

July 11, 1961

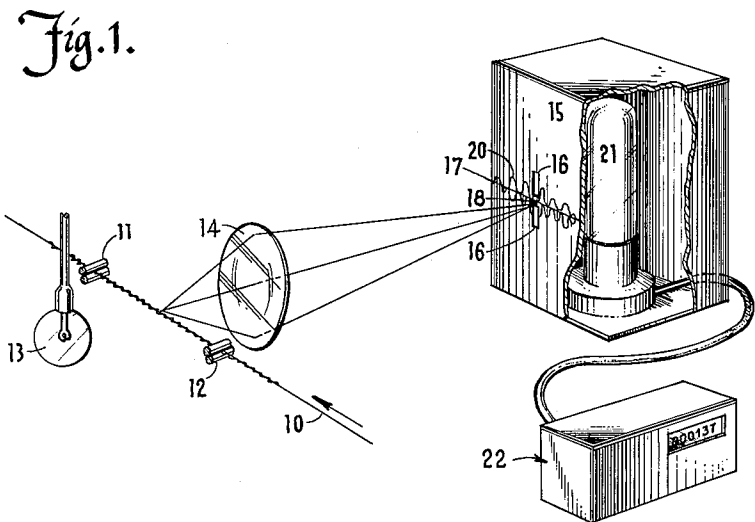
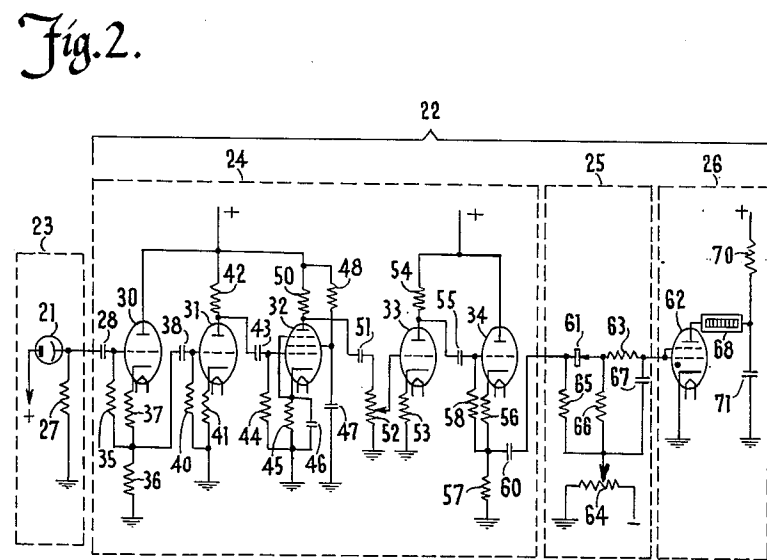
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2,991,685

APPARATUS FOR TESTING BULKED YARN

Filed Oct. 7, 1957

4 Sheets-Sheet 1



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Fig. 3.

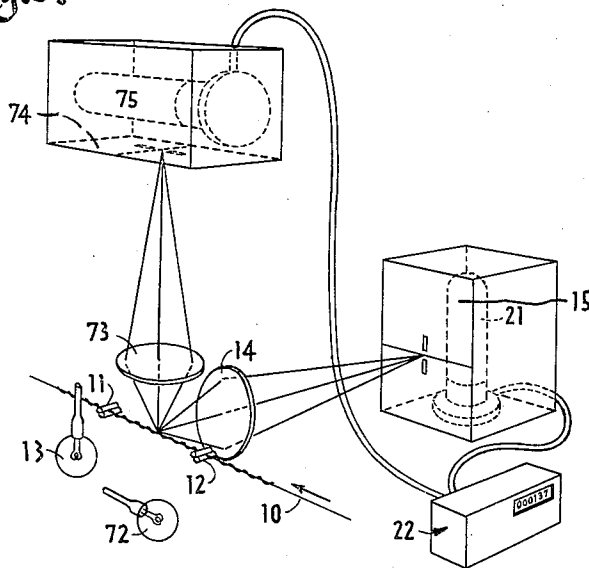
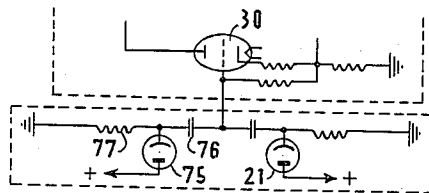


Fig. 4.



