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**VACANT PACKAGE-PROOFING CONTROL DEVICE FOR PACKAGING MACHINE**

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(56) Prior Art Documents
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(57) Claim

1. A vacant package-proofing control system for a packaging machine, comprising:

a first motor for driving a conveyor for feeding articles to be packaged with a predetermined space defined therebetween into a packaging material which is to be formed into a tube;

a second motor for driving a plurality of rolls which deliver said packaging material formed into said tube at a position disposed downstream of said conveyor;

a third motor for driving a pair of sealers for achieving end-sealing of said packaging material formed into said tube in a crosswise direction relative to the line of feed of said articles to be packaged;

an absence detecting sensor disposed at a predetermined position upstream of a location at which said articles to be packaged are transferred from said conveyor to said tubular packaging material for detecting any absence of a packaging article being transported upon said conveyor with a predetermined amount of space defined between said articles, and for generating a signal in response to detection of said absence of said packaging article;

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reference timing pulse generating means for generating predetermined reference timing pulse signals with respect to said feeding of said packaging articles by said conveyor;

means for determining the coincidence of said absence detection signal from said absence detecting sensor and a reference timing pulse signal from said reference timing pulse generating means; and

means for stopping said second motor for feeding said packaging material and said third motor for achieving said end-sealing of said packaging material under gradual deceleration conditions in response to a determination of said coincidence of said absence detection signal from said absence detecting sensor and a reference timing pulse signal from said reference timing pulse generating means by said coincidence determining means, and after a predetermined duration of time during which said second and third motors are stopped for a predetermined number of cycles corresponding to the number of absent packaging articles, for starting said second and third motors under gradual acceleration conditions until the speeds and phases of said second and third motors are synchronized with those of said first motor for driving said conveyor.

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Complete Specification for the invention entitled:

Vacant Package-Proofing Control Device for Packaging Machine

The following statement is a full description of this invention, including the best method of performing it known to me/us

# VACANT PACKAGE-PROOFING CONTROL DEVICE FOR PACKAGING MACHINE

## FIELD OF THE INVENTION

This invention relates to a vacant package-proofing control device which can suitably prevent formation of vacant packages (packages containing no articles to be packaged) when feeding of packaging articles (articles to be packaged) to a bag-making/packing/packaging machine is interrupted separately or successively.

## BACKGROUND OF THE INVENTION

There has widely been known a horizontal bag-making/packing/packaging machine in which, while packaging articles are successively fed into a packaging material such as a film and the like being fed out horizontally into a form of tube through a bag-making device, and the longitudinal end portions of the tubular packaging material containing the packaging articles are subjected to lengthwise sealing on the overlapping faces, followed by crosswise sealing and cutting of the tubular packaging material on both sides of each packaging article to produce oblong pillow type packages successively. In this connection, the above longitudinal sealing is generally referred to as "center sealing"; whereas the crosswise sealing, "end sealing", and these latter mentioned terms will be used hereinafter, respectively.

The horizontal bag-making/packing/packaging machine mentioned above has various types of working mechanisms such as a conveyor for feeding packaging articles, feed rolls for delivering a packaging material, rolls for achieving

center-sealing, sealers for achieving end-sealing for the packaging material and others. The driving system in the conventional packaging machine described above has one main motor as a common driving source and is designed to drive a number of working mechanisms mentioned above in connection with one another through mechanical power transmission systems, respectively, using this motor.

Feeding of packaging articles to the above bag-making/packing/packaging machine is generally achieved by forwarding them at a necessary speed as carried on an endless chain of the above conveyor under engagement with attachments which are disposed thereon with a predetermined space. Accordingly, if it should happen that packaging articles are not supplied to any of the corresponding attachments of the conveyor for some reasons, feeding of the packaging articles to the tubular packaging material formed in the packaging machine is temporarily interrupted to form so-called absence of packaging article (there may be considered a case when such absence occurs separately and when two or more absence occur in succession). If such absence of packaging article should occur, "vacant package" containing no packaging article may be present among the intact packages to be formed successively by the packaging machine. Formation of such vacant packages will not only lead to waste of the packaging material but also involves inconveniences that a special device for separating and removing them from other intact packages is required. Therefore, when there is any absence of packaging article in the row of the packaging articles transported on the conveyor, it is necessary to take a measurement for preventing formation of such vacant packages.

Accordingly, in a conventional packaging machine having a purely mechanical constitution, procedures are used to detect absence of packaging article by means of a photo-

electric tube and the like in the row of the packaging articles fed with a predetermined space on the feed conveyor and stop the film delivering mechanism and the end-sealing mechanism based on the detection. For example, there has previously been employed a constitution wherein a detection section for detecting absence of packaging articles is disposed in the feed path of the feed conveyor; and a clutch which is actuated by the signal from this detection section is disposed for the respective driving sections of the packaging sheet delivering mechanism and the rotary sealing mechanism, so that the packaging sheet delivering mechanism and the rotary sealing mechanism may be stopped by actuation of the clutches during the absence of packaging articles from the feed conveyor.

However, in the packaging machine having the above constitution, great mechanical shock will be produced when the packaging sheet delivering mechanism and the rotary sealing mechanism are stopped or started by handling the clutches, and further it suffers a problem that it does not show high-speed response upon detection of any absence of packaging articles and others.

## OBJECT OF THE INVENTION

It is the object of the present invention to overcome or substantially ameliorate the above disadvantages.

There is disclosed herein a vacant package-proofing control system for a packaging machine, comprising:

a first motor for driving a conveyor for feeding article to be packaged with a predetermined space defined therebetween into a packaging material which is to be formed into a tube;

a second motor for driving a plurality of rolls which deliver said packaging material formed into said tube at a position disposed downstream of said conveyor;

a third motor for driving a pair of sealers for achieving end-sealing of said packaging material formed into said tube in a crosswise direction relative to the line of feed of said articles to be packaged;

an absence detecting sensor disposed at a predetermined position upstream of a location at which said articles to be packaged are transferred from said conveyor to said tubular packaging material for detecting any absence of a packaging article being transported upon said conveyor with a predetermined amount of space defined between said articles, and for generating a signal in response to detection of said absence of said packaging article;

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reference timing pulse generating means for generating predetermined reference timing pulse signals with respect to said feeding of said packaging articles by said conveyor;

means for determining the coincidence of said absence detection signal from said absence detecting sensor and a reference timing pulse signal from said reference timing pulse generating means; and

means for stopping said second motor for feeding said packaging material and said third motor for achieving said end-sealing of said packaging material under gradual deceleration conditions in response to a determination of said coincidence of said absence detection signal from said absence detecting sensor and a reference timing pulse signal from said reference timing pulse generating means by said coincidence determining means, and after a predetermined duration of time during which said second and third motors are stopped for a predetermined number of cycles corresponding to the number of absent packaging articles, for starting said second and third motors under gradual acceleration conditions until the speeds and phases of said second and third motors are synchronized with those of said first motor for driving said conveyor.

As has been described above, according to the vacant package-proofing device of this invention, each of the motors for delivering the packaging material and the motor for achieving end-sealing may be stopped with gradual deceleration when there is any absence of packaging articles on the conveyor and hence it is expected in such state that vacant packages are formed, and then they are started with gradual acceleration at the point when the packaging articles which are fed successively have compensated the number of absent packaging articles. Thus, formation of vacant packages can effectively be prevented. Moreover, since the sealers in the end-sealing mechanism may be controlled to stop at the positions completely separated from the packaging material, burning of the packaging material can effectively be prevented. Further, while the above motors are gradually decelerated when they are to be stopped, they may be gradually accelerated after they are started, whereby deviation of packaging articles from the regular positions which may be caused by the mechanical vibration and the like can be obviated even during high-speed operation.

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Further, when the motor for delivering the packaging material is in pause, a pair of sealing means or achieving center-sealing may be automatically approached or separated from each other in accordance with the timing to stop or start feeding of the packaging material, whereby burning of the packaging material which may be caused during the process of closing or opening of the center-sealing rolls can also be prevented.

## BRIEF DESCRIPTION OF THE DRAWINGS

A preferred form of the present invention will now be described by way of example with reference to the accompanying drawings, wherein:

Fig. 1 shows a block diagram of a control circuit to be employed in the vacant package-proofing control device according to this invention;

Fig. 2 shows an illustration of timing, with passage of time, of the motions of the conveyor and the sealers with the flow of the packaging material to which the articles to be packaged are inserted, when one packaging article is absent;

Figs. 3 and 4 each show a graphic illustration of the relationship between the number of revolution of the packaging machine and the open/close timing of the sealing rolls when one packaging article is absent;

Fig. 5 shows an illustration of timing, with passage of time, of the motions of the conveyor and the sealers with the flow of the packaging material to which the articles to be packaged are inserted, when two packaging articles are absent;

Fig. 6 shows a graphic illustration of the relationship between the number of revolution of the packaging machine and the open/close timing of the sealing rolls when two packaging articles are absent in succession;

Fig. 7 shows a graphic illustration of an example when the packaging machine is operated at a relatively high speed of revolution and also two packaging articles are absent in succession;

Fig. 8 shows a timing chart illustrating timing of each working member when the packaging machine is operated at low speed and absence of packaging article has been detected twice;

Fig. 9 shows a flow chart illustrating the function of the vacant package-proofing control device according to a preferred embodiment of this invention;

Fig. 10 shows an illustration where the control device according to this embodiment is employed in a triple motor-driven horizontal bag-making/packing/packaging machine.

## DETAILED DESCRIPTION OF THE INVENTION

Next, the vacant package-proofing control device for a packaging machine according to this invention will be described below by way of suitable embodiment referring to the attached drawings.

(DRIVING SYSTEM FOR THE PACKAGING MACHINE)

Fig. 10 shows an embodiment where the control device according to this invention is employed in a triple motor-driven horizontal bag-making/packing/packaging machine. This packaging machine essentially comprises a motor A for driving a conveyor 12 for feeding packaging articles (packaging articles) 10, a servomotor B for driving rolls (feed rolls) 18 for delivering a packaging material 16 and a servomotor C for driving an end-sealing mechanism 20.

