

(19)



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11) Publication number:

0 611 842 A1

(12)

EUROPEAN PATENT APPLICATION(21) Application number: **94102098.4**(51) Int. Cl.⁵: **D05B 59/02, B65H 63/08**(22) Date of filing: **11.02.94**

(30) Priority: **15.02.93 JP 25501/93**
26.10.93 JP 267507/93

(43) Date of publication of application:
24.08.94 Bulletin 94/34

(84) Designated Contracting States:
DE IT

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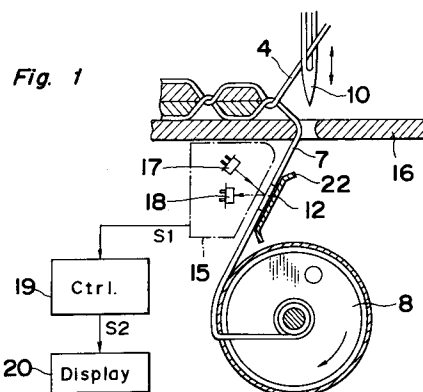
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(54) **Sewing machine with photoelectric detector.**

(57) An elongated element or sewing thread (7) has a portion thereof formed with at least one fluorescent latent marking (12) containing a fluorescent substance. Passage of the fluorescent latent marking past a detecting position is detected by a non-contact photoelectric detecting system (15). The photoelectric detecting system (15) includes a light emitting element (17) for emitting a beam of light towards the elongated element (7), and a light detecting element (18) for sensing light emitted from that portion of the elongated element or sewing thread upon excitation of the fluorescent substance by radiations from the light emitting element. The non-contact photoelectric detecting system (15) is so designed that, upon receipt of the light emitted from that portion of the elongated element or sewing thread, the light detecting element may issue a signal (S₁) indicative of the passage of that portion of elongated element past the detecting position at which the radiations from the light emitting element reach. The signal (S₁) outputted from the light de-

tecting element (18) and, hence, the photoelectric detecting system (15) may be utilized as representing a condition of the elongated element or sewing thread (7), for example, the amount of the elongated element or sewing thread left on a bobbin or reel (8), or an approach of exhaustion of the thread element or sewing thread from the bobbin or reel.

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BACKGROUND OF THE INVENTION

(Field of the Invention)

The present invention relates to a detecting mechanism in the sewing machine which detecting the presence or absence of a thread wound around a under thread bobbin, and is applicable in both industrial and home sewing machines.

(Description of the Prior Art)

As is well known to those skilled in the art, when for example, bobbin thread wound around a bobbin accommodated beneath the needle plate has been completely exhausted, the empty bobbin must either receive a supply of bobbin thread wound again around the empty bobbin or it must be replaced with another bobbin around which thread has been wound beforehand. It has been a long established practice either to remove the empty bobbin from the sewing machine so that the empty bobbin can be wound with bobbin thread by the use of a bobbin winding device, or to prepare a number of bobbins in anticipation of the replacement.

In the case of the conventional industrial sewing machine, due to mechanical limitations the length of the bobbin thread wound around the bobbin is relatively short, say, about 200 meters whereas that of the upper or needle thread runs about 5,000 meters. For this reason, a frequent replacement of the empty bobbin with another bobbin is required before the upper or needle thread is exhausted. Not only is this cumbersome, but also the sewing efficiency tends to be decrease.

No means for detecting the time elapsed until the bobbin may be emptied, that is, the point at which the bobbin is replaced with another bobbin, have hitherto been installed in any conventional sewing machine. Under these circumstances, the determination of the necessity of bobbin replacement depends on the use of imagination and skill of worker operating the sewing machine. If the worker continues the sewing job without knowing that the bobbin thread has completely been used, that is, the bobbin has been emptied, a piece of cloth being sewn is fed idle past the sewing needle with no lock stitch formed thereon. Once this occurs, the attendant worker is forced to re-try the sewing operation. This involves a problem in that perforations left by the sewing needle with no thread passed therethrough may impair the appearance of the piece of cloth.

In order to substantially eliminate the problems discussed above, an attempt has been made to count the number of revolution of the bobbin within the sewing machine in the hope that a cue for the

amount of bobbin thread remaining on the bobbin can be available.

This attempt has, however, been found insufficient. Partly because the length of bobbin thread drawn from the bobbin per one revolution thereof varies with the number of turns of bobbin thread around the bobbin and partly because the thickness of bobbin thread varies depending on the type of material in the bobbin thread used, counting the number of revolutions of the bobbin does not give an accurate indication of the amount of bobbin thread remaining on the bobbin.

A different approach has also been made to use a bobbin in which magnetic paint is applied to a segment of the bobbin thread inwardly of the terminus thereof so that the passage of that portion of the bobbin thread can be magnetically, in order to provide a signal indicating that the bobbin will soon be emptied. However, it has been found that this magnetic detecting system often fail to detect the passage of the paint-coated segment of bobbin thread properly. As stitching proceeds, the bobbin thread being drawn from the revolving undergoes an oscillatory motion. Therefore, it often occurs that the bobbin thread being drawn from the bobbin fails to keep a close contact with a magnetic sensor.

The magnetic detecting system referred to above has an additional problem in that application of the magnetic paint to a segment of bobbin thread results in the formation of a blackish stain on that segment of bobbin thread and, therefore, if it is used to form stitches on the piece of cloth with upper or needle thread, the blackish stain may constitute an obstacle to the appearance of the piece of cloth.

In addition, where the magnetic sensor is installed in the sewing machine at a location below the needle plate and adjacent the bobbin casing, the magnetic sensor is subject to malfunction, or reduction in performance, caused by an accumulation of dust and/or lint, oil and the like on a light receiving area and/or the magnetic head, thereby posing a problem associated with reliability.

Two types of non-contact photoelectric detecting systems for detecting the timing at which the bobbin replacement is to be carried out are also well known and are shown in Fig. 13 and Figs. 14 and 15, respectively. The known system shown in Fig. 13 includes a light emitting element 102 and a light detecting element 103 held in position to receive a beam of light emitted from the light emitting element 102. In this known system, the path of travel of the beam from the light emitting element 102 towards the light detecting element 103 is defined so as to extend past a position spaced a short distance radially outwardly from an outer periphery of a hub of the bobbin so that, until

the effective outer diameter of the bobbin 100 is progressively reduced to a predetermined minimum diameter, the light detecting element 103 remains inactive. However, since the bobbin thread being used for an actual sewing accompanied by a reduction of the effective outer diameter of the bobbin down to the predetermined minimum diameter, the beam from the light emitting element 102 is, as shown therein, received by the light detecting element 103 which is then activated to output a signal indicative of the need to replace the bobbin.

According to the non-contact photoelectric detecting system shown in Figs. 14 and 15, the bobbin 100 employed in association therewith is of a structure in which the hub 100 has been axially divided, with one half 104a, being reduced in diameter relative to 104b. An outer peripheral surface of the large diameter portion 104b of the hub 104 is colored in a color different from that of the bobbin thread 101.

Fig. 14 illustrates the bobbin 100 having a full number of turns of bobbin thread wound therearound to an effective outer diameter before use, whereas Fig. 15 illustrates the bobbin 100 from which the bobbin thread has almost completely exhausted leaving some turns of bobbin thread around the reduced diameter portion 104a. Under the condition shown in Fig. 15, the colored outer peripheral surface of the large diameter portion 104b of the hub 104 is exposed to the outside.

