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## (54) Package grade determination system and package transfer system

(57) To provide a package grade determination system in a package transfer line that can improve accuracy in determining the grade of a package.

A package grade determination system in a package transfer line that transfers a package processed by a package processing machine, which consists of a large number of units, to the exterior of the machine. The system comprises a yarn quality monitoring means provided for each unit in the machine to constantly monitor data on the quality of yarn processed into packages, a transfer means for transferring packages ejected from the large number of units in the package processing machine to the exterior while identifying the sources of the packages, an inspection means for inspecting, at least, weight or appearance of the package transferred by the transfer means, and a grade determination means for combining data on each package from the yarn quality monitoring means with data on each package from the inspection means to determine the grade of the package.

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## Description

### Field of the Invention

The present invention relates to a system for determining the grade of a package processed by a package processing machine consisting of a large number of units and a package transfer system in a draw texturing machine having an individual drive device per unit.

### Background of the Invention

In a package transfer line that transfers a package processed by a package processing machine such as a draw texturing machine to the exterior of the machine, a package ejected from a unit to the exterior undergoes weight, knitting, and appearance inspections while being transferred along a transfer line and then packed. The package is then graded based on the inspection data, labelled and transferred to the subsequent process.

On the other hand, each unit has a control means including a tension sensor for monitoring and adjusting the tension of yarn before it is formed into a package in order to maintain the tension at the appropriate level good condition and to abort the operation if it exceeds the allowable range, followed by its ejection to the exterior of the machine as a half package.

In addition, in a draw texturing machine having a individual drive device, packages doffed from each unit are simultaneously ejected and transferred to the subsequent process using a transfer means. The time interval used for the simultaneous transfer is equal to the time required to wind a predetermined length of yarn around an empty bobbin without yarn breakage to form a full package.

The grading in such a package transfer line, however, is carried out based only on inspection data such as the weight or appearance of a package. Data on the quality of yarn formed into a package, such as the tension of the yarn, is not taken into consideration, thereby limiting the accuracy with which grade can be determined.

In a draw texturing machine, packages do not simultaneously become full on all units, and yarn breakage or abnormal tension of yarn may cause a package to be ejected from the unit before it becomes full (i.e., while it is a small package). In this case, the small package must be manually removed, thus requiring a large amount of time and labor.

The present invention is provided in view of these problems of the prior art, and its object is to provide a package grade determination system for use in a package transfer line that can improve accuracy in grading packages, and to provide a package transfer system for a draw texturing machine that can automatically transfer not only full but also small packages.

### Summary of the Invention

To accomplish this object, the present invention comprises a yarn quality monitoring means for constantly monitoring data on the quality of processed yarn for each unit, a means for inspecting, at least, the weight and appearance of the package, a means for transferring the package ejected from each of the units to the inspection means while identifying the source of the package, and a means for combining data on each package from the yarn quality monitoring means and data on each package from the inspection means to determine the grade of each package.

The present invention adds data on the quality of yarn in a package, such as the tension of the yarn prior to processing, to the grading of a processed package, such as appearance and weight inspections, in order to determine the grade of the package.

According to the present invention, the package grade determination means can distinguish data on packages that are removed instead of being transferred from the package processing machine to the transfer means. Since the data on removed packages (i.e., small packages) is excluded, those packages that become full or half full instead of being removed and which are ejected to the exterior of the processing machine can be labelled easily.

The present invention also has an automatic warehouse in which packages that have passed through the inspection means are stored. Those that reach the automatic warehouse have each been graded by combining data on each package from the yarn quality monitoring means with data on each package from the inspection means.

Further, the present invention makes determinations based on both tension and inspection data, so multi-phase evaluation can be executed to increase accuracy in grading.

Furthermore, the present invention comprises a doffing device for doffing a package when it becomes full or if an error occurs in the yarn, a shelf means for temporarily storing doffed packages for each unit, a shutter means for simultaneously ejecting a leading package stored on each shelf means, a means for transferring packages simultaneously ejected to the exterior of the machine, and a control means for controlling the operation of the doffing means, shutter means, and transfer means, wherein the control means sets a second interval at which the transfer means executes transfer that is shorter than the first interval at which the full package is obtained. The shutter means for each unit is

opened and packages temporarily stored on the shelf means, including full and small packages, are simultaneously transferred by the transfer means in the time required to fill a empty bobbin, that is, a time interval shorter than the first interval. Small packages are obtained when an error such as yarn breakage or abnormal yarn tension occurs.

According to the present invention, the amount by which the second interval is set shorter than the first interval is predetermined by considering the probability of yarn breakage that may occur in the machine. This invention thus minimizes the amount by which the second interval is set shorter than the first interval to inhibit the transfer efficiency of the transfer means in simultaneously transferring the packages from each unit along the machine.

## Brief Description of the Drawings

Figure 1 is a block diagram of apparatuses in a package grade determination system in a package production and transfer line according to the present invention.

Figure 2 is a flow chart showing one embodiment of a grading method.

Figure 3 shows one embodiment of a list of data provided by a package grade determination means.

Figure 4 is a layout of draw texturing machine factory.

Figure 5 is a layout of a unit of draw texturing machine.

Figure 6 is a side view showing one embodiment of a yarn winding control device.

Figure 7 is a plan view showing a yarn cutting means in the doffing device in Figure 6.

Figure 8 shows temporal charges in uptwisting tension.

Figure 9 is a block diagram of a package transfer system for draw texturing machine of the present invention.

Figure 10 is a flowchart of the package transfer system for draw texturing machine of the present invention.

Figure 11 shows temporal changes in the package transfer system for draw texturing machine of the present invention.

Figure 12 shows the state of a shelf means immediately prior to the opening of the shutter means in Figure 3.

## Detailed Description of the preferred Embodiments

Embodiments of the present invention are described with reference to the drawings. Figure 1 is a block diagram of a package grade determination system in which a package production and transfer line is applied to a draw texturing machine. Figure 2 is a flow chart showing one embodiment of a grading method. Figure 3 is an example of data for a package grading means.

Before describing each figure in detail, as an example of a package processing machine consisting of a large number of units, an example of a transfer and inspection means is described with reference to the layout of a draw texturing machine factory in Figure 4, and the structure and operation of a yarn quality monitoring means consisting of a tension sensor are described with reference to the layout of a unit of a draw texturing machine in Figure 5 as well as Figures 6 and 8.

In Figure 4, 1 is a draw texturing machine, 4 is an STS (a Sky Train System that is a self-travelling transfer cart having a track on its ceiling and hanging and supporting a carrier 40, which is described below), 6 is a loading device that transfers a package installed on the STS transfer cart to a tray , 7 is a weight inspection device, 8 is a sampling device, 9 is a knitting inspection device, 10 is an automatic warehouse, 11 is a warehouse crane, 12 is an appearance inspection device, 13 is a labeller that reads an ID (an identification number) attached to each tray to identify the associated draw texturing machine and unit, 14 is a bagging device, 15 is a packing device, 16 is a labeller for indicating the grade of a boxed package, and 17 is a seal device for covering the package with a plastic film.

The draw texturing machine 1 unwinds yarn from a supply package P1 and draws and twists yarn before winding it around a winding package P2. In the draw texturing machine 1, each of the large number of units includes an automatic doffing device and a tension sensor 35, which is described below, identifies and stores yarn quality data (such as its tension) for each package, and ejects a full package P2 to a storage arm provided for each unit for temporary storage. A specified length of yarn is wound in each unit of the draw texturing machine 1 at the same speed, a full package P2 is ejected from each unit at a period of time equal to the specified length and stored in the storage arm.

The draw texturing machine 1 includes package shutters 39 that simultaneously open the storage arm for each unit to simultaneously eject leading packages P2, and the package shutters 39 simultaneously operate in a time that is somewhat shorter than the specified length. Since the package shutters 39 operate in a time that is somewhat shorter than the specified length, not only full but also half packages can be automatically transferred. Subsequent to the simultaneous ejection from each unit disposed along the machine, the packages P2 are loaded onto STS transfer carts 4 in the order of the units disposed along the machine. Thus, the packages P2, ejected from the draw texturing machine 1 in the order of the units, are transferred to the tray loading device 6 in a tray circulating apparatus 20 in which they are loaded onto the trays so as to be associated with the source units in the draw texturing machine 1.

The tray circulating apparatus 20 conducts a weight inspection for the package P2 on the tray (a weight inspection

device 7), a knitting inspection (a sampling device 8 and a knitting inspection device 9) and an appearance inspection (an appearance inspection device 12). Data on each package from these inspection means (inspection data) is sent to a host computer 73 (see Figure 1), where it is combined with data on yarn quality (quality data) from the draw texturing machine 1, which is described below, to grade the package as "A", "B", or "C". Such a grade is written to the ID of the tray on which that package is loaded.

The packages P2 are subsequently stored in the respective storage sections of an automatic warehouse 10 associated with grades "A", "B", and "C". The result of a knitting inspection is also manually written to the ID of the tray for the package P2 in the automatic warehouse 10 to determine the grade of the package P2. Packages P2 of a predetermined grade are removed from the automatic warehouse 10 and transferred through the bagging device 14, packing device 15, labeller 16 and seal device 17.