The conveyor 12 is composed of an endless chain 24 and a plurality of attachments 14 fixed thereon with a predetermined space, so that the packaging articles 10 carried thereon under engagement with the attachments 14 may be fed into the packaging material 16 being formed into a tube through a bag-making device 26 disposed downstream the conveyor. The conveyor 12 is driven by the motor A through a sprocket-chain transmission system provided for a drive shaft 28 as shown in Fig. 10. The above motor A

is, for example, an AC induction motor and it is controlled to be operated at variable speed by a variable speed controller 30 such as an inverter as shown in Fig. 1 and the like.

A reference timing pulse generating means $S_1$ typified by a rotary encoder is provided for the above drive shaft 28. This reference timing pulse generating means $S_1$ generates pulses as a predetermined reference timing for the timing of feeding packaging articles 10 from the feed conveyor 12, and the present location of the packaging article 10 being transported on the conveyor 12 can be known by converting the number of pulses generated by the encoder into angle.

The sheet-form packaging material 16 delivered from a feed source (not shown) comprising a roll of sheet is supported between the above pair of feed rolls 18 to be delivered toward the bag-making device 26 disposed downstream the conveyor 12. The packaging material 16 having been formed into a tubular bag 16a through this bag-making device 26 is fed downstream with the overlapping faces along the longitudinal end portions thereof being supported between a pair of feed rolls 34.

Further a pair of heat-sealing rolls 36 are engageably provided so that they may be engaged (closed) while the packaging material 16 is under feeding to effect center-sealing of the above overlapped both end portions of the packaging material 16 by pressing the overlapped both end portions supported therebetween as it is fed. Incidentally, a motor 38 is provided as a drive source for achieving open/close motion of these center-sealing rolls 36, and this motor 38 is controlled as will be described below to effect supporting or releasing of the overlapped end portions by these two rolls 36. Alternatively, in

place of the use of the above motor 38, an actuator such as a solenoid, a hydraulic cylinder, etc. can be employed corresponding to respective design specifications. Further, in place of the illustrated center-sealing rolls 36, various types of sealing modes such as belt-sealing to support a portion to be sealed between a pair of rotating belt with pressure, slide nip-sealing to press-seal a portion to be sealed by a pair of nip rolls (unheated) as the portion to be sealed is passed through a pair of heated bars and others can suitably be employed corresponding to respective design specifications.

The above pair of feed rolls 18 are driven by the servomotor B through a belt-pulley transmission system as illustrated in Fig. 10. The power of the servomotor B is diverged through a drive shaft 32 to synchronously drive said pair of feed rolls 34 and the heat-sealing rolls 36. Revolution of the servomotor B is constantly detected by a rotary encoder $RE_1$ to effect servo-actuated control of the servomotor B by feeding back the number of revolution to the control circuit.

On the other hand the sealers 40 rotatably disposed to oppose each other in a vertical relationship in the end-sealing mechanism 20 are driven by the servomotor C through a belt-pulley transmission system, and this servomotor C is designed to be controlled by a rotary encoder $RE_2$ for servo-actuated control. As the sealers 40, there may suitably be employed, in place of the rotary sealing mechanism according to this embodiment, a so-called block motion system sealing mechanism in which sealers are moved horizontally and synchronously along the line of feeding the tubular bag 16a, ascended to be spaced from the tubular bag 16a and retracted horizontally from each other, and then descended again for horizontal motion.

As shown in Figs. 2 and 5, a sensor for detecting absence of packaging articles (absence detecting sensor) 42, for example, comprising a light emitting/receiving device is disposed upstream the point of delivering the packaging articles 10 from the conveyor 12, which is adapted to detect absence of the packaging articles 10 to be forwarded on the conveyor under engagement with the attachments 14, respectively. This absence detecting sensor 42 is disposed, for example, at a position shifted upstream from the original point of feeding the packaging articles from the conveyor 12, i.e. at the position corresponding to the second attachment from the above original point of delivery and performs detection for each of the packaging articles 10 passing the detection zone of the sensor 42. The sensor 42 detects any possible absence of the packaging article in the present cycle or in the cycle immediately before it and outputs a signal to a control circuit 22 to be described later. As will be described below in more detail, the control circuit 22 is designed to give a control command to stop the motors B and C with deceleration after waiting for the number of shifts preliminarily inputted at the position where the absence detecting sensor 42 is disposed in the conveyor 12.

(CONTROL CIRCUIT)

Fig. 1 shows schematically a block diagram of an exemplary control circuit to be employed in the vacant package-proofing control device according to the embodiment of this invention. Various data are inputted from outside to a central processing unit (CPU) in the control circuit 22, and commands based on the result obtained after operational processing of these inputted data are adapted to be given to the motor B for feeding the packaging material 16, the motor C for achieving end-sealing and the motor 38 for achieving open/close motion of the sealing rolls

36, respectively.

The control circuit 22 has an operational block 50 comprising an operational section for calculating the cycle stop timing $Q_0$ and an operational section for calculating gradual acceleration/deceleration coefficient of the motors B and C, and data including (1) the cut pitch for cutting the packaging material 16, (2) the height of the packaging article 10, and (3) the distance from the original point of feeding the packaging articles 10 into the tubular bag 16a to the sealers 40 are inputted to this operational block 50 by means of an external inputting means such as a keyboard, etc, and the resulting calculated output is inputted to a vacant package-proofing control block 52. The term "acceleration/deceleration coefficient of the motor" used herein is intended to mean the degree of smoothness in the motion of the motor when it is accelerated or decelerated (i.e. the degree that the motor rotates slowly or rapidly), which is defined by a coefficient of, for example, 1 to 9. Accordingly, if the coefficient of the motor is set at 5, the deceleration for stopping the motors B and C or starting them with acceleration will be achieved in the range of 180° [360° (a full rotation of the reference timing pulse generating means $S_1$) x 5/10]. Also, each of the above sealers 40 makes a turn which corresponds to 1/2 rotation of the reference timing pulse generating means $S_1$, i.e. a rotation of only 90° as the result of the decelerated stopping or accelerated starting of the motor C, depending on the above condition. The rotation angle of the reference timing pulse generating means $S_1$ to those of the sealers 40 constantly keep a ratio of 1/2. Incidentally, the acceleration/deceleration coefficient of the motors B and C and the cycle stop timing $Q_0$ are adapted to be inputted to the above operational block 50, as necessary, as correction data.

Absence detection signals from the absence detecting sensor 42 are inputted through an input port 54 to one of the inputting sections of an AND circuit 60; whereas the reference timing pulses and the number of revolution in the conveyor 12 are separately derived from the pulse signals from the reference timing pulse generating means $S_1$, and the former number of timing pulse is inputted to a timing setting section 58 together with the absence detection reference timing (absence detection timing) to be inputted by means of a keyboard and the like. The latter number of revolution is directly inputted to the vacant package-proofing control block 52. The timing setting section 58 inputs deviation timing signals inputted by means of the keyboard based on the reference timing signals from the reference timing signal generating means $S_1$ to the other inputting section of the AND circuit 60. In this AND circuit 60, "absence detection" signals are inputted to a shift setting means 56, based on the AND provision that the absence detection signal from the absence detecting sensor 42 coincides with the absence detection timing signal to be inputted from the timing setting section 58 should concur.

To this shift setting means 56, the number of shifts to be defined by means of a keyboard and the like is inputted, and upon receipt of the "absence detection" signal from the AND circuit 60, the shift setting means 56 is allowed to wait for a period based on the required number of shifts and then outputs a command signal to the vacant package-proofing control block 52.

Thus, the vacant package-proofing control block 52 gives control commands to the motor B for feeding the packaging material 16 and the motor C for achieving end-sealing through servo amplifiers 61 and 62, respectively, to stop under gradual deceleration or start with gradual accelera-

tion, and also to give commands of disengagement (opening) and commands of engagement (closing) through an output port 64 to the motor 38 for achieving open/close motion of the sealing rolls 36.

Next, function of the vacant package-proofing control device according to the embodiment of this invention having such constitution will be described. In the undesired formation of vacant packages mentioned above, there are cases when such absence of the packaging articles 10 being forwarded on the conveyor under engagement with the attachments 14 happens singly and when there are two or more such absence of packaging articles 10 in succession. Therefore, description will be made on the respective cases.

Fig. 2 shows an illustration of timing with passage of time of the motions of the conveyor 12 and the sealers 40 with the flow of the packaging material 16 to which the packaging articles 10 in the direction indicated with an arrow are inserted when there is an absence of one packaging article; wherein the attachments 14 attached with a predetermined space moving on the feed conveyor 12 are designed to push forward corresponding packaging articles 10 in the direction indicated with an arrow and feed them one by one into the packaging material 16 which is fed downstream at a predetermined speed to be formed into a tube. The absence detecting sensor 42 is disposed at a position shifted at least to the position of the second attachment upstream from the point of transferring the packaging articles 10 relative to the feed conveyor 12, to monitor constantly absence of packaging articles 10 passing by the detection zone of the sensor 42. On the other hand, the reference timing pulse generating means $S_1$ generates pulses continuously as a necessary reference timing for the time of feeding the packaging articles 10

from the conveyor 12 for feeding packaging articles to be driven by the motor A, to output them to the timing setting section 58 shown in Fig. 1.

In Step 1 of Fig. 2, when the third attachment 14c upstream from the point P of transferring the packaging articles 10 from the conveyor 12 appears having no packaging article 10 engaged therewith, i.e. in article-free state, the above sensor 42 detects this absence to input an absence detection signal to the above input port 54 of the control circuit 22. The above timing setting section 58 generates one timing pulse as the absence detection timing signal based on the absence detection timing to be inputted by means of a keyboard and the like in one rotation (360°) of the rotary encoder constituting the reference timing pulse generating means $S_1$. This pulse agrees with the rising pulse which is an "article presence" signal to be outputted by the absence detecting sensor 42 as shown in the timing chart of Fig. 8. In this regard, the intervals between the rising pulses outputted from the absence detecting sensor 42 can be regarded as the cycle of feeding the packaging articles 10 being forwarded successively under engagement with the corresponding attachments 14.

