitted from a concentrated source, is expanded to allow the passage of wires perpendicular to those being counted, and is then reconcentrated at a detecting means. Accordingly, a system is provided which substantially overcomes the effects of ambient radiant energy, and which is very sensitive to the passage of a strand to be counted, but which is not responsive to the passage of a strand perpendicular to the strands being counted.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and advantages of the invention will be seen and understood by reference to the specification and appended drawings wherein:

FIG. **1** is a plan view of typical wire fabric;

FIG. **2** is a cross section of the beam projecting and receiving apparatus;

FIG. **3** is a plan view of the pattern of the beam of light at the wire fabric with a fragment of the wire fabric being shown in passage beneath the light;

FIG. **4** is a cross section taken along plane IV—IV of FIG. **2**;

FIG. **5** is a plan view of the receiving apparatus; and

FIG. **6** is a cross section of an alternative receiving apparatus having two refocusing lenses and two photoelectric cells.

PREFERRED EMBODIMENT

In the preferred embodiment, the apparatus includes a light source **20** for projecting a beam of light across the path followed by wire fabric **1** and a receiver **30** for receiving at least a portion of that beam of light (FIG. **2**). Light source **20** includes a container **21** within which a light bulb **22** is mounted by means of a clamping bracket **23**. The jaws of the clamp can be tightened or loosened by screw **24** such that bulb **22** can be removed or reoriented. Bulb **22** is an inexpensive filament type lamp having a filament **25**.

There is a projection opening **27** in container **21** which allows a beam of light to be emitted from container **21**. The beam which is emitted through projection opening **27** is controlled by means of a projection lense **26**. Projection lense **26** is convex such that it focuses the beam of light at focal point F^1 (FIG. **2**). Receiver **30** is positioned a substantial distance from focal point F^1 such that the cross section of the beam of light which cast upon receiver **30** is expanded substantially. Because of the nature of filament lamp **22**, the pattern of light cast upon receiver **30** will be somewhat elliptical, as indicated by the elliptical pattern shown in phantom lines in FIG. **3**.

In practicing the counting method to count strands **11** of fabric **1**, the fabric **1** is passed a sufficient distance from lense **26** such that the cross section of the beam of light which is cast upon the fabric will have a length dimension l_1, parallel to the second set strands **11**, which is greater than the thickness of a first set strand **10** (FIG. **3**). Since the pattern of the beam as cast by filament lamp **22** is generally elliptical, it should be noted that the filament **25** must be nted generally parallel to the strands **11** in order to maximize the dimension l_1.

The receiving apparatus **30** comprises a container **35** having a receiving lense **31** mounted at the top surface thereof. Lense **31** comprises generally an arcuate section of a cylinder (FIG. **2**). The top surface or receiving surface **36** is elongated and flat. A pair of sides **37** depend downwardly from receiving surface **36** (FIG. **4**) and extended along the length thereof. The bottom surface or refocusing surface **38** of lense **31** is curved, corresponding generally to the surface of a cylinder (FIG. **2**). That portion of the light beam which impinges upon receiving surface **36** is refracted by lense **31** and, due to the curvature of refocusing surface **38**, is refocused at focal point F^2 of lense **31**. The sides **37** are silvered or opaqued to insure that all light

impinging upon receiving surface 36 is transmitted only out through refocusing surface 38.

An elongated aperture 33 is provided at the top surface of container 35, in which lense 31 is mounted. If necessary, receiving surface 36 can be partially masked in order to permit the passage only of an elongated portion of the beam of light into receiving lense 31. The receiving surface 36, as masked if necessary, is approximately as long as dimension l_1 of the projected beam, and has a thickness equal to or less than that of a strand 11, i.e. the strand being counted.

Within the container 35, a photoelectric cell 32 is positioned generally at the focal point F^2 of lense 31. Photoelectric cell 32 is a conventional photo resistive photoelectric cell and is connected to conventional circuitry which registers the presence or absence of light at the surface of photoelectric cell 32. Characteristically, such cells have a very high resistance when no light is impinging upon their surface. Once light begins to activate the cells, their resistance drops very rapidly, and finally levels off sharply at a minimum resistance. Thus, these cells are extremely sensitive to the presence of any light on their surface.