In Figure 5, the draw texturing machine 1 includes feed rollers 24, 28, 30, heaters 25, 29, a cooling plate 26, and a belt twister 27. A synthetic yarn Y pulled out from the supply package P1 by the first feed roller 24 is introduced into the primary heater 25 and transferred to the second feed roller 28 through the cooling plate 26 and the belt twister 27. The yarn Y is then passed through the secondary heater 29 and the third feed roller 30 and wound round the winding package P2. The twisting formed by the belt twister 27 propagates to the first feed roller 24 and is thermally fixed by the primary beater 25. That is, the upstream side of the belt twister 27 is a twisting side, while the downstream side is an untwisting side. The draw texturing machine 1 has such as a single unit and a large number of units are disposed therein in the direction of the thickness of the sheet of the drawing.

The belt twister 27 consists of two bolts 33, 34 that cross each other, and the tension of the synthetic yarn Y is detected by the tension sensor 35 provided on the downstream side of the belt twister 27. The tension sensor 35 measures the untwisting tension and adjusts the nip force of the belt twister 27 by controlling the pressures of the two belts so that the untwisting tension will fall within the controlled range. An yarn breakage sensor 36 is provided on the downstream side of the secondary heater 29. 37 is a yarn cutter that operates in response to the detection of the yarn breakage sensor 36 to cut the yarn on the upstream side of the first feed roller 24 in order to prevent the yarn from becoming intertwined with each other within the path.

The draw texturing machine 1 has an individual automatic doffing device. That is, it automatically performs for each unit doffing operations such as the replacement of empty bobbins used for the draw texturing machine 1 and threading. Fully wound packages P2 are held in a storage arm 38 and through opening and closing of the package shutter 39, simultaneously transferred to carriers 40 constituting the transfer carts of the STS 4, on which they are transferred to the tray loading device 6 shown in Figure 4. If the tension of the yarn is detected to be abnormal by the tension sensor 35, that yarn is cut during processing and ejected as a half package. In addition, if the yarn is cut due to a mechanical error, it is also ejected as a half package.

If the winding is suspended in this manner, a controller 70 installed in the machine in Figure 1 references the value of a doffing timer 50 and lights a lamp if the specified time has not been passed, that is, the length of that half package is one-tenth or less of the specified value, thereby notifying the operator of this condition to remove that package. In addition, if any package has been removed, there will be an empty position in the order in which packages are sequentially removed from each unit. Then, based on the value of the doffing timer 50, the controller 70 automatically marks the quality data on the removed package to clearly show that this data is for the missing package. Thus, the IDs of the trays can subsequently be correlated with the units to provide the correct grading based on a comparison of quality data, which is in turn based on the tension of the yarn and inspection data such as appearance.

A tension control mechanism 41 and a winding control mechanism 42 are described below with reference to Figures 6 to 8.

These mechanisms maintain the tension of the yarn in good condition based on the quality data from the tension sensor 35 and abort the winding of the yarn if the tension exceeds the allowable range in order to eject it as a half package from the draw texturing machine 1. In addition to these operations, this operation stores quality data in a host computer 73 (see Figure 1) to use it to grade full packages P2.

The tension control mechanism 41 is composed of the tension sensor 35 provided on the downstream side of the belt twister 27 and a tension control section 46 that drives a pressure control means 45 of the belt twister 27 based on a value detected by the tension sensor 35.

A target value T0 for the tension of the yarn, a target range with an appropriate interval (for example, ±2 gr) above and below the target value T0, and an allowable range with an interval (for example, ±10 gr) between the target value T0 and an upper and lower limit are input to the tension control section 46 beforehand, as shown in Figure 8, and the pressure of the twister 27 is adjusted via the pressure control means 45 to set the untwisting tension T within the target range ($Tu < T < Td$). If an abnormal untwisting tension T that is out of the allowable range is detected during the control operation ($T > Tmax$, $T < Tmin$), that tension value and the corresponding detection period (yarn length L) are input to the winding control section 47 of the winding control mechanism 42. If the tension exceeds the target range ($Tu < T < Td$), that tension value and the corresponding detection period (yarn length M) are detected. The yarn can be graded so as to correspond to the quality of the drawing and twisting operations based on the amount by which the tension

exceeds the target and allowable ranges.

The winding control section 47 of the winding control mechanism 42 is built into the controller 70 provided in the draw texturing machine, together with the tension control section 46 in order to control a winder 49 of the draw texturing machine and to doff a fully wound package P2 in response to a specified length signal from the doffing timer 50 provided in each unit. Based on information from the tension control mechanism 46, the winding control section 47 determines the quality of a package P2 round which the yarn is being wound, and if it is bad, aborts winding to order the package to be doffed immediately. That is, the winding control section 47 not only receives an abnormal tension value and an abnormal detection period L that is an accumulated value of the length of the corresponding yarn (L1 + L2 + ...) but also counts the number of times that abnormal tension has been detected (frequency) N, and compares these values to preset allowance rules (acceptance standards). If, for example, the abnormal tension yarn length L is 10 m or less, that package is graded as "a", whereas if it is more than 10 m, that package is graded as "b", and once the package has been graded as "b", the control section issues an operation instruction to a drive section 53 of an auto doffer 52 provided in each winder 49 in order to eject it as a half package. Such abnormal packages are manually removed.

According to the present invention, packages of grade "a" that are automatically transferred can further be graded. Those of the packages of grade "a" having an abnormal tension yarn length L of 10 m or less that have an abnormal tension yarn length L of 5 m or less are graded as "a1" and those that have an abnormal tension yarn length L of more than 5 m and 10 m or less are graded as "a2". The yarn length M that can be used if the tension exceeds the target range (Tu < T < Td) can be combined with the yarn length L to grade the package as "a1" or "a2". The untwisting tension of the draw texturing machine is related to the quality of drawing and twisting operations, so the quality of the yarn in the package can be graded using the untwisting tension to allow the package to be comprehensively graded as "A", "B", or "C".

The auto doffer 52 is composed of a yarn cutting means 54 for cutting processed yarn Y that is to be wound, a cradle drive shaft 56 for longitudinally moving a cradle 55 that grips the winding package P2 and also opening and closing the cradle 55, a empty bobbin supply drive shaft 59 for vertically moving a empty bobbin stocker 58 in which empty bobbins 57 are accommodated, and a threading arm 60 for threading yarn round a new empty bobbin 57.

The yarn cutting means 54 is provided near a traverse device 61 of the winder 49, and is composed of a cutter 64 having a yarn capturing groove 63 with a cutting edge 62 and an actuator (not shown in the drawings) for lifting the cutter 64 to the level of a yarn path, as shown in Flare 7. In response to an instruction from the winding control section 47, the actuator lifts the cutter 64 to allow it to capture and cut the processed yarn Y being traversed. The processed yarn Y that has been cut is held in an air sucker 65 provided at the front end of the traverse device 61, and after the empty bobbin has been replaced, the threading arm 60 is turned to draw the yarn to the end of the empty bobbin and to thread it round that end.

In addition, after the yarn has been cut, the cradle drive shaft 56 is rotated to bring the cradle 55 down backward in order to open it, thereby causing the winding package P2 to he ejected to a receiving section (not shown in the drawings) provided behind the winder 49. The empty bobbin stocker 58 is subsequently lowered to allow the cradle 55 to grip a new empty bobbin, and the cradle 55 is then brought down forward by the cradle drive shaft 56 until it contacts a friction roller 66. Then, new winding is started.

36 is an yarn breakage detection sensor that allows doffing to be executed if the yarn is cut due to a mechanical error. A doffed package is held in the storage arm 38 provided in each unit. Based on an instruction output from the controller 70 installed in the machine, every period of time that is shorter than the time T equal to the length of yarn in a full package, the package shutter 39 then simultaneously ejects the leading packages from the units disposed along the machine.

Next, the package grade determination system in the above package production and transfer line is described with reference to the block diagram in Figure 1.

In Figure 1, the main devices described in Figure 4 are arranged in the order of the draw texturing machine 1, STS 4, tray loading device 6, package weight inspection device 7, knitting inspection device 9, package appearance inspection device 9, automatic warehouse 10 and labeller 13. Packages ejected from the draw texturing machine 1 are arranged in the order of the units and transferred to the automatic warehouse 10 in that order. Data on the quality of yarn for the draw texturing machine 1 is input to the controller 70 installed in the machine, while data on the packages from the package weight inspection device 7 and the package appearance inspection device 12 is input to an on-site personal computer 71. A transfer controller 75 enables transfer using the STS 4, tray loading device 6, and automatic warehouse 10 in such a way that the IDs of the trays are correlated with the sources of the packages. A labeller personal computer 74 for the labeller 13 is used to output data required for labelling. The controller 70 installed in the machine, on-site personal computer 71, labeller personal computer 74, and transfer controller 75 are connected to the host computer 73 via a main communication network 72. The host computer 73 functions as a package grade determination means that combines data on each package from the yarn-quality monitoring means such as the tension sensor 35 with data on each package from the inspection means such as the package appearance inspection device 9 to grade each package.