If coincidence of the absence detection signal ("no packaging article") from the absence detecting sensor 42 and the absence detection timing signal from the timing setting section 58 should occur in the AND circuit 60 shown in Fig. 1 as the AND provision, the vacant package-proofing control block 52 gives a deceleration command to the motor B for feeding packaging material 16 and the motor C for achieving end-sealing, and both motors B and C are stopped with gradual deceleration. However, as will be described later referring to Fig. 9, the above sensor 42 is not only designed to stop immediately the two motors

B and C with gradual deceleration to stop feeding of the packaging material 16 and the motions of the sealers 40 with gradual deceleration upon identification of the absence of the packaging article, but the sensor 42 also monitors thereafter if a packaging article 10 is forwarded by the following fourth attachment 14d or not.

In Step 2 of Fig. 2, when the absence detecting sensor 42 detects presence of the packaging article 10 in the fourth attachment 14d, the two motors B and C are controlled to start deceleration after waiting until the present location $Q_1$ of the packaging article under feeding to be known from the reference timing pulse generating means $S_1$ agrees with the cycle stop timing $Q_0$ as will be described later referring to the flow chart of Fig. 9. Accordingly, the packaging material 16 under feeding by the motor B and formed into a tube through the bag-making device 26 is forwarded at normal speed until the packaging article 10 forwarded under engagement with the second attachment 14b (the one preceding the attachment 14c in which the packaging article is absent) is fed into the packaging material at the point of transfer P.

As shown in Step 3 of Fig. 2 and in Fig. 3 (to be described later), a control is achieved for starting deceleration of the motor B for delivering the packaging material 16 to stop it when it has made a 180° turn in terms of an angle conversion of the encoder $S_1$. The motor C for driving the sealers 40 is also controlled to start deceleration to stop at the point when the sealers 40 have reached the positions where they are free from contact with the tubular packaging material 16 as a result of the 180° turning in terms of an angle conversion of the encoder $S_1$, i.e. where the sealers 40 have made a 90° turn from their positions of engagement. (In the present specification, the above control is achieved when the

cycle stop timing $Q_0$ has been set to be at the position of engagement of the sealers 40 and the original point P of transferring the packaging article 10 from the conveyor 12, provided that the acceleration/deceleration coefficient described above has conveniently been set at 5. In such situation, although the sealers 40 are controlled to stop at the point where they have made a 180° turn in terms of an angle conversion of the encoder in the reference timing pulse generating means $S_1$, which corresponds to 1/2 cycle, the rotation angle of the sealers 40 themselves will be only 90° because of the decelerated stopping.)

It should be noted that the stop angle of the sealers 40 to be achieved as a result of the decelerated stopping will automatically be set to be at positions such that they may be free from contact with the above tubular packaging material 16, since the preset values of the above acceleration/deceleration coefficient and the cycle stop timing $Q_0$ are calculated from the inputted data to be inputted by means of a keyboard and the like including the cut pitch for cutting the packaging material 16, the height of the article, etc., whereby contact between the sealers 40 with the packaging material 16 can be obviated when the sealers 40 are decelerated for stopping to prevent undesired burning of the packaging material 16. Further, the above conveyor 12 is operated at a steady state speed and with the phase irrespective of the decelerated stopping or accelerated starting the above motors B and C.

Next, as shown in Step 4 of Fig. 2, when the packaging article 10 under engagement with the fourth attachment 14d compensates for the absent pitch formed by the third attachment 14c, i.e. when the present location $Q_1$ of the packaging article 10 under feeding is synchronized with the cycle stop timing $Q_0$, the two motors B and C in pause

are controlled to be started with gradual acceleration. After gradual acceleration of the motors B and C until the speeds and phases thereof may be synchronized with the steady state speed and phase of the motor A for driving the conveyor 12, they are continued to be operated at the steady state speed, respectively.

As has been described heretofore, according to the device of this embodiment, the motor B for delivering the packaging material 16 and the motor C for driving the sealers 40, after it is allowed to wait (be shifted) until the present location $Q_1$ of the packaging article 10 under feeding agrees with the cycle stop timing $Q_0$, are stopped under gradual deceleration. After a duration of stopping for a necessary period, the motors B and C are started with acceleration. Namely, the motors B and C do not make any abrupt stop or start, if any absence of packaging article 10 should be detected, so that neither vibration nor shock may suddenly be generated in the system itself and that deviation of the packaging article 10 can effectively be prevented. Moreover, since the sealers 40 are allowed to locate at positions where they are completely free from contact with the packaging material 16 when they are stopped, burning of the packaging material 16 to be caused by the contact with the sealers 40 can effectively be prevented, advantageously.

Fig. 5 illustrates, with passage of time, the timing of the motions of the conveyor 12 and the sealers 40 with the flow of the packaging material 16 to which the packaging articles 10 are inserted, when two packaging articles are absent. In such a situation, as shown in Steps 1 and 2 of Fig. 5, the absence detecting sensor 42 detects first absence in the third attachment 14c and the second absence in the fourth attachment 14d, respectively. Upon detection of the absence of two packaging articles 10 in

succession, the two motors B and C are allowed to start deceleration after waiting until the present location $Q_1$ of the packaging article 10 under feeding is synchronized with the cycle stop timing $Q_0$. Incidentally, the feed conveyor 12 is operated at steady state speed even after stopping of the two motors B and C, and acceleration of these motors B and C are started when the absence of two preceding packaging articles has been compensated with the packaging article under engagement with the fifth attachment 14e, i.e. when the present location $Q_1$ of the packaging article 10 under feeding agrees with the cycle stop timing $Q_0$. Upon synchronization of the speeds and phases of the two motors B and C with those of the motor A for driving the feed conveyor 12, the above control is completed.

(OPEN/CLOSE CONTROL OF SEALING ROLLS)

Now, in the packaging machine according to the embodiment, the overlapping longitudinal end portions of the packaging material 16 are subjected to center-sealing by means of the rolls 36 as described above. In the above process, there remains a problem about how the operation of opening or closing the sealing rolls 36 should be made when feeding of the packaging material 16 and the rotation of the sealers 40 are stopped upon identification of any absence of the packaging article 10. The reason is that if the sealing rolls 36 remain closed when feeding of the packaging material 16 is stopped upon occurrence of the absence, the packaging material 16 which is in contact with the rolls 36 will be melted or burnt.

Accordingly, when the feeding of the packaging material 16 and the rotation of the sealers 40 are stopped upon detection of any absence of packaging article 10, the center-sealing rolls 36 should also positively be disengaged to

be spaced from the packaging material 16.

However, due to the time lag to be generated associated with the motions of closing and opening the sealing rolls 36, if the opening or closing process respectively requires, for example, 0.2 second, a mechanical difficulty occurs that the above speed may be too slow to follow the stop/start cycle of the two motors B and C for a packaging machine which is operated at high cycle. Thus, in the present embodiment, a control is achieved wherein the open/close motion of the rolls 36 is used only when the timing of closing the sealing rolls 36 is delayed relative to the timing of opening the sealing rolls 36, otherwise no open/close motion of the sealing rolls 36 is used.

Figs. 3 and 4 each show a graphic illustration of the relationship between the revolution of the packaging machine and the open/close timing of the sealing rolls 36 when there is an absence of one packaging article; wherein Fig. 3 shows when the packaging machine is operable at a relatively low speed; whereas Fig. 4 shows when the packaging machine is operable at a relatively high speed. Now, referring first to Fig. 3, an example when the packaging machine has a low speed revolution of 60 packages/minute (cycle time: 1 second), wherein the time to be required for closing the sealing rolls 36 is preset, for example, at 0.2 second as described above. As can be seen from the curve shown in Fig. 3, when the cycle stop timing $Q_0$ is preset at 0° in terms of the angle conversion of the feeding encoder $S_1$, deceleration of the two motors B and C is started gradually from the beginning of the next cycle, i.e. when the rotation angle of the encoder $S_1$ becomes 0°, upon detection of the absence of one packaging article, to stop at the positions where they have made an advance of 180° in terms of the angle conversion of the feed encoder $S_1$, i.e. at the middle of one cycle.

This state of stopping continues from the positions of 180° in terms of the angle conversion of the encoder $S_1$ to the next 0°, i.e. from the end point of the present cycle to the beginning of the next cycle (cycle stop timing $Q_0$), and upon initiation of the next cycle, gradual acceleration of the two motors B and C are started. In the next cycle, at the positions where they have made an advance of 180° in terms of the angle conversion of the feeding encoder $S_1$, the speeds and phases of the two motors B and C are synchronized with the revolution (60 rpm) and phase of the motor A for driving the conveyor 12 to resume steady state operation.

In this process, in view of the open/close timing of the sealing rolls 36, the opening timing therefor is first set at 0.5 second after completion of stopping of the above two motors B and C. After closing of the rolls 36 which requires 0.2 second as described above, and also at the point when the two motors B and C are started, the rolls 36 should completely be closed. Taking these time allowance into consideration, the two rolls 36 once made open should be resuming the closing motion 0.8 second after starting of the cycle which is repeated every one second. Namely, since the timing of opening the two rolls 36 can precede the timing of closing them based on the cycle stop timing $Q_0$, opening and closing of the sealing rolls 36 are conveniently achieved while the two motors B and C are in pause.

Therefore, as shown in Fig. 4, for example, when the revolution of the packaging machine is as high as 200 packages/minute (cycle time: 0.3 second), the timing of closing the sealing rolls 36 can be found to be 0.1 second after starting of the deceleration of the two motors B and C when calculated back based on the cycle stop timing $Q_0$.

On the other hand, it is 0.15 second after these motors B and C have advanced to the positions of 180° in terms of the rotation angle of the rotary encoder in the reference timing pulse generating means $S_1$ when they are stopped completely, and at the point after passage of this 0.15 second, the timing of opening the sealing rolls 36 is set. In this situation, since the closing timing comes to precede the opening timing, a control for locking the open/close motion of the two rolls 36 is achieved. Namely, when the closing timing can be set only in the process of the deceleratiin motion of the two motors B and C in determining the closing timing to be discussed later referring to Fig. 9 upon reading of the actual feed revolution of the feed conveyor 12 by the reference timing pulse generating means $S_1$, the two rolls 36 are adapted to perform no open/close motion.

