

June 11, 1963

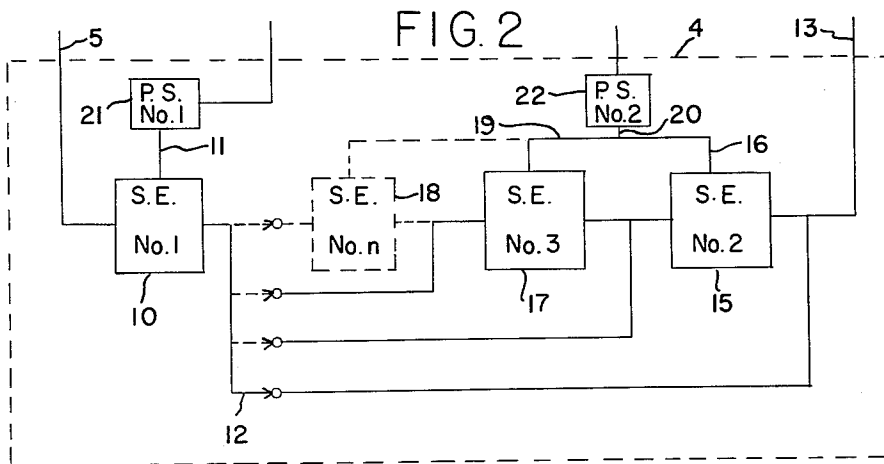
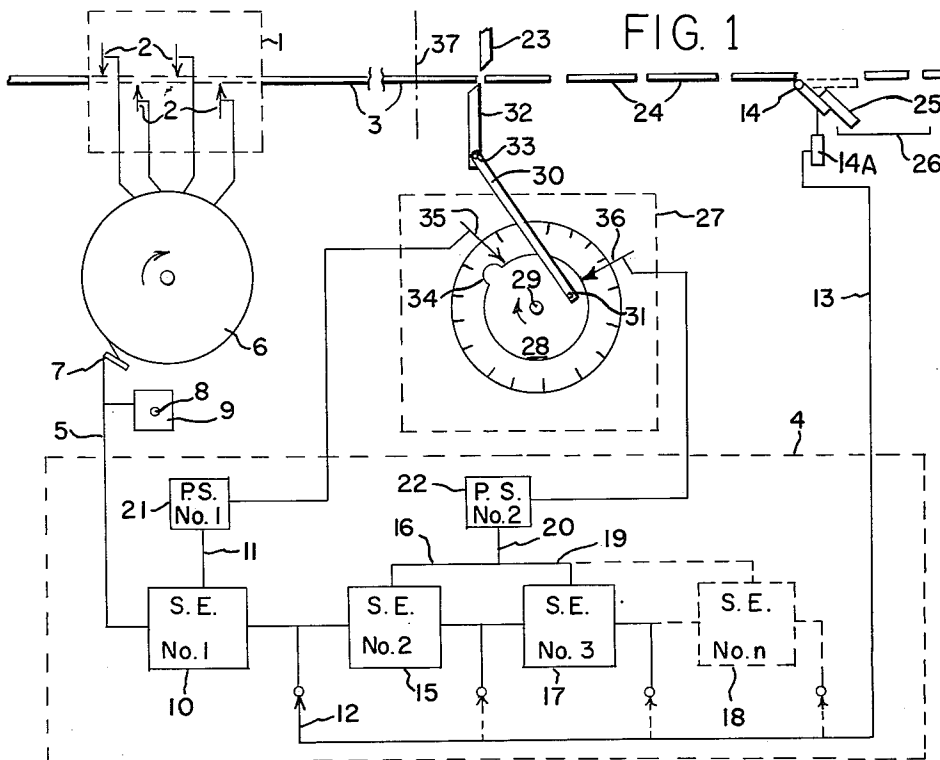
R. R. WALSH