Indicators indicating data or conditions required for operation, a temperature control device, various alarm devices, and the controller 70 including a control panel are provided at each end of the draw texturing machine 1. The controller 70 installed in the machine can process data on the quality of the yarn provided from the tension sensor 35 in the draw texturing machine 1 in order to control the tension of the yarn and can also identify the source of the package (information on what unit that package came from and when that package was generated). It also inputs quality data to the host computer 73 through the main communication network 72.

The on-site personal computer 71 receives inspection data such as data on the weight of the package from the package weight inspection device 7, data on dyeing from the knitting inspection device 9, and data on the appearance of the package from the appearance inspection device 12. Such data can be displayed on the on-site personal computer 71 and output at the site (using a monitor or printer).

In addition, after ejecting a package to the exterior of the draw texturing machine 1 and loading it on a tray, the transfer controller identifies the ID of the tray during transfer, then correlates the ID with each inspection data from the on-site personal computer 71, and then inputs the data to the host computer 73 via the main communication network 72.

The host computer 73 receives data on the quality of yarn from the controller 70 installed in the machine and various inspection data on packages from the on-site personal controller 71, and can output this data using an appropriate means such as a monitor or a printer. The data can be output by the host computer 73 in a list of data such as that shown in Figure 3. The list identifies the type of yarn, doffing date and time, machine No. unit No. and grade such as "A", "B", and "C" for each package loaded on the tray. The host computer 73 also stores data on each package stored in the automatic warehouse 10 so that packages of a required grade can be obtained by operating a warehouse crane 11.

Data on small packages that have been ejected from the draw texturing machine 1 as half packages due to abnormal tension and that has one-tenth or less of the required weight as in ID No. 144-48 in Figure 3 is marked as data for missing packages. Like the other data, however, the data on the quality of yarn is sent to the host controller 73 as production management data. After appearance inspection, the confusion of packages can thus be avoided when the above data is combined with the results of quality evaluations based on yarn tension.

In addition, packages are graded as "A", "B", or "C" by determining whether or not the corresponding data is within the range of that grade, as shown in Figure 2. Step #81 determines based on the quality data from the tension sensor 35 whether or not the tension is within the range of that grade, that is, it conforms to grade "a1" described above. If the data is within the range of grade "a1", then step #82 determines whether or not the weight is within the range of grade A, and steps #83 and #84 determine whether or not the appearance is within the range of grade A. The results are combined to finally determine whether to grade this data as "A" or "B". On the other hand, if the yarn quality data is not within the range of grade "a1" and is determined to be of grade "a2", then the determination on the weight in step #85 and the determination on the appearance in steps #86 and #87 are combined to finally determine whether to grade this data as "B" or "C".

Based on instructions from the host computer 73 and the on-site personal computer 71, the transfer controller 75 controls the transfer lines including the STS 4, tray loading device 6, and automatic warehouse 10. In these transfer lines, the transfer controller 75 constantly stores the ID of each package and can output data on the quality or weight of any package on any transfer line from the host computer 73 as required.

Although the above embodiment has been described in conjunction with the draw texturing machine as a package processing machine, the present invention is applicable to a large number of spun yarn winders from which packages are doffed and stored in a warehouse after inspections. In this case, a yarn diameter inspection device can be installed for each unit in the spun yarn winder to grade the quality of yarn based on the presence of fluff.

Figures 9 and 10 are a block diagram of a package transfer system for draw texturing machine of the present invention. Figure 11 shows temporal changes at each unit during the production of packages. Figure 12 illustrates the state of the shelf means immediately prior to the opening of the package shutter in Figure 11.

In Figure 9, a package transfer system comprises the doffing device 52 provided for each unit in the draw texturing machine 1, the shelf means 38 and package shutter means 39, the transfer means (the STS transfer cart 4) for transferring packages from each unit, the controller 70 installed in the draw texturing machine 1, the controller 75 for controlling the transfer executed by the STS, the controller 70, and the host computer 73 for controlling the controller 75, as described above. The controllers 70, 75 and the host computer 73 constitute a control means for controlling the system.

The doffing device 52 is provided in the winder (winding meanism) 49 for each unit in the draw texturing machine 1 (see Figure 6). The doffing device 52 doffs a package if a predetermined length of yarn is wound round a bobbin to form a full package without yarn breakage or if yarn breakage or abnormal tension occurs. According to the present invention, the time required to wind a predetermined length of yarn round a bobbin to form a full package without yarn breakage is referred to as a first interval T1, which is set by the controller 70 in the draw texturing machine 1.

The shelf means is provided for each spindle ① to ⑧ and temporarily stores doffed packages for each unit (see Figure 12). The shutter means 39 is provided at the end of the shelf means so that the leading packages (including full

and small packages) shown by the thick line can be simultaneously ejected to the transfer means (to the right relative to the sheet of the drawing).

The STS transfer cart 4 as the transfer means transfers to the subsequent process the packages (including full and small packages) simultaneously ejected from the draw texturing machine 1. The cycle during which the packages are transferred from the draw texturing machine 1 is referred to as a second interval T2, which is set by the controller 75 for the STS.

The present invention is characterized in that the second interval T2, that is, the interval from the time when the shutter means 39 is opened until it is closed is set shorter than the first interval T1. This saves the time and labor required to manually remove small packages that have failed to become full due to yarn breakage.

Referencing the flow chart in Figure 10, the first interval T1 corresponding to the specified amount of winding time is set in the controller 70 for the draw texturing machine (step #1). The first interval T1 may be automatically input from the settings for the machine operational conditions in the host computer 73. Likewise, the second interval T2 that is a transfer interval is set for the STS controller 75 that is the transfer means in such a way as to be shorter than the first interval T1 (step #2). The first interval T1 may also be automatically input from the settings for the machine operation conditions in the host computer 72. In this case, the host computer 73 automatically calculates the ratio between T2 and T1 while considering a stored yarn breakage occurrence rate and inputs the result to the controller 75.

When the operation of the draw texturing machine is initiated (step #3), the counting of the second interval T2 is started. The flow is repeated (step #4, NO) until the second interval T2 has expired. Once the second interval T2 has expired (step #4, YES), the packages in the first rows on the shelf means are simultaneously ejected by the package shutter (step #5). The packages corresponding to one row of the machine are loaded on the STS that is the transfer means (step #6), and the STS transfer cart is then driven to transfer the package to the tray loading device that is the tray circulating device (step #7). During this operation and prior to the subsequent operation, the operator inspects abnormal units in the draw texturing machine (step #8). The operator cheeks whether or not the lamp for each unit in the draw texturing machine is lit (step #9). If the lamp is lit (step 9, YES), the operator removes the remaining small packages on the shelf means (step #10). For those units from which small packages have been removed, the operator turns the reset button on to turn the lamp off (step #11). After all lamps for the units in one row of the machine have been turned off (step #9, NO), the process returns to step #4 to repeat the flow.

Next, the significance of setting the second interval T2 that serves as the transfer interval shorter than the first interval T1 during which a specified length of a full package is formed is described with reference to Figure 3.

In Figure 11, T1 denotes the time from the formation of a full package until the next full package is formed, that is, the first interval, while T2 indicates the interval during which the shutter means is open, that is, the second interval. Reference numerals ① to ⑧ designate the units.

Figure 12 shows the state of the units ① to ⑧ prior to the opening of the shutter means 39, more specifically, immediately prior to the opening B of the package shutter if the units ① to ⑧ operate as shown in the temporal change chart in Figure 11.

If no error occurs as in the spindle ① , packages are sequentially formed. In the units ② and ③ , one small package is formed during T2. In the unit ④ , a small package is ejected immediately after a full package has been formed, and in the unit ⑤ , two small packages are continuously formed. In the unit ⑥ , two small packages are continuously formed after a full package has been formed, and in the unit ⑦ , a small package is formed some time after a full package. In the unit ⑧ , a second small package is formed some time after a first package has been formed. When the shutter means 39 is opened, only the packages at the end of the shelf means 38 that are shown by the thick line are ejected to the transfer means. Thus, immediately after transfer, in the spindles ① to ③ , all packages (including full and small packages) on the shelf means 38 have been ejected, whereas one small package remains on the shelf means 38 in the units ④ , ⑤ , ⑦ , ⑧ and two small packages remain in the unit ⑥ , respectively. According to the present invention, the alarm lamp L lights for only the unit ⑥ in which two small packages remain to urge the operator to remove the packages.

Conventional machines have also required the operator to perform the same manual operation for the units ④ , ⑤ , ⑦ , ⑧ in which one small package remains, but this is not required by the present invention. That is, due to the reduced interval during which the packages are simultaneously transferred (that is, the second interval is shorter than the first interval), a full package may not have been formed prior to the subsequent simultaneous transfer, and the remaining small package is then ejected for adjustment.

Next, an example of a method for determining the second interval is described. This method determines the interval based on the yarn breakage occurrence rate in the machine.

