

Aug. 9, 1966

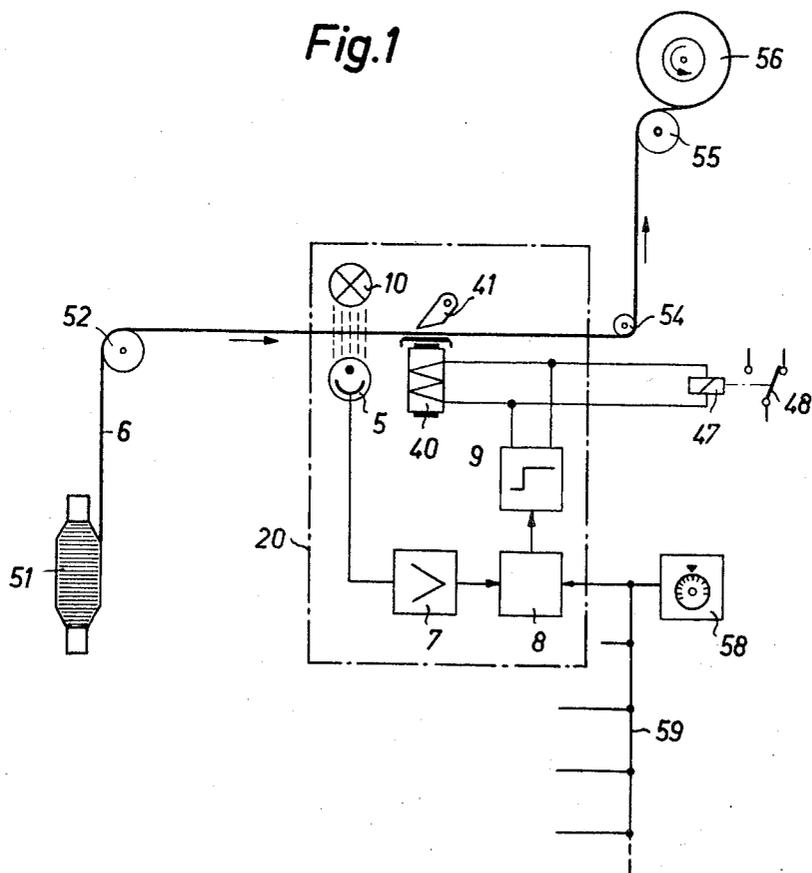
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FIBER GAUGING-CUTTING MEANS AND COMPONENTS THEREFOR