According to the photoelectric detecting system shown in Figs. 14 and 15, a light emitting element 102 and a light detecting element 103 are so positioned that the light detecting element 103 can detect a beam of light emitted from the light emitting element 102 and reflected from an outer peripheral surface of a barrel of bobbin thread wound around the hub 104 or the outer surface of the large diameter portion 104b of the hub 104. This photoelectric detecting system provides a signal indicative of the need to replace the bobbin when the light detecting element 103 senses a change in color of the beam of light reflected from the bobbin 100.

However, in either case, there is a problem in that, because the amount of bobbin thread remaining on the bobbin varies depending on the thickness of bobbin thread used, substantially accurate detection of the amount of bobbin thread remaining on the bobbin is impossible.

Also, both of the photoelectric detecting systems shown in Fig. 13 and Figs. 14 and 15, respectively, have an additional problem in that, if one or both of the light emitting and receiving elements are installed in the sewing machine at a location below the needle plate and adjacent the bobbin casing, the light emitting and receiving elements are subject to malfunction, or impaired perfor-

mance, caused by a pile-up of dust and/or flue, oil and the like on a light emitting element and/or the light detecting element.

SUMMARY OF THE INVENTION

Accordingly, the present invention has been devised to substantially eliminate the problems found in the prior art systems discussed above and is intended to provide an improved sewing machine provided with a relatively highly reliable means, particularly the amount of bobbin thread left on the bobbin or an approach of exhaustion of the bobbin thread from the bobbin.

Broadly speaking, the present invention has two aspects; 1) Segment of thread coated with a fluorescent substance providing an elongated element detected by a sensor, and 2) a processing device including, inter alia, a non-contact photoelectric detecting system operable with the elongated element. The photoelectric detecting system includes a light emitting element for emitting a beam of light towards the elongated element, and a light detecting element for sensing light emitted from that portion of the elongated element upon excitation of the fluorescent substance by radiations from the light emitting element. The non-contact photoelectric detecting system is so designed that, upon receipt of the light emitted from that segment of thread coating the elongated element, the light detecting element may issue a signal indicative of the passage of that segment past the detecting site at which the radiations from the light emitting element reach.

The signal outputted from the light detecting element and, hence, the photoelectric detecting system may be utilized as representing a condition of the elongated element, for example, the amount of the elongated element left on a bobbin or an approach of exhaustion of the thread element from the bobbin.

The elongated element is comprised of a segment of thread which has been coated with a fluorescent substance to form a latent marking on the thread, and the fluorescent substance utilizable may be of a kind which can be excited by infra-red radiations to emit light. Containment of the fluorescent substance in the thread element, for example, the sewing thread is almost unnoticeable and, therefore, it will not provide any eyesore even though it is actually sewn on a piece of cloth.

Also, according to the present invention, the processing device may be a sewing machine equipped with means for replacing the exhausted supply of sewing thread with another similar sewing thread. In this case, the replacing means is operable in response to a signal from the photoelectric detecting system to implement a predeter-

mined process, for example, a thread replacement, on the thread element.

The present invention has an additional object to provide a method of detecting the passage of that segment of the thread element at the detecting site at which the radiations from the light emitting element reach.

More specifically, according to one preferred embodiment of the present invention, there is provided a sewing machine which includes a feed means for feeding the sewing thread past a detecting site, a trailing end portion of said sewing thread bearing a fluorescent latent marking which emits light upon receipt of infrared radiations; and a non-contact photoelectric detector comprised of a light emitting element for emitting a beam of light towards the detecting site so as to impinge upon the sewing thread being fed, and a light detecting element for sensing light emitted from that segment of the sewing thread when its coating of the fluorescent substance by radiations from the light emitting element. Upon receipt of the light emitted from the fluorescent latent marking at that segment of the sewing thread, the light detecting element may issue a signal indicative of the passage of that segment of the sewing thread past the detecting site.

As indicated previously, the signal outputted from the light detecting element may be utilized as representing a condition of the sewing thread, for example, the amount of the thread element left on a bobbin or an approaching exhaustion of departure of thread from the bobbin.

According to another preferred embodiment of the present invention, the beam of light from the light emitting element towards the detecting site and the light from excited fluorescent light from the detecting site towards the light detecting element are guided through light guides such as, for example, optical fibers. The use of the light guides allow the photoelectric detecting system to be disposed at a location remote from the detecting site and, therefore, the light emitting and receiving elements are substantially free from malfunction, or impaired in performance, which would be caused by an accumulation of dust and/or lint, oil and the like on a light emitting element and/or the light detecting element.

BRIEF DESCRIPTION OF THE DRAWINGS

This and other objects and features of the present invention will become clear from the following description taken in conjunction with preferred embodiments thereof with reference to the accompanying drawings, in which like parts are designated by like reference numerals and in which:

Fig. 1 is a schematic side sectional diagram showing a portion of a sewing machine incorporating a non-contact photoelectric detecting device according to a first preferred embodiment of the present invention;

Fig. 2 is a schematic perspective view showing that portion of the sewing machine;

Fig. 3 is an elevational view, on an enlarged scale, showing a sewing thread used in association with the photoelectric detecting device of the present invention;

Fig. 4 is a view similar to Fig. 3, showing a modified form of the sewing thread;

Fig. 5 is a view similar to Fig. 1, showing a second preferred embodiment of the present invention;

Fig. 6 is a spectrograph of light used in the present invention in conjunction with a particular fluorescent substance used in the sewing thread;

Fig. 7 is a view similar to Fig. 1, showing a third preferred embodiment of the present invention;

Fig. 8(a) is a schematic diagram showing a process of applying a fluorescent latent marking to the sewing thread;

Fig. 8(b) is a schematic diagram showing a process of detecting the passage of the fluorescent latent marking on the sewing thread

Figs. 9 to 11 are schematic top plan views showing different types of elongated elements which may be employed in the present invention, respectively;

Fig. 12 is a schematic perspective view showing an optical fiber which may be used as one of the elongated elements employable in the present invention;

Fig. 13 is a schematic transverse sectional view of the bobbin showing one prior art method of photoelectrically detecting the amount of thread left on the bobbin is detected according to the prior art; and

Figs. 14 and 15 are schematic side views of the bobbins, respectively, showing another prior art method of photoelectrically detecting the amount of thread left on the bobbin.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Referring first to Figs. 1 and 2, a sewing machine schematically shown therein may be of any known structure and comprises a machine head 2 positioned in the known manner above a needle plate 16. The machine head 2 includes, as is well known to those skilled in the art, a presser adjustment screw 1 for adjustably positioning a presser bar to adjust the pressure under which a piece of cloth is clamped between the needle plate 16 and

a presser foot 6 carried by the presser bar. The machine head 2 also includes a needle thread tension adjustment 3 for adjusting an upper or needle thread 4 to be stitched, a needle bar having a lower end to which a stitching needle 10 is replaceably secured by means of a needle clamp screw 5, and a thread take-up lever 11 movable up and down.

The sewing machine also comprises a reciprocally rotatable hook or shuttle 9 positioned beneath the needle plate 16 and adapted to removably accommodate through a latch lever a bobbin 8 around which bobbin thread 7 is wound in a number of turns. Although not shown, the sewing machine is known to further comprise means for intermittently feeding the piece of cloth as the stitching proceeds, which means includes one or two feed dogs cooperable with the presser foot.