In a draw texturing machine with N units, if A yarn breakages occur and A small packages are formed per hour, the yarn breakage rate can be expressed as A (number of packages / time x N).

| | |
|---|---|
| Yarn breakage rate | A (number of packages / time x N) |
| Number of units in the machine | N (number) |
| Time required to obtain a full package (first interval) | H (hours) |
| Number of STS transfers | Sn (times) |
| STS transfer cycle (second interval) | St (hours) |

If the yarn breakage rate is A (number of packages / time x N), A x H (number of packages / N) small packages are formed during a single doffing operation (H hours). It is assumed that yarn breakage evenly occurs in each unit and in terms of the diameter of the package. Then the number of all packages formed per doffing operation (including full and small packages and those being wound) can be expressed by the following equation.

| | |
|---|---|
| N (number) | Full and small packages |
| $N + \Sigma (A \times H)/(A \times H + 1)$ (number) | Packages being wound |

$$\text{(Number of all packages)} = \Sigma (A \times H) / (A \times H + 1)$$

$$\Sigma (A \times H) / (A \times H + 1) = \frac{(A \times H + 1) \times A \times H / 2 + N}{(A \times H + 1)}$$

$$= N + A \times H / 2 \quad \text{(number)}$$

That is, if D doffing operations are performed at an interval of H hours, $(N + A \times H / 2) \times D$ packages can be obtained. On the other hand, the STS transfers N packages at a time. Thus, if Sn transfer operations are required to transfer all these packages using the STS, the following equations are established.

$$N \times Sn = (N + A \times H / 2) \times D \quad \text{(number)}$$

$$Sn = (N + A \times H / 2) \times D / N = (1 + A \times H / 2N) \times D$$

On the other hand, if the STS transfer cycle (the second interval) is represented as St, the time required by the STS to execute Sn transfer operations is represented by St x Sn, during which D doffing operations are performed at an interval of H hours. Thus, the following equation can be given. $St \times Sn = D \times H$

Consequently, the second interval St can be expressed as follows.

$$St = D \times H / Sn = D \times H / (1 + A \times H / 2N) \times D = H / (1 + A \times H / 2N).$$

Specifically, if the number of units N = 216, the time required to obtain a full package (the first interval) H = 6 (hours), and the yarn breakage occurrence rate is 2.5 (number of packages / time x 216), the transfer cycle (the second interval) $St = H / (1 + A \times H / 2N) = 5.8$ (hours) .

The package grade determination system according to the present invention grades packages using not only inspection data on the weight and appearance of the packages but also data on the quality of yarn that is formed into packages. Thus, the accuracy in grading can be improved accordingly.

The present invention can identify data on packages that must be manually removed prior to the grading process because they are small packages that are inappropriate as products. Thus, quality data for the package processing machine and inspection data obtained after packages have been formed can be correlated with each other easily without confusion.

The present invention grades packages by combining quality data for the package processing machine and inspection data obtained after packages have been formed before storing them in the automatic warehouse. As a result, the packages can be stored and delivered depending on the total grade.

Since the present invention grades packages based on both tension and inspection data, multi-phase evaluation can be provided to increase the accuracy in grading.

The package transfer system for a draw texturing machine of the present invention reduces the interval during which packages are simultaneously transferred. As a result, even small packages can be automatically transferred to save the time and labor required to manually remove such packages.

The present invention reduces the second internal that is the transfer interval while considering the yarn breakage occurrence rate in the machine. Thus, it can minimize the decrease in transfer efficiency caused by the reduction in the transfer interval.

## Claims

1. A package grade determination system for a package processed by a package processing machine having a large number of units, comprising a yarn quality monitoring means for constantly monitoring data on the quality of processed yarn for each unit, a means for inspecting ,at least, weight or appearance of the package, a means for transferring the package ejected from each of said units to said inspection means while identifying the source of the package, and a means for combining data on each package from said yarn quality monitoring means and data on each package from said inspection means to determine the grade of each package.

2. A package grade determination system according to claim 1 wherein said grade determination means distinguishes data on packages removed instead of being transferred from said package processing machine to said transfer means from data on packages which are transferred thereto, both sets of data being generated by said yarn quality monitoring means.

3. A package grade determination system according to claim 1 or claim 2 including an automatic warehouse in which packages that have passed through said inspection means are stored.

4. A package grade determination system according to any one of the claims 1 to 3, wherein said package processing machine is a draw texturing machine and wherein said yarn quality monitoring means is a sensor for detecting an untwisting tension.

5. A package transfer system in a draw texturing machine having an individual drive device per unit comprising a doffing device for doffing a package when it becomes full or if an error occurs in yarn, a shelf means for temporarily storing doffed packages for each unit, a shutter means for simultaneously ejecting a leading package stored on each shelf means, a means for transferring packages simultaneously ejected to the exterior of the machine, and a control means for controlling the operation of said doffing means, shutter means, and transfer means, wherein said control means sets a second interval at which said transfer means executes transfer that is shorter than the first interval at which said full package is obtained.

6. A package transfer system according to claim 5 wherein the amount by which said second interval is set shorter than said first interval is predetermined by considering the probability of yarn breakage that may occur in the machine.

FIG. 1

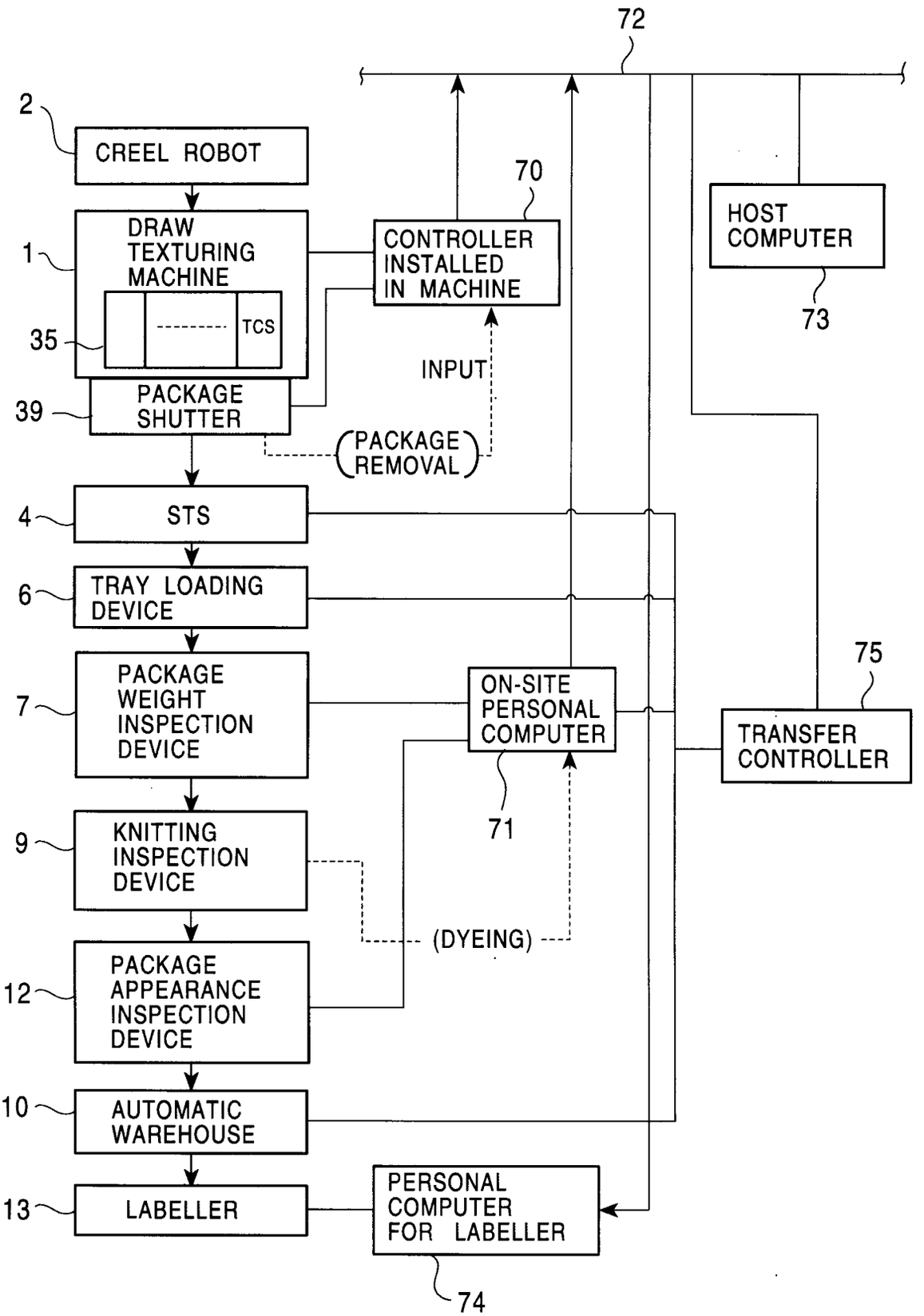

72
2
CREEL ROBOT
70
CONTROLLER INSTALLED IN MACHINE
HOST COMPUTER
1
DRAW TEXTURING MACHINE
TCS
35
73
INPUT
39
PACKAGE SHUTTER
PACKAGE REMOVAL
4
STS
6
TRAY LOADING DEVICE
75
7
PACKAGE WEIGHT INSPECTION DEVICE
ON-SITE PERSONAL COMPUTER
TRANSFER CONTROLLER
71
9
KNITTING INSPECTION DEVICE
(DYEING)
12
PACKAGE APPEARANCE INSPECTION DEVICE
10
AUTOMATIC WAREHOUSE
13
LABELLER
PERSONAL COMPUTER FOR LABELLER
74