Next, in Fig. 6, a graphic illustration of the relationship between the revolution of the packaging machine and the open/close timing of the sealing rolls 36 when there is an absence of two packaging articles in succession is shown, in which the revolution of the packaging machine is relatively as low as 60 packages/minute (cycle time: 1 second) similarly to the case shown in Fig. 3. Fig. 7 shows an example where the revolution of the packaging machine is relatively as high as 200 packages/minute (cycle time: 0.3 second) similarly to the case shown in Fig. 4.

The relationship described referring to Fig. 3 basically applies to the example shown in Fig. 6. However, because of the absence of two successive packaging articles, the motors B and C are stopped additionally for another cycle, whereby the period during which the center-sealing rolls 36 are kept open to be preset will be the longer. The timing of closing the sealing rolls 36 will be set such

that the sealing rolls 36 may start closing 0.2 second earlier relative to the cycle stop timing $Q_0$ which is the end of the second cycle. Accordingly, during such low speed operation, the open/close motion of the sealing rolls 36 can be achieved without any difficulty.

The relationship shown in Fig. 7 is basically the same in the function as the one described referring to the above Fig. 4, except that there is a difference only in the number of absence, i.e. 1 or 2, and the motors B and C are controlled to stop for another additional cycle. Namely, the motors B and C, after starting of deceleration, stop when they have advanced to the positions of 180° in terms of an angle conversion of the encoder $S_1$ to be kept in pause for 0.15 second, and after a duration of this period the sealing rolls 36 are opened unconditionally.

On the other hand, the sealing rolls 36 are required to be closed completely after passage of 0.6 second when the motors B and C are to be started. Accordingly, the timing of closing the rolls 36 is set to be at the point 0.4 second after starting of the deceleration of the motors B and C, based on the provision that the closing of the two rolls 36 takes 0.2 second (0.6 sec. - 0.2 sec. = 0.4 sec.).

Next, Fig. 8 shows a timing chart illustrating (1) the operation state of the motors B and C; (2) the open/close operation of the motor for achieving open/close motion of the sealing rolls 36; and (3) the relationship between the absence detection timing and the behavior of the absence detecting sensor 42 an so on when absence of packaging article has been detected twice. Incidentally, while pulses are generated with a predetermined interval through on/off operation to provide the absence detection timing, the absence detecting sensor 42 detects any absence of

packaging articles 10 forwarded under engagement with the respective attachments 14.

The above sensor 42 also detects movement of the attachment 14 itself on the conveyor 12 to output a momentary pulse as shown in Fig. 8 when the attachment 14 passes with no packaging article 10. In this case, if the rising of the momentary pulse upon detection of the attachment 14 happens to coincide with the pulse of the absence detection timing, the above mentioned AND condition will be nullified in spite of the absence of packaging article. Therefore, the absence detecting sensor 42 is designed to detect the attachment 14 at a position off the absence detection timing pulse.

Fig. 9 shows a flow chart illustrating the function of the vacant package-proofing control device according to the present embodiment. The above absence detecting sensor 42 detects absence of packaging article in the attachment 14 passing the detection zone of the sensor in the present cycle and further in the subsequent cycle. In this chart, for the convenience of explanation, an example is shown where two sets of absence detecting sensors 42 are used. However, the number of sensors 42 to be employed may be one or two as necessary. The flow of the function shown in this chart will be described below depending on the case.

(In case of absence of one packaging article)

When absence of packaging article is detected only in the present cycle and not in the subsequent cycle, the flow line transits to the flow system shown on the right side of the chart. Namely, upon detection of an absence of one packaging article 10, the motors B and C start deceleration after waiting until the present location $Q_1$ to be

known from the reference timing pulse generating means $S_1$ agrees with the cycle stop timing $Q_0$. On the other hand, the reference timing pulse generating means $S_1$ reads the number of revolution in the feed conveyor 12 to determine the timing of closing the sealing rolls 36. The determination of this closing timing is achieved by calculating every time the closing timing $Q_c$ in terms of the rotation angle from the value of time Tc required for closing the rolls 36 and the revolution N of the packaging machine.

For example, if the time Tc for closing the rolls is 0.2 second (Tc = 0.2 sec.), and the revolution N of the packaging machine is 60 rpm (N = 60 rpm), the period for one cycle will be 1 second (t = 1 sec.).

$\therefore$ $Q_c = 360° \times (t - Tc/t)$

It can be seen that the closing timing will be at the positions where the motors have advanced to 288° in terms of the rotation angle obtained from 360° x (1 - 0.2/1).

Upon determination of the closing timing $Q_c$, judgment is made if the opening timing precedes the closing timing based on the cycle stop timing $Q_0$. As described above referring to Fig. 3, when the packaging machine is operable at low revolution, and the opening timing precedes the closing timing in one cycle starting from the original point of feeding, the rolls 36 are disengaged after waiting until the opening timing agrees with the present location $Q_1$. Subsequently, closing of the sealing rolls 36 are started upon agreement of the closing timing which is 0.2 second before the cycle stop timing $Q_0$ (also the timing for starting the two motors B and C) with the present location $Q_1$. The motors B and C are started with acceleration upon achievement of the present location $Q_1$ = cycle stop timing $Q_0$

Incidentally, when it is judged that the closing timing will be preceding the opening timing, i.e. when the packaging machine is operated at a too high revolution for the opening timing to precede the closing timing in one cycle starting from the original point of feeding, each of the above-mentioned open/close operations of the rolls 36 are entirely skipped and the motors B and C are started with acceleration upon achievement of the present location $Q_1$ = cycle stop timing $Q_0$.

(In case of absence of two packaging articles)

When absence of packaging article is detected both in the present cycle and in the subsequent cycle, by the absence detecting sensor 42, respectively, the sensor 42 memorizes the second absence and proceed onto the flow system continuing directly below for "absence of two or more articles". Upon agreement of the present location $Q_1$ to be known from the reference timing pulse generating means $S_1$ with the cycle stop timing $Q_0$, deceleration of the motors B and C is started. After starting of the deceleration of the motors B and C and after waiting until the present location $Q_1$ agrees with the opening timing which has been calculated beforehand, i.e. the timing for stopping the motors B and C, the sealing rolls 36 are disengaged unconditionally.

Subsequently, the second absence memorized previously by the absence detecting sensor 42 is confirmed here (wherein in case of the second or further absence, the flow line proceeds onto YES), and then the reference timing pulse generating means $S_1$ reads the number of revolution of the conveyor 12 after waiting until the present location $Q_1$ agrees with the cycle stop timing $Q_0$. After calculation of the timing for closing the sealing rolls 36, detection of absence by the detecting sensor 42 is confirmed again.

If a third absence is not identified here, closing of the sealing rolls 36 is started upon agreement of the present location $Q_1$ with the closing timing which have been calculated previously. Further, upon agreement of the present location $Q_1$ with the cycle stop timing $Q_0$, the motors B and C are started with acceleration.

The claims defining the invention are as follows:

1. A vacant package-proofing control system for a packaging machine, comprising:

a first motor for driving a conveyor for feeding articles to be packaged with a predetermined space defined therebetween into a packaging material which is to be formed into a tube;

a second motor for driving a plurality of rolls which deliver said packaging material formed into said tube at a position disposed downstream of said conveyor;

a third motor for driving a pair of sealers for achieving end-sealing of said packaging material formed into said tube in a crosswise direction relative to the line of feed of said articles to be packaged;

an absence detecting sensor disposed at a predetermined position upstream of a location at which said articles to be packaged are transferred from said conveyor to said tubular packaging material for detecting any absence of a packaging article being transported upon said conveyor with a predetermined amount of space defined between said articles, and for generating a signal in response to detection of said absence of said packaging article;

reference timing pulse generating means for generating predetermined reference timing pulse signals with respect to said feeding of said packaging articles by said conveyor;

means for determining the coincidence of said absence detection signal from said absence detecting sensor and a reference timing pulse signal from said reference timing pulse generating means; and

means for stopping said second motor for feeding said packaging material and said third motor for achieving said end-sealing of said packaging material under gradual deceleration conditions in response to a determination of said coincidence of said absence detection signal from said absence detecting sensor and a reference timing pulse signal from said reference timing pulse generating means by said coincidence determining means, and after a predetermined duration of time during which said second and third motors are stopped for a predetermined number of cycles corresponding to the number of absent packaging articles, for starting said second and third motors under gradual acceleration conditions until the speeds and phases of said second and third motors are synchronized with those of said first motor for driving said conveyor.



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2. A vacant package-proofing control system for a packaging machine according to claim 1, further comprising:

means for stopping said pair of sealers at positions where they are free from contact with said packaging material when said third motor for achieving said end-sealing is stopped under said gradual deceleration conditions.

3. A vacant package-proofing control system for a packaging machine according to claim 1, further comprising:

a control means for stopping said pair of sealers for achieving said end-sealing of said packaging material at predetermined positions based upon the calculation of inputted data including the cut pitch for cutting said packaging material, and the height of said packaging article.

4. A vacant package-proofing control device for a packaging machine according to claim 1, having:

a motor for driving a conveyor for feeding articles to be packaged with a predetermined space therebetween into a packaging material which is delivered downstream being formed into a tube;

a motor for driving a series of rolls which deliver downstream the packaging material into a tubular form;

a motor for driving a pair of sealers for achieving end-sealing of the packaging material formed into a tube into the crosswise direction relative to the line of feed; and

a pair of sealing means disposed disengageably relative to overlapped portions of said packaging material, for applying center sealing to overlapping longitudinal end portions of said packaging material formed into a tube when they are moved closer with each other, further comprising:

a reference timing pulse generating means which generates predetermined reference timing pulses for the timing of feeding the packaging articles from said conveyor;

a means for starting with gradual acceleration the motor for feeding said packaging material and the motor for achieving end-sealing with gradual deceleration and for allowing said reference timing pulse generating means to read the number of revolution of said conveyor, followed by calculation of the sealing timing of said sealing means from the point where restarting of the motors and having made a stop with gradual deceleration and the time required for the sealing motions of said sealing means; and



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a means for judging which of the timing for spacing said sealing means based on the point of stopping the motor for feeding said packaging material and the motor for achieving end-sealing with gradual deceleration or the sealing timing calculated above precedes the other;

wherein said sealing means are designed to be spaced from each other based on the timing of stopping the motor for driving the rolls and the motor for driving the sealers as the spacing timing and subsequently moved closer to each other with a sealing timing obtained by calculating back the time required for the sealing motion of said sealing means based on the point where the motor for driving the series of rolls and the motor for driving the pair of sealers are started again when it is judged that the spacing timing precedes the sealing timing, whereas when it is judged that said sealing timing precedes said spacing timing, said sealing means are designed not to perform any spacing motion.

