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(54) **Monitoring production in bag making machines**

(57) A bag-making machine, wherein flat lengths of paper tube section (1) pass through the machine in continuous succession by means of a conveyor to receive end closures, is provided with a monitoring arrangement including sensors (5) which detect the edges of the workpieces.

The measuring points provided by sensors (5) are arranged at a spacing corresponding to the machine cycle, so that when there is deviation from a predetermined expected position, regulating action can be taken on the running of the machine before a complete stoppage may be necessary. Each work piece entering the machine initiates a subsequent comparison of expected and actual values of position, and a fault indication which would be caused by the absence of a work piece is inhibited by changing the expected value so as to maintain normal operation of the machine.

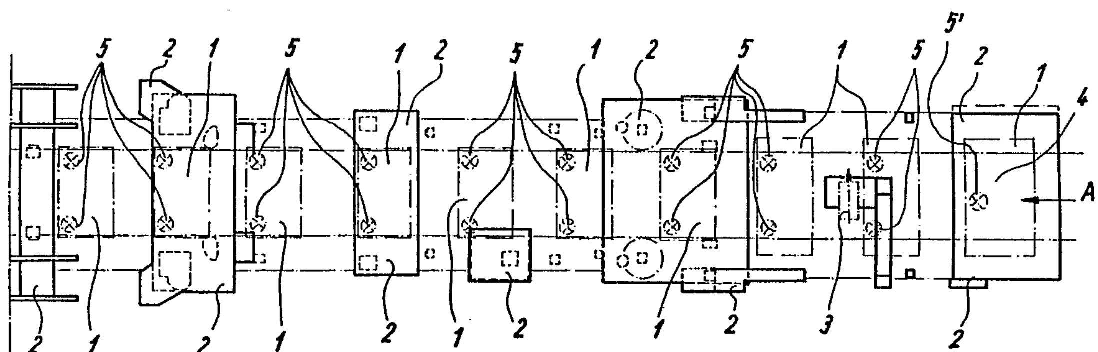

Fig. 1

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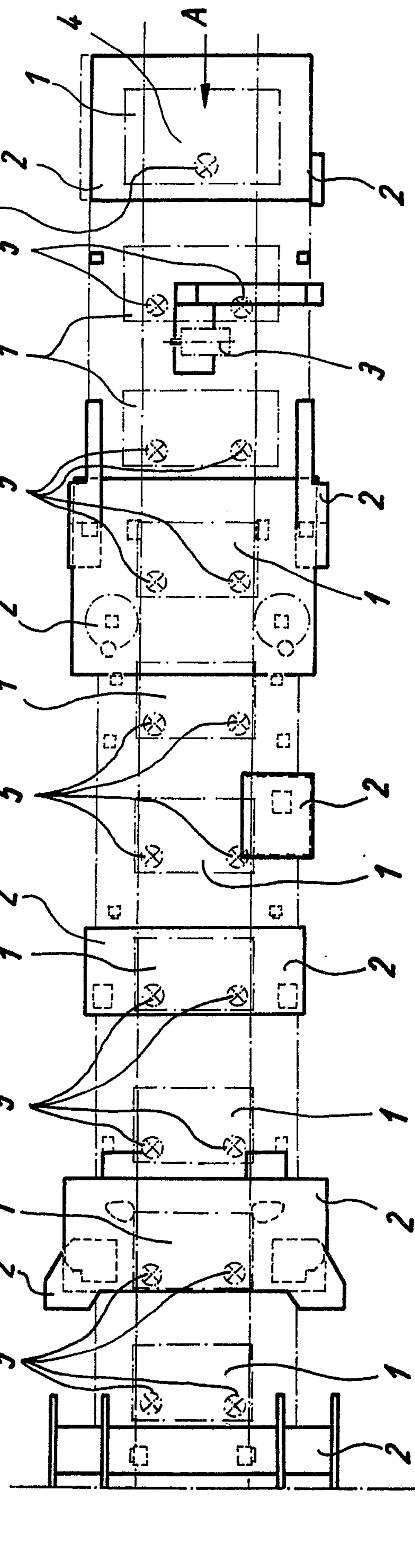