Filed July 22, 1963

2 Sheets-Sheet 1



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FIBER GAUGING-CUTTING MEANS AND COMPONENTS THEREFOR

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2 Sheets-Sheet 2

Fig. 2

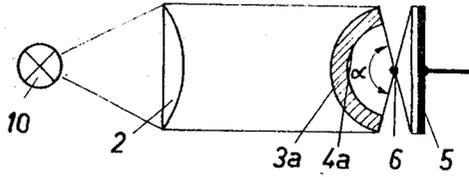


Fig. 3

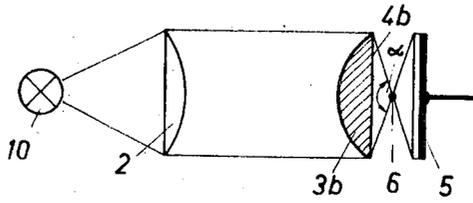


Fig. 4

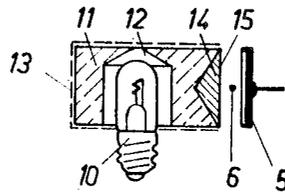


Fig. 5

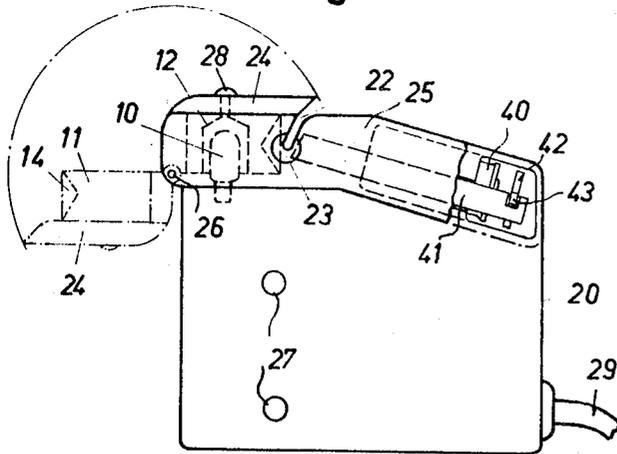
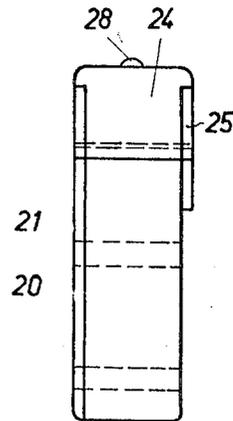


Fig. 6



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FIBER GAUGING-CUTTING MEANS AND
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8,770/62

14 Claims. (Cl. 83-365)

This invention relates to apparatus by which a running textile fiber or other fiber is gauged and, also, may be automatically interrupted in its running in the event the cross-sectional dimensioning of the fiber does not conform to tolerance requirements therefor. More particularly, this invention relates to improvements in such apparatus whereby the gauging of such cross-sectional dimensioning is substantially independent of direction.

When spinning textile fibers, it happens unavoidably that changes of the yarn diameter occur in certain portions of the yarn or that the yarn diameter is modified by spun-in impurities (for example, parts of the cotton boll). The cross sections of the portions deviating from the norm may be circular or may have any other shape. If the cross section deviates from the required value beyond a certain amount, the improperly sized part must be removed from the yarn in the course of a rewinding process inasmuch as it may otherwise cause a disturbance during further working of the yarn or may impair the appearance or quality of the final product. Of course, only such deficiencies are removed as exceed a certain dimension; elimination of only slight deviations of the cross section would be unnecessary and uneconomical.

Changes in the cross section may be detected by means of known thread cleaners if those changes are thickenings, i.e., render the fiber oversize. A mechanical thread cleaner consists of a metal plate which is provided with a slit through which the thread is guided. Thereby, the width of the slit corresponds to the selected dimension of the thread or yarn diameter. While running through the metal slit during rewinding, any thickened portion is caught in it and detected.

As a practical matter, however, it has been found that the aforementioned mechanical thread cleaner removes deficiencies in the cross section only incompletely. The principal reason for this is that deficiencies in the cross section occur not only in the form of round thickenings but frequently, also, as flattened or squashed portions so that the diameter of the yarn in one direction does not deviate from the established value or is even smaller than the same. Evidently, such deficiencies will not terminate the passage of the fiber through the mechanical thread cleaner.

These and other shortcomings of the mechanical thread cleaner have resulted in the development of photoelectric thread cleaners during recent years. In the case of such thread cleaners, the thread is generally conducted between a source of light (e.g., an incandescent bulb with a condensing lens) and a light-electric receiver (photo cell or photo element). Part of the light of the parallel light beam emanating from the condensing lens is masked by the thread which is running through so that the cross section of the thread is projected as a shadow on the light receiver. Thus, changes in the cross section of the thread cause changes of the quantity of light striking the light receiver so that the electric voltage or current amplitude shows corresponding fluctuations. These changes in the electric current or voltage may be used, after amplification, to operate an automatic electromagnetic cutting device, for example, the device interrupting the thread near the deficiency established.

By means of such a simple photoelectric device, flat and

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crushed deficiencies in the cross section are established correctly only if they are located at right angles to the direction of the beam. If, however, the same defect is parallel to the light beam, the shadow of the thread is not changed nor is there obtained an electric signal indicating such deficiency. In order, however, to definitely recognize and separate (i.e., eliminate) a defect in the cross section greater than a certain given tolerance, it is absolutely necessary that a defect in the yarn produce at least approximately the same electric signal in any given location with respect to the light beam.