5. A vacant package-proofing control system for a packaging machine as set forth in claim 1, wherein:

said absence detecting sensor comprises a photodetector.

6. A vacant package-proofing control system for a packaging machine as set forth in claim 1, wherein:

said coincidence determining means comprises an AND circuit.

7. A vacant package-proofing control system for a packaging machine as set forth in claim 1, wherein:

said reference timing pulse generating means comprises a rotary encoder.

8. A vacant-package-proofing control system for a packaging machine as set forth in claim 3, wherein said control means further comprises:

a control circuit for calculating a gradual acceleration/deceleration coefficient for said second and third motors for feeding said packaging material and for achieving said end-sealing of said packaging material whereby said second and third motors can be stopped and started under said gradual deceleration and acceleration conditions.

9. A vacant package-proofing control system substantially as hereinbefore described with reference to the accompanying drawings.

DATED this FIFTH day of September 1990
Fuji Machinery Co., Ltd.

Patent Attorneys for the Applicant
SPRUSON & FERGUSON

FIG.1

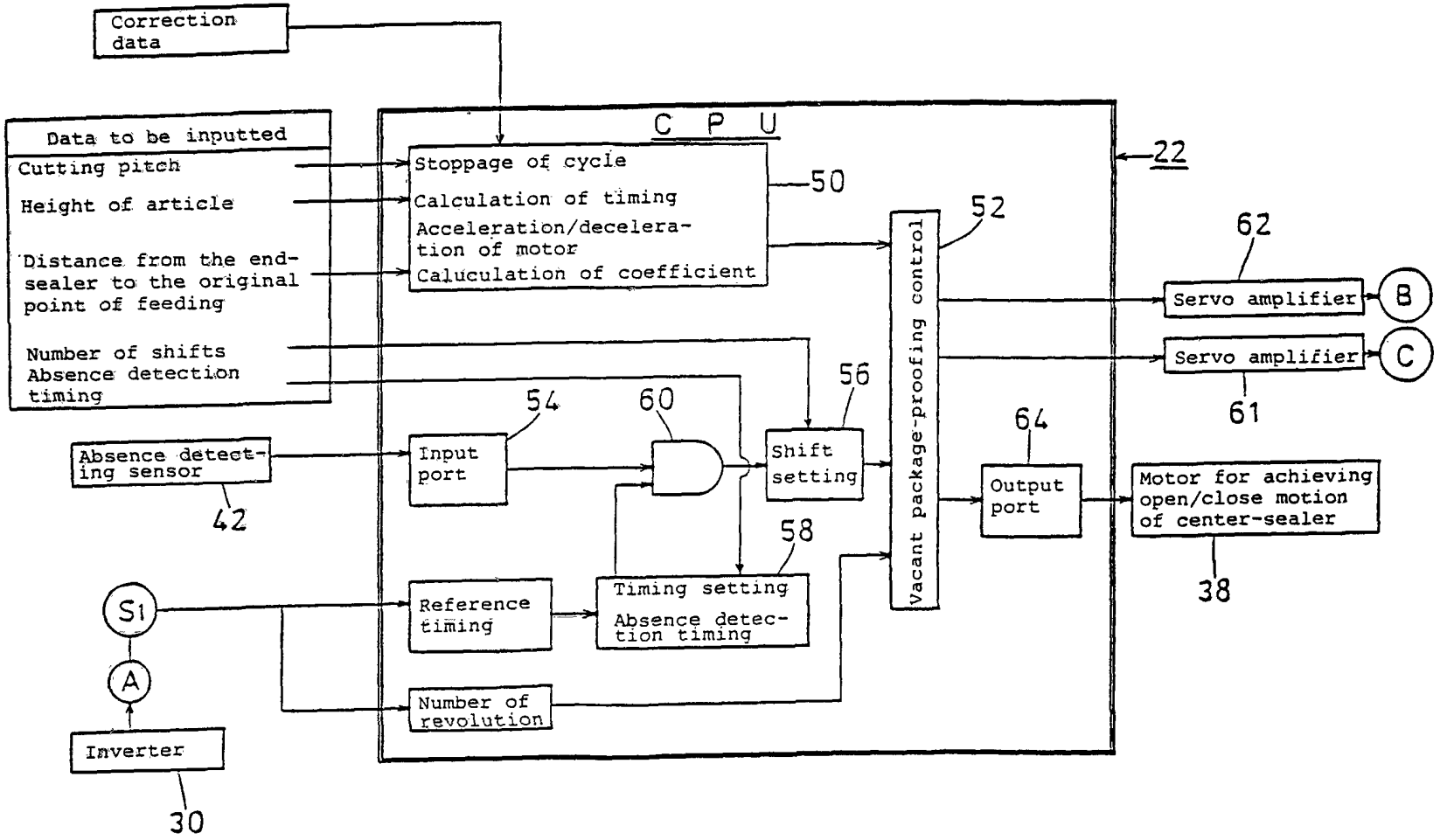


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FIG.2

(Absence of one packaging article)