Fig. 1

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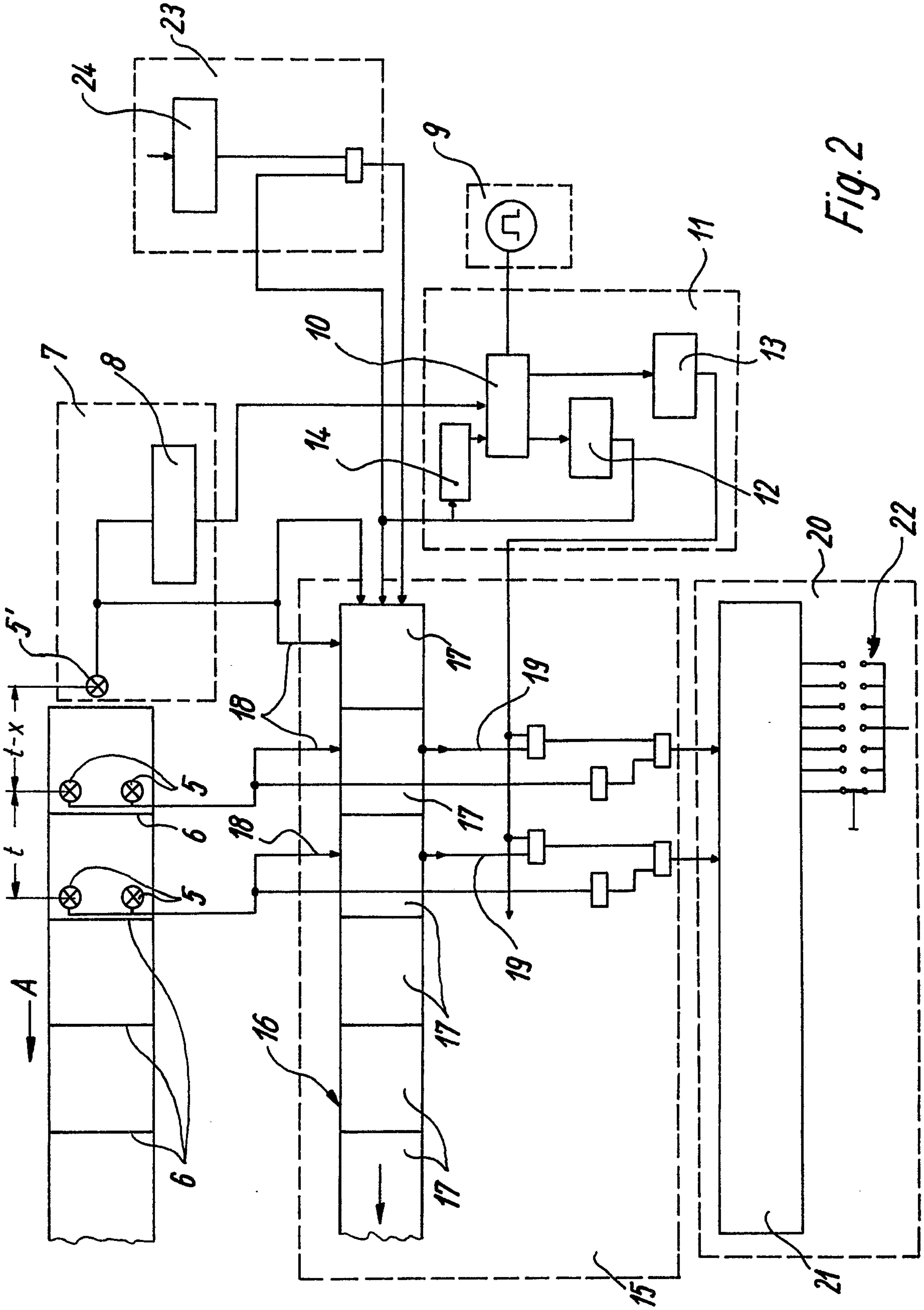

Fig. 2

SPECIFICATION

Method of and apparatus for monitoring production in bag machines

The invention relates to a method of and apparatus for monitoring production in bag machines and in particular to such a method and apparatus capable of providing a regulating action, such as immobilising the machine, in the presence of a fault.