3,093,020

REJECT MEMORY SORTING APPARATUS

Filed Dec. 4, 1956

2 Sheets-Sheet 1



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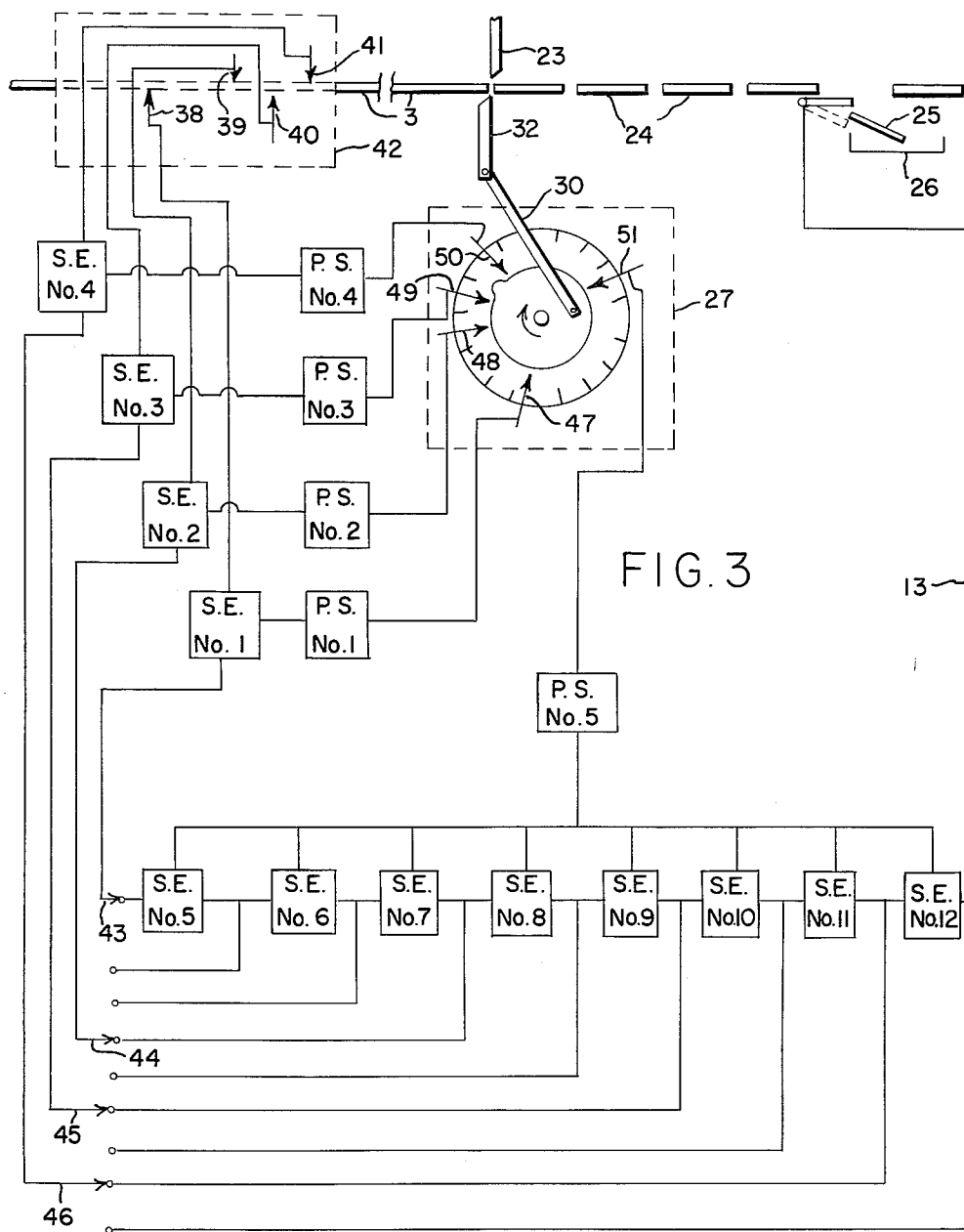
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REJECT MEMORY SORTING APPARATUS

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This invention relates to control apparatus and more particularly to such apparatus in association with automatic inspection and sorting mechanisms. More specifically, this invention relates to a delay memory control device for controlling a product sorting mechanism in response to an inspection signal.

In the manufacture or processing of products which are divided into discrete product units, it is often essential or desirable that a sorting of such products take place. The sorting may be on the basis of size, quality, quantity, cleanliness, color or other end criterion, and may be a classification process or simply a separation of unacceptable from acceptable products.