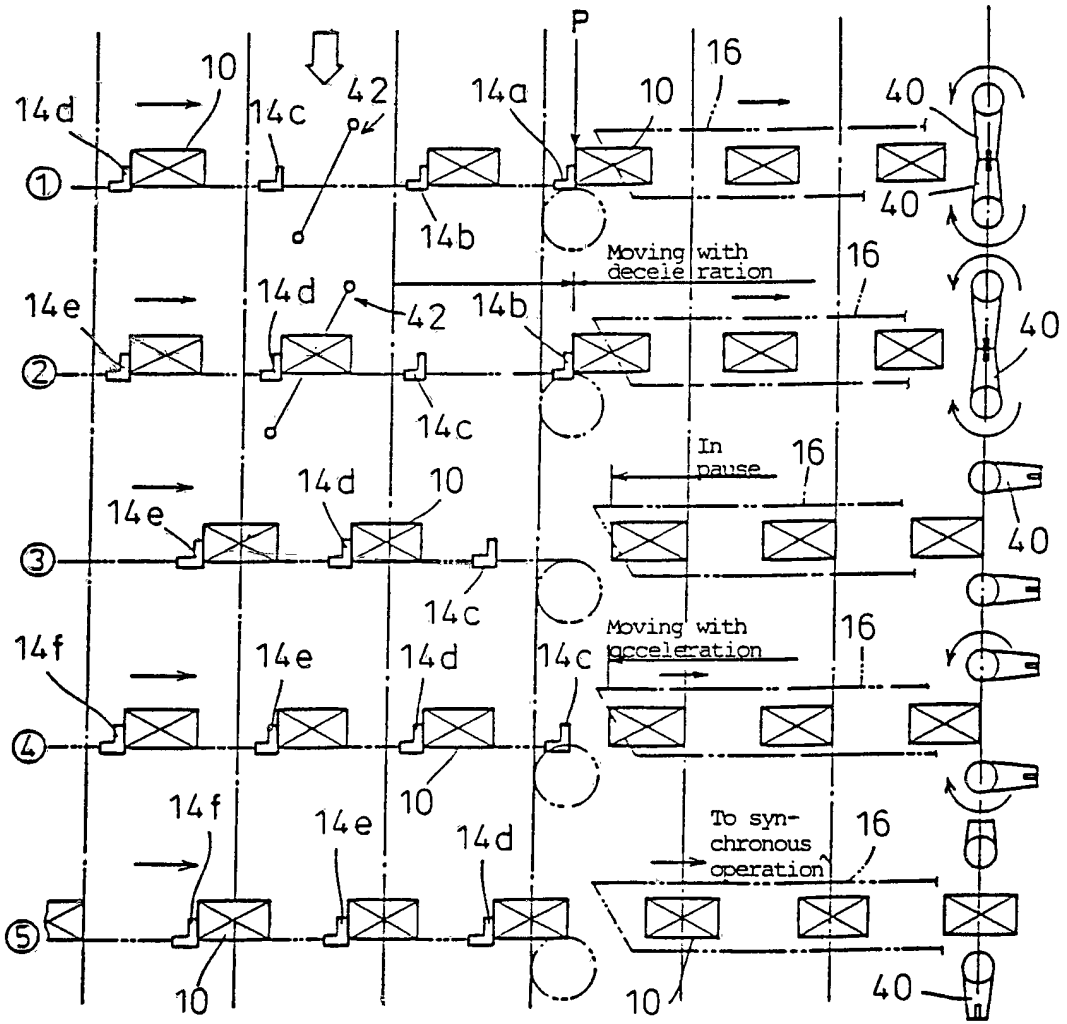


FIG.3

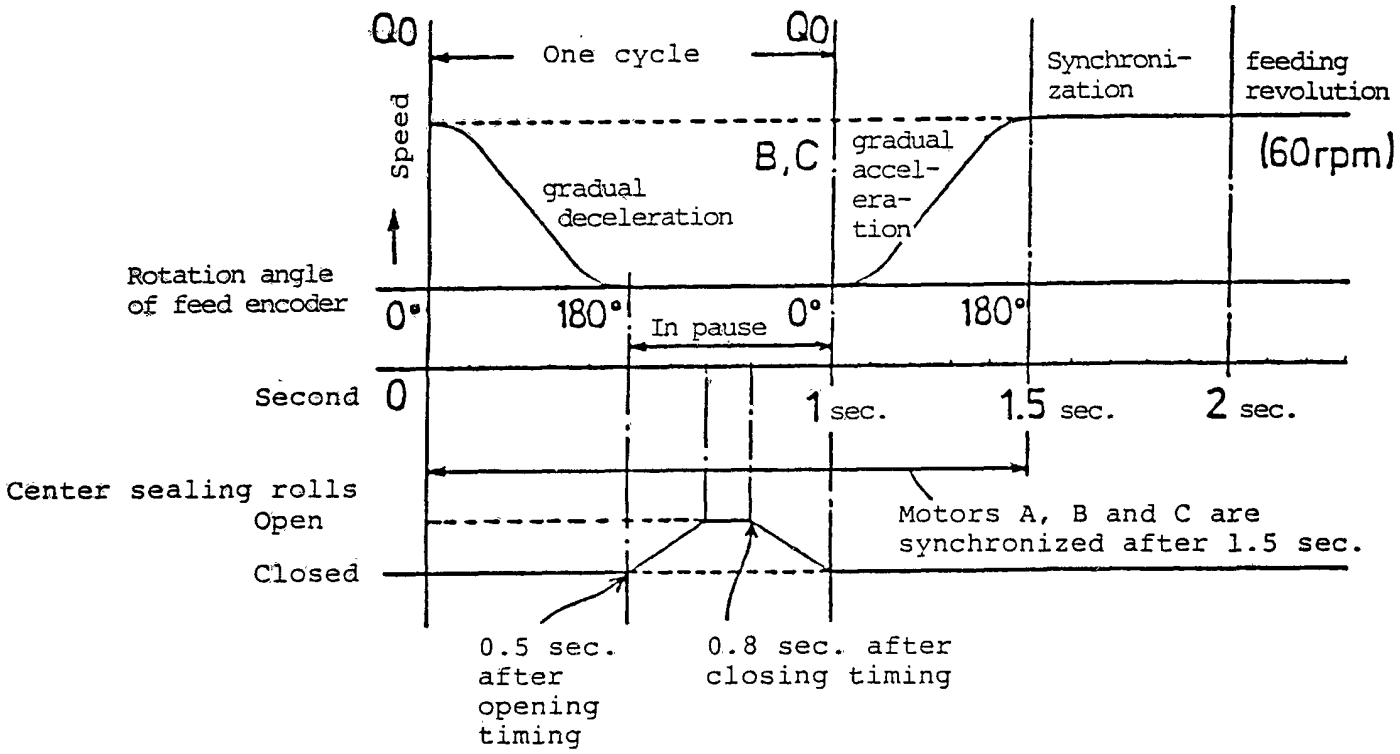

(In case of low-speed operation,
60 packages/min; cycle time: 1 sec.)
Q0
One cycle
Q0
Synchroni-
zation
feeding
revolution
Speed
B,C
gradual
accel-
era-
tion
(60rpm)
gradual
deceleration
Rotation angle
of feed encoder
0°
180°
In pause
0°
180°
Second
0
1 sec.
1.5 sec.
2 sec.
Center sealing rolls
Open
Closed
Motors A, B and C are
synchronized after 1.5 sec.
0.5 sec.
after
opening
timing
0.8 sec. after
closing timing

FIG.4

(In case of high speed operation,
200 packages/min.; cycle time: 0.3 sec.)

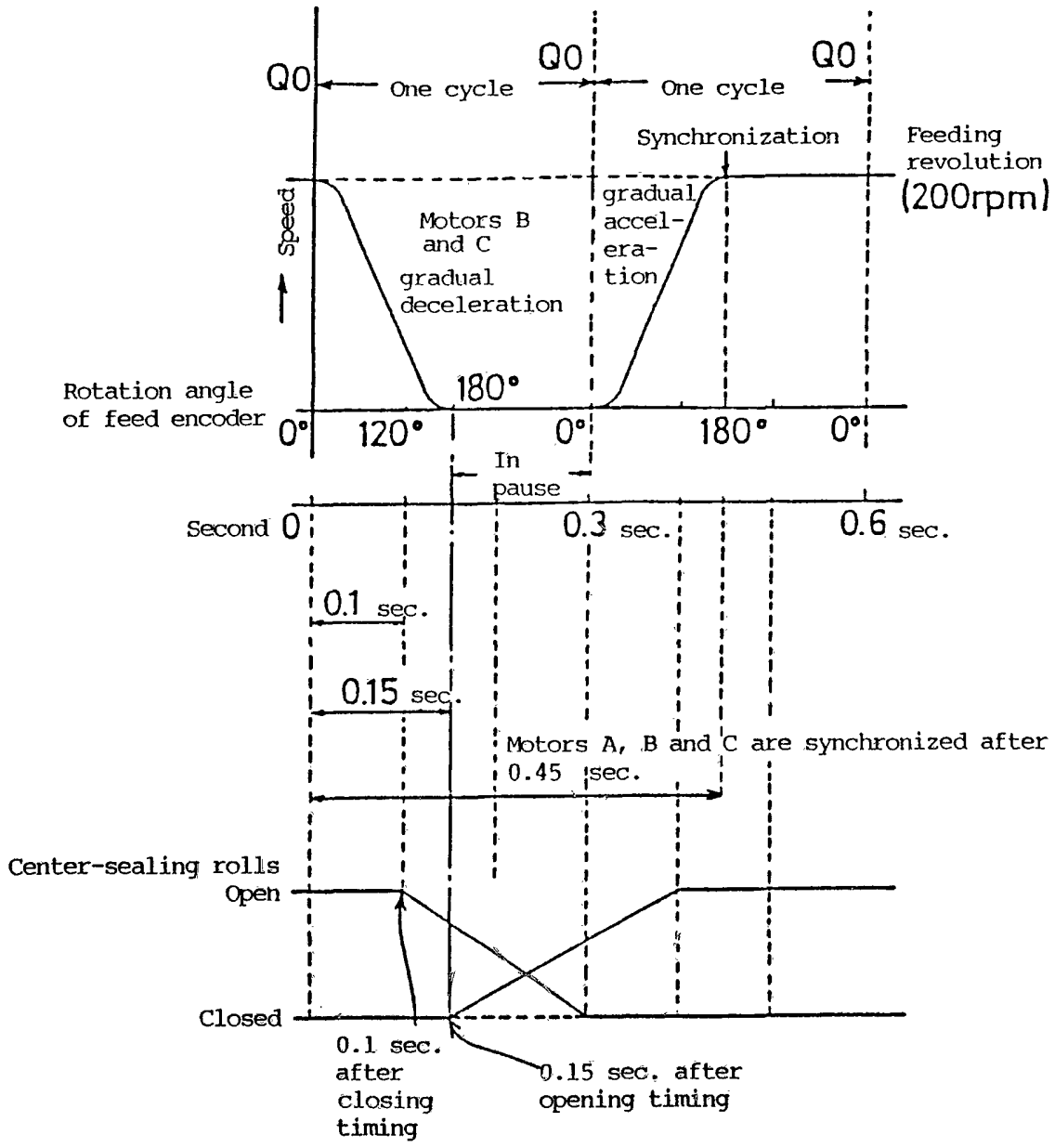


FIG.5

(Absence of two packaging articles)

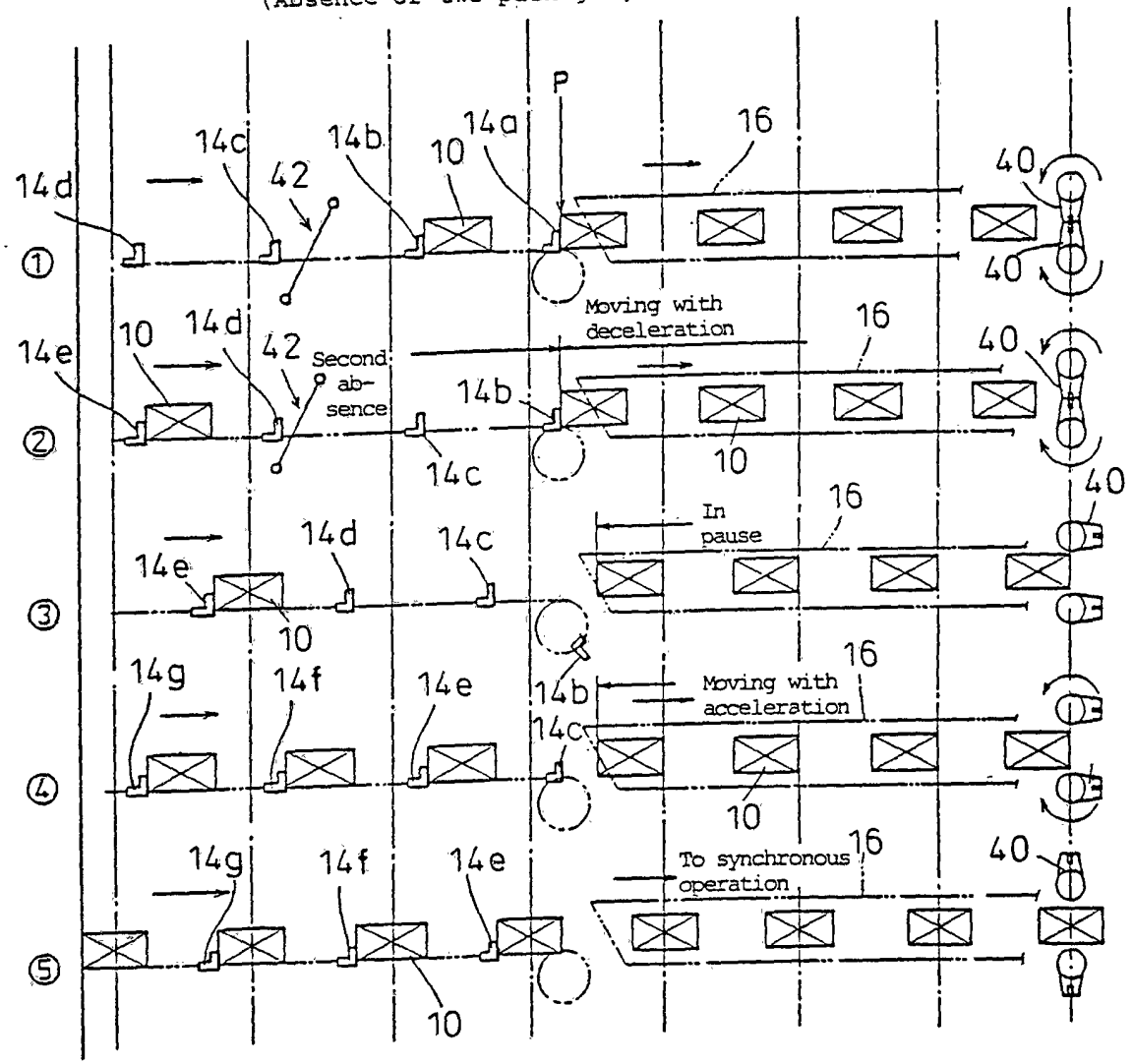


FIG.6

(In case of low-speed operation, 60 packages/min.;
cycle time: 1 sec.; absence of two packaging articles)