Again, as is well known to those skilled in the art, as the thread take-up lever 11 driven in any known manner starts its descending motion accompanied by a rotation of the hook 9 in a counterclockwise direction as viewed in Figs. 1 and 2, the stitching needle 10 pierces through the piece of cloth resting on the needle plate 16. As soon as the stitching needle 10 reaches a position proximate to the hook 9, the hook 9 rotates clockwise in readiness for a finger of the hook 9 to hook a loop of the needle thread 4 while passing it around the bobbin 8. As the thread take-up lever 11 further descends, the stitching needle 10 is shifted upwards with the loop of the needle thread 4 caught by the finger of the hook 9.

A subsequent upward shift of the thread take-up lever 11, the stitching needle is brought to an elevated position, accompanied by a reverse rotation of the hook 9 to permit the needle and bobbin threads 4 and 7 to cross each other. Complete return of the take-up lever 11 to an upwardly shifted position results in a pull of the needle thread 4 to thereby complete a single stitch.

In this way, the piece of cloth is sewn. As the stitching proceeds, the bobbin thread 7 comes to be consumed earlier than the needle thread 4 since, as hereinbefore discussed, the length of the bobbin thread 7 wound around the bobbin 8 is relatively small, say, about 200 meters whereas that of the needle thread 4 runs about 5,000 meters. If the stitching is desired to continue, replacement of the bobbin must be performed preferably shortly before the terminus or trailing end of the bobbin thread 7 departs from the bobbin 8. Therefore, the necessity arises to detect the amount of bobbin thread 7 left on the bobbin 8, particularly the approach of departure of the bobbin thread 7 from the bobbin 8.

To meet this necessity, at least one portion of the bobbin thread 7, preferably 1 mm or greater in length, is coated or impregnated with a fluorescent

substance as will now be described in detail. It is to be noted that the fluorescent substance referred to above, which can advantageously be employed in the practice of the present invention, is of a kind which emits a fluorescent light when radiated by infrared rays of light. Examples of this fluorescent substance include an inorganic compound selected from the group consisting of YNdYbPO_4 , $\text{LiNdP}_4\text{O}_{12}$, $\text{LiNd}_{0.8}\text{Yb}_{0.2}\text{P}_4\text{O}_{12}$ and $\text{Al}_3\text{Nd}(\text{BO}_3)_4$. The fluorescent substance in which an activator such as neodymium (Nd) or ytterbium (Yb) is added is known to be chemically so stable as to be highly effectively excited.

Referring now to Fig. 3, the bobbin thread 7 is shown having leading and trailing end extremities 13 and 14 opposite to each other. So far shown therein, the fluorescent substance is coated to or impregnated in a segment of the bobbin thread 7, spaced a predetermined distance L1 inwardly from the trailing end extremity 14, to form two adjoining fluorescent latent markings 12.

The predetermined distance L1 between the trailing end extremity 14 of the bobbin thread 7 and the position of the fluorescent latent markings 12 is so chosen as to correspond to or be somewhat greater than the maximum possible length of that portion of the bobbin thread that is required during a particular sewing operation to complete a stitching with no thread cut halfway during the sewing operation. More specifically, this maximum possible length is defined to represent the length corresponding to the longest one of stitching lengths that would be required to be sewn into over a particular material to be sewn subsequent to detection of the passage of the fluorescent latent markings 12 past a detecting site as will be described later.

Alternatively, as shown in Fig. 4, fluorescent latent markings 12 may be formed over the entire length of bobbin thread 7 at predetermined intervals between the leading and trailing end extremities 13 and 14. Where the bobbin wound with bobbin thread of a type shown in Fig. 4 is employed, the timing at which the terminus of bobbin thread is expected to depart from the bobbin can be determined by counting the number of the fluorescent latent markings 12 passing through the detecting site and then determining the difference between the total number of the fluorescent latent markings 12 on the entire length of bobbin thread less the counts of the fluorescent latent markings 12 past across the detecting site. This determination of the approach of exhaustion of the bobbin thread from the bobbin can be implemented by an electronic circuit technology as will be described below and as can readily be understood by those skilled in the art.

It is to be noted that, where the fluorescent latent markings 12 spaced at predetermined intervals is used over the entire length of bobbin thread as shown in Fig. 4, indication is also possible of the amount of bobbin thread actually used for sewing.

A photoelectric detecting unit 15 operable with the sewing thread of, for example, a type shown in and described with reference to Fig. 3 will now be discussed with particular reference to Fig. 1. The photoelectric detecting unit 15 shown therein includes a light emitting element 17 for emitting a beam of infra-red rays of light including near infra-red light and a light detecting element 18 for sensing fluorescent light emitted from the fluorescent latent markings 12 on that portion of the bobbin thread 7. At an appropriate detecting site beneath the needle plate 16, a back-up guide plate 22 is disposed for support of a length of bobbin thread 7 from rear so that lateral oscillatory motion of the length of bobbin thread 7 during the passage thereof incident to the stitching operation can be suppressed.

The beam of infra-red light emitted from the light emitting element 17 when projected onto the length of bobbin thread 7 then passing along the back-up guide plate 22 forms a spot of infrared light of a diameter sufficient to encompass the thickness of the length of bobbin thread 7. Preferably, the infra-red light spot referred to above has a diameter which is 10 times the thickness of the bobbin thread 7 used, so that the passage of the fluorescent latent markings 12 past the detecting site can be assuredly detected even though the length of bobbin thread 7 undergoes a slight lateral oscillatory motion.

When the fluorescent latent markings 12 in that portion of bobbin thread 7 pass across the detecting site while the beam of infra-red rays of light is continuously projected towards the guide plate 22, the fluorescent substance contained in the fluorescent latent markings 12 is excited to emit a fluorescent light having a center wavelength quite different from that of the infra-red light. This fluorescent light so emitted is sensed by the light detecting element 18.

As described above, the fluorescent latent markings 12 emits the fluorescent light when excited by the infra-red light emitted from the light emitting element 17. In this case, the infra-red light projected by the light emitting element 17 is reflected by an interface between the fluorescent substance, forming the fluorescent latent markings 12, and that portion of the bobbin thread 7 to excite the fluorescent substance. Accordingly, where the length of bobbin thread 7 is white, pale pink, pale yellow or pale azure in color, having a surface reflectance of not lower than 20%, preferably 50% and more preferably 80%, is used on the bobbin 8, the light

detecting element 18 upon sensing the excited fluorescent light can provide a relatively high output voltage proportional to the intensity of the fluorescent light detected thereby.

Excitation of the fluorescent substance forming the fluorescent latent markings 12 can advantageously be enhanced if a thread support surface of the guide plate 22 is polished to have a high surface reflectance. However, the present invention does not exclude the use of a sewing thread of any other color than those referred to above and may work satisfactory even with a sewing thread, such as a black sewing thread, having a slightly lower surface reflectance.

The output S1 generated by the light detecting element 18 in response to detection of the excited fluorescent light is supplied to a central control 19 at which the voltage output S1 is processed according to a predetermined program to subsequently feed a display signal S2 to a display unit 20 which may be either or both of an indicator lamp and an indicator alarm. The display signal S2 applied to the display unit 20 is indicative of the passage of that portion of the bobbin thread 7 past the detecting site and is used to call an operator's attention that the amount of bobbin thread of a length corresponding to the distance L1 is let on the bobbin 8.