In known bag machines, work pieces pass through the machine spaced at intervals defining a machine cycle, the machine being immobilised in the event of a fault. The work pieces are in the form of tube sections of paper or similar and need to be provided with a closure at one or both ends. The tube sections pass continuously and successively on a conveyor through the various stages of the machine. It is known to provide control rails just above the path of the bags, in order to switch off the machine if blockages occur due to malfunction of the processing assemblies or similar. These control rails are known as blockage rails. When there is trouble inside the machine, for example caused by a piece of tubing crumpling up, the appropriate blockage rail is urged out of its control position, whereby a switch is operated and the machine immobilised. The cause of the trouble is usually an accumulation of paper which brings several work pieces into collision. When this accumulation has already taken place, the function of the blockage rails is then to prevent the succeeding tube sections from being conveyed into the region of the jam before the operator can switch off the machine. The removal of a blockage takes a relatively long time and is increasingly difficult to unblock the more tube sections are caught in the jam. Apart from the loss of production which is always suffered, it may be that components of the machine will be damaged in addition.

The invention therefore seeks to provide a method and apparatus capable of exerting a regulating action on the machine which tends to avoid such blockages, and therefore eliminate or at least reduce times of immobilisation.

The present invention provides a method of monitoring production in a bag machine, wherein work pieces pass through the machine spaced at intervals defining a machine cycle, one edge of each work piece is sensed in respect of its actual spatial position at intervals corresponding to the machine cycle to provide a respective actual value indicative of position, the actual value is compared with a predetermined expected value indicative of expected position, the result of the comparison is used to control the running of the machine, and a fault indication which would be generated as a result of the comparison because of the absence of a work piece is inhibited thereby maintaining normal operation of the machine.

The present invention further provides apparatus for carrying out the above method, the apparatus comprising

(a) a detecting means for detecting work pieces entering the machine;

(b) a sensing means for sensing the edges of the work pieces passing through thereby to provide an indication of their actual positions;

(c) a transmitter for providing an indication of the path covered by a work piece which has entered the machine;

(d) a comparator for comparing actual and expected values indicative of actual and expected positions of the work pieces;

(e) a timing and counting means arranged to activate the sensing means and to cause the comparator to make the comparison between the expected and actual values thereby to ascertain the amount of error and/or the location of the fault;

(f) a reading-in device for transferring the position of the work pieces sensed to the comparator; and

(g) a control means for regulating the running of the machine or for immobilising the machine.

The sensing of the edges of the work pieces makes it possible to recognize changes in the position of the work pieces before blockages are created by the collision of several work pieces. Since a blockage builds up within a stretch of path which may vary in length, it is possible to ascertain the displacement of a work piece from its original position, so that even before the actual blockage begins to form, measures can be initiated to prevent any trouble leading to immobilisation of the machine. The measures may be initiated either or both by the extent of the difference of the actual position of the work piece from the expected position and by the position where the fault is discovered inside the machine. For instance it is possible to immobilise the machine in the usual way by switching off the drive. If necessary, this can also be expedited by appropriate braking. There is the further possibility of changing the speed at which the work pieces pass through, preferably by initiating a reduction in speed; an additional possibility is for the speed at which the work pieces previously travelled to be re-established automatically once the work pieces recorded as faulty have passed through the machine. Yet another possibility is for the stations which the faulty work piece still has to run through to be put out of operation, thereby additionally avoiding waste caused by faulty end formation.

A further important advantage is that, using this monitoring method, end formation is very accurate in respect of the shape and dimensions of the end formed, since displacements in the position of the work pieces passing through can be recognised. Within an admissible limit, therefore, the work pieces are virtually always conveyed in the same relative position into the assemblies which carry out an operation in the end forming process, otherwise a fault is indicated. A further advantage is that fault indications caused by the absence of one or more work pieces are not recognised as such owing to neutralisation of the fault indications. The absence of work pieces may be due, firstly to trouble in the feed, or secondly to removal during immobilisation of the machine when trouble has been signalled. The machine can therefore be restarted automatically without special measures being carried out.