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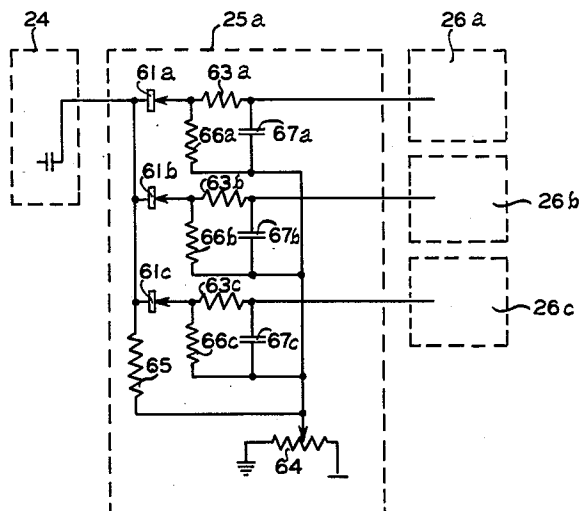
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Fig. 5.



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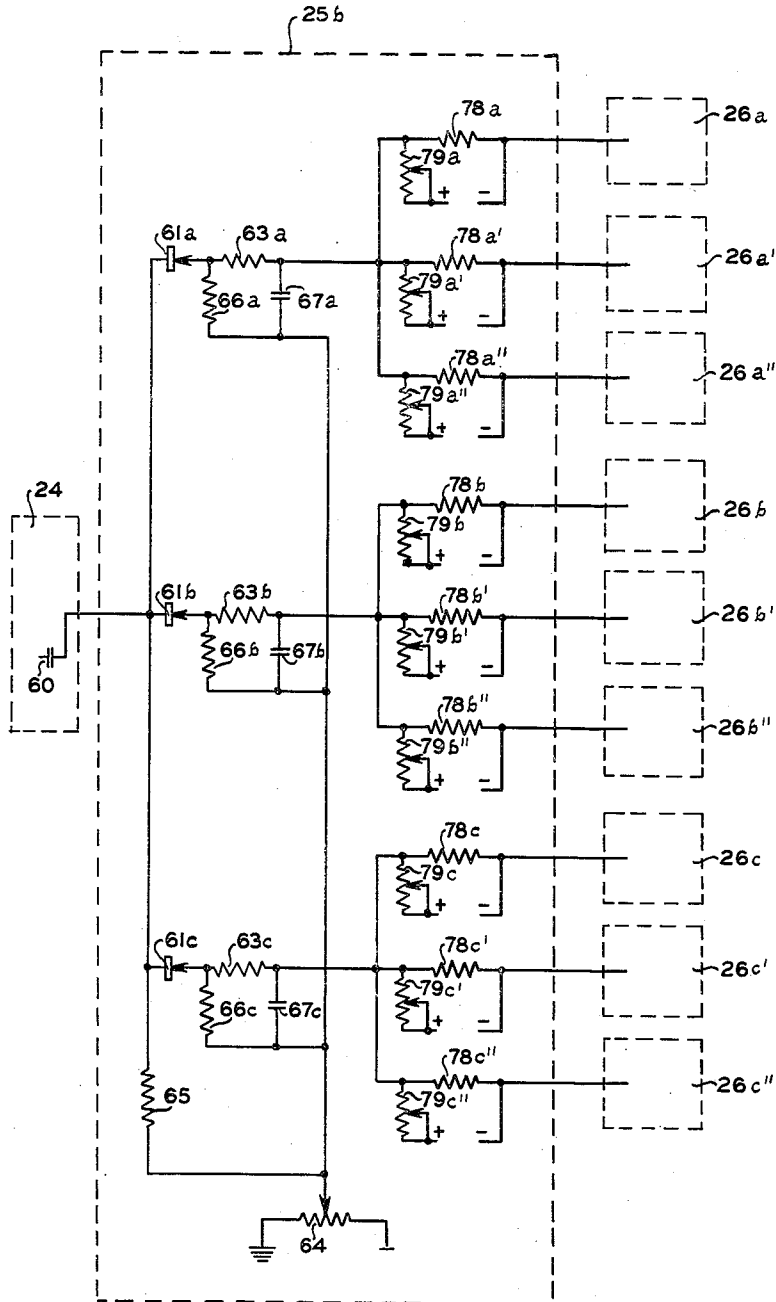
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Fig. 6.



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APPARATUS FOR TESTING BULKED YARN
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Filed Oct. 7, 1957, Ser. No. 688,746

Claims priority, application Netherlands Oct. 24, 1956

2 Claims. (Cl. 88—14)

The present invention relates generally to the testing of voluminous yarns and more particularly to a process and apparatus for the testing and registering of non-uniform portions of continuously bulked yarn.

Looped type bulky yarn may be manufactured, for instance, by propelling a twisted yarn consisting of a plurality of endless filaments through a confined zone by means of a stream of gas and by changing the direction of travel of the yarn thus treated after it discharges from the zone. Yarn treated in this manner is characterized by small loops formed by individual filaments protruding from the core of the yarn. These loops render the yarn more bulky or voluminous than the untreated component. An example of this system of bulking is illustrated in U.S. patent application Serial No. 564,681, filed February 10, 1956, now Patent No. 2,807,862, dated October 1, 1957, which is owned in common with the present application.

