Jan. 24, 1961 E. M. ALLEN 2,968,856

METHOD FOR CONTINUOUSLY STRAIGHTENING SHEET MATERIAL

Filed March 8, 1957 2 Sheets-Sheet 1

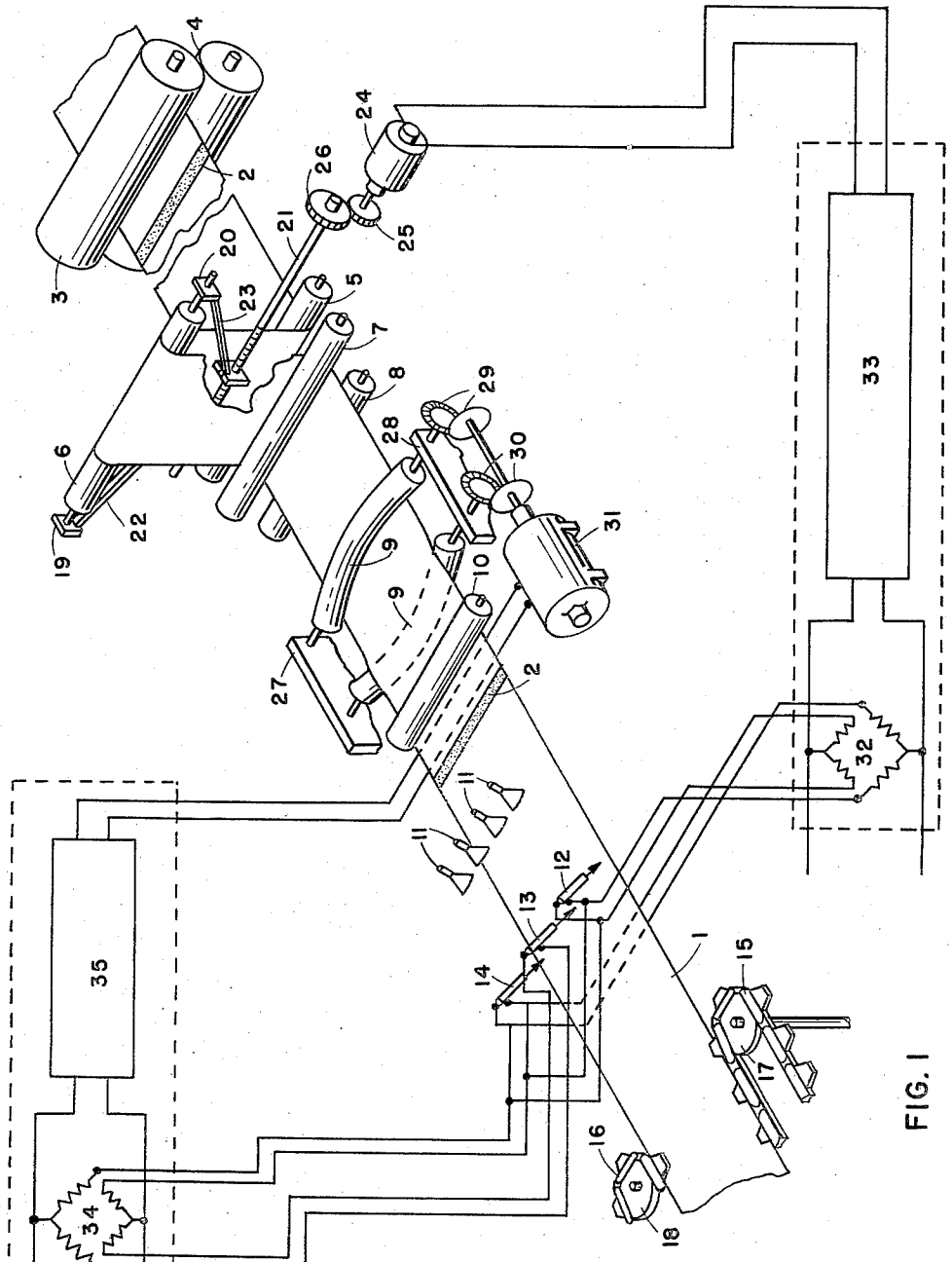


FIG. 1

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2 Sheets-Sheet 2

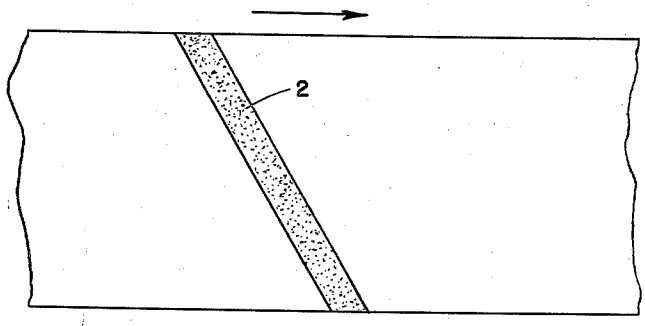


FIG. 2

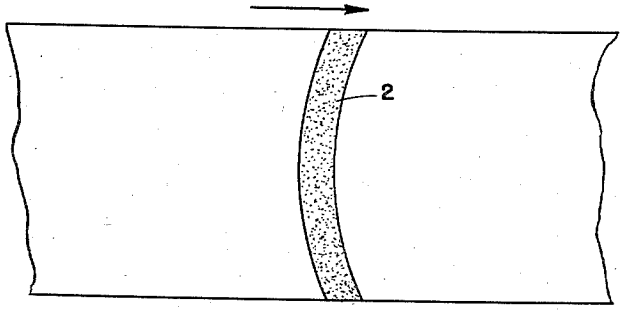


FIG. 3

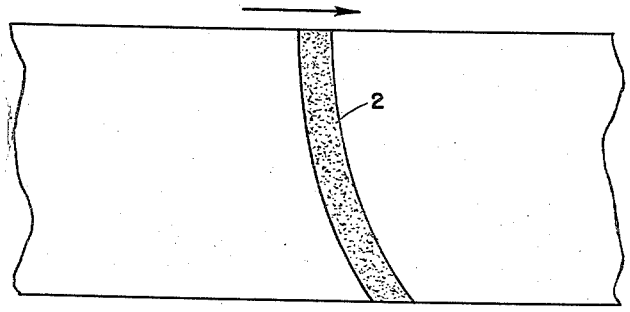


FIG. 4

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2,968,856

METHOD FOR CONTINUOUSLY STRAIGHTENING SHEET MATERIAL

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Filed Mar. 8, 1957, Ser. No. 644,886

3 Claims. (Cl. 26—51.5)

This invention relates to an improved automatic weft straightener and method.

The problem of apparatus for straightening the weft of woven fabrics in order to insure that the weft yarns be disposed in right angular relation to the warp yarns and to insure that they shall be straight from one selvedge to the other of the fabric has been a serious one. Two types of weft yarn misalignment are present. In the one case the weft yarns, while parallel to each other in straight lines, are not at right angles to the warp yarns. The second case is that the weft yarns, while generally at right angles to the warp yarns, are not parallel but are bowed in one or the other direction. Of course, both types of misalignment may occur at the same time; that is to say, where the weft yarns are not at right angles to the selvedges and are also not parallel to each other but curved.