This requirement led to the construction of photoelectric devices with two or more crossing light beams, the thread running through the zone of intersection of the beams and causing a multiple shadow on the light receiver or receivers. (See, for example, Belgian Patent No. 597,995 or D.D.R. Patent No. 8834). Such arrangements, however, do not comply with the aforementioned conditions in a satisfactory manner. This is so because, if a flat thickening of the cross section is turned 90° around the longitudinal axis of the thread in the zone of intersection of two bundles of rays intersecting perpendicularly, the same masking of light and the same size of the signal will be obtained. If, however, the same defect in the cross section is turned only 45°, the quantity of light is correspondingly changed in the two intersecting light bundles, namely, $\sin 45^\circ = 0.707$ so that the light receiver registers in both light bundles a total light modification of $2 \cdot \sin 45^\circ = 1.41$, i.e., the signal is approximately 40% stronger than in the former case. In other words, the anisotropy of the aforescribed arrangement excludes an exact measuring and discriminating in accordance with defined values of defects inasmuch as the same defect may be registered with various values, depending on the angle formed, and, thus, may be classified in various categories of cleaning. Consequently, a determination by multiple-beam gauging of conformity to a predetermined tolerance may not result in the desired yarn quality. In practice, deviations of $\pm 10\%$ from an established value of dimensioning in cross section of a fiber correspond to a different cleaning category, i.e., another quality class.

It is true that an added improvement could be obtained by having the thread scanned by three light beams angularly spaced by intervals of 60°. Even then, however, a disturbing anisotropy would be present. This is so because, while three or more intersecting light bundles are theoretically possible, in practice, the optical arrangement would be too complicated and the dimensions of the device too extensive.

Moreover, there are still other shortcomings connected with the aforementioned thread cleaners which work by means of directional light bundles and photoelectrically. Specifically, if the thread changes in position at a right angle to the direction of its running in the zone of intersection of the light bundles, to prevent such positional changes from causing irregularities of the signal, it is necessary to use homogeneous parallel bundles of light rays. The production of such parallel rays depends heavily (in addition to the focusing optics) upon the utilization of a point-shaped source of light. In practice, however, such a source hardly ever exists or is obtainable only with great difficulty. The miniature incandescent bulbs customarily used in thread cleaners do not, under any circumstances, constitute a point-shaped source of light, because light is emitted from all parts of the incandescent spiral filament. This means that a parallelism of the rays is obtained only approximately, thus resulting in additional inaccuracies in the scanning of the yarn defects.

One may expect a considerable amount of dust to be caused by the passing through of the yarn. This dust con-

sists mainly of fiber particles, parts of cotton bolls and other substances. Frequently such dust deposits on photocells, lenses, mirrors, etc. so as to result in a reduction of the effective light quantity. The use of electronic compensation or control circuits in order to prevent losses of sensitivity is known. Those arrangements, however, work accurately only as long as the dust deposits approximately homogeneously on the optical parts or the photocell. If in one spot on an optical element there occurs an individual dust deposit which is relatively dense, such deposit is shown as a shadow by the directional beam, i.e., a "hole" or a dark spot shows in the path of the rays. If a thickened portion of a thread passes through this part of the light ray, a completely wrong value is measured and the defect is not eliminated.

If two bundles of rays at a right angle with one another are used which are obtained by deflection by means of a mirror which is 45° inclined, part of the light which is reflected on the thread in the zone of intersection will reach the photoelectric cell in an undesired manner. This will result in extraneous differences in the results of the fiber gauging, the results depending in part on whether the yarn involved or the pertinent defect is dark or light.

An object of this invention is, accordingly, to provide fiber gauging and cutting apparatus which is free of the aforementioned deficiencies of heretofore known mechanical and electro-optical thread cleaners.

Another object of this invention is to provide improved components which are utilizable in such apparatus.

These and other objects are realized according to the invention by providing an electro-optical gauge in which diffuse scattered light is emitted from an area on one side of an axis of a fiber-scanning zone, the area subtending in a plane normal to the axis an angle which has its vertex on such axis and which is obtuse and, preferably, is as large as is practical. Disposed on the opposite side of said axis is a photoelectric means in optically coupled relation with said light emitting area to receive light energy therefrom as a function of the cross-sectional dimensioning of a length of fiber in said zone. Because the said area emits diffused scattered light and subtends an obtuse angle in relation to the said axis, the amount of light energy received by the photoelectric means is substantially independent of direction.