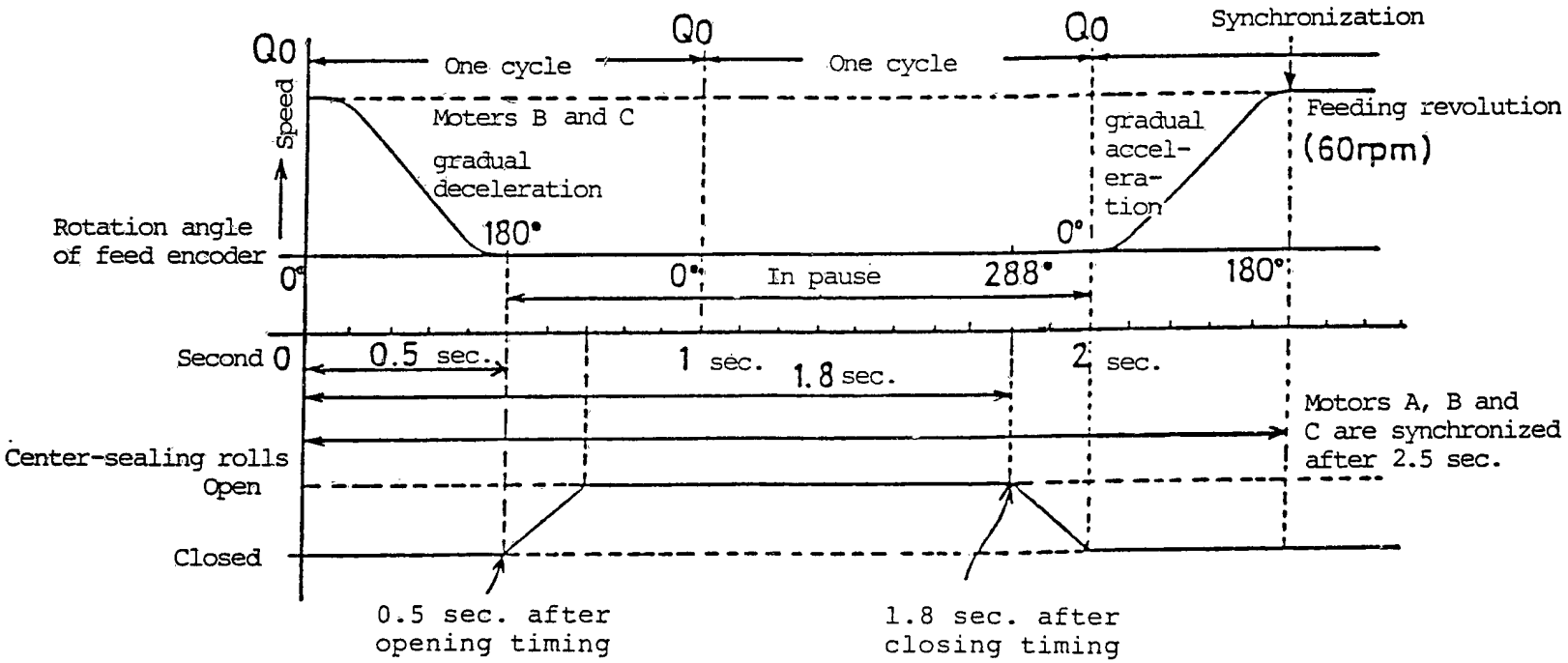


FIG.7

(In case of high-speed operation, 200 packages/min.;
cycle time: 0.3 sec.; absence of two packaging articles)