Yarn which is generally similar but which, however, has a less pronounced looped appearance is obtained if untwisted bundles of filaments are treated in the same manner as indicated above and twisted immediately thereafter. An example of this system of bulking is discussed in U.S. Patent No. 2,783,609, dated March 5, 1957.

Moreover, still another type of bulked yarn may be produced in the manner discussed in U.S. application Serial No. 649,719, filed April 1, 1957, which matured to Patent No. 2,959,909, on November 15, 1960, and which is owned in common with the present application. This bulked yarn differs in at least one respect over the type discussed above in that sinusoidal curls, as distinguished from loops, are produced in the individual filaments of the yarn treated.

Moreover, there are other types of voluminous yarns, such as, for example, abraded filament yarn, crimped yarn and spun yarn. The first-mentioned yarn is obtained by drawing filament yarn over an abrasive surface so that a number of filaments break. These broken filaments protruding outwardly render the yarn more bulky. Crimped yarn may be manufactured by leading thermoplastic filaments into the heated portion of a stuffer box with the aid of clamping rollers and against the action of mechanical pressure, then cooling the filaments in crimped condition and thereafter leading the same out of the box. Yarn which has been spun into continuous form from staple lengths is of course well known and will not be discussed further herein.

The uniformity in the arrangement of the loops, curls and/or broken filaments produced by the various processes discussed above is particularly important, since bulked yarn having portions thereof devoid of bulkiness (i.e. non-looped, non-curbed or without protruding ends) give rise to streakiness when woven into fabric.

A primary object of the present invention, therefore, is to provide an apparatus for examining the quality of voluminous yarn.

An additional object of this invention is to provide an apparatus for testing the uniformity of the bulkiness of a continuously moving voluminous yarn while at the same time registering interruptions in the bulkiness thereof.

A further object of this invention is to provide an apparatus for determining whether or not apparent interruptions in bulkiness are due to flattened bulked portions or

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to an actual non-bulked condition in the yarn being tested.

In accordance with one embodiment of the present invention, an image of a running length of bulked yarn is formed on a screen by the use of a suitable light source, which screen, at least to one side of the image, is provided with one or more apertures, one end of which coincides with the outer extremity of the image formed from the central portion or core of the yarn. Temporary interruptions in the normally occurring and continuously fluctuating light quantities transmitted through the apertures in the screen are recorded in order to indicate quality in the yarn tested.

The most simple manner in which an image of the traveling yarn may be produced is to pass the yarn alongside a source of light so that the silhouette formed thereby falls on the screen. This system operates very effectively for coarsely bulked yarn but the image thus formed is generally too obscure for use with finely bulked yarn. Consequently, it is preferred that known optical means be utilized to sharpen the image of the yarn formed on the screen.

Inasmuch as the yarn is fed continuously by the usual conveying means during examination thereof, it becomes apparent that the image formed on the screen is not stationary but also moves continuously. In this connection, care should be taken so that the image of the central portion or core of the yarn remains continuously on the closed portion of the screen. On the other hand, the image of the loops, curls and/or broken filaments protruding beyond the core should pass over the apertures provided in the screen, since the present invention is concerned with the testing of the uniformity of the bulk portion as distinguished from uniformity of core.

The image of the outwardly protruding yarn portions, however, is not constant with regard to its light intensity. If the optical image is formed by application of transmitted light, then dark portions of the image originating from the protruding yarn portions and light image portions originating from the spaces between said protruding yarn portions will continually move over the apertures in the screen. Thus, in the case of a regularly formed or uniformly bulked yarn a continuous fluctuation of the transmitted quantity of the light may be observed behind these apertures. However, as soon as portions of the yarn which are not bulked pass through the testing device, no image of protruding yarn portions is formed, that is to say, the normally occurring continuous variation in the transmitted quantities of light is temporarily discontinued. In this case, the transmitted quantity of light is constant and also at a maximum. If, however, the optical image is formed with the aid of light falling on the yarn, no light will pass through the apertures in the screen, in the absence of protruding yarn portions, which means that the area behind the screen remains dark for this period.

In both cases discussed above there is no fluctuation in light intensity behind the screen in the absence of bulked yarn; in other words, the quantity of transmitted light is constant, whether it be zero or at a maximum. These periods of constant light transmission which correspond in number and length to the non-bulked portions of the traveling yarn are registered in a manner to be more fully described hereinafter. The periods, therefore, provide a quality measure of the bulked yarn.

Although it is possible to test with a screen in which the apertures are provided on only one side of the area where an image of the yarn core is formed by the source of light, it is preferred according to this invention to utilize a screen having apertures on both or opposite sides of the core image. These apertures are separated by a closed area having at least the width of the yarn core image, whereupon only the image formed by the pro-

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truding or bulked portion of the yarn is passed through the screen. When utilizing apertures arranged in this manner, it can be seen that opposite peripheries or edges of the yarn are examined simultaneously.