In a preferred example, the sensing of the first edge of an incoming work piece is used to initiate the subsequent comparisons between the expected and actual positions. This embodiment ensures that the expected position is only stipulated when a work piece is present.

Furthermore is is particularly advantageous that the machine is immobilised by disconnection with or without braking, depending on the extent of the difference between the actual and expected values in respect of the spatial position and/or the location of the fault. On the one hand, normal switching off is then possible, with corresponding after-running of the machine, so that no addition braking forces arise. On the other hand there is the possibility of immobilising the machine with a so-called quick stop in order to prevent an accumulation of paper in larger or smaller proportions. It is further possible for the machine to continue running with a different (preferably reduced) speed of passage, depending on the extent of the difference between the actual and expected values in respect of the spatial position and/or the location of the fault, the original speed being re-established after a given time. This avoids immobilising the machine when the fault which has occurred would clearly not cause any accumulation of paper. If this should result in incorrect formation of the end of the bag, it would be discarded anyway in the usual way by the end control normally provided.

In a further preferred example, provision is made to utilise the fault indication, generated by removal of a work piece from the machine, by taking the actual value resulting therefrom as the new expected value for the continued operation. This arrangement makes it possible to remove one or more work pieces from the machine when a fault occurs, without thereby making restarting difficult through fault signals generated by the absence of the work pieces. The arrangement existing inside the machine when one or more work pieces are removed is detected by the sensors and used as the required state for further monitoring.

It is particularly advantageous for the leading edge of the work pieces to be sensed. In bag machines this is usually regarded as a reference, since it is always in a certain position whatever the dimensions of the work pieces, e.g. the width of the bag. The distance between the leading edges of two successive work pieces always corresponds to the machine cycle in the usual way. The machine cycle can conveniently be considered as that measure in which, during one revolution of a drive shaft of the machine, defined as a single-turn shaft, the chains, belts or the like used to convey a work piece advance a distance corresponding to the cycle, for example 68 cm. The design of an appropriate machine accordingly always has to be related to the cycle set.

As a means of detecting the oblique position of work pieces passing through the machine, it is particularly advantageous for the leading edge to be sensed at two places spaced laterally from each other with respect to the path of the work pieces. Only two sensors at the same height are then required at each sensing station, relative to the path of the work pieces.

In order that the present invention may be more readily understood, an embodiment thereof will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a highly diagrammatic plan view of a bag making machine; and

Figure 2 is a theoretical circuit diagram for checking the positions of work pieces passing within the bag making machine.

In the bag making machine shown diagrammatically in Figure 1, the work pieces, e.g. flattened tube sections 1 of paper or similar material, to be provided with a closure at one or both ends, are transported continuously in a transverse position in the direction of the arrow A by conveying elements (not shown). The tube sections 1 are shown in dash and dot lines and for representational reasons, less than the actual number have been shown. The distance between two successive lengths of tubing 1 corresponds to the cycle of the machine. The assemblies 2 required to form the ends are shown only symbolically in Figure 1, and will not be described in detail. The bag machine is driven by a drive 3 which again is shown only schematically and will not be described in detail.

As will be seen from Figure 1, a sensing means 4 is arranged in the path of the tube sections 1 passing through, to sense the leading edges of the sections 1. In the present example, the sensing means 4 is formed by light barriers 5, two light barriers in each case, relative to the path of the tube sections 1, being arranged at equal height and laterally spaced from each other. Each light barrier consists of a light emitter/receiver arrangement in which the light beam is broken by an obstruction in its path. Two light barriers are further arranged one behind the other in each case, as seen in the direction in which the tube sections 1 pass through; the distance between two light barriers arranged at the same height corresponds to the machine cycle. As will be seen from Figure 1, the result is that at a given moment in the normal operative state of the bag machine corresponding to a monitoring phase, the light barrier will be located immediately behind the leading edge of the associated tube seciton 1. If the light barriers 5 were activated at that moment, in other words, if the presence of an obstruction in the light paths was checked, the light beam would be interrupted. Since the barriers operate on the light-dark principle and preferably are arranged to provide a fault signal if the light path is not interrupted, no fault signal would be given in that case.