During such manufacturing or processing, an inspection or detection device will examine the products and give a signal as a result of such examination. The signal may give binary information, e.g., the product should be accepted or rejected, which can be coded in binary form stating that the product should be classified and sorted into any one of a plurality of possible categories. The products may be examined while in a continuous form, such as a continuous filament, web, film, solid or liquid, stream, etc., prior to or after separation into discrete product units, i.e., discrete lengths or quantities of products for end use, e.g., packaging or further processing.

The apparatus of this invention is directed to all of the above and in a particular aspect to the automatic inspection of a continuous film, followed by transverse severing of the film into sheets and subsequent rejection by a sorting mechanism of sheets of unacceptable quality from sheets of acceptable quality in response to a signal from the inspection apparatus.

It is therefore an object of this invention to provide an improved control apparatus for transferring a signal from an inspection device to a sorting mechanism for sorting discrete product units. Another object is to provide such apparatus which will deliver the signal to the sorting mechanism and actuate the sorting mechanism at the precise time required for sorting the product unit which initiated the signal. Still another object is to provide such apparatus readily adjustable for unit products of varying lengths. Yet another object is to provide such apparatus which will automatically operate independent of the product through-put rate, as well as the distance from the inspection device to the sorting mechanism.

An additional object is to provide such apparatus which will transfer such control information reliably and at the desired time. A further object is to provide a reject memory sorting apparatus which, using memory storage components having fixed discrete time delay periods, controllably delays a signal to obtain an adjustable time delay period of any preselected duration wherein the adjustment is not limited to the duration of a fixed discrete time delay period. A still further object is to provide such apparatus having storage elements capable of collecting all defect or inspection signals with respect to a single unit product, storing the collected signals and de-

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livering the entire group of collected signals as a single signal to a reject or sorting mechanism at the precise required time. Still other objects will be apparent from the following description of the invention.

The apparatus of this invention will now be described by way of illustration in association with a film inspecting, chopping and sorting apparatus, which is a preferred application.

The invention will be readily understood by reference to the accompanying drawings, wherein FIG. 1 is a schematic diagram of a film inspecting, chopping and sorting apparatus embodying the improvements of the present invention; FIG. 2 is an alternative arrangement of the components of the memory section shown in FIG. 1; and FIG. 3 is a schematic diagram of a preferred embodiment of this invention.

Referring now to FIG. 1, inspection device 1 having one or more detectors 2 examines the continuous film 3 for defects. A signal of such a defect is delivered to memory section 4 through connecting line 5. If only one detector 2 is utilized, the defect signal may go directly from the detector to memory section 4. However, as in the illustrated embodiment, wherein more than one detector is used, each detector may produce a separate signal for the same defect. The inspection apparatus is not critical and may be of any type which is capable of producing an electrical signal in response to a stimulus initiated by a product variation, change, irregularity or defect. For example, if the product being inspected is a web or film of varying electrical conductivity, conducting feelers or contact sensors may be utilized in a known manner to signal a change in web properties which may be indicative of defects.

To effect one or more signals from a multiplicity of detectors, a mechanical memory wheel 6 of known construction, e.g., that described in Ladrach, U.S. Patent 2,217,342 is inserted as shown between the inspection device 1 and the memory section 4 and may be suitably connected to the inspection device as illustrated and described in the Ladrach patent. The memory wheel rotates in synchronization with the through-put speed of the film 3. A defect signal from a detector operates to push out beyond the edge of the memory wheel one of many of the defect indexing pins carried by the wheel. If the same defect is observed by a subsequent detector, concurrent rotation of the memory wheel 6 will place the wheel in such a position that the defect signal from the subsequent detector will operate to attempt to push out as described the pin which has already been pushed out by the first detector.

It will be seen therefore that one protruding pin for each defect will, upon rotation of the wheel 6, effect through closure of cam switch 7 or similar device, the transmission of the defect signal to the memory section 4. Suitable memory wheels are known in the art, e.g., Ladrach U.S. Patent No. 2,217,342.

The equivalent of a defect signal, for apparatus testing or film sampling purposes, may be initiated by manual actuation of push button 8 on sample switch 9.

The defect signal from the inspection device enters storage element No. 1, which may be similar to those described in An Wang, U.S. Patent 2,708,722, indicated by reference number 10, where it is stored until a shift pulse from lead line 11 effects the transfer of the stored signal in a known manner. Upon receipt of the shift

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pulse, the output signal of storage element No. 1 will, depending on the setting of sliding contact 12, enter other series connected storage elements or directly through connecting line 13 actuate reject mechanism 14, which may be operable by a solenoid 14A or other suitable means.