In order to attain reliable observation values in the instant method of examination, it is of fundamental importance that the image of the yarn core never be allowed to pass over the apertures in the screen, which of course would influence the quantity of light passing there-through. It is necessary, therefore, that the traveling bulked yarn oscillate as little as possible in the test area. Such oscillation may be suppressed to a great extent by suitably supporting the yarn on opposite sides of the test area and, further, by the choice of a suitable tension. It should be noted, however, that the amount of tension which may be applied is limited; consequently, oscillation of the yarn cannot be entirely suppressed. Accordingly, in order to prevent the image of the yarn core from passing over the apertures, in the preferred embodiments of this invention, the apertures extend laterally of the direction of yarn travel and are separated by a closed area having a dimension between apertures approximately twice that of the yarn core image. On the other hand, the width of the closed area obviously must be less than that of the bulked portion image or the bulked portion could not be examined. This double width is sufficient to maintain the core image within the closed area between apertures notwithstanding unavoidable oscillation of the traveling yarn.

On examination or testing of bulked yarn in the manner described above, it has been found, occasionally, that yarn which had been indicated as being of inferior quality nevertheless, when woven, produced fabric which did not show undesirable streaks. Further examination of these samples showed that the bulked portion which initially protruded radially in all directions of the yarn core had become flattened, probably due to the winding of this yarn into package form. When the flattened portion passes through the test area it is of course possible that the plane of this portion sometimes will coincide with the plane through which the yarn travels and in which the image of the yarn core is situated, in which case the image of the bulked portion coincides with the image of the yarn core. Such a condition obviously is registered on the testing device as an absence of bulk although, actually, a bulked condition exists and no streaks are produced when the yarn is woven into fabric.

In order to overcome this apparently false examination and to determine whether a flattened bulked condition or an unbulkied condition actually exists, it is proposed, in a second embodiment of this invention, to provide an additional testing unit consisting of a second source of light and a second screen, which may be similar to the first, the additional unit being arranged in a plane perpendicular to that of the first unit, and to provide a suitable circuit whereupon the temporary interruptions in the normally occurring and continuously fluctuating light quantities transmitted through the apertures in the two screens may be registered together. Thus, if the yarn is bulked at all, an image thereof is always projected on at least one screen and generally on both screens, and whatever bulkiness is present will be recorded on a common registering apparatus. It is preferred that the two screens be formed in the same manner, but it is of course possible to construct one screen with apertures on both sides of the core image area and the other screen with apertures on only one side thereof.

For performing the foregoing test procedure, a device may be utilized which consists of one or more sources of light situated on one side of a yarn path or test area, suitable means for conveying yarn at a constant or substantially constant speed through this path, one or more screens located on the side of the yarn path opposite to a respective source of light, said screens being provided with apertures on at least one side of the area on which an image of the yarn core is formed by a source

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of light, a photo-receiver capable of converting light signals into electrical alternating voltages or alternating currents, preferably a photo-electric cell, arranged behind each screen and an apparatus common to all the photo-receivers for registering temporary interruptions in the voltage or current fluctuations generated thereby.

In this device, the mechanism for conveying the yarn with a constant velocity may comprise two rollers which are constantly rotated at the same speed. It is also possible, however, to withdraw yarn from a supply spool through a tensioning device by a winding or take-up spool driven at a constant peripheral speed, the tensioning device of course being positioned before the test area in order to reduce undesirable oscillations.

As mentioned hereinabove, screens having apertures on one or both sides of the core image may be used in the practice of this invention. In order to eliminate the effect of slight oscillation in the traveling yarn, however, it is preferred that screens having apertures on both sides of said area be utilized. When using apertures on only one side of the closed core image area of the screen, it can be seen that oscillation of the yarn results in movement of the bulked portion image to a greater or lesser extent over the apertures provided therefor, this producing fluctuations in the quantity of light transmitted there-through which is independent of the bulk form of the yarn. On the other hand, if apertures are provided on both sides of the closed core image area of the screen, a more complete covering of the aperture of one side, produced by oscillation in the yarn, occurs simultaneously with a reduction in the covering of the cooperating aperture on the opposite side of the closed area. Consequently, the quantity of light transmitted through any pair of cooperating apertures to a photo-receiver is independent of the yarn oscillation and remains constant.

Although, as previously mentioned, yarn silhouettes may serve for the examination according to this invention, it is preferred that an optical image of the yarn be cast upon the screen. This optical system may be arranged between the source of light and the screen in order to produce a sharp optical image of the traveling yarn on the screen and through the apertures.