Where the sewing thread of a type shown in and described with reference to Fig. 4 is used on the bobbin 8, the central control 19 may be so designed as to count the number of the fluorescent latent markings 12 having past the detecting site so that the counts representative of the amount of thread actually used from the bobbin 8 can be displayed by the display unit 20.

Fig. 5 illustrates an alternative embodiment of the present invention. In the embodiment shown particularly in Fig. 1, the photoelectric detecting unit 15 has been shown as positioned in the proximity to the path of movement of the stitching needle 10. Depending on the type of the sewing machine, however, the space in the sewing machine beneath the needle plate 16 and in the proximity to one or both of the lowered position of the stitching needle 10 and the bobbin 8 is limited due to the presence of various mechanical component parts.

According to the alternative embodiment of the present invention shown in Fig. 5, the photoelectric detecting unit 15 may be disposed at a location remote from the path of travel of the bobbin thread 7 between the bobbin 8 and the needle plate 16 and, for this purpose, makes use of input and output light guides 23a and 23b. Each of the light guides 23a and 23b may be in the form of a length of optical fiber.

As shown in Fig. 5, on one side of the length of bobbin thread 7 opposite to the guide plate 22, a light guide holder 24 is disposed. This light guide holder 24 is used to hold, in close proximity to the guide plate 22, respective ends of the light guides 23a and 23b adjacent the detecting site so that the infra-red beams emerging outwardly from the input light guide 23a can illuminate the length of bobbin thread 7 while the excited fluorescent light can enter the output light guide 23b. It is to be noted that the light guide holder 24 may be integrally formed with the guide plate 22.

With the photoelectric detecting unit 15 positioned remote from the detecting site, opposite ends of the light guides 23a and 23b remote from the detecting site are optically coupled with the light emitting and receiving elements 17 and 18, respectively. Preferably, a condensing lens 25 is disposed between the light emitting element 17 and the input light guide 23a and a filter 26 having a cut-off frequency as discussed subsequently is disposed between the light detecting element 18 and the output light guide 23b.

Referring to Fig. 6, a curve a shown therein represents a spectrum of the infra-red light emitted by the light emitting element 17 which is employed in the form of a semiconductor laser diode, and that of the light reflected from the length of bobbin thread 7. A curve b represents a spectrum of the fluorescent light emitted from the fluorescent substance forming the fluorescent latent markings 12 which is employed in the form of $\text{LiNdP}_4\text{O}_{12}$. A curve c represents a cut-off region of the filter 26 and a region of light which passes through the filter 26. As can readily be understood from the graph of Fig. 6, the filter 26 used is effective to cut off the light reflected from the length of bobbin thread 7, but to allow the passage therethrough of only the excited fluorescent light from the fluorescent latent markings 12 towards the light detecting element 18.

A third preferred embodiment of the present invention is shown in Fig. 7. In any one of the first and second embodiments of the present invention, the infra-red beam of light emitted from the light emitting element 17 has been shown and described as projected onto the length of bobbin thread 7 passing across the detecting site. However, in the embodiment shown in Fig. 7, the respective ends of the light guides 23a and 23b are retained in a hole defined in the needle plate 16 preferably in the proximity to the stitching needle 10 so as to confront an undersurface of material being sewn. The back-up guide plate 22 is, in the instance shown in Fig. 7, positioned above the needle plate 16 so as to suppress a wavy motion of the material being sewn. So long as this embodiment of Fig. 7 is concerned, the back-up guide

plate 22 may be a part of the known presser foot.

As is well known to those skilled in the art, as the length of bobbin thread 7 is stitched together with the length of needle thread 4 into the material being sewn, the bobbin thread 7 forms discrete segments of the length of bobbin thread corresponding to the stitches, which are exposed to the outside. Thus, in the illustrated instance, while the material is being sewn, those discrete segments of the length of bobbin thread 7 come in at the undersurface of the material being sewn and successively move past the detecting site at which the respective ends of the light guides 23a and 23b are exposed.

The photoelectric detecting unit 15 according to the embodiment shown in Fig. 7 thus detects the passage of the fluorescent latent markings 12 when some of those discrete segments of the length of bobbin thread 7 that contain the fluorescent latent markings 12 come above the detecting site defined by the hole in the needle plate 16 as the stitching proceeds.

In describing any one of the foregoing embodiments of the present invention, reference has been made to the detection of the passage of the length of bobbin thread 7. However, those skilled in the art will readily conceive an applicability of the present invention to the detection of the passage of the length of needle thread 4 in combination with or other than the detection of the passage of the length of bobbin thread 7.

Also, the concept of the present invention is equally applicable to any other processing machine than the sewing machine which deals with any elongated member, for example, a roll of strip or belt, other than sewing thread. This processing machine will now be described with particular reference to Figs. 8(a) and 8(b).

Fig. 8(a) illustrates a marking process in which at least one fluorescent latent marking 31, functionally corresponding to each fluorescent latent marking 12 or 31 discussed hereinbefore, is formed on a portion of the elongated member 30. As shown therein, the elongated member 30 wound at one end on a supply roll 50 and at the opposite end on a take-up roll 51 is supplied from the supply roll 50 onto the take-up roll 51 past a marking site at which a marking device 32 and a back-up guide plate 52 are disposed on respective sides of a segment of the elongated member 30. The marking device 32 is supported for movement between lifted and lowered segments in a direction generally perpendicular to that portion of the elongated member 30 passing across the marking site. This marking device 32 applied the fluorescent substance to a desired portion of the elongated member 30 to thereby form the fluorescent latent marking 31.

The elongated member 30 which can be employed in the practice of the present invention may include, in addition to the sewing thread discussed in connection with the foregoing embodiments of the present invention, a belt, band, strip or string of any suitable material. For example, a band of textile fabric shown in Fig. 9; a strip of plate glass, synthetic plate material, synthetic film, paper, steel material such as shown in Fig. 10; a roll of recording paper such as heat-sensitive recording paper or perforated recording paper having feed perforations 38 as shown in Fig. 11 for use with a facsimile machine or a computer output device; or a string of optical fiber, glass tube or glass rod as shown in Fig. 12, can be utilized in the practice of the present invention.

The marking device 32 may be a thermal transfer type printer, a stamper or an ink-jet printer.

The position of the elongated member 30 where the fluorescent latent marking 31 is to be formed varies depending on the purpose for which the photoelectric detection is desired. For example, the fluorescent latent marking 31 may be formed at leading, trailing and intermediate portions of the elongated member 30 in one or plural number. As a matter of course, more than one fluorescent latent marking may be formed on the elongated member 30 at desired or required intervals over the entire length of the elongated member 30. Where the elongated member 30 is fed from the supply roll 50 towards the take-up roll 51 at a high speed, the use of the plural fluorescent latent markings may be recommended.