If the output signal from storage element No. 1 enters storage element No. 2, indicated by reference number 15, the signal will be stored therein until a shift pulse from lead line 16 effects the transfer of the stored signal in a known manner. Upon receipt of the shift pulse, the output signal of storage element No. 2 will, depending on the setting of sliding contact 12, directly actuate reject mechanism 14 or enter another series connected storage element, e.g., storage element No. 3, indicated by reference number 17 and in turn any number of others, indicated by reference number 18. Each of these latter storage elements also stores signals until a shift pulse through lead line 19 empties the element. It can be seen that the shift pulse which effects the transfer of a signal out of storage element No. 2 is the same shift pulse which effects the transfer of a signal out of all subsequent storage elements, for reasons hereinafter explained, and enters lead lines 16 and 19 through connecting line 20.

The shift pulse which acts to shift a stored signal out of storage element No. 1 is different from and from a different source than the shift pulse which actuates all the other storage elements. The former shift pulse will for convenience be referred to as pulse No. 1 and may be conveniently shaped in a known manner, if and as desired, by pulse shaper No. 1, indicated by reference number 21. The latter shift pulse will for convenience be referred to as pulse No. 2 and may similarly be conveniently shaped by pulse shaper No. 2, indicated by reference number 22.

An alternative arrangement of the components of memory section 4 is shown in FIG. 2. The defect signal through connecting line 5 from the inspection device enters storage element No. 1, indicated by reference number 10, where it is stored until shift pulse No. 1 from pulse shaper No. 1, indicated by reference number 21, and lead line 11 effects the transfer of the stored signal in a known manner. Upon receipt of the shift pulse, the output signal of storage element No. 1 will, depending on the setting of sliding contact 12, enter another series connected storage element, or directly through connecting line 13 actuate the reject mechanism. If the output signal from storage element No. 1 enters storage element No. 2, indicated by reference number 15, the signal will be stored therein until shift pulse No. 2 from pulse shaper No. 2, indicated by reference number 22, effects the transfer of the stored signal in a known manner to the reject mechanism. If the setting of sliding contact 12 directed the output signal from storage element No. 1 into storage element No. 3, indicated by reference number 17, or any other, indicated by reference number 18, the signal would be stored until pulse No. 2 effected a transfer of the stored signal into the next series connected storage element, e.g., No. 2, wherein the signal would be stored until the next pulse No. 2 acted to transfer the signal to the reject mechanism.

It will be seen from the above description that the memory section 4 contains two groups of storage elements, each group being acted upon by a separate and different shift pulse to shift a stored signal out of a group or from one storage element to another storage element within a group. Each group will include at least one storage element. For example, in the embodiments illustrated in FIGURES 1 and 2, the first group, acted upon by pulse No. 1, includes only one storage element (storage element No. 1), while the second group, acted upon by pulse No. 2, includes a plurality of storage elements (storage elements No. 2, No. 3 and No. n). Each group is conventionally referred to in the art as a shift register

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which may be of either the single line type or the double line type. An embodiment will later be described wherein the first group includes more than one storage element.

Storage elements suitable for use in a shift register according to this invention are characterized by being capable of receiving an input signal and storing the signal until receipt of a shift pulse which effects an emptying of the storage element in readiness for a new input signal. Between the time of receiving a first input signal and discharging the signal in response to the shift pulse, the storage element is unaffected by any additional imposed input signal or signals. It will be seen therefore that the first shift register in the embodiments of FIGURES 1 and 2, i.e., the shift register responsive to shift pulse No. 1 and made up of storage element No. 1, acts as a "collector" to receive all signals from all defects for any one unit product, while delivering only a single output signal for each unit product for actuating the reject mechanism only once for any one defective unit product.

It will be readily understood that shift pulse No. 1 must act once for each unit product, to shift information as to whether a particular unit product is acceptable or rejectable and to "clear" or empty the "collector" preparatory to receiving defect signal information with respect to the next succeeding particular unit product.

It will also be readily understood that shift pulse No. 2 must act once for each unit product to cause the second shift register to shift information internally in memory section 4 to another successive storage element, or to release stored information to the reject mechanism at the precisely correct time for actuating the reject mechanism to reject the unit product which initiated the stored defect information.