The apparatus for registering temporary discontinuation in the voltage or current fluctuations generated by the photo-receiver may be comprised of various embodiments, the necessity for amplification of these fluctuations being dependent on the embodiment selected. It is preferred, however, that this registering apparatus comprise an amplifier system, a rectifier circuit with a time constant for rectifying the amplified voltage or current fluctuations and an apparatus for recording or counting the temporary variations in the rectified voltage or current.

On applying this apparatus for examining or testing bulked yarn, the voltage or current fluctuations generated by the photo-receiver are, of course, amplified by the amplifier system and fed to the rectifier circuit. The time constant of the rectifier circuit in this case, however, is chosen so as to correspond to the minimum magnitude or duration of the interruptions to be registered in the bulk form of the yarn which is being tested. This time constant usually is so chosen that interruptions amounting to 1 cm. or more are registered, which results, of course, in undetected passage through the testing device of interruptions of shorter duration. In the case of interruptions in the bulk form of 1 cm. or more, the voltage rectified by the rectifier circuit is modified to such an extent that the threshold value, or value required to energize the counting apparatus, is attained. On the other hand, due to the time constant of the rectifier circuit, this threshold value is not attained in the event of interruptions in the bulk form of less than 1 cm. duration.

Other objects and advantages of this invention will become apparent upon study of the following detailed description of preferred embodiments taken in conjunction with the accompanying drawings, in which

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FIGURE 1 is a perspective view, partly in section, illustrating one form of an apparatus useful for testing and registering non-uniform portions of continuously traveling bulked yarn;

FIGURE 2 illustrates a circuit diagram suitable for use with the apparatus shown in FIGURE 1;

FIGURE 3 is a perspective view, partly in section, illustrating a modification of the apparatus shown in FIGURE 1 suitable for testing the yarn in two separate planes;

FIGURE 4 illustrates the changes required to be made in the circuit of FIGURE 2 in order to utilize the multi-planer inspection device shown in FIGURE 3;

FIGURE 5 represents a modification of the circuit diagram shown in FIGURE 2, illustrating a plurality of rectifier circuits having different time constants, with appropriate counting stages for each rectifier circuit; and

FIGURE 6 represents still another modification of the circuit diagram shown in FIGURE 2, and illustrates a plurality of rectifier circuits having different time constants, with appropriate counting stages for each rectifier circuit, as well as potentiometer circuits for providing the various counters with different threshold values.

Like parts in the various embodiments are identified with like reference numerals.

With attention directed to FIGURES 1 and 2 of the drawing, the first embodiment of this invention will now be explained in more detail. Bulkied yarn indicated by reference numeral 10 is fed at a constant speed from a supply source to a winding machine, in the direction of the arrow, by conventional means, none of which has been shown as the same is not necessary to an understanding of the present invention. Two pairs of guide rods 11, 12, respectively, define the test area or yarn path and prevent excessive oscillation of the bulkied yarn passing there-through. On one side of the test area, and approximately midway between guide rods 11, 12, a small electric light source 13 is supported by suitable means (not shown). This light serves as a means for illuminating a portion of the yarn traveling in the test area and as a means for triggering the photo-receiver unit, to be described hereinbelow. An optical system or lens 14 is located on the side of the yarn path opposite from the light source and serves as a means for focusing or sharpening the yarn image cast by the light. A screen 15 is located in alignment with the light source, yarn path and optical system and therefore receives the image formed by these elements.

A pair of elongated apertures 16, 16 are suitably formed in the screen 15 and are arranged with the longitudinal axes thereof perpendicular to and equi-distantly spaced on either side of the yarn path, which path is represented on screen 15 by line 17. These apertures are spaced longitudinally one from the other a distance which is approximately twice the width of the image formed by the central portion of the yarn, or yarn core. This closed area between apertures 16, 16 is situated where said yarn core image is projected on the screen, as represented by reference numeral 18 in FIGURE 1. The images caused by the bulkied portion of the yarn being tested are represented by reference numeral 20 in this figure, and of course extend outwardly from the closed area 18 a considerable distance, as shown.

A photo-receiver in the form of a photo-electric cell 21, for example, is located behind screen 15 and receives the light transmitted through the apertures 16, 16 from light source 13. This cell 21 is adapted to convert variations in the quantity of light received from the source into electrical voltage or current fluctuations. If, however, the photo-electric cell is illuminated with a constant intensity, no alternating voltages or currents are generated thereby. With the assistance of registering device generally illustrated by reference numeral 22, the periods in which no or an insufficient amount of current or voltage is generated are recorded. As will be shown hereinbelow, these periods correspond with the passage of non-bulked portions of yarn through the test area.

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The circuit diagram for the above-described apparatus will next be discussed with attention directed particularly to FIGURE 2. The broken line framed portion 23 represents the photo-receiver unit, and the three remaining broken line framed portions, which together constitute the registering device 22, represent an amplifier system 24, a rectifier circuit 25 and a counting stage 26, respectively.