The problem for certain classes of fabrics has been solved completely and satisfactorily by the device and method described and claimed in the Patent No. 2,638,656, May 29, 1953, to Tuttle, MacIsaac and Sturtevant. It is with an improvement to the method and apparatus of the said patent that the present invention deals. Essentially, the patent provides for weaving a narrow band of weft threads at periodic intervals which are treated with a fluorescent or phosphorescent pigment. As the fabric passes through the machine, it passes under a row of ultraviolet lights which illuminate a band across the fabric and at right angles to the selvedges. A series of photocells or other photoelectric devices are disposed so that they receive visible, but not ultraviolet, light from the illuminated band of fabric. When the band of weft threads treated with the colorless fluorescent or phosphorescent material is illuminated by the ultraviolet lights, it fluoresces; and the fluorescent light, which is in the visible spectrum, is received by the photocells. If the weft threads are at right angles to the selvedges and are parallel, all photocells receive visible light at the same time and there is no differential signal in the amplifier circuits fed by the electrical signals from the photocells. If the weft threads are parallel to each other but are not at right angles to the selvedges, the band is effectively a diagonal and it comes into the illumination of the ultraviolet lights at different times, one edge being illuminated before the other. This produces a differential signal between the outer photocells and, after amplification, this controls motors which vary the rate at which the fabric edges are pulled, the variation, of course, being in the direction to restore parallelism of the weft threads and a right angled orientation with respect to the selvedges. In the case of a curved or bowed band, either the central photocells are first illuminated or the outside ones are first illuminated. In

either event, a differential is set up between the signals from the outside photocells and from the central photocells which again, after amplification, controls a motor which rotates certain bowed rollers which have the effect of straightening out the weft threads by pulling the central portion of the fabric either faster or slower than the edges, as the case may be. If both types of distortion of the weft threads occur at the same time, then there will be a differential signal of both types and both correcting motors will be actuated in the proper direction.

Despite the complete and elegant solution of the weft straightening problem with most fabrics which is effected by the method and apparatus of the above-referred-to patent, problems have arisen recently, and there is a growing demand for fabrics which cannot be straightened by the patented method. The problem is posed by the desirability for certain uses of dyeing the whole fabric with colorless fluorescent dyes or brighteners and is even a problem in the case of dyed material where one or other of the dyes, though colored, is also fluorescent. Whenever there is material normally in the fabric, either colored or colorless, which fluoresces, the method of the above-referred-to Tuttle et al. patent cannot be used; yet with such fabrics, the problem of weft straightening is just as serious as with ordinary fabrics which are not dyed with fluorescent materials. It is with the solution of this problem that the present invention deals, and it is a further advantage of the present invention that it is equally applicable to fabrics, whether or not they have an overall dyeing of fluorescent material.

The present invention does not use a narrow dyed band of fluorescent material, but, on the contrary, uses phosphorescent material and displaces the band illuminated by the ultraviolet light and the band seen by the photocells a few inches so that no fluorescent light strikes the photocells. An extremely sharp separation is perfectly achieved because the fluorescent substances which are normally applied to fabrics have an extraordinarily rapid decay of emitted fluorescent light after the ultraviolet illumination ceases. With almost all fluorescent material half lives are obtained which are of the order of microseconds or less. Phosphorescence, however, does not decay at anywhere near so rapid a rate and there are many phosphors which have relatively long half lives. However, it is not necessary that a phosphor phosphoresce for many seconds. It is sufficient if there is substantial phosphorescent light emitted after a second or two or even a major fraction of a second. The fabric passes through the straightening machine quite rapidly at a rate of a good many inches a second. Thus, even with phosphorescent material of fairly short half life, there is still adequate phosphorescent light emitted when the band of ultraviolet illumination and the band of fabric seen by the photocells is displaced by three or four inches so that no critical control is involved.

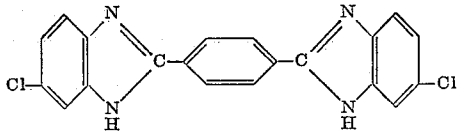
When the present invention is used in which the weft straightening is controlled not by any light which is reemitted at the time of ultraviolet irradiation but by phosphorescent light which is continued for a considerable period after illumination has ceased, the machine can be used interchangeably with fabrics which have no fluorescent overall dyeing or pattern and those which have been dyed with a brightener or other fluorescent material. No change of adjustment in the machine is needed and, therefore, the method and apparatus is of more general applicability.