For a better understanding of the invention, reference is made to the following description of exemplary embodiments thereof and to the accompanying drawings wherein:

FIG. 1 is a schematic diagram of fiber gauging and cutting apparatus according to the invention;

FIG. 2 shows schematically the structure of one form of electro-optical gauge for the FIG. 1 apparatus;

FIG. 3 shows schematically the structure of another form of electro-optical gauge for the FIG. 1 apparatus;

FIG. 4 shows schematically the structure of a preferred embodiment of an electro-optical gauge for the FIG. 1 apparatus;

FIG. 5 is a structural diagram in front elevation of the FIG. 1 apparatus when incorporating the FIG. 4 gauge; and

FIG. 6 is a view in end elevation of the structure shown in FIG. 5.

The basic construction of an electro-optical fiber gauge and the latter's arrangement on a winding machine is shown schematically in FIG. 1. The yarn or thread 6 is drawn off the spool 51. The thread runs over the control roll 52, the guide roller 54 and the grooved drum 55 (in case of a traverse winding frame) towards the cross-wind bobbin 56 by which it is wound. As a rule, a considerable number of threads 6 are drawn off simultaneously from individual spools 51 and are individually wound on such cross-wind bobbin. However, for the sake of simplicity, the path of only a single thread is shown.

In order to supervise and control the cross section of the thread and to eliminate undesirable defects, an electro-optical arrangement in form of a light barrier with the lamp 10 as a light transmitter and the photoelectric cell

5 or some other suitable photoelectric means as a light receiver is provided for each thread in a suitable location along the path of the thread, in this case between the control roll 52 and the guide roller 54. The thread 6 is conducted through the scanning zone between the light transmitter 10 and the light receiver 5 and the thread portion which at any given moment passes through the scanning zone masks a smaller or larger portion of the light directed towards the receiver, depending on the given cross section of the thread. Thus, if the thread 6 passing through has a thickening, the quantity of light striking the photocell 5 is reduced. In reverse, if the cross section is reduced the quantity of light will be increased on passage (of the thread). Thus, the photocell 5 delivers a signal which is characteristic in amplitude and sign of the deviation from the required value of the cross section of the portion of the thread in the scanning zone at any given moment. This signal is conducted by means of an electronic amplifier 7 to a matching or comparing circuit 8. The last-named circuit also receives an electronic reference voltage which is adjustable by means of the potentiometer 58 or some other voltage adjusting means. The reference voltage establishes the threshold of discrimination of the circuit 8 and thereby the admissible limit of error of the signal received from the amplifier. If this limit of error as selected by component 58 is exceeded, a switch circuit 9 is triggered by the output of the comparing circuit 8 to energize a solenoid 40. The solenoid in turn actuates a knife 41 to cut the thread 6 at a point near the scanning zone. The defective thread portion can then be removed, and the ends of the thread may subsequently be knotted together.

In the case of automatic winding frames it is often desirable that, upon operation of the thread cleaner and cutting of the thread, the passage of the thread and the driving of the bobbin 56 are momentarily interrupted. To this end, a relay 47 may be electrically connected in parallel with the knife solenoid 40. Such relay has a contact 48 which, upon excitation of the solenoid 40, operates a coupling or braking arrangement (not shown) for the drive of the bobbin.

In case of the simultaneous winding of a number of bobbins by means of one winding frame, as mentioned above, it is obvious that each thread must be allotted its individual gauging and cutting device 20. In this instance, the device 58 for the generation and adjustment of the reference voltage may, as indicated by line 59, be utilized jointly for several thread cleaners 20, all these devices being common to the same winding frame. Thereby, it becomes possible to adjust without any difficulty the limit of sensitivity of all such several thread cleaners by means of the common connecting line 59. Subsequent adjustment is likewise easily possible during operation. The working voltages for the lamp, amplifier, magnet, etc. are preferably likewise supplied by one supply or source for several thread cleaners.