Means for supplying pulse No. 1 and pulse No. 2 to the memory section at the correct times will be referred to hereinafter as the "computing section" and will now be described.

Referring again to FIG. 1, computing section 27 comprises a mechanical cam wheel 28 suitably mounted for rotation about hub 29. The rotary motion of cam wheel 28 is provided by crank arm 30 fastened to wheel 28 by any suitable means, e.g., pin 31, and to reciprocating shear knife 32 of chopper 23 by any suitable means, e.g., pin 33. Cam wheel 28 has protruding from any suitable part thereof, e.g., the periphery, cam 34 which, upon rotation of wheel 28, will automatically operate to close adjustable cam switch 35 and adjustable cam switch 36 once for each complete rotation of the wheel 28. Cam switches 35 and 36 are each adjustable in a circular path about wheel 28 such that camming contact between cam 34 and each of the cam switches will be made during each rotation of the wheel. It can be seen therefore that pulse No. 1 and pulse No. 2 will act upon the first and second shift registers respectively when cam 34 effects closure of cam switches 35 and 36 respectively.

Since crank arm 30 is directly operable from shear knife 32, the wheel 28 will obviously rotate once per chop or, in other words, once per unit product, and it follows that cam switch 35 will operate and pulse No. 1 will be transmitted once per chop, i.e., once per unit product. The same is of course true of pulse No. 2.

A convenient way of determining the proper setting for each of the adjustable cam switches is as follows: A reference point or line or base line is selected along the path of film travel, e.g., at reference line 37. This reference line is preferably located at a distance from the reject mechanism which is equal to the longest unit product which will be processed on the apparatus. However, the reference line may be at any other position, and may be in front of or in the rear of the chopper. For any given desired unit product length, cam switch 35 should be set to be operated by cam 34 when the point corresponding to the trailing edge of one unit product and the point corresponding to the leading edge of the next following unit product cross the reference line.

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If the unit product is the same length as the distance from the reference line to the reject mechanism, the sliding contact 12 in the memory section 4 is set as shown by the solid line in either FIG. 1 or FIG. 2. In operation with this setting, a continuous film 3 illustrated as moving from left to right, passes through inspection device 1 where a first unit product is inspected from the point corresponding to its leading edge to the point corresponding to its trailing edge. If a defect is detected, the signal set on the memory wheel 6, rotates with the wheel. Since the speed of rotation of the wheel is synchronized with the forward speed of the film, it sends defect information with respect to the first unit product, by actuating cam switch 7, and records the defect in the first shift register, i.e., storage element No. 1 at the same time the leading edge of the first unit product crosses the reference line. The location of switch 7 is such that with the synchronized wheel and web, a defect noted and set on the wheel will arrive at switch 7 at the same time that the point corresponding to the leading edge of the first unit product crosses the reference line. All defect signals with respect to that first unit product will be stored "collected" in the first shift register until, at the time the point corresponding to the trailing edge of the first unit product and the point corresponding to the leading edge of the second unit product cross the reference line, cam 34 operates cam switch 35 to deliver shift pulse No. 1 to the first shift register. Since the leading edge of the first unit product is at this same time at the reject mechanism, the shift pulse No. 1 effects the delivery of the output signal of the first shift register, through sliding contact 12 and connecting line 13, to actuate the reject mechanism 14 thereby rejecting defective sheet 25 which is collected in tray or box 26. This emptying of the storage element No. 1 by shift pulse No. 1 of course clears the element ready to receive defect signals or information with respect to the second unit product, which is just starting to cross the reference line with what corresponds to its leading edge. The operation continues automatically for successive following unit products in the same manner.

The setting of cam switch 36 is necessary to provide for the processing of products having a unit length different from the distance from the reference line to the reject mechanism.