It is important that receiving surface 36 be longer than the thickness of a first set strand 10. This insures that at least some light will be received at photoelectric cell 32 when a first set strand 10 passes over lense 31. Also, it is important that the width of receiving surface 36 be equal to or less than the thickness of a second set wire strand 11. It probably could be slightly greater than the thickness of such strand 11, such that a small amount of light would get to the surface of photoelectric cell 32 even when a wire strand 11 is passing directly over lense 31, but this would necessitate more complicated circuitry in order to render the system sensitive to the passage of a strand to be counted, but still keep it insensitive to the passage of a strand 10.

In operation, the beam of light is projected from light source 20 and is expanded by projection lense 26. Light source 20 is positioned on one side of fabric 1 and receiver 30 is positioned on the other side. Fabric 1 is moved between these two elements in a direction generally parallel to strands 10. It is passed a sufficient distance from projection lense 26 that only a portion of the beam can be blocked by a first set strand 10. In this manner, the passage of a strand 10 through the beam of light does not create a darkened condition at the surface of photoelectric cell 32. A sufficient quantity of light passes around strand 10 that photoelectric cell 32 maintains its minimum resistance even though some of the light is partially blocked. With the passage of a second set strand 11, a shadow is cast over receiving surface 36. Hence, the passage of a strand 11 completely eclipses receiving surface 36 such that substantially no light is received at surface 36 and accordingly, no light is refocused at photoelectric cell 32. When no light radiated energy is received at photoelectric cell 32, the circuitry connected thereto registers the passage of a wire strand 11. This circuit can be a conventional counting circuit which activates a cutting shear upon the passage of a certain number of strands 11.

FIG. 6 shows an alternative receiver assembly in which the container 35 includes two receiving lenses 31 and two photoelectric cells 32. Each set of receiving lense 31 and photoelectric cell 32 is separated by means of a partition 39. The receiving lenses 31 are sufficiently close together that they both lie generally within the cross section of the beam of light. The two photoelectric cells 32 are connected to a circuit 40 which registers the passage of a strand 11 only after both photoelectric cells have been successively darkened. Thus, a wire strand 11 must first pass over the left lense 31 to thereby raise the resistance of the left photoelectric cell 32 and it must then pass over the right lense 31 to thereby raise the resistance of the right photoelectric cell 32. If the resistance of only one cell is raised, the register circuit 40 will fail to indicate the passage of a strand 11. This merely provides an added measure of insurance against the accidental counting on a non-existant strand.

Thus, the present invention provides a unique method and apparatus for counting passing strands of wire in wire fabric 1. The passage of strands 11 will be indicated, but the passage of strands 10, perpendicular thereto, will not be registered. As a result, the positioning of light source 20 and receiver 30 with respect to the strands 10 is no longer critical. Similarly, the unrolling of fabric and the movement of the fabric past projector 20 and receiver 30 is no longer critical. When a strand 10 strays into the path of the light beam, it will in no way affect the accuracy of the system.

It is also possible to use other types of radiated energy in the manner set forth in the preferred embodiment. Indeed, it will be understood that the above is merely a preferred embodiment and that many alterations and changes can be made thereof without departing from the spirit and broader aspects of the invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A method for counting parallel wire strands in wire fabric having a first set of parallel strands and having a second set of parallel strands generally at right angles to said first set strands, said method comprising: moving the fabric in a direction generally parallel to the orientation of the first set strands; projecting a beam of radiated energy from one side of said fabric across the path of said fabric; expanding the cross section of said beam such that, at said fabric, only a portion thereof can be blocked by one of said first set strands; receiving said beam on the opposite side of said fabric at an elongated surface, said surface being oriented generally parallel to said second set strands and having a length greater than the thickness of a first set strand and having a width equal to or less than that of a second set strand, such that the passage of a second set strand substantially blocks the transmission of energy to said elongated surface; registering the passage of a second set strand each time substantially no energy is received at said elongated surface.