If on the other hand, one or more tube sections

1 were to change position from their expected position predetermined by the feed in time with the machine, then at least one of a pair of associated light barriers 5 at the same height would no longer be covered by the leading edge. The relevant light barrier would therefore transmit a signal interpreted as a fault. This would initiate measures appropriate to the fault or to the place where the fault occurs, by means of a circuit which will be explained in detail later. Since the light barriers are arranged to be activated whenever each leading edge should be covering them according to the predetermined expected position, it is not necessary for the light barriers to be adjusted to the particular width of the tube section being currently processed, since the leading edge can be regarded as a reference edge. As the bag is transported by conveying elements such as chains, belts or the like, it can be taken to be impossible for the leading edge of a tube section to be displaced in the direction of passage; an error, which in this event would no longer be acknowledged as such, can consequently be excluded from the outset. It has been found in practice that the tube sections conveyed are displaced in the opposite direction to the direction of passage, so that the recognition of faults with the present arrangement is guaranteed. This also applies when one end of a tube section is displaced so as to be in an oblique position. Owing to the arrangement of two light barriers laterally spaced from one another but at the same height, a fault signal is then transmitted.

With the monitoring system as described, an accumulation of work pieces can largely be avoided, since this can be recognised in the preliminary phase, namely in the shifting of the pieces of tubing out of their expected position.

Since displacement kept within limits does not lead to accumulation, displacement over a certain distance may be permissible with this arrangement. This may be achieved by having the distance between the first light barrier in the direction of passage and the next one shorter than the machine cycle or the distance from the succeeding light barrier, by a small amount relative to the machine cycle. This differential amount corresponds to the allowable amount of tolerance within which, during the subsequent comparative measurements, deviation from the predetermined expected position is possible with the initiation of appropriate measures. In the present example, the arrangement is such that, as seen in the direction of passage of the tube sections 1, the first monitoring is effected only by one light barrier arranged approximately in the centre of the machine, since it can be taken that there has not as yet been any deviation from the expected position at that point. The light barrier in question carries reference 5′.

A possible theoretical circuit diagram is shown in Figure 2. The continuous passage of the work pieces is indicated by the direction of the arrow A. The leading edge of the tube sections 1, which forms the reference edge, is shown at 6. The distance between the light barriers 5 in the direction of passage corresponds to the distance between cycles and is defined as *t*. The distance between the first light barrier 5′ in the direction of passage and the succeeding light barriers 5 is an amount *x* less than the distance between cycles and is defined as t-x, x presenting an amount of tolerance relative to the allowable deviation from the expected value. In Figure 2, only three successive light barriers or pairs of light barriers have been drawn for the sake of simplicity. The arrangement illustrated extends over the whole path of the tube sections 1. The light barrier 5′ is a component of a symbolically indicated detecting means 7. The light barrier 5′ detects the tube sections 1 entering the bag machine and initiates the counting process by means of a counting process release 8, through a counter 10 electrically connected to a transmitter means 9. In the present example the transmitter means 9 is in the form of a pulse generator arranged to emit a certain number of pulses for each revolution of a rotating part of the machine, corresponding to the conveying distance covered by the tube sections 1 within the machine. It is particularly advantageous for one pulse to be emitted for each distance of 1 mm travelled by the work pieces. It then follows that the number of pulses emitted during one cycle of the machine corresponds to the conveying distance covered in mm. If the machine is designed e.g. for a cycle of 680 mm, the conveying distance will also be 680 mm and 680 pulses will accordingly be emitted in one cycle.

The counter 10 is a component of a symbolically represented timing and counting arrangement 11, which additionally comprises a pulse generator 12 to generate a shifting pulse, which will be explained later, a pulse generator 13 for an interrogation pulse which will be explained later, and a resetting means 14 for the counter 10.