Referring now to Fig. 8(b) showing a photoelectric detecting system utilizable with the elongated member 30 shown in Fig. 8(a), the elongated member 30 having the plural fluorescent latent markings 31 spaced at predetermined intervals is shown as being fed in one direction by means of a roller drive 33 including a drive roller 33a and a driven pinch roller 33b. The passage of the elongated member 30 past the detecting site defined by a back-up guide table 42 and located between the roller drive 33 and a processing unit 37 is constantly monitored by a photoelectric detecting unit 36. The photoelectric detecting unit 36 includes the light emitting element 34 and the light detecting element 34 and operated in a manner substantially identical with the photoelectric detecting unit 15 employed in any one of the foregoing embodiments of the present invention.

As described in connection with any one of the previously described embodiments of the present invention, the light detecting element 34 generates an output signal S1 in response to the detection of the fluorescent light emitted from the fluorescent latent marking 31 as the latter moves past the detecting site. This output signal S1 is supplied to

a central control 38 for processing the output signal S1 according to a predetermined program to subsequently feed a display signal to a display unit 41. The display unit 41 is shown to have an alphanumeric information display 39 and an indicator lamp or alarm 40. The display signal applied to the display unit 20 is indicative of the passage of the fluorescent latent marking 31 born on the elongated member 30 past the detecting site and is used to call an operator's attention that a specific or length of the elongated member 30 is left or has been fed.

The processing unit 37 may be of any suitable equipment depending upon the type of the elongated member 30 to be processed. It may be, for example, a sewing machine, a cutting machine, a bending machine, a brake unit for interrupting the supply of the elongated member 30, a material exchanger, a supply unit for the elongated member, a printer, a laminating machine, a coating machine, a surface treatment machine, a heat treatment apparatus, a chemical processing apparatus, a vapordeposition apparatus, a sputtering apparatus or the like.

Although the present invention has been described in connection with the preferred embodiments thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications are apparent to those skilled in the art. Such changes and modifications are to be understood as included within the scope of the present invention as defined by the appended claims, unless they depart therefrom.

Claims

1. An elongated member having at least one marking formed thereon for photoelectric detection, said marking being a fluorescent latent marking containing a fluorescent substance and capable of emitting a fluorescent light when excited by radiation of infra-red rays of light.
2. The elongated member as claimed in Claim 1, said elongated member being a sewing thread and wherein said fluorescent latent marking is formed on a predetermined segment of the sewing thread.
3. An apparatus for photoelectrically detecting a passage of an elongated member, which comprises:

a transport means for transporting in one direction along a transport path an elongated member having at least one marking formed thereon, said marking being a fluorescent latent marking containing a fluorescent sub-

stance and capable of emitting a fluorescent light when excited by radiation of infra-red rays of light;

an photoelectric detecting means disposed on the transport path and including a light emitting element for projecting the infra-red light towards a detecting position and a light detecting element for receiving the excited fluorescent light only when the fluorescent latent marking on the elongated member passes across the detecting position; and

a processing means for applying a predetermined process to the elongated member based on an output from the light detecting element.

4. The apparatus as claimed in Claim 3, wherein said elongated member is a sewing thread having leading and trailing ends opposite to each other, said fluorescent marking being formed on a portion of the sewing thread spaced a predetermined distance inwardly from the trailing end thereof, and wherein said photoelectric detecting means provides an indication of the amount of the remaining sewing thread corresponding to said predetermined distance.

5. A method of applying a predetermined process to an elongated member, which comprises the steps of:

forming a fluorescent latent marking on a portion of an elongated member, said marking containing a fluorescent substance and capable of emitting a fluorescent light when excited by radiation of infrared rays of light;

transporting the elongated member in one direction along a transport path;

projecting an infra-red beam of light from a light emitting element towards a detecting position along the transport path to excite the fluorescent latent marking when during the transport of the elongated member the fluorescent latent marking moves past the detecting position;

detecting with a light detecting element a fluorescent light emitted from the fluorescent latent marking as a result of excitation of the fluorescent substance to provide an output signal;

applying the predetermined process to the elongated member on the basis of the output signal from the light detecting element.

6. A sewing machine including a reciprocally movably supported stitching needle, which comprises:

a sewing thread having at least one mark-

ing formed thereon, said marking being a fluorescent latent marking containing a fluorescent substance and capable of emitting a fluorescent light when excited by radiation of infra-red rays of light; and

an photoelectric detecting means disposed on a transport path and including a light emitting element for projecting the infra-red light towards a detecting position and a light detecting element for receiving the excited fluorescent light only when the fluorescent latent marking on the elongated member passes across the detecting position, said light detecting element providing an output signal indicative of a condition of use of the sewing thread.

7. The sewing machine as claimed in Claim 6, wherein said detecting position is defined on the transport path and in the proximity to a path of travel of the stitching needle.

8. The sewing machine as claimed in Claim 7, wherein said detecting means is disposed spaced a substantial distance from the detecting position, and further comprising input and output light guides for guiding the infra-red light from the light emitting element towards the detecting position and the fluorescent light from the detecting position towards the light detecting element, respectively.

9. The sewing machine as claimed in Claim 6, wherein said portion of the sewing thread is spaced a predetermined distance inwardly from a terminus of the sewing thread, and further comprising a display means operable in response to the output signal to provide an indication that a length of the sewing thread corresponding to the predetermined distance is available for a sewing operation.

10. The sewing machine as claimed in Claim 9, wherein said sewing thread is bobbin thread.

11. The sewing machine as claimed in any one of Claims 6 to 10, wherein that portion of the sewing thread where the fluorescent latent marking is formed has a length not smaller than 1 mm.