With most practical phosphorescent materials, and rel-

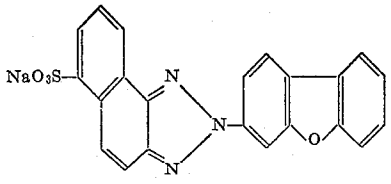
atively there are very few of them which can be practically applied to fabrics, the intensity of phosphorescence is not as high as the intensity of fluorescence. As a result it is desirable to use somewhat more sensitive photoelectric radiation detectors, for example photomultiplier tubes which may however be operated at very moderate voltages with greater reliability than for extremely high voltage power supplies. About the only other requirement of the present invention which is not met in the original Tuttle method and apparatus and which is critically dimensioned is that the field of view of the photocells must be rather sharply adjusted and so care must be taken that their orientation is maintained throughout the operation of the machine.

Among the phosphorescent chemicals which can be practically dyed on the weft threads are the following.

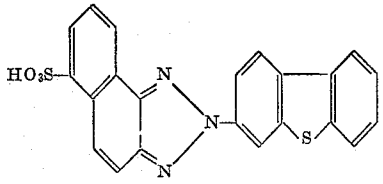
2,2'--phenylene-bis-[5(6)-chlorobenzimidazole]



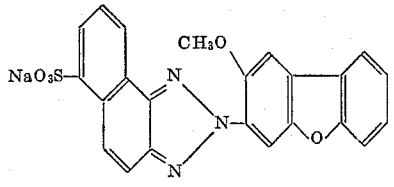
2-(3-dibenzofuryl)-2-naphtho(1,2)triazole-6-sulfonic acid sodium salt



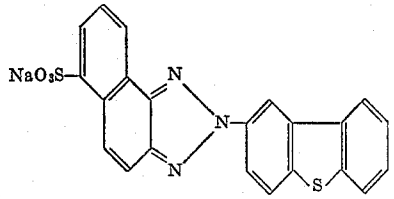
2-(3-dibenzothienyl)-2-naphtho[1,2]triazole - 6 - sulfonic acid



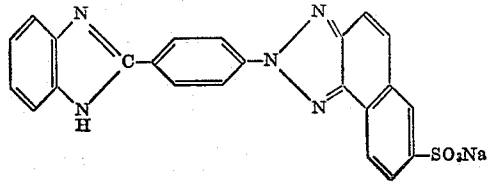
Sodium-2-(2-methoxy-3-dibenzofuryl)-naphtho(1,2)-triazole-6-sulfonate



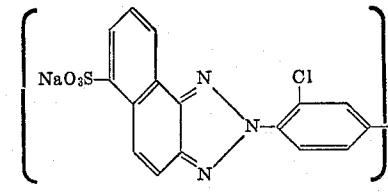
Sodium 2-(2-dibenzothienyl) - 2 - naphtho(1,2)triazole-6-sulfonate



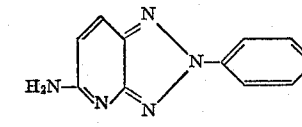
2-(p-[2-benzimidazolyl]phenyl)-2-naphthol(1,2)triazole-6-sulfonic acid sodium salt



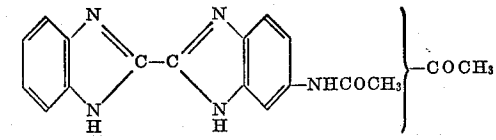
2,2'-(4,4'-[3,3'-dichlorodiphenylene])bis-2-naphtho(1,2)-triazole-6-sulfonic acid disodium salt



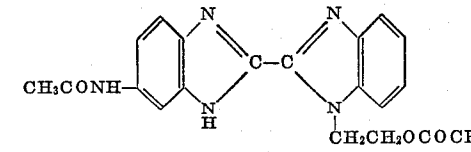
5-amino-2-phenyl-2-pyrido[2,3-d]-v-triazole



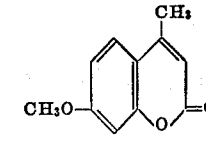
5(6)-acetamido-x-acetyl-2,2'-dibenzimidazole



5'(6')-acetamido-2,2'-dibenzimidazole - 1 - ethanol acetic ester



7-methoxy-4-methyl coumarin



While the invention is in no sense limited to the phosphorescent materials enumerated above, these constitute the preferred materials. It is possible to apply inorganic phosphors but in general their application to weft threads is more difficult than with the brighteners which have chemical affinity for the weft yarns. However, with certain synthetic materials in which the phosphorescent material has to be applied with the aid of film-forming material, other types of phosphors such as inorganic phosphors are equally suitable.