In order to remedy the aforescribed disadvantages of the customary photoelectric thread cleaners known until now, it is in accordance with the present invention that the light transmitted be provided by an areally extending diffuse radiator, and that such radiator be disposed so close to the thread running through that the portion of thread located in the scanning zone at any given moment is illuminated at an angle which is as obtuse as possible. Two different basic structures for such a light means are schematically shown in FIGS. 2 and 3, the view in each figure being in the direction of the thread. Corresponding parts are marked by the same reference number.

In both structures, the source means of the light comprises a light-generating means 10 (preferably an incandescent lamp) a condensing lens 2, and a light-diffusing body, the body designated by 3a and 3b in, respectively FIGS. 2 and 3. The body 3b in FIG. 3 is a prismatic body of diffuse translucent material, provided, for example, by frosted glass or by some glass-like translucent material such as milky opaque "Plexiglas." The body 3a in

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FIG. 2 has the shape of a semicircularly bent strip of uniform thickness, while the body 3b (FIG. 3) has the cross section of a circle segment. Opposite the aforementioned bodies 3a and 3b is disposed an areally extending photocell or photo element 5 acting as a light receiver. The thread 6 to be examined passes between the diffusely scattering body 3a or 3b and the relatively close-in light receiver 5. In the arrangement as per FIG. 2, the thread runs in the axis of the cylindrical surface formed by the body 3a.

The respective, thread-facing light-emitting or exit surfaces 4a and 4b of the bodies 3a and 3b, are each to be considered as a secondary source of light which illuminates the thread 6 at an angle α which is as obtuse as possible, i.e., extends approximately over half of the thread circumference. Consonantly, the photocell 5 is shaped sized and disposed in such a manner that, seen from the thread, it subtends about the same obtuse angle as the diffusing body. The mentioned obtuse angles are obtained by utilizing comparatively small distances between the thread and, respectively, the body 3a (or 3b) and the photocell 5.

After the light has travelled from the incandescent lamp 10 through the translucent glass body 3a or 3b, it is emitted in completely diffusely scattered form from the surface 4a or 4b. In other words, no preferred direction of the rays is present and thus, no defined image or shadow of the thread 6 is created on the areal light receiver 5. Therefore, changes in the cross section of the thread 6 will result in changes in brightness distributed all over the surface of the light receiver, wherefore local differences in light sensitivity or changes in the position of the thread running through will create no effect. Inasmuch as the thread is lit uniformly diffusely at an angle α which is approximately 180°, the shape and direction of any deviations of the cross section are without any importance. The arrangement is free of any anisotropy such as is unavoidable in the case of directional rays.

A condition for elimination of anisotropy is that the thread 6 be illuminated over the entire angle α with at least approximately equal light intensity. In the arrangements in accordance with FIGS. 2 and 3, this condition is complied with in different ways. Inasmuch as the substantially homogeneous irradiated body 3a is of uniform overall thickness, the intensity of the diffusely emerging radiation is the same in each part of the exit surface 4a. Furthermore, as said exit surface 4a is everywhere at the same distance from the thread 6, the aforementioned condition is complied with to a very good approximation.

In the shaped body 3b in accordance with FIG. 3, on the other hand, the thickness decreases towards the two edges and consequently, the exit intensity is greater at the edges of the surface 4b. However, the distance of those two edge portions from the thread 6 is considerably larger than the distance of the thread from the less intensely radiating middle portion of the surface 4b. Those two aspects have a balancing effect so that, at all irradiated spots of the thread 6 over the entire angle α , approximately uniform brightness will prevail. By suitable shaping of the cross section of the body 3b and by suitably selecting the transmittance of the translucent material used, any possibly remaining inhomogeneities may be eliminated.

There are other suitable constructions for the diffuse areal radiator. Thus, there may be used, for example, as a light exit surface a so-called grey (neutral) wedge, i.e., a partly translucent plate the blackening (density) of which in the center (at the shortest distance from the thread 6) is strongest and diminishes towards the edges whereby uniform light intensity is obtained all over the angle α .