Fig. 1

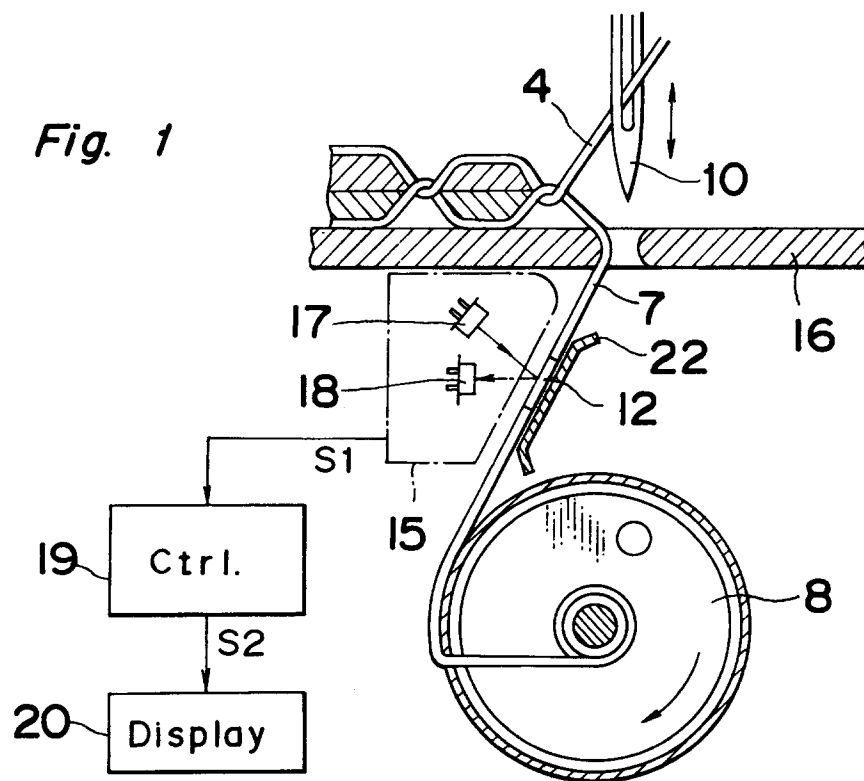


Fig. 2

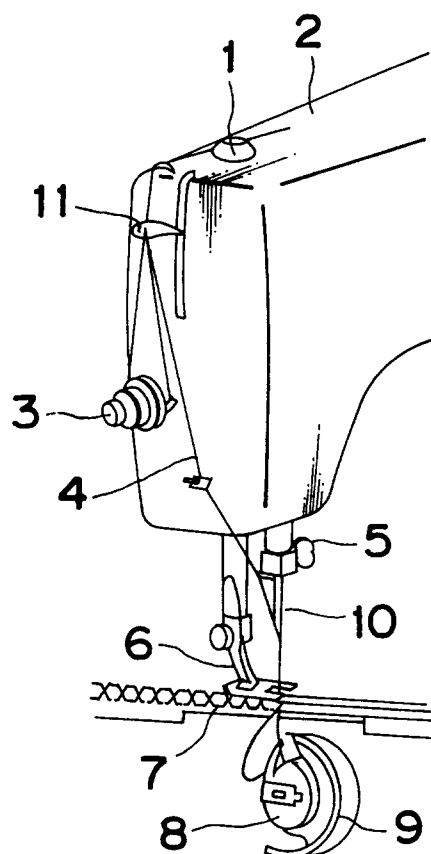


Fig. 3

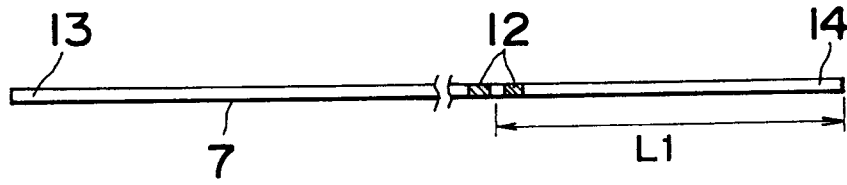


Fig. 4

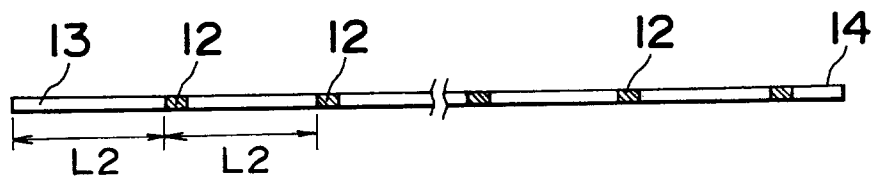


Fig. 5

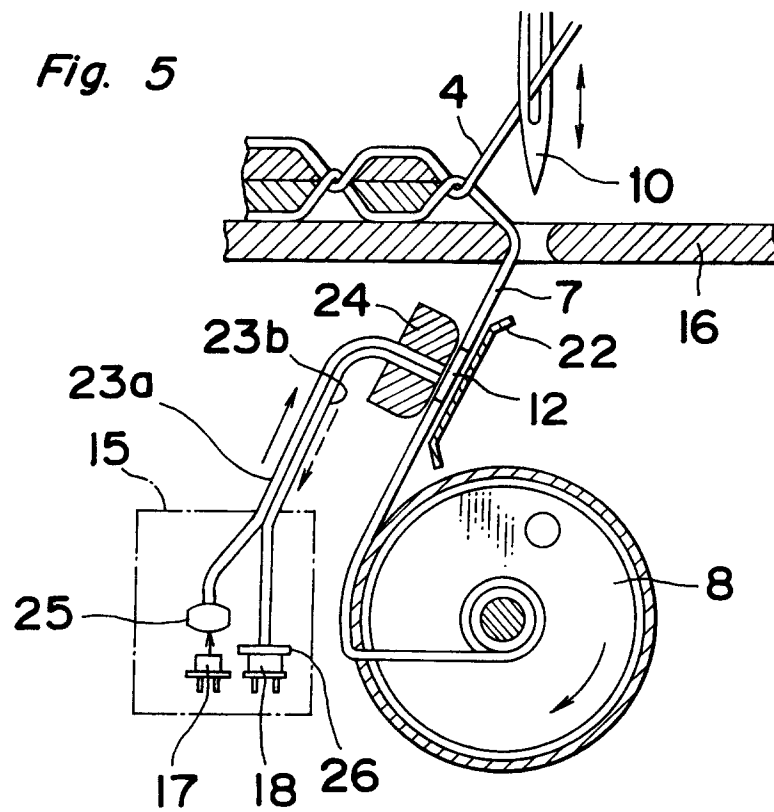


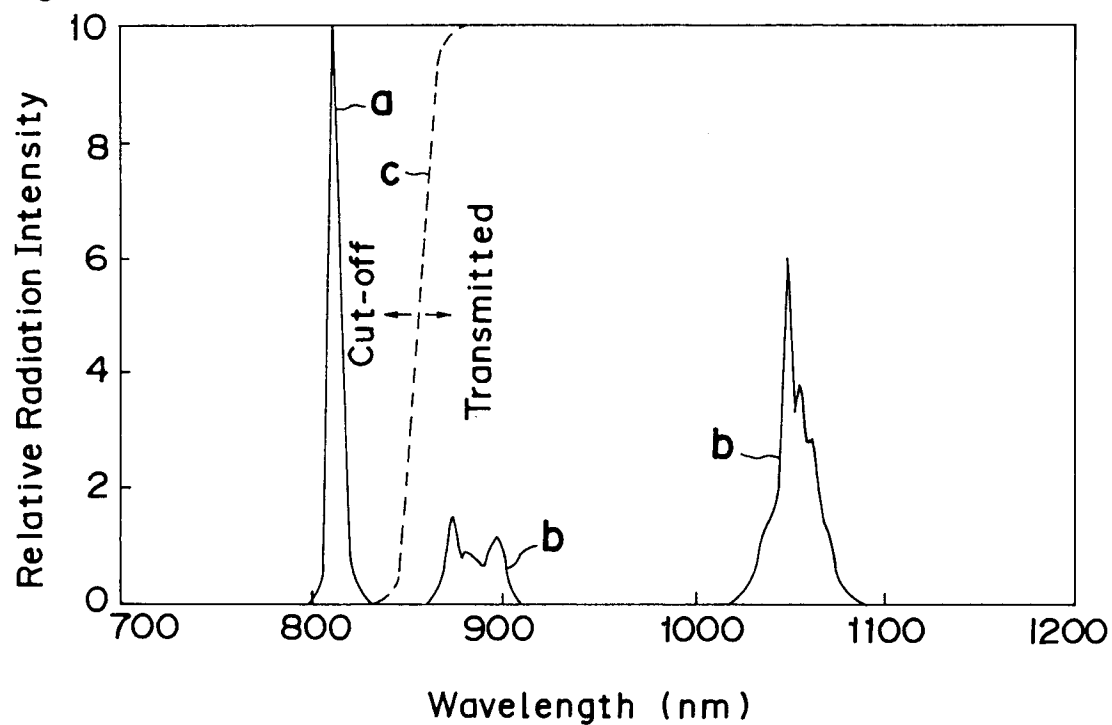
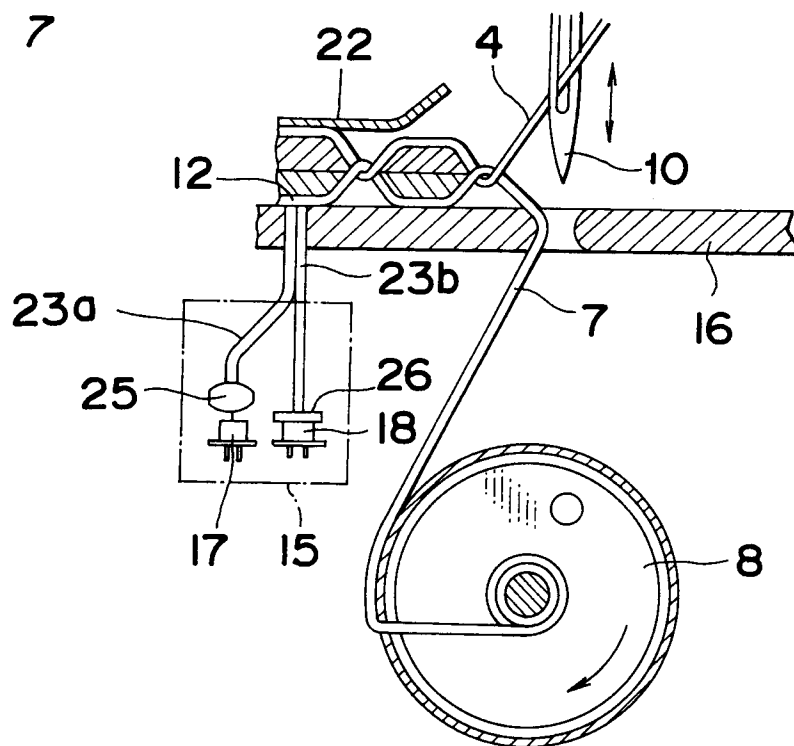
Fig. 6**Fig. 7**