The invention will be described in greater detail in conjunction with the drawings in which:

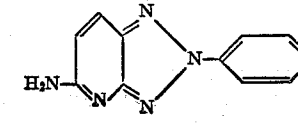
Fig. 1 is a perspective of a weft straightening machine;

Fig. 2 is a plan view of a portion of the fabric with weft threads not at right angles to the selvedges;

Fig. 3 is a similar plan view with weft threads bowed; and,

Fig. 4 is a similar plan view in which the weft threads are both bowed and not at right angles to the selvedges.

Fig. 1 is substantially the same as the first figure of the Tuttle patent referred to above except for the orientation of ultraviolet illuminants and photoelectric detectors. Also the electrical circuits of the amplifiers are shown purely as a block diagram since the same circuits used in the Tuttle patent are equally applicable here. A length of fabric **1** having spaced bands **2** of weft threads dyed with the phosphorescent compound



passes between a pair of rolls 3 and 4 under an idler roll 5 to a canting roll 6 and then down under a second idler roll 7. The band then passes over an idler roll 8 and then between a pair of bow straightening rolls 9, 9, under another idler roll 10 and finally under a row of ultraviolet lights 11 which illuminate a narrow band across the moving material some three or four inches from the band seen by the three photocells 12, 13 and 14, finally passing to a tenter having endless chains 15 and 16 driven by the pulleys 17 and 18.

The canting roll 6 is journalled for rotation in suitable bearing blocks 19 and 20 which are connected to a screw shaft 21 through links 22 and 23. The screw 21 is driven by the motor 24 through gears 25 and 26. If the web of fabric is skewed, the skew can be corrected by rotation of the motor 24 in the proper direction which elevates one end of the canting roll 6 and lowers the opposite end.

The skew corrector cannot correct a bowing of the band and this is effected by the bowing correcting rolls 9, 9 which are journalled in blocks 27 and 28, the shafts of the two rolls being respectively driven through bevelled gearing 29 and 30 by the reversible bow correcting motor 31. The rotation of the bowed correcting rolls 9 and 9 can correct any bowing which is present in the web passing under and over. The operation of bow correcting rolls is conventional in the art and is described in U.S. Patent 2,492,737 of December 27, 1949.

The outside photoelectric detectors 12 and 14 are connected into the differential signal input bridge 32 of the amplifier 33 which drives the motor 24 on response to a differential signal. Similarly there is a connection from the outer photoelectric detectors 12 and 14 and the center photoelectric detector 13 to a differential bridge input 34 which feeds an amplifier 35 which drives the motor 31. As has been pointed out above, the differential signal inputs 32 and 34 are of conventional design as shown in the Tuttle patent and so are the amplifiers. Their design is not affected by the present invention except insofar, of course, that the electrical components of the differential inputs must match the photoelectric detectors used. Thus, for example, a photomultiplier tube generates a signal of considerably higher impedance than does an ordinary photocell of the barrier-layer type and the electrical circuit in the differential input must of course have suitable impedance and other characteristics to match the signal which it receives.