If the unit product is of a length equal to half the distance from the reference line to the reject mechanism, the sliding contact 12 is set as shown in either FIG. 1 or FIG. 2 between storage elements No. 2 and No. 3 of the second shift register. Cam switch 36 is set to coincide exactly with cam switch 35. With this arrangement, pulses No. 1 and No. 2 will be delivered at the same time. In operation, the inspection and "collecting" of information in the first shift register is the same as just described above. At the time the point corresponding to the trailing edge of the first unit product and the leading edge of the second unit product crosses the reference line, pulse No. 1 effects a transfer of the stored information from storage element No. 1 to storage element No. 2. All defect signals with respect to the second unit product will next be "collected" in storage element No. 1. At the time the point corresponding to the trailing edge of the second unit product and the leading edge of the third unit product cross the reference line, pulse No. 1 is again delivered, and simultaneously pulse No. 2 effects a shift of the information with respect to the first unit product out of storage element No. 2, through sliding contact 12 and connecting line 13, to actuate the reject mechanism 14 at the precise time the leading edge of the first unit product is at the reject mechanism.

Similarly, it will readily be understood that where the total length of three unit products is equal to the distance from the reference line to the reject mechanism, the setting of cam switch 36 will likewise coincide with cam switch 35. It will only be necessary to insert another storage element, e.g., storage element No. 3, in series in

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the second shift register, responsive to shift pulse No. 2, and adjust sliding contact 12 accordingly to include the additional storage element. Similar arrangements can of course be made for any such circumstance where the length of the unit product being processed is exactly divisible into the distance from the reference line to the reject mechanism.

For other circumstances, wherein the unit product length is not exactly divisible into the distance from the reference line to the reject mechanism, proper setting of cam switches 35 and 36 and sliding contact 12 still enable automatic rejecting or sorting of unit products, as will now be described.

Cam switch 35 is set, for the particular unit product length, to be closed by cam 34 at the same time described above, i.e., when the point corresponding to the trailing edge of one unit product and the leading edge of the next following unit product cross the reference line 37.

Sliding contact 12 is set at the position to accommodate the next smaller integral unit product exactly divisible as described above. Thus, for example, if the distance between the reference line and the reject mechanism is one and one-third, one and one-fourth, one and a half (or any fractional portion between one and two) of a unit product length, the sliding contact is set to accommodate a unit product of a length one-half the distance between the reference line and the reject mechanism; as stated above, this setting will be between storage elements No. 2 and No. 3 of the second shift register. Similarly, if between two and three unit products fit between the reference line and the reject mechanism, sliding contact 12 will be set to accommodate three unit products; as stated above, this setting will be between storage elements No. 3 and No. n .

Cam switch 36 is set to be closed by cam 34 at the time when the leading edge of a unit product, with respect to which defect information is then stored in the last series connected storage element in the second shift register, reaches the reject mechanism.

By way of explanation, the operation of the apparatus of this invention will now be described with respect to the processing, e.g., chopping, of a product of unit product length equal to two-fifths of the distance from the reference line to the reject mechanism, with cam switch 35 set to be operated by cam 34 when the point corresponding to the trailing edge of one unit product and the leading edge of the next following unit product cross the reference line, and with cam switch 36 set to be operated by cam 34 when the leading edge of a unit product is at the reject mechanism. The sliding contact 12 will be set between storage elements No. 3 and No. n .

In operation, the inspection and "collecting" of information in the first shift register occurs as described above. At the time the point corresponding to the trailing edge of the first unit product and the leading edge of the second unit product cross the reference line, pulse No. 1 effects a transfer of the stored information from storage element No. 1 to storage element No. 2, whereupon storage of information in storage element No. 1 immediately begins with respect to the second unit product. When the point corresponding to the trailing edge of the first unit product and the leading edge of the second unit product cross a point one-fifth of the way from the reference line to the reject mechanism, pulse No. 2 is delivered and effects a transfer of the information stored in storage element No. 2 to storage element No. 3, but since there was yet no stored defect signal in storage element No. 3, no defect signal is transmitted to the reject mechanism.

The remainder of the steps follow in orderly sequence. At the time when the point corresponding to the trailing edge of the second unit product and the leading edge of the third unit product cross the reference line, pulse No. 1 effects a transfer of the stored information from storage element No. 1 to storage element No. 2. When the

point corresponding to the trailing edge of the second unit product and the leading edge of the third unit product cross a point one-fifth of the way from the reference line to the reject mechanism (at the same time the point corresponding to the trailing edge of the first unit product and the leading edge of the second unit product are crossing a point three-fifths of the way from the reference line to the reject mechanism; and at the same time the leading edge of the first unit product is at the reject mechanism), pulse No. 2 effects the delivery of the stored information out of storage element No. 3 to actuate the reject mechanism for the first unit product, and simultaneously effects the transfer of the stored information from storage element No. 2 to storage element No. 3. The operation continues repetitively in this manner, with the defect information collected and stored in the first shift register until shift pulse No. 1 effects an output signal for each unit product inspected from the first shift register, and shift pulse No. 2 effecting the delivery at the correct time to the reject mechanism of a reject signal for the particular unit product then at the reject mechanism.