Fig. 8(a)

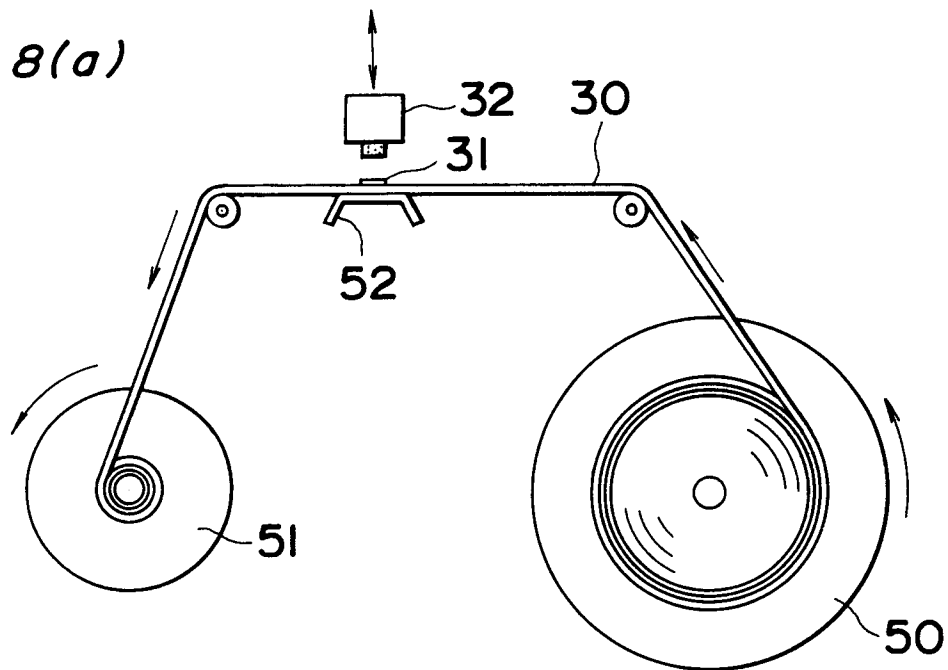


Fig. 8(b)