A comparator 15 is further provided, including a shift register 16 with control components (not shown). The shift register 16 comprises a plurality of stages 17; the number of stages must be at least as high as the number of work pieces which may be present in the machine. When the first light barrier 5′ is interrupted by the entry of a work piece, this is read into the first stage 17 in the shift register 16. After the completion of a machine cycle, when the counter 10 has counted a predetermined number of pulses from the transmitter means 9, the pulse generator 12 releases a shifting pulse, by means of which the signal read into the first stage of the shift register 17 is moved on by one stage. The work piece inside the machine is simultaneously conveyed one cycle further, whereby the next light barrier 5 in the conveying direction is interrupted by the entering piece. The comparison is resolved by the next pulse emitted by the transmitter 9, whereby the counter 10 enables the pulse generator 13. The stages 17 of the shift register 16 are each provided with a parallel input 18 and a parallel output 19, and for monitoring purposes the parallel outputs of the particular stages 17 in the shift register 16 are each compared with the states of the corresponding light barriers within the machine. The process described is continued in constant succession, so that monitoring is provided for all the work pieces in the machine.

If the interrogating pulse is emitted by the pulse generator 13, the parallel outputs 19 of locations 17 of the shift register 16 are occupied. If the work pieces to be checked are conveyed far enough for the light barriers 5 to be interrupted, no difference will emerge from the comparison of expected and actual values when this stage is detected, so no fault signal will be generated by the comparator 15.

If on the other hand a work piece is conveyed a distance such that two of the light barriers 5, located at the same height relative to the path of the pieces 1, are no longer interrupted or only one light barrier is interrupted, this means that a work piece has shifted counter to the direction of passage or is in an oblique position, whereby a fault signal is then generated when the comparison is made, and initiates one of the measures already described.

The possibilities described above are illustrated in the circuit diagram in Figure 2.

However it is possible, in contrast, that the interrogating pulse emitted by the pulse generator 13 may be produced before the shifting pulse is emitted by the pulse generator 12. This can be achieved by changing the counts at which the generators 12, 13 will be activated. If one of the light barriers 5 is then found, on comparison, to be already interrupted, this means that the associated work piece has shifted in the direction of passage. The subsequent comparison will then again initiate one of the measures already described. This possibility is not specifically shown in the circuit diagram.

After each cycle of the machine, the counter 10 is reset to the value 0 by the resetting means 14, and the new counting process is simultaneously initiated.

If a work piece is missing from the current intake, a shift pulse is nevertheless released by the pulse generator 12, so that an empty stage is formed in the shift register 17, thereby neutralising fault signals which would otherwise be produced by the light barriers 5 as a result of the comparison.

If a fault signal is triggered, this is processed in a control means 20, thereby initiating one of the measures already described. The control means 20 comprises a control unit 21 and a program store 22. Programs varying according to its capacity may be entered in the program store 22, with the result that, when a fault appears, measures varying according to the amount of error and/or the location of the fault are initiated by the control unit 21. The measures to be initiated have already been mentioned several times by way of example, if a fault signal is emitted which causes the machine to stop, there is the possibility of correcting the fault with the machine stationary, either by moving the work piece which initiated the signal manually into its expected position or else by taking it out of the machine. To prevent a fault signal from being generated on subsequent comparison in the latter case, a reading-in device 23 is provided, made up of control components which will not be explained in detail and a control unit 24. When a work piece is removed, the remaining pieces which are left in the machine are detected by the control components of the reading-in device 23, and their arrangement is transferred to the shift register 16. This may be done by way of the parallel inputs 18. The missing work pieces are thereby represented as empty stages. The actually existing position of the bags is consequently taken as the expected position for the comparison.

The invention is not restricted to the particular example illustrated. Continuous checking of the position of the work pieces within the bag machine is a significant advantage.

CLAIMS

1. A method of monitoring production in a bag machine, wherein work pieces pass through the machine spaced at intervals defining a machine cycle, one edge of each work piece is sensed in respect of its actual spatial position at intervals corresponding to the machine cycle to provide a respective actual value indicative of position, the actual value is compared with a predetermined expected value indicative of expected position, the result of the comparison is used to control the running of the machine, and a fault indication which would be generated as a result of the comparison because of the absence of a work piece is inhibited thereby maintaining normal operation of the machine.