The photo-receiver unit 23 comprises the aforementioned photo-electric cell 21 which is supplied in known manner by a source of current (not shown), and a resistor 27 of 2.2 meg-ohms resistance which is provided between the cathode of said cell 21 and ground. The output side of cell 21 is electrically connected through condenser 28, having a capacity of 100 micro-micro farad, to amplifier system 24, which intensifies the alternating voltages generated by photo cell 21 by a factor of 20,000. The amplifier system 24 comprises five electrical valves or tubes 30, 31, 32, 33 and 34, each of which has a filament supplied with current in a known manner not here illustrated.

The first valve or tube 30 is a triode of the type ECC81 having the control grid thereof connected to the output or cathode of cell 21, as shown in the drawings. Further, this grid is grounded through two resistors 35, 36 of 2.2 meg-ohms and 10 kilo-ohms, respectively. The anode or plate of the tube 30 is connected to a source of current (not shown) having a potential of 120 volts. The cathode is connected to ground through resistor 37 of 1 kilo-ohm and aforesaid resistor 36.

The second amplifier stage comprises the tube 31 which also is a triode of the type ECC81. The control grid of this tube is connected through condenser 38 of 100 micro-micro farad capacitance to a junction point or terminal between resistors 36 and 37 and, additionally, is grounded through resistor 40 of 0.82 meg-ohms. The cathode of tube 31 is grounded through resistor 41 of 1 kilo-ohm, and the plate is connected, first, to a 120 volt source (not shown) through resistor 42 of 100 kilo-ohm and, additionally, is connected to the control grid of tube 32 of the third amplifier stage through condenser 43 of 100 micro-micro farad capacitance.

The third amplifier stage comprises tube 32 which is a pentode of the type EF86. The control grid of this tube is grounded through a resistor 44 of 0.82 meg-ohm and the cathode of this tube is, in addition to being connected to the suppressor grid thereof, connected through resistor 45 of 2.2 kilo-ohm to ground. A condenser 46 of 0.1 micro-farad capacity is connected in parallel with the resistor 45. The screen grid of tube 32 is grounded through condenser 47 of 0.5 micro-farad capacity and, further, is connected to the 120 volt potential, common also to tubes 30 and 31, through 0.82 meg-ohm resistor 48. The plate of tube 32 is connected to said 120 volt potential through 0.2 meg-ohm resistor 50 and is grounded through 1000 micro-micro farad condenser 51 and through potentiometer 52 of 1.5 meg-ohm resistance. The sliding connection of potentiometer 52 leads to the control grid of tube 33.

The tube 33, which represents the fourth stage of amplification, is a triode also of the type ECC81 having the cathode thereof grounded through 1 kilo-ohm resistor 53. The plate of this tube is connected to a 250 volt potential through 100 kilo-ohm resistor 54 and to the control grid of tube 34, which also is of the type ECC81, through condenser 55 of 0.01 micro-farad capacitance. The cathode of tube 34 is grounded through resistor 56 of 2.2 kilo-ohm resistance and a 10 kilo-ohm resistor 57 mounted in series therewith. The control grid of this tube is connected through a 1 meg-ohm resistor 58 to the junction point of resistors 56, 57 and the plate is maintained at 250 volts, as stated above. The junction point between resistors 56 and 57 leads, through 0.5 micro-farad condenser 60, to the rectifier stage indicated at 25. The above-described amplifier system 24 has an input impedance of approximately 10 meg-ohms, an output im-

pedance of about 10 kilo-ohms and, as previously stated, an amplification factor of approximately 20,000, whereas the frequency response characteristic is adapted to the frequencies of the voltages which are provided by the photo-receiver unit 23.

The rectifier circuit 25 comprises a germanium diode tube 61 of the type 0.A.85. The cathode thereof is connected to the output of amplifier 24 and the plate is connected to the control grid of the counting stage tube 62, which is a tetrode of the type PL2D21, through 220 kilo-ohm resistor 63. The cathode of germanium diode tube 61 is also connected to the sliding contact of potentiometer 64, which has 1 kilo-ohm resistance, through 200 kilo-ohm resistor 65. Moreover, the plate of this tube also is connected to the sliding contact of said potentiometer through 220 kilo-ohm resistor 66. Similarly, the control grid of tetrode 62 is connected to said sliding contact through 15,000 micro-micro farad condenser 67, the screen grid of said tube being directly connected to the control grid thereof.

One side of potentiometer 64 is grounded and the other side is connected to a negative potential of about 5 volts. The cathode of the tube 62 is grounded, whereas the plate is connected to a potential of about 200 volts through a counter 68 and a 400 kilo-ohm resistor 70. The terminal between counter 68 and resistor 70 is grounded through condenser 71 of 1 micro-farad capacitance.