FIG. 4 shows a particularly advantageous and space-saving arrangement of the optical elements of a light transmitter in accordance with the invention. A body 11, shown in cross section and consisting of clear transparent

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material, for example an inorganic or organic glass mass, has formed therein a hollow 12 in which is placed the bulb of the incandescent lamp 10. At the front surface of the preferably prismatic body 11 is inserted a body 14 made of light-transmitting but diffusely scattering material, the light exit surface 15 of which body is disposed to face the thread 6 and the areal light receiver 5. On all other side surfaces, the body 11 is covered with a reflecting surface 13 as, for example, a good coating of white paint. In this manner, the body 14 is caused to be irradiated largely homogeneously, in spite of the spatial closeness of the incandescent lamp 10. The cross section of the body 14 is shaped according to the principle of FIG. 3. It is to be understood, however, that a body of the type of 3a as in FIG. 2 may likewise be used. It has been found that, by the effect of the coating 13 and the position of the incandescent lamp 10, the simple form of the body 14 having plane surfaces furnishes uniform illumination. A special advantage of the arrangement as per FIG. 4 may be found in the fact that practically the entire light flux emanating from the lamp 10 is made use of.

FIGS. 5 and 6 show, in approximately natural size, a preferred construction of a complete thread cleaning unit 20 wherein are contained all parts which in FIG. 1 are surrounded by a dot-dash line. A metal case 20, preferably die cast, which is closed by a lateral lid 21 is provided with a thread guide eye 23 made of a material which resists wear and tear. The thread is introduced into this eye through a slit in the case 22. The perforated passage 27 serve to attach the unit to the winding machine.

An electro-optical gauge device, in construction analogous to the one in FIG. 4, is placed in the immediate vicinity of the thread guide 23, i.e., on both sides of the slit 22. The parts 11 and 14 as per FIG. 4 are fastened to an angle piece 24 which may be rotated around the axis 26 as indicated by the circular dot-dash line. On the other side of the thread guide 23 is arranged the photocell 5 (not shown). The incandescent lamp 10 is fastened in a socket in the case 20. When the angle piece 24 is swung out, the optical elements can be easily cleaned and the incandescent lamp 10 can be exchanged, if necessary. In order to monitor (check) the incandescent lamp, a pin 28 consisting of transparent material, colored red, for example, is inserted into the angle piece 24, such pin protruding into the hollow space 12 destined to house the lamp bulb.

In the upper part of the case 20 is arranged the knife 41 which can be displaced, and the blade of which is directed towards the path of passage of the thread. The knife cuts the thread whenever a defect to be eliminated is detected by the electro-optical gauge. The knife 41 is located underneath the removable lid 25 which in FIG. 5 is shown partly removed. Behind the knife 41, in a hollow space in the case, is located the electromagnet 40 which acts in conjunction with a hinged armature 42. A cam 43 of the armature engages a recess in the knife 41 so that, when the electromagnet 40 is excited and attracts the armature 42, the knife is displaced towards the left in FIG. 5 to execute the cutting movement.

In the remaining part of the case 20 are housed the amplifier 7, the comparing circuit 8 and the control circuit 9. All of the components 7-9 may be transistor circuits. The reference voltages for the degree of cleaning (line 59 in FIG. 1) and the working voltages for the lamp 10, the transistor circuits and the cutting electromagnet 40 are supplied by means of a multi-wire cable. The dimensions of the entire device in accordance with FIGS. 5 and 6 do not exceed approximately 70 x 70 x 23 mm.

As is obvious from the foregoing description, the defects described above of the known electro-optical thread cleaners working with directional light rays are eliminated as a result of the application of the diffuse light radiator for the scanning of the thread, in accordance with the invention. The diffuse homogeneous illumina-

tion does not create any defined images of the thread and of the defective contours on the light receiver. Rather, in case of a change in the cross section of the thread, there occurs a change in the light intensity uniformly distributed over the entire surface of the areally extending light receiver. The light emanating from the areal diffuse light radiator does not have a preferred direction of beams, instead, but the thread is evenly illuminated over the entire angle α which is approximately 180° . i.e., over half of the circumference and from all directions. An additional advantage resides in the fact that the optical elements are inexpensive. In particular, no accurately manufactured expensive parts such as lenses, mirrors and the like are required.