FIG. 2

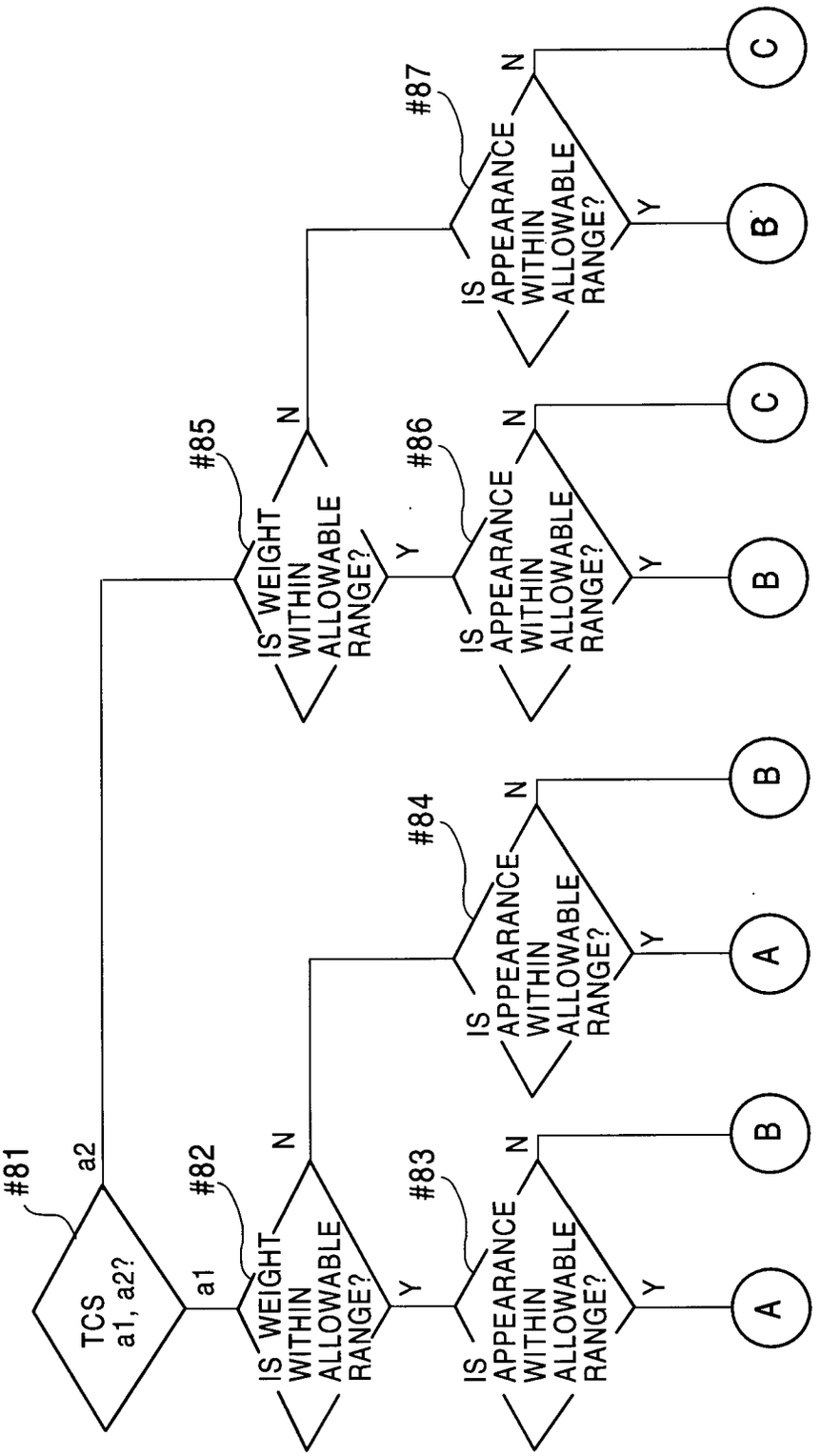

#81
TCS
a1, a2?
a2
a1
#82
IS WEIGHT WITHIN ALLOWABLE RANGE?
N
Y
#83
IS APPEARANCE WITHIN ALLOWABLE RANGE?
N
Y
A
B
#84
IS APPEARANCE WITHIN ALLOWABLE RANGE?
N
Y
A
B
#85
IS WEIGHT WITHIN ALLOWABLE RANGE?
N
Y
#86
IS APPEARANCE WITHIN ALLOWABLE RANGE?
N
Y
B
C
#87
IS APPEARANCE WITHIN ALLOWABLE RANGE?
N
Y
B
C

FIG. 3

| PACKAGE ID | MC NO. | SP NO. | DOFFING DATA AND TIME | GRADING TCS | WEIGHT GRADING | APPEAR ANCE GRADING | GRADE | DYEING | REMARK |
|---|---|---|---|---|---|---|---|---|---|
| 144-46 | 3 | 24 | 1996/12/25 14:23 | ○ | ○ | ○ | A | ○ | —— |
| 144-47 | 3 | 25 | 1996/12/25 12:10 | ○ | × | | A | ○ | —— |
| 144-48 | 3 | 26 | —— | —— | —— | —— | —— | —— | EJECTION |
| 144-49 | 3 | 27 | 1996/12/25 13:20 | ○ | × | × | B | ○ | |
| | | | | | | | | | |