2. A method for counting parallel wire strands in wire fabric having a first set of parallel strands and having a second set of parallel strands generally at right angles to said first set strands, said method comprising: moving the fabric in a direction generally parallel to the orientation of the first set strands; projecting a beam of radiated energy from one side of said fabric across the path of said fabric; expanding the cross section of said beam such that, at said fabric, its dimension in a direction generally parallel to said second set strands is greater than the thickness of one of said first set strands; receiving said beam on the opposite side of said fabric at an elongated surface, said surface being oriented generally parallel to said second set strands and having a length greater than the thickness of a first set strand and having a width equal to or less than that of a second set strand, such that the passage of a second set strand substantially blocks the transmission of energy to said elongated surface; reconcentrating that portion of said beam received at said elongated surface onto the surface of an energy detecting cell; registering the passage of a second set strand each time substantially no energy is received at said cell.

3. The method of claim 2 which comprises receiving said beam at more than one said elongated surface, all being generally within the cross section of said radiated beam; moving said fabric such that a given second set strand passes said elongated surfaces in succession; separately reconcentrating that portion of said beam received at each of said elongated surfaces onto the surface of a separate energy detecting cell for each said elongated surface; registering the passage of a second set strand each time substantially no energy is received at all of said energy detecting cells in succession.

4. The method of claim 2 in which said projecting step comprises projecting a light beam; and in which said reconcentrating step comprises focusing said beam of light onto the surface of a photoelectric cell.

5. A counting apparatus for counting parallel wire strands in wire fabric moving past said counting apparatus, said fabric

having a first set of parallel strands and having a second set of parallel strands disposed generally at right angles to said first set strands, said apparatus comprising: means to be positioned on one side of said passing fabric for projecting a beam of radiated energy whose cross section at said fabric includes a dimension, parallel to said second set strands which is greater than the width of one of said first set strands; means to be positioned on the opposite side of said passing fabric for receiving and reconcentrating that portion of said beam defining an elongated cross section which is parallel to said second set strands, and which has a length greater than the thickness of a first set strand and a thickness equal to or less than the thickness of a second set strand; means for detecting said radiated energy being positioned in the path of said portion of said beam at the point at which it is substantially reconcentrated.

6. A counting apparatus for counting parallel wire strands in wire fabric moving past said counting apparatus, said fabric having a first set of parallel strands and having a second set of parallel strands disposed generally at right angles to said first set strands, said apparatus comprising: a light source for projecting a beam of light across the path of said fabric; a projection lense for expanding the cross section of said beam of light such that only a portion thereof can be blocked by a first set strand; a receiving lense to be placed on the side of said fabric opposite said light source for refocusing said light beam, said receiving lense having an elongated receiving surface for orientation parallel to said second set strands; said receiving surface having a length greater than the thickness of a first set strand and having a thickness equal to or less than the thickness of a second set strand; means for detecting light being positioned generally at the focal point of said receiving lense such that the blocking of substantially all light by the passage of a second set strand over said elongated receiving surface of said receiving lense can be detected by said detecting means.

7. The apparatus of claim 6 in which said receiving lense comprises generally a semi-circular section of a cylinder, having a flat receiving surface, a pair of flat sides depending downwardly from said receiving surface and extending the length thereof, and having a curved refocusing surface; said flat sides being opaqued so as to permit the passage of light only from said receiving surface out through said refocusing surface.

8. The apparatus of claim 6 in which more than one of said receiving lenses are provided, each having one of said elongated receiving surfaces; said plurality of receiving lenses being arranged in succession along the path followed by said fabric and generally within the cross section of said beam of light; one of said detecting means being provided for each of said receiving lenses, means being provided for indicating the passage of a single second set strand in response to a successive indication of a substantially darkened condition at all of said detecting means.

9. The apparatus of claim 8 in which all of said detecting means and said receiving lenses are mounted in a common container, partitions being provided between adjacent sets of said receiving lenses and detecting means whereby the light from a given receiving lense will be detected solely by a single detecting means.

10. The apparatus of claim 6 in which said light source comprises a filament lamp, said lamp being oriented such that said filament is oriented generally parallel to said second set strands to thereby insure that said beam cross section at said fabric is wider than the thickness of one of said first set strands.

11. The apparatus of claim 6 in which said projection lense is convex, said lense being positioned with respect to said passing fabric such that said fabric is beyond the focal point of said projection lense.

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