A preferred embodiment of the apparatus of this invention is diagrammatically illustrated in FIG. 3 of the drawings. In this embodiment, no memory wheel 6 of the previously described embodiments is utilized.

Referring now to FIG. 3, four separate detectors 38, 39, 40 and 41 in inspection device 42 deliver defect signals respectively to storage elements No. 1, No. 2, No. 3 and No. 4, each of which constitutes a separate shift register out from which the stored information is shifted by shift pulses No. 1, No. 2, No. 3 and No. 4 respectively arriving from the computing section through pulse shapers No. 1, No. 2, No. 3 and No. 4 respectively. It can be seen that these four shift registers in parallel together make up a first group of storage elements which acts as the first shift register of the previously described embodiments.

The separately collected defect signals from storage elements No. 1, No. 2, No. 3 and No. 4 are, as in the embodiment of FIG. 2 described above, shifted through respective sliding contacts 43, 44, 45 and 46 into the last shift register which is acted upon by shift pulse No. 5 arriving from the computing section through pulse shaper No. 5. The last shift register is made up of series connected storage elements No. 5 through No. 12.

In operation, the cam switches 47, 48, 49 and 50 are each set to be acted upon by the cam on the rotating cam wheel at the time when the point corresponding to the trailing edge of one unit product and the leading edge of the next following unit product pass the respective detector. Each detector can now be thought of as a "reference line" for each of shift pulses No. 1, No. 2, No. 3 and No. 4 respectively. Each of sliding contacts 43, 44, 45 and 46 and cam switch 51 are set according to the hereinbefore described teaching with respect to the embodiment illustrated by FIG. 2. It can be seen that this arrangement effects the delivery to the reject mechanism at the precise time the leading edge of a unit product arrives at the reject mechanism of a defect single signal containing all stored information pertinent to that particular unit product.

It will be comprehended from the above that other arrangements of circuit elements can be constructed. It is essential only that the control apparatus include at least two individual shift registers connected in series between the inspection device and the sorting mechanism, the first shift register being capable of being acted upon by means for delivering a shift pulse for each unit product at a time when the unit product passes a preselected point, and the second shift register being capable of being acted upon by a shift pulse for each unit product at a time when the unit product arrives at the sorting mechanism. The first shift register may comprise a single storage element, or it may comprise a multiple of series connected storage elements, or it may comprise a multiple of

parallel storage elements, or it may comprise a multiple of parallel shift register circuits each comprising a multiple of series connected storage elements. The second shift register may comprise either a single storage element or a multiple of series connected storage elements.

The novel mechanical computing section described above, while preferred because of its simplicity and durability of construction and facility of cooperative connection with a reciprocating shearing or chopping mechanism, may of course be replaced by any equivalent or other means, which may be separate means or a combined means, capable of delivering the required shift pulses at the necessary times. For example, a computer wherein the rotating cam is replaced by a commutator and the cam switches replaced by contact brushes bearing on the surface of the commutator could be utilized. Similarly, any other suitable make-and-break contact device, as well as a magnetic device, could be used.

The computing section could be replaced by electronic computing means which could digest the pertinent information with respect to the processing variables and initiate the delivery of the shifting pulses at the proper time. Alternatively, in some applications wherein the product units are capable of ready discernment prior to division from continuous form, e.g., where a repetitive pattern appears on a fabric, "seeing eye" or similar photoelectric means could signal the correct time for delivery of the shifting pulses.

While the adjustment of each of the cam switches and sliding contacts in the apparatus of this invention has been described as a separate adjustment, it can of course be readily adapted for automatic adjustment upon the setting of a single variable device, e.g., a switch, dial, etc., which can be suitably calibrated as desired, e.g., in length of unit products. Such an adaption could be readily made, if desired, since the amount of change in switch and contact positions are related to each other, being proportional to the distances from the various reference points to the reject mechanism. Therefore, the switches and contacts can be geared to a common adjustment shaft or knob by application of