In the operation of the above-described embodiment, bulked yarn is fed at a constant rate of speed, preferably 120 meters per minute, in such a manner as to intercept the beam of light between source 13 and optical system 14. As stated above, the yarn core image falls on the closed area 18 between apertures 16, 16 of screen 15 and the image of the bulked portion travels across these apertures. As a result of the form of the loops, curls, etc., the quantity of light passing through the apertures continuously fluctuates. The photo-receiver 21 converts these fluctuations into an electric alternating voltage which is amplified about 20,000 fold by the amplifier system 24 and thereafter supplied to the rectifier circuit 25. In this last circuit, the passage for the positive side of the alternating voltage is blocked, whereas the negative side is allowed to pass through and, also, is smoothed. The degree of smoothing is determined by the time constants of the filter elements. Said time constants are determined by the values of resistor 63 and condenser 67, as well as by the value of condenser 67 and the sum of resistance of the resistors 63 and 66.

The negative and smoothed voltage on the condenser 67 is added to the negative voltage originating from the potentiometer 64. The total of these voltages is supplied to the tube 62 as a bias and suffices to prevent plate current from flowing therethrough. If, however, during a certain time T a non-bulked or very slightly bulked portion of yarn passes through the test area, the photo-receiver 21 supplies no, or substantially no, alternating voltage. The negative voltage on the condenser 67 in said time T is therefore decreased to such an extent that the above-mentioned total voltage is insufficient to prevent flow of the plate current. The tube 62 thereafter is ignited or rendered conducting and the counter 68 is energized. Thus, the time constants of the circuit in which the condenser 67 and the resistors 63 and 66 are provided should be adapted to the minimum length or duration of the non-bulked portion of yarn which is to be detected. The velocity of the traveling yarn also must be considered in this respect.

Plate current will flow through the tube 62 as long as the condenser 71 retains a voltage which is higher than the arc voltage of the tube. Thereafter, the passage of current will cease and the condenser 71 will again be charged through the resistor 70. Consequently, the counter is again readied for the testing and recording of subsequent non-bulked portions. The time constant of

the circuit in which the resistor 70 and the condenser 71 are provided must exceed the time constants of the rectifier circuit if it is desired to count a non-bulked portion of yarn only once. This sets a limit to the resolving power of the testing device, which power may be defined as the capability of counting separately two non-bulked portions of yarn at some distance from each other.

It is pointed out that should it be found desirable to utilize other and/or different type electron tubes, the values given above for resistance and capacitance obviously should be changed accordingly.

With attention now directed to FIGURES 3 and 4 of the drawing, the second embodiment of this invention will be explained. As mentioned earlier in this specification, it sometimes becomes necessary to test or examine the yarn from two or more different planes in order to determine more clearly whether an actual non-bulked condition exists or whether the bulked portion has merely become flattened. The apparatus shown in these figures, wherein those parts corresponding to the apparatus of FIGURES 1 and 2 have been identified by like reference numerals, illustrates one system which functions to overcome such apparently false testing of the yarn.

The testing apparatus represented by light source 13, optical system 14, screen 15, photo-receiver unit or photo-electric cell 21 and the registering device 22, which tests for bulkiness in what may be termed a generally vertical plane, is supplemented by a second unit which tests for bulkiness in a second plane, which plane as shown, may be disposed approximately normal to the aforesaid vertical plane, or generally horizontal, but at approximately the same point longitudinally of the yarn being tested. The second testing unit may consist of a second light source 72 disposed, in this instance, below the yarn path, a second optical system 73, disposed above the yarn path or on the side thereof opposite the light source, a second image-receiving screen 74, having apertures therein comparable to those of screen 15, and a second photo-electric cell 75, all of which may be similar to comparable elements of the first test unit. The first and second testing units therefore operate to perform identical functions, but in different planes. Inasmuch, however, as registration of a non-bulked portion of yarn by one of these units is not a true indication of the quality of yarn unless the other unit registers likewise, it becomes apparent that the two units should feed fluctuations in current or voltage to the same registering device 22.

Accordingly, the second photo-electric cell 75 is connected to the first stage 30 of amplifier system 24 through condenser 76 in the same manner as the photo-electric cell 21 of the first test unit, as illustrated in FIGURE 4. The cell 75 is grounded through resistor 77 in the same manner as that of cell 21 and is connected to a source of current in known manner, not shown. In view of the manner in which the cells 21 and 75 are connected, the circuits having been suitably modified in order to render the same compatible, it will be seen that both supply current or voltage fluctuations to the same amplifier system, rectifier circuit and counting stage. Consequently, actuation of either of these cells as the result of bulky yarn protruding from the yarn core will prevent recording of a non-bulked portion of yarn on the counter 68.