In Fig. 1 the web of fabric is shown with bands 2 parallel and at right angles to the selvedges. In other words, it shows a web with straight wefts. When the band 2 passes through the zone of illumination of the ultraviolet lamps 11 and then passes under the band scanned by the photoelectric detectors 12, 13 and 14, all three photoelectric detectors are actuated at the same time. There will therefore be no differential signal either in the input 32 or the input 34 and, hence, neither motor 24 nor 31 will rotate, which is of course as it should be since the photoelectric detectors show that the web is straight as far as the weft threads are concerned. If, however, a web with the bands 2 shown in Fig. 2 passes through the machine, photoelectric detector 14 will receive phosphorescent light before detector 12. There will however be no difference between the combined detectors and detector 13. Therefore, a differential signal will be generated in 32 which causes the motor 24 to turn in a direction to correct the skew present. The length of time during which the motor 24 turns is, of course, proportional to the amount of skew because the turn will not stop until photoelectric detector 12 is illuminated. The correction for skew will cause the next illuminated band 2 to be straight and so there will be no further signal in 32 and no rotation of the motor 24 until the web again becomes skewed.

If the web is bowed, as shown in Fig. 3, the outer detectors 12 and 14 will be illuminated at a time when there is no illumination on the central detector 13. This will cause no differential signal in 32 but will cause a differential signal in 34. As a result this is amplified in 35 and the motor 31 turns in a direction to eliminate the bowing.

If the web is both bowed and skewed, as is shown in Fig. 4, then when the band 2 passes under the photocells there will be produced a differential signal both in 32 by reason of the skew and in 34 by reason of the bow, and so both motors 24 and 31 will turn in the proper direction to straighten out the web again.

The bands shown in the web described above are of phosphorescent material. If the remainder of the web is coated with fluorescent material, it will be apparent that this will in no way affect the operation of the machine because the portion of the web illuminated by the ultraviolet light is removed from the portion seen by the photoelectric detectors by a distance corresponding to a second or two in time. The particular phosphorescent compound described has a substantial fraction of a second. This is so enormously long compared to the fraction of a microsecond, which is the half-life of the ordinary fluorescent material, that the photoelectric detectors are responding only to phosphorescent radiation and they are not affected by the fluorescent light from the web as a whole, for this has completely died out before it is brought within the field of view of the photoelectric detectors.

It has been pointed out above that the exact method of applying the phosphorescent material to the bands of weft threads is not important so long as the band is of suitable width. When dealing with the compound described, which is substantive for cellulosic fabrics, if the web is a cellulosic fabric the outside of the weft bobbin can be very quickly dyed with the phosphorescent compound so that penetration is only slight and only the outer layer of the bobbin is dyed. When the loom is operated which weaves the web, this short length of dyed weft yarn will produce a relatively narrow band. Where phosphorescent materials are used which are not substantive to the fabric of the web, it becomes necessary to apply them in the form of a band by other means, such as printing and the like. The present invention is of course not concerned with the particular suitable and conventional means of applying the phosphorescent material to the weft threads.

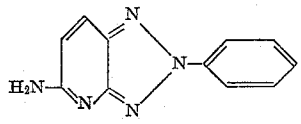
I claim:

1. In a method of controlling electrically-operable mechanical means for maintaining the contour of a moving length of web material wherein a plurality of photoelectric detectors are associated with said electrically-operable mechanical means and are adapted to view only a transverse band of said web, the differential output of different photoelectric detectors controlling said electrically-operable mechanical means; the improved method permitting operation when said web carries fluorescent material, said improvement comprising: applying phosphorescent material, other than any luminescent material normally carried by said web, in spaced transverse stripes on said web; illuminating with ultraviolet light substantially only a transverse zone across said web; placing said photoelectric detectors to receive light emitted from any one transverse band containing said phosphorescent material only after said web has been moved through and a predetermined distance beyond said illuminated zone, said predetermined distance being sufficient so that the detectors receive a substantial portion of phosphorescent light emitted from said one transverse stripe which has been but no longer is being illuminated by said ultraviolet light, whereby said photoelectric detectors receive substantially no fluorescent light emitted by said transverse stripe.

2. A method according to claim 1 in which the phos-

phorescent material is substantive to weft threads of a woven web and periodic lengths of weft thread are dyed with said phosphorescent material before weaving.

3. A method according to claim 2 in which the phosphorescent material is 5-amino-2-phenyl-2-pyrido-[2,3-d]-v-triazole having the formula:



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