FIG. 4

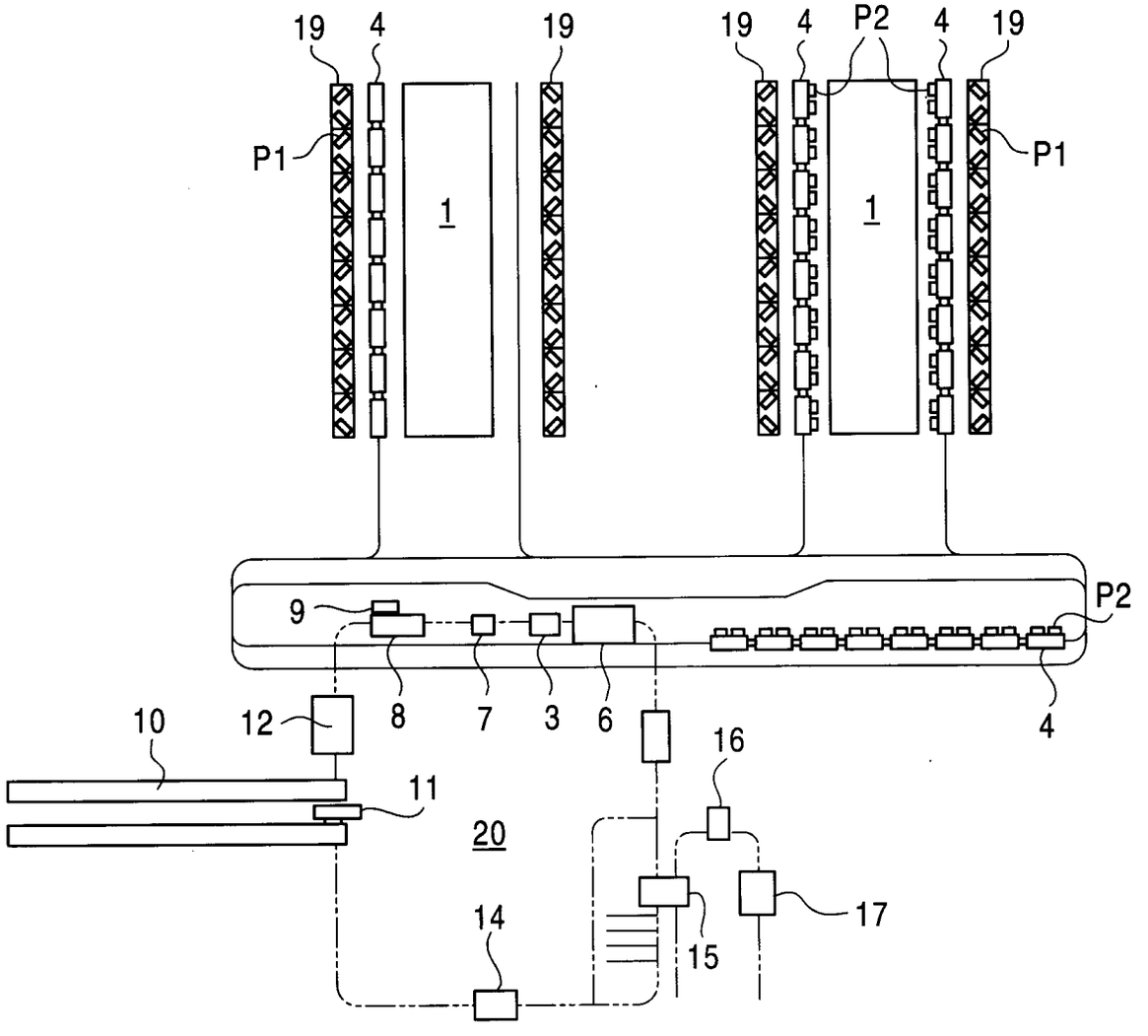


FIG. 5

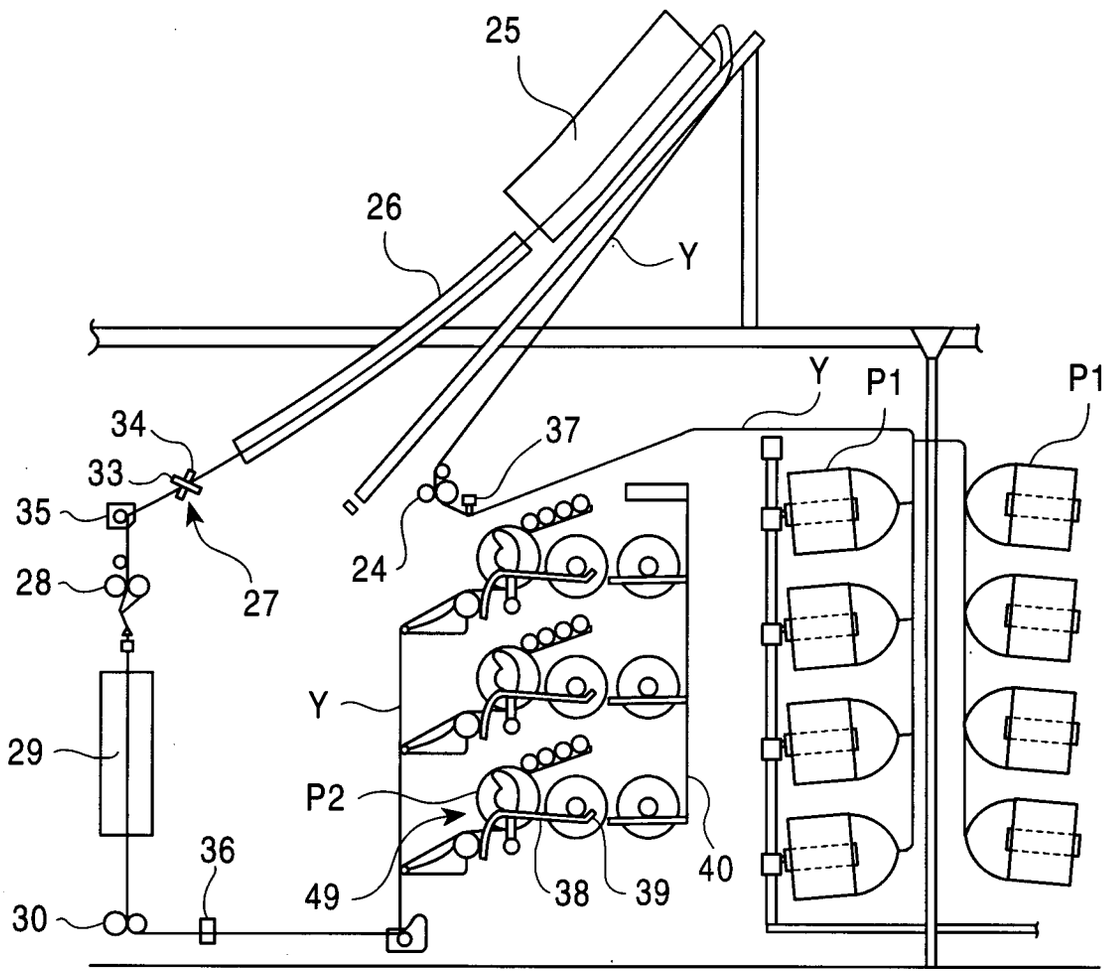


FIG. 6

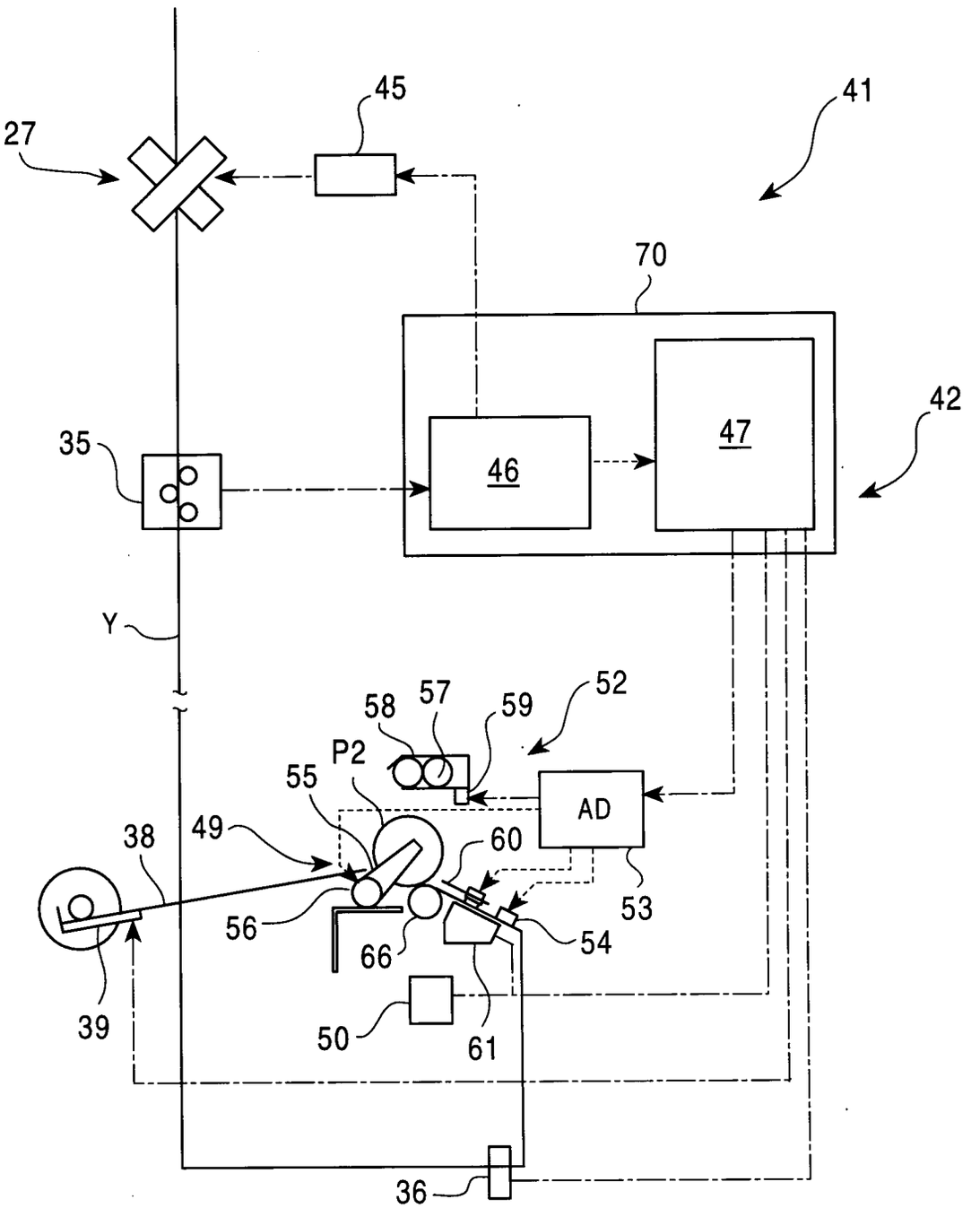

27
45
41
70
42
35
46
47
Y
58
57
59
52
P2
55
AD
38
49
60
53
56
54
66
39
50
61
36

FIG. 7

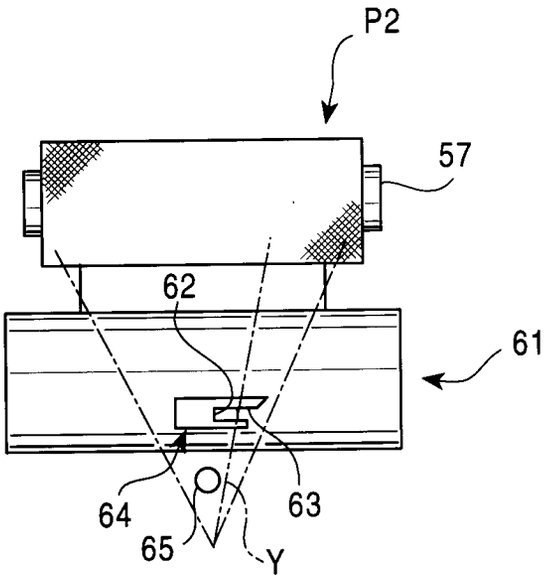

P2
57
62
61
64
65
63
Y

FIG. 8

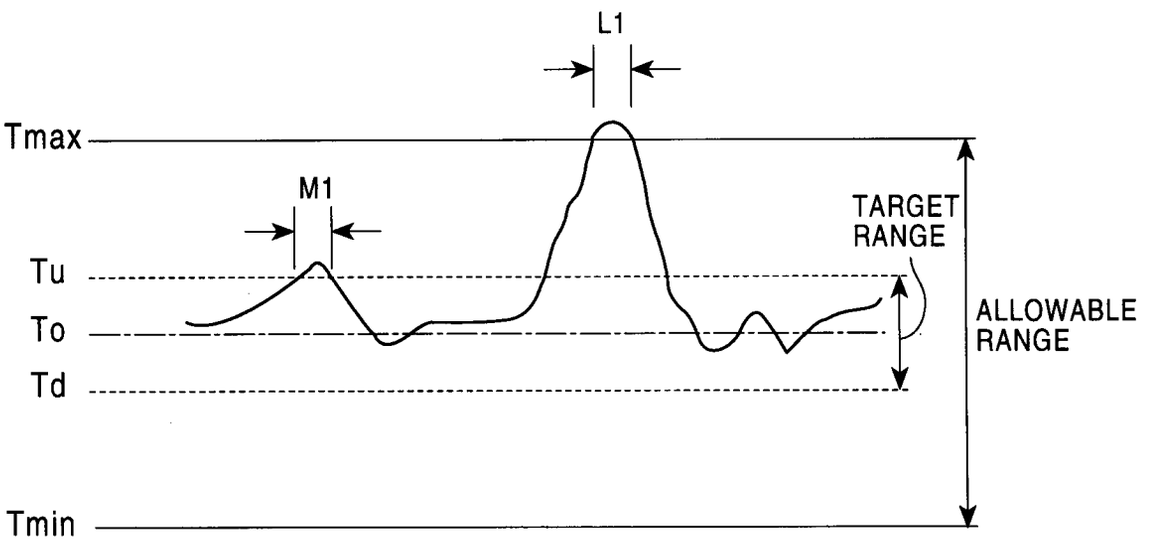

L1
Tmax
M1
TARGET RANGE
Tu
To
Td
ALLOWABLE RANGE
Tmin

FIG. 9

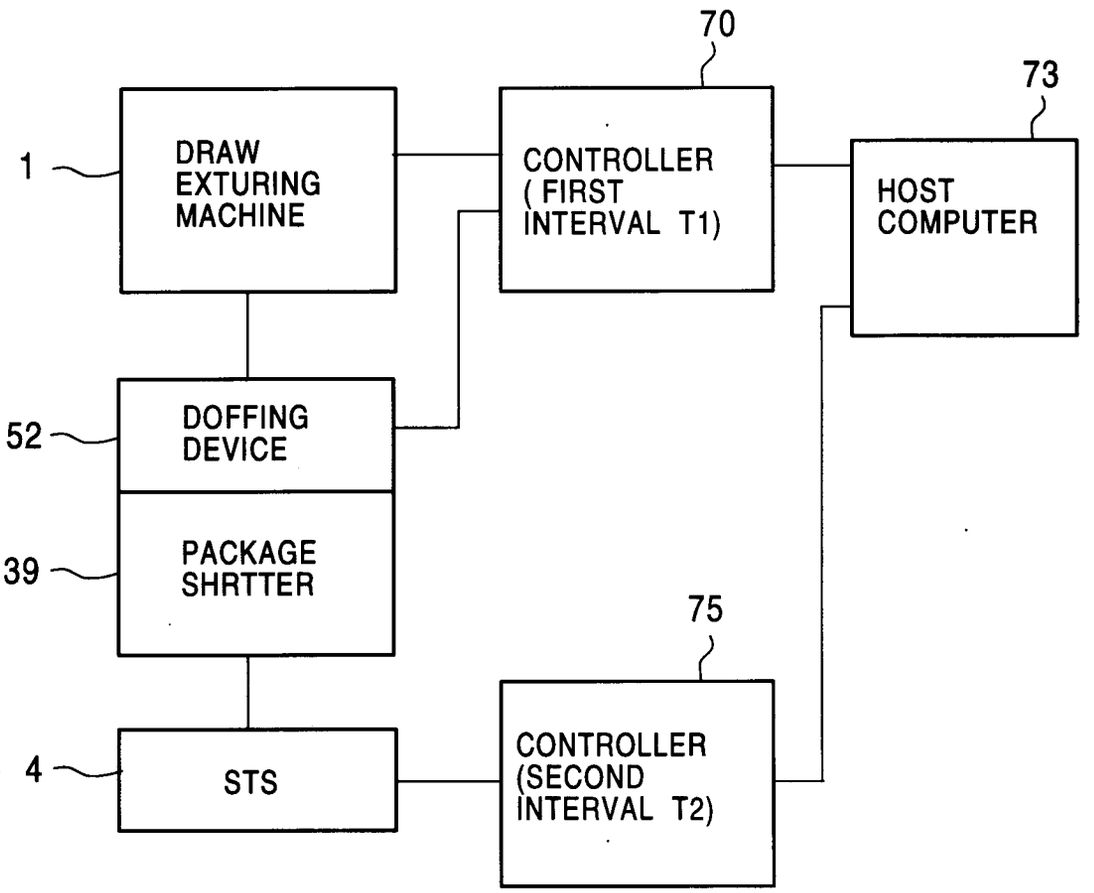

70
73
1
DRAW EXTURING MACHINE