While specific illustrations have been given above, it is obvious that many modifications fall within the scope of this invention. For example, the apertures in the screens may vary not only in shape, but also in number. They may be circular, oblong or square. In the case of circular apertures, a number may be provided which vary in diameter according either to a straight line or curved line progression. Preferably, however, elongated or slit-shaped apertures such as shown in the drawings are used, these apertures extending with the longitudinal axes thereof transverse to the direction of yarn travel and in alignment one with the other.

Moreover, in order to receive an even clear insight into

the characteristics of the non-bulked portions of yarn, a registering device having an amplifier and a plurality of rectifier circuits following one another in parallel and having different time constants and counters connected thereto, may be utilized. For such an arrangement, attention is directed to FIGURE 5, wherein three different rectifier circuits, indicated generally at 25a, are connected in parallel between the amplifier system 24 and counters 26a, 26b, 26c, one for each rectifier circuit. The diode tubes 61a, 61b, 61c correspond in function to the diode 61 shown in FIGURE 2, while the resistors 63a, 63b, 63c, 66a, 66b, 66c, and condensers 67a, 67b, 67c, correspond to resistors 63, 66 and condenser 67, respectively, in FIGURE 2. The value of components in the rectifier circuits 61, 63, 66, 67 (a, b and c) are so chosen that each has a different time constant.

The various time constants of the rectifier circuits, in this case, may be chosen in such a manner that one counter 26a records interruptions in the bulk form of more than 1 cm. duration while a second counter 26b records interruptions of 1.5 cm. and longer, with, if desired, a third counter 26c recording interruptions of more than 2 cm. duration, etc. From the values indicated by these various counters, the interruptions of from 1 to 1.5 cm., from 1.5 to 2 cm., and so forth, may be easily calculated.

Additionally, a number of secondary counters having different threshold value may be connected in parallel across each of the above-mentioned or primary counters, as shown in FIGURE 6. It is possible, with an apparatus of this type, to determine not only incremental differences in the duration of interruptions but also different sizes of the loops, curls, etc. being tested. These changes may, of course, be incorporated in the testing apparatus irrespective of whether one or more test units be used.

In FIGURE 6, the rectifier system 25b comprises three rectifier circuits 61, 63, 66, 67 (a, b and c) which are similar in arrangement and functions to corresponding parts shown in FIGURE 5. In the device of FIGURE 6, however, the counters have different threshold values and therefore are energized upon different quantities of light fluctuations. Counters 26a, 26a' and 26a'' are connected in parallel with and record fluctuations passing through corresponding rectifier circuits 61a, 63a, 66a and 67a. Moreover, counters 26b, 26b' and 26b'' and counters 26c, 26c' and 26c'' are electrically connected to rectifier circuits 61b, 63b, 66b, 67b and 61c, 63c, 66c, 67c, respectively.

The different threshold values for these counters are obtained through the use of potentiometer circuits, each consisting of a resistor and rheostat electrically connected to a direct voltage source, and each inserted between a rectifier circuit and a corresponding counting stage. Resistor 78a and rheostat 79a control the threshold value of counter 26a, while the other resistors and rheostats, indicated by suffixes a, b or c, with appropriate primes and double primes, control the threshold values of corresponding counters, also indicated by suffixes a, b or c, with appropriate primes and double primes.

Inasmuch as other modifications will become apparent

to those skilled in the art, it is intended that the scope of the present invention be limited only to the extent set forth in the following claims.

What is claimed is:

1. An apparatus for testing yarn having a core portion and a bulked portion comprising a test area through which yarn is conveyed at a substantially constant speed, at least one test unit including a source of light disposed on one side of said test area for illuminating the yarn being tested, a screen disposed adjacent to the test area for receiving an image of the yarn cast by said source of light, said screen having a pair of apertures through which the image cast by said yarn bulked portion may be transmitted, said apertures being spaced apart about twice the diameter of the image of said yarn core portion but less than the diameter of the image of said bulked portion to define therebetween a closed area in alignment with and for receiving the image cast by said yarn core portion, a photo-receiver unit mounted behind said screen in alignment with said apertures for converting light signals transmitted therethrough into electrical voltages, an amplifier system electrically connected to said photo-receiver unit, a plurality of rectifier circuits electrically connected in parallel to receive the output of said amplifier system, each rectifier having a time constant different from that of the others, a plurality of counters electrically connected in parallel to each rectifier circuit whereby incremental differences in the duration of interruptions generated by said photo cells may be recorded, each of said counters having a threshold value different from other counters in the same circuit, and means for guiding yarn alongside and substantially centrally between the apertures in said screen, whereby the effect of yarn oscillation during testing will be neutralized.
2. An apparatus for testing yarn as set forth in claim 1 wherein first and second test units are provided for testing the same section of traveling yarn, wherein said second unit operates in a plane approximately perpendicular to the plane of operation of said first unit to eliminate error which might arise due to yarn flatness, and wherein said amplifier is electrically connected to both said first and second test units.

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