2. A method according to claim 1, wherein the initial sensing of the edge of an incoming work piece is used to initiate the subsequent comparison of expected and actual values.

3. A method according to claim 1 or claim 2, wherein the machine is immobilised as a result of the fault indication by switching it off with or without braking, depending on the extent of the difference between the actual and expected values and/or according to the location of the indicated fault within the machine.

4. A method according to claim 1 or claim 2, wherein the machine is kept running after receiving a fault indication but with a different, preferably reduced throughput speed, depending on the extent of the difference between the actual and expected values, and/or according to the location of the indicated fault within the machine, and that the original speed is re-established after a predetermined time.

5. A method according to any one of the preceding claims, wherein the fault indication which would subsequently be generated by the removal of a work piece from the machine is inhibited by using the actual value resulting from the removal as the new expected value for further operation.

6. A method according to any one of the

preceding claims, wherein the leading edge of each work piece is sensed.

7. A method according to claim 6, wherein the leading edge is sensed at two spaced-apart locations.

8. Apparatus for monitoring production in a bag machine according to the method as claimed in claim 1, the apparatus comprising

(a) a detecting means for detecting work pieces entering the machine;

(b) a sensing means for sensing the edges of the work pieces passing through thereby to provide an indication of their actual positions;

(c) a transmitter for providing an indication of the path covered by a work piece which has entered the machine;

(d) a comparator for comparing actual and expected values indicative of actual and expected positions of the work pieces;

(e) a timing and counting means arranged to activate the sensing means and to cause the comparator to make the comparison between the nominal and actual values thereby to ascertain the amount of error and/or the location of the fault;

(f) a reading-in device for transferring the position of the work pieces sensed to the comparator; and

(g) a control means for regulating the running of the machine or for immobilising the machine.

9. Apparatus according to claim 8, wherein the detecting means comprises a light barrier which senses the leading edge of a work piece.

10. Apparatus according to claim 8 or claim 9, wherein the detecting means includes a setting means for initiating the counting process.

11. Apparatus according to claim 8, claim 9 or claim 10, wherein the sensing means comprises sensors spaced apart by the intervals defining the machine cycle.

12. Apparatus according to claim 11, wherein the sensors can be activated in time with the machine.

13. Apparatus according to claim 11 or claim 12, wherein with respect to the direction of movement of the work pieces through the machine, two sensors are arranged at each location at the same height and spaced from each other perpendicular to the direction of movement.

14. Apparatus according to any one of claims 8 to 13, wherein each sensor is in the form of a light barrier.

15. Apparatus according to any one of claims 8 to 14, wherein the transmitting means comprises a pulse generator.

16. Apparatus according to claim 15, wherein the pulse generator emits pulses in response to rotation of a part of the machine, the number of pulses emitted corresponding to the distance travelled by a work piece per cycle of the machine.

17. Apparatus according to claim 16, wherein a pulse is generated each time a distance of 1 mm is travelled.

18. Apparatus according to any one of claims 8 to 17, wherein the comparator comprises a shift register.

19. Apparatus according to claim 18, wherein the shift register has a number of stages at least corresponding to the number of work pieces within the machine any moment.

20. Apparatus according to claim 19, wherein each stage of the shift register has a parallel input and a parallel output.

21. Apparatus according to any one of claims 8 to 20, wherein the timing and counting means comprises a counter, a first pulse generator responsive to the counter to emit an interrogation pulse, a second pulse generator responsive to the counter to emit a shifting pulse and a re-setting device for the counter.

22. Apparatus according to any one of claims 8 to 21, wherein the reading-in device comprises a control unit for transferring the actual position of the work pieces to the comparator.

23. Apparatus according to any one of claims 8 to 22, wherein the control means comprises a control unit and a programme store.

24. A method of monitoring production in a bag machine, substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

25. Apparatus for monitoring production in a bag machine, substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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