I claim:

1. An electro-optical fiber gauge comprising, source means of diffused scattered light on one side of an axis for a fiber-scanning zone, said source means being a radiator of said light over an emitting area subtending an obtuse angle from said axis in a plane normal thereto, and photoelectric means on the opposite side of said axis and in optically coupled relation with said source means to receive light energy from said area as a function of the cross-sectional dimensioning of a length of fiber in said zone.

2. A gauge as in claim 1 in which said source means is characterized towards said axis by a light-emitting surface having a straight line intersection with any plane within said angle which contains said axis.

3. A gauge as in claim 1 in which, for any direction within said angle, the distance between said area and axis and the intensity of light radiated from said area towards said axis are mutually proportioned to provide uniform illumination in all such directions for a length of fiber in said zone.

4. A gauge as in claim 1 in which said source means comprises light generating means and light diffuser means disposed in a path for light from said generating means to said axis.

5. A gauge as in claim 4 in which said light diffuser means is a translucent diffuser body in the form of an arc of an annulus of constant radial thickness, said body having towards said axis an inner circular cylindrical surface coaxial with said zone axis.

6. A gauge as in claim 4 in which said light diffuser means is a translucent diffuser body having an extent transverse to said path and having a transmittance to light in such path which decreases in the transverse direction away from the extremes of said body towards the center thereof, said diffuser body having towards said axis a light-emitting surface which is closer to said axis at said center than at said extremes.

7. A gauge as in claim 6 in which said diffuser body has a convex-planar cross section in said plane, the planar side of said body being provided by said surface.

8. A gauge as in claim 6 in which said body has a planar base towards said axis and a pair of sides tapering from said base towards each other in the direction towards said light-generating means, said base being provided by said surface.

9. A gauge as in claim 6 in which said gauge is in the form of a variable density optical wedge.

10. An electro-optical fiber gauge comprising, source means of diffuse scattered light on one side of an axis for a fiber-scanning zone, said source means being a radiator of said light over an emitting area subtending a first obtuse angle from said axis in a plane normal thereto, photoelectric means on the opposite side of said axis and having a light receiving area subtending a second angle which is the projection through said axis of said first angle, said light-receiving area being optically-coupled with said light-emitting area to receive light energy therefrom as a function of the cross-sectional dimensioning of a length of fiber in said zone.

11. Source means of diffused scattered light for an electro-optical fiber gauge, said source means comprising, a block of transparent material having a hollow formed therein, light generating means in said hollow, translucent light diffusing means at the front end of said block, and light reflecting means on the rest of the exterior of said block.

12. Thread gauging and cutting apparatus comprising, means to guide a fiber along a path providing a fiber-scanning zone, source means of diffused scattered light on one side of the axis for said zone, said source means being a radiator of said light over an emitting area subtending an obtuse angle from said axis in a plane normal thereto, photoelectric means on the opposite side of said axis and in optically coupled relation with said source means to receive light energy from said area as a function of the cross-sectional dimensioning of a length of fiber in said zone and to convert said light energy into an electric indicating signal of the acceptability or non acceptability of said dimensioning, fiber-cutting means adjacent said zone, and control means responsive to said signal when indicative of non-acceptability of said dimensioning to actuate said fiber-cutting means.

13. Apparatus as in claim 12 in which said control means comprises a source of a reference signal, signal-comparing means responsive to inputs of said indicating and reference signals to provide an output only upon an impermissible departure of the value of said indicating signal from the value of said reference signal, and means triggered by said output to actuate said fiber-cutting means.

14. Apparatus as in claim 12 further comprising support means for said photoelectric means, fiber-cutting means and control means, and means securing said light source means to said support means through a movable coupling, said coupling permitting selective positioning of said source means towards and away from said axis.

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60 WILLIAM S. LAWSON, *Primary Examiner.*