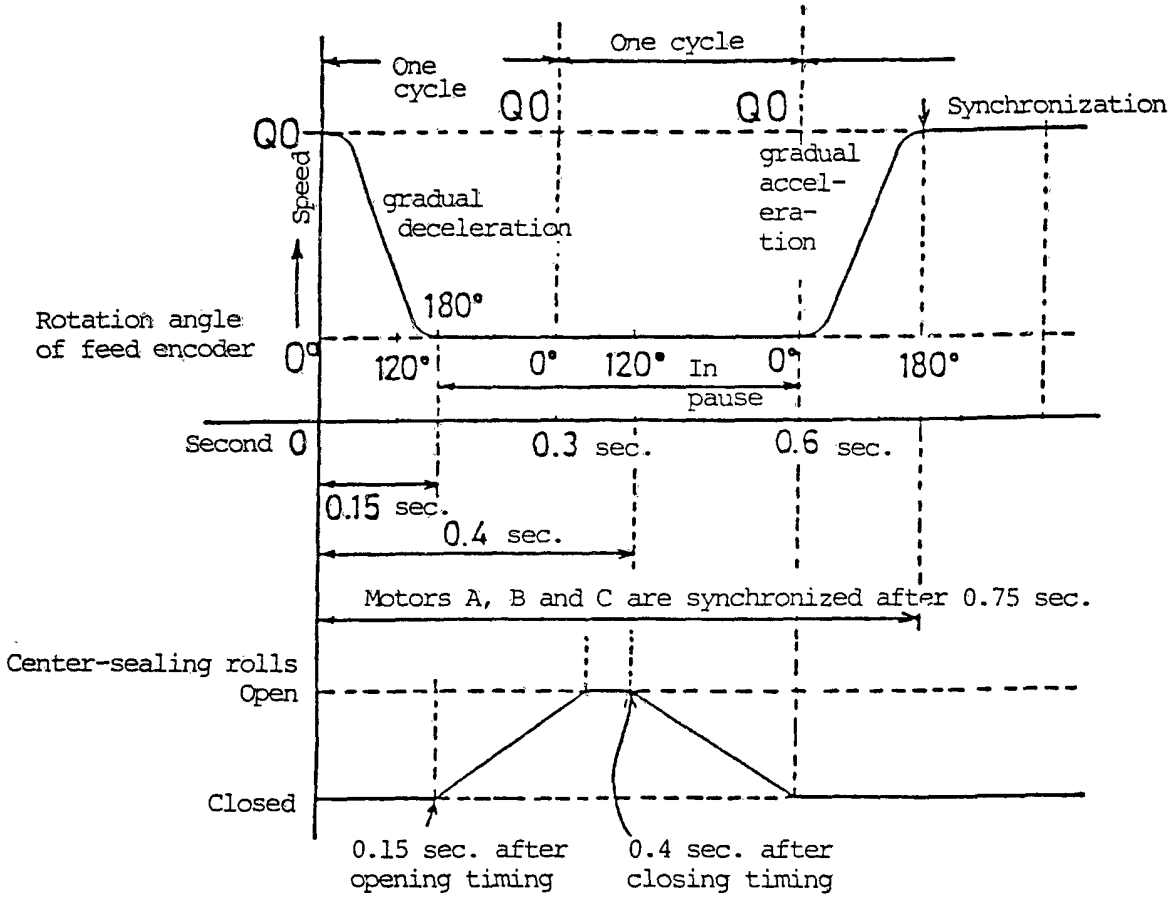


FIG.8

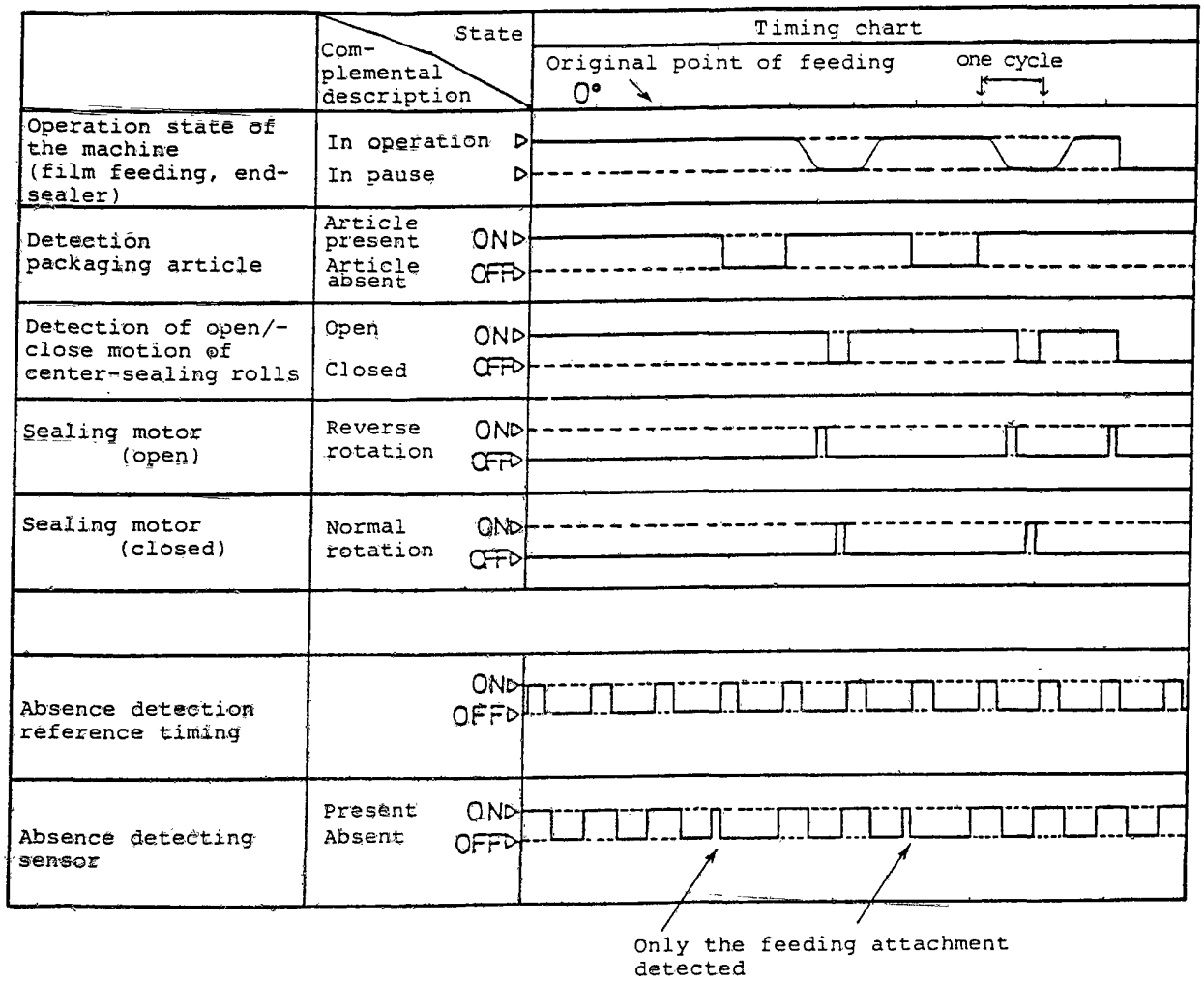

State
Com-
plemental
description
Timing chart
Original point of feeding
0°
one cycle
Operation state of the machine (film feeding, end-sealer)
In operation
In pause
Detection packaging article
Article present
Article absent
ON
OFF
Detection of open/-close motion of center-sealing rolls
Open
Closed
ON
OFF
Sealing motor (open)
Reverse rotation
ON
OFF
Sealing motor (closed)
Normal rotation
ON
OFF
Absence detection reference timing
ON
OFF
Absence detecting sensor
Present
Absent
ON
OFF
Only the feeding attachment detected

FIG.9

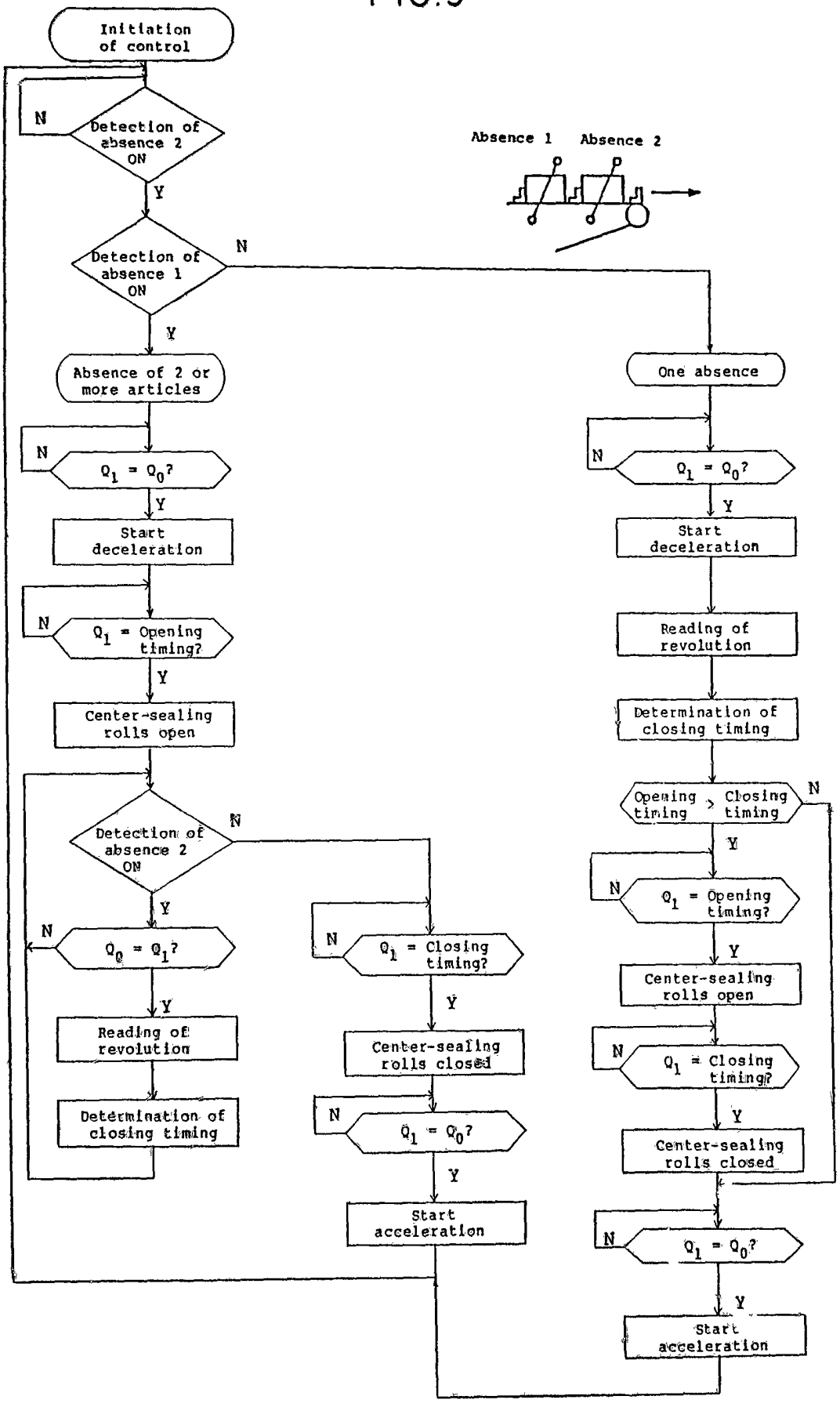
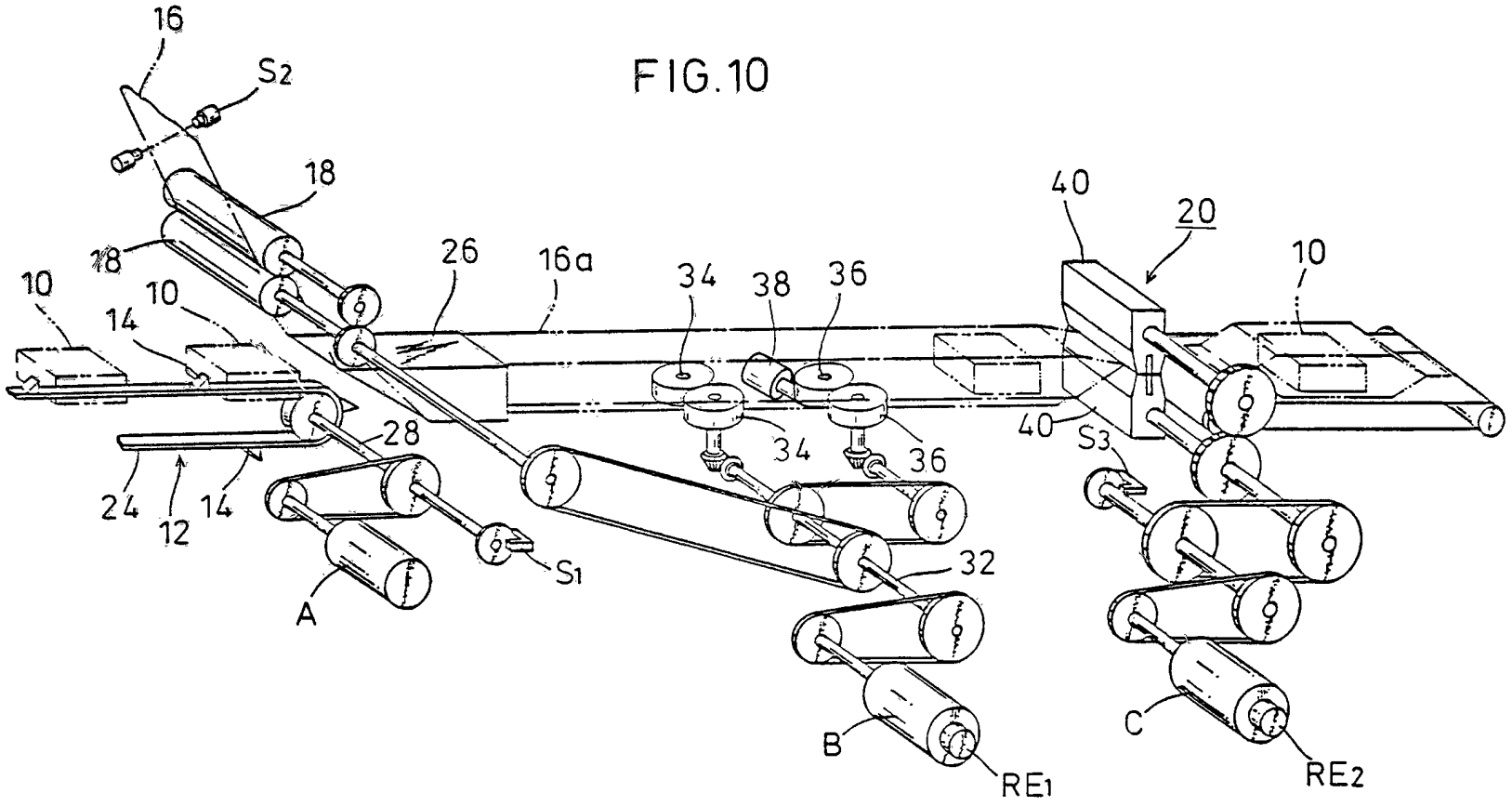

Initiation of control
Detection of absence 2 ON
N
Y
Detection of absence 1 ON
N
Y
Absence of 2 or more articles
$Q_1 = Q_0$?
Start deceleration
$Q_1$ = Opening timing?
Center-sealing rolls open
Detection of absence 2 ON
N
Y
$Q_0 = Q_1$?
Reading of revolution
Determination of closing timing
$Q_1$ = Closing timing?
Center-sealing rolls closed
$Q_1 = Q_0$?
Start acceleration
Absence 1
Absence 2
One absence
$Q_1 = Q_0$?
Start deceleration
Reading of revolution
Determination of closing timing
Opening timing > Closing timing
N
Y
$Q_1$ = Opening timing?
Center-sealing rolls open
$Q_1$ = Closing timing?
Center-sealing rolls closed
$Q_1 = Q_0$?
Start acceleration

FIG.10

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