CONTROLLER ( FIRST INTERVAL T1)
HOST COMPUTER
52
DOFFING DEVICE
39
PACKAGE SHRTTER
75
4
STS
CONTROLLER (SECOND INTERVAL T2)

FIG. 10

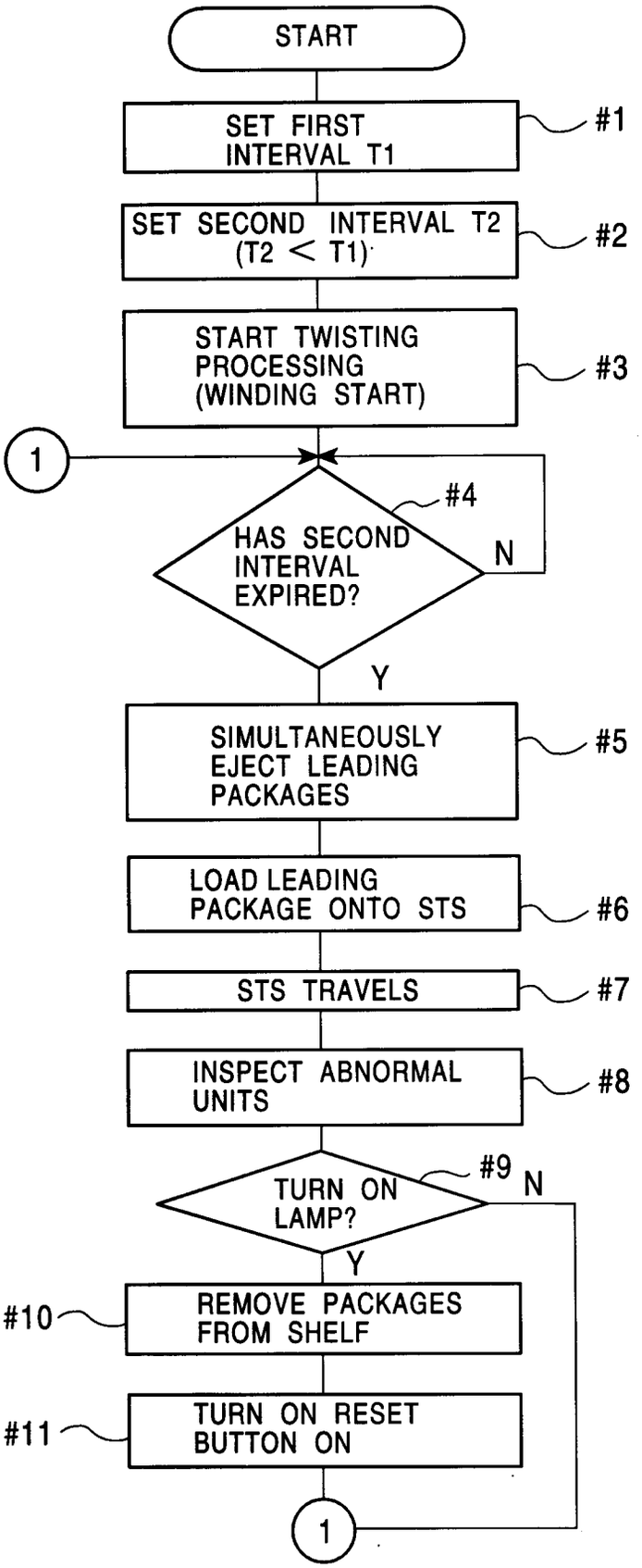

START
SET FIRST INTERVAL T1
#1
SET SECOND INTERVAL T2 (T2 < T1)
#2
START TWISTING PROCESSING (WINDING START)
#3
1
#4
HAS SECOND INTERVAL EXPIRED?
N
Y
SIMULTANEOUSLY EJECT LEADING PACKAGES
#5
LOAD LEADING PACKAGE ONTO STS
#6
STS TRAVELS
#7
INSPECT ABNORMAL UNITS
#8
#9
TURN ON LAMP?
N
Y
#10
REMOVE PACKAGES FROM SHELF
#11
TURN ON RESET BUTTON ON
1