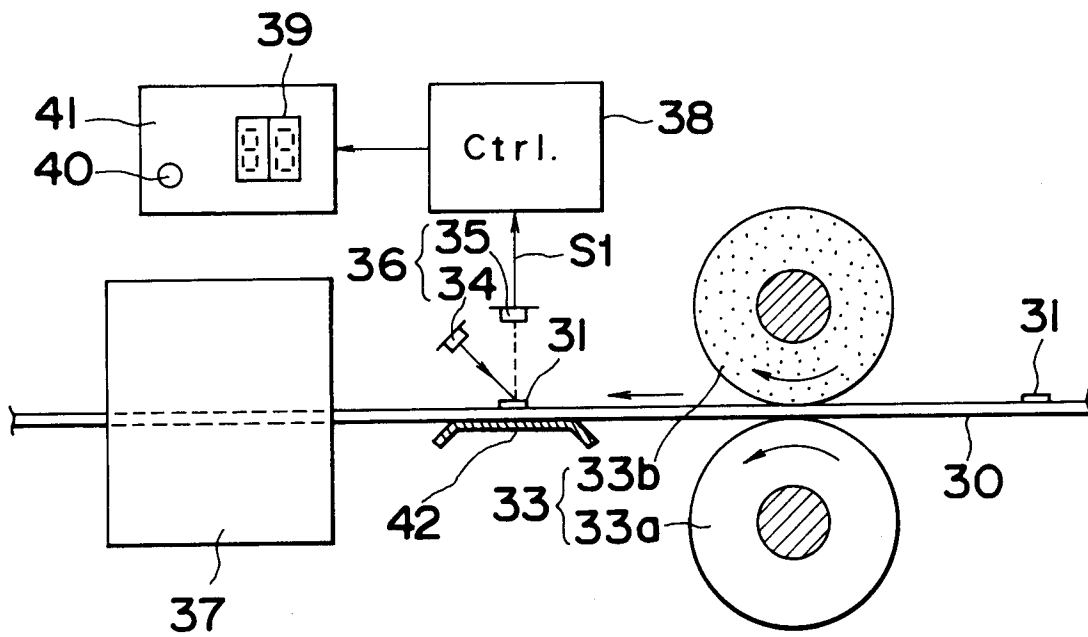


Fig. 9

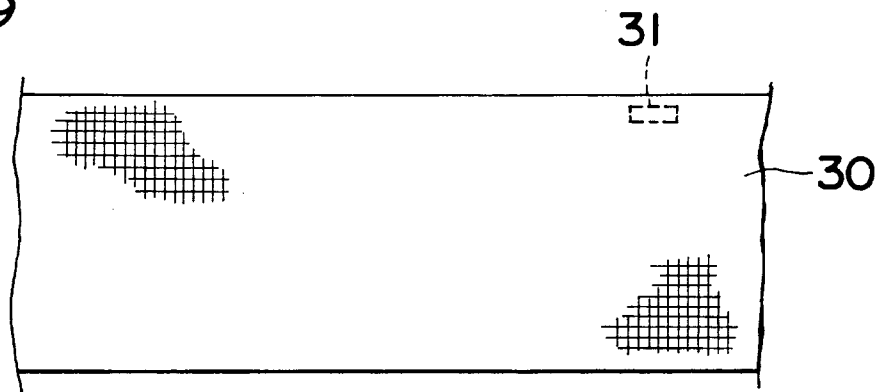


Fig. 10

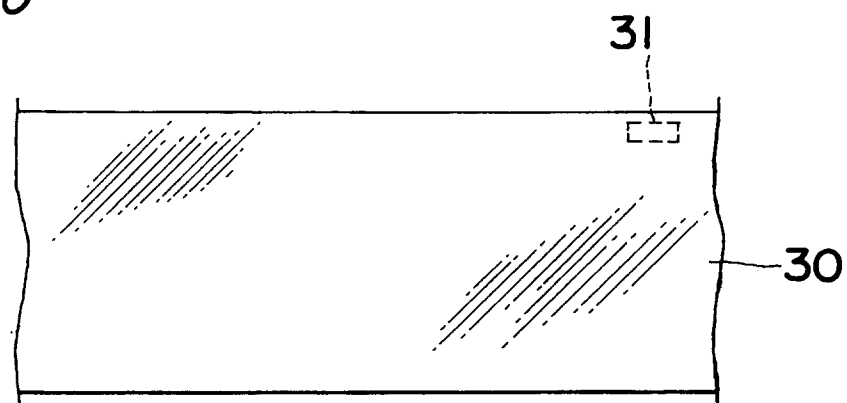


Fig. 11

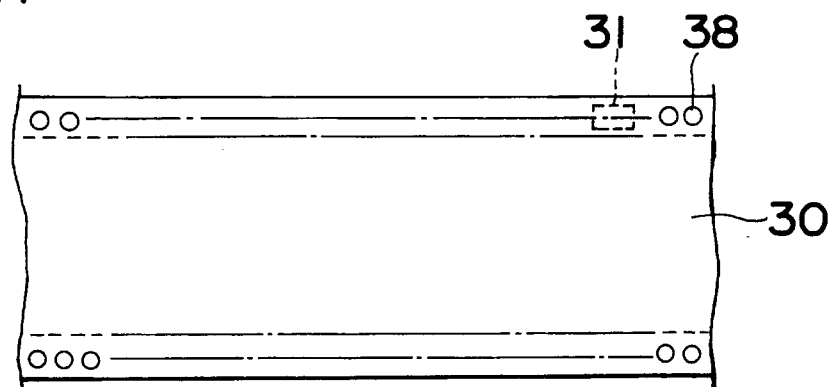
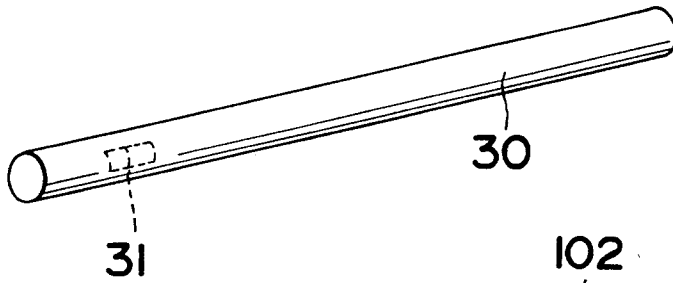


Fig. 12



*Fig. 13
Prior Art*

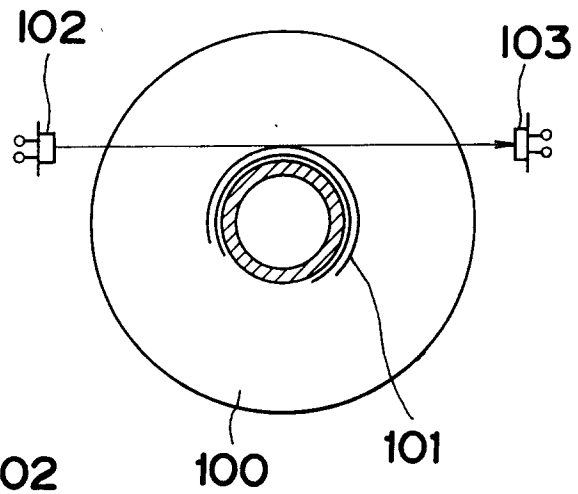
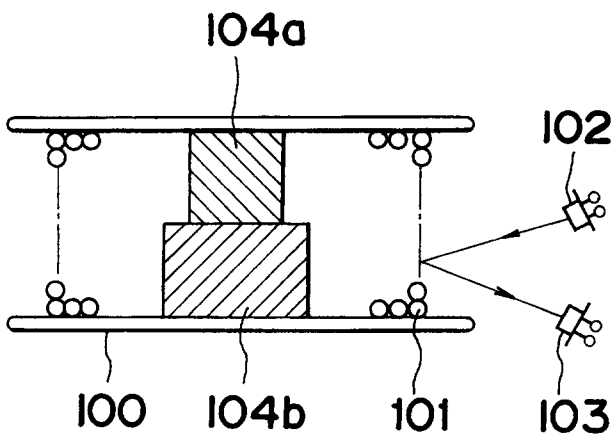
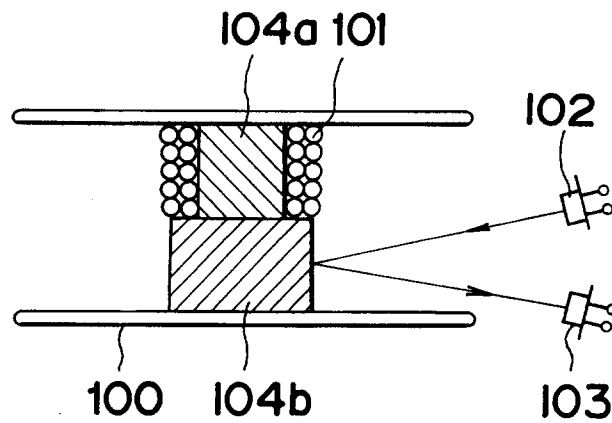


Fig. 14 Prior Art



*Fig. 15
Prior Art*





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 10 2098

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X,P	EP-A-0 529 764 (BALDWIN GRAPHICS SYSTEMS, INC.) * column 11, line 1 - column 12, line 1 *	1,3,5	D05B59/02 B65H63/08
Y,P	* column 4, line 11 - line 14 *	1,2	
Y	--- PATENT ABSTRACTS OF JAPAN vol. 15, no. 181 (C-0830) 9 May 1991 & JP-A-03 045 293 (JANOME SEWING MACH CO LTD) * abstract *	1,2	
X	--- PATENT ABSTRACTS OF JAPAN vol. 16, no. 128 (C-0924) 2 April 1992 & JP-A-03 292 994 (KOSEN SEWING MACH SHOKAI KK) * abstract *	6-11	
A	--- PATENT ABSTRACTS OF JAPAN vol. 7, no. 98 (M-210) 26 April 1983 & JP-A-58 022 252 (TOHYO SHIBAURA DENKI KK) * abstract *	1,3,5	
A	--- DATABASE WPI Week 8621, Derwent Publications Ltd., London, GB; AN 86-131573 & BE-A-904 003 (DE POORTERE V) 2 May 1986 * abstract *	1,3,5	TECHNICAL FIELDS SEARCHED (Int.Cl.5) D05B B65H D01H
A	--- US-A-2 854 938 (WINBERG) * column 6, line 12 - line 15 *	1-11	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 7 June 1994	Examiner Tamme, H-M
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document			