FIG. 11

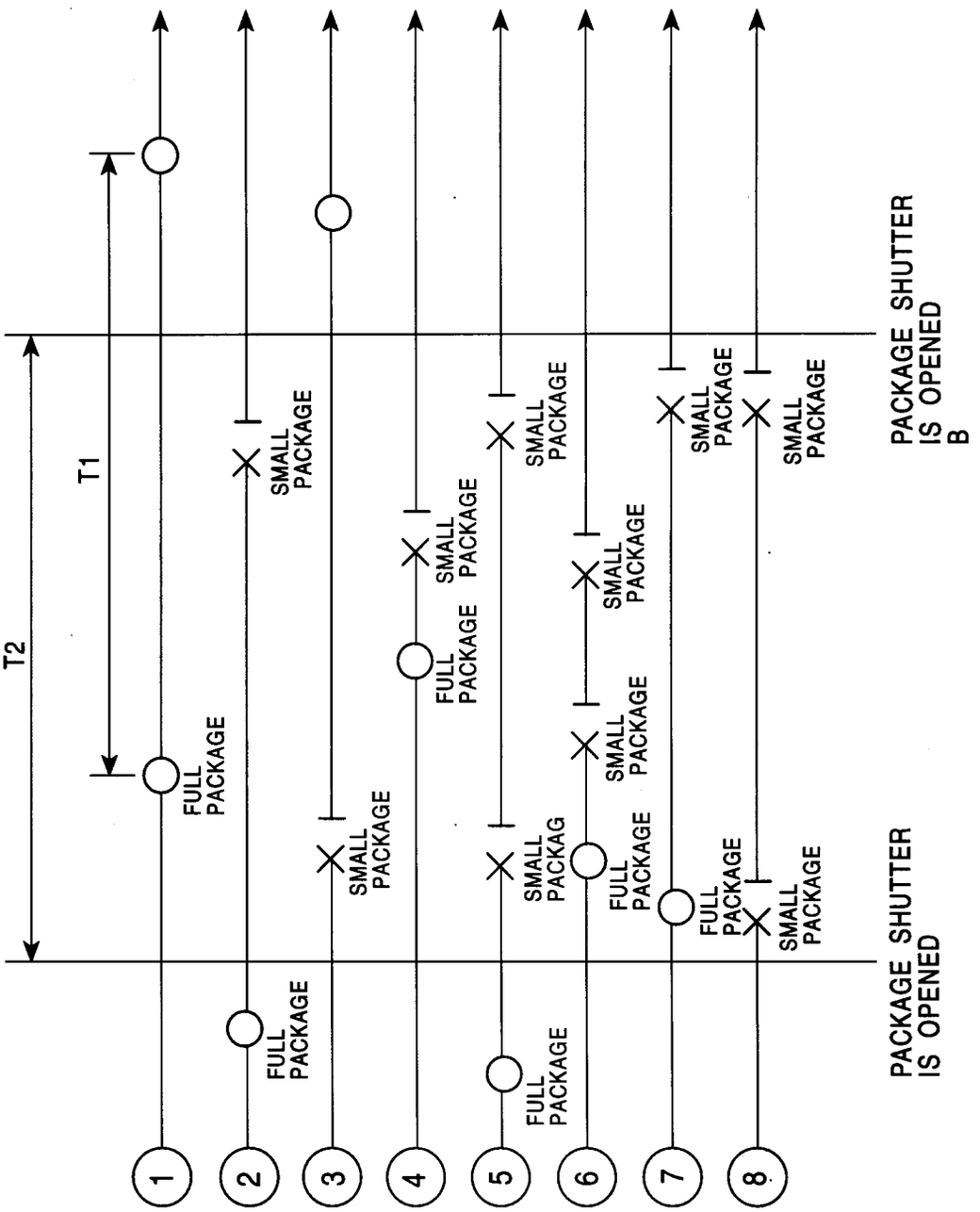
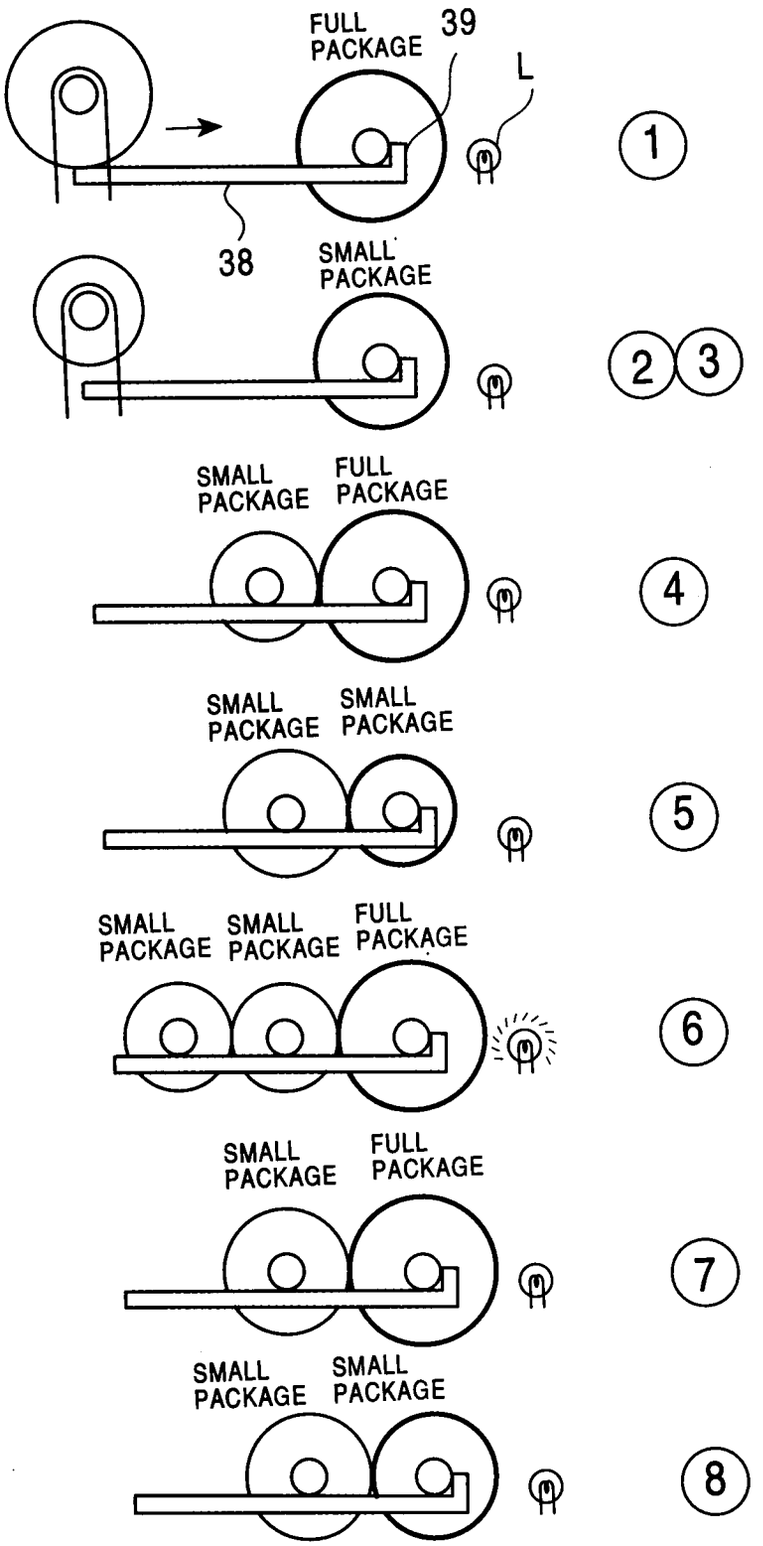

T2
T1
FULL PACKAGE
SMALL PACKAGE
PACKAGE SHUTTER IS OPENED
B
PACKAGE SHUTTER IS OPENED
1
2
3
4
5
6
7
8

FIG. 12


FULL PACKAGE
39
L
1
38
SMALL PACKAGE
2 3
SMALL PACKAGE
FULL PACKAGE
4
SMALL PACKAGE
SMALL PACKAGE
5
SMALL PACKAGE
SMALL PACKAGE
FULL PACKAGE
6
SMALL PACKAGE
FULL PACKAGE
7
SMALL PACKAGE
SMALL PACKAGE
8

European Patent Office

# EUROPEAN SEARCH REPORT

Application Number EP 97122442.3

## 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. 6) |
|---|---|---|---|
| A | US 5555712 A (K. NAKADE) 17 September 1996 (17.09.96), claims 1-3,7. -- | 1,2,5 | B 65 H 54/22 |
| A | US 4888945 A (Y. MAEDA) 26 December 1989 (26.12.89), claims 1,4,5,7,8. -- | 1,2,5 | |
| A | US 5531391 A (A. YAMAMOTO) 02 July 1996 (02.07.96), claims 1,9,10. -- | 1,5 | |
| A | DE 4333809 C2 (MURATA K.K.) 03 July 1997 (03.07.97), claims 1,2,10. ---- | 1,5 | |

TECHNICAL FIELDS SEARCHED (Int. Cl. 6)

B 65 H 54/00
B 65 H 63/00
B 65 H 69/00
D 01 H 7/00
D 01 H 13/00

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| VIENNA | 18-03-1998 | JASICEK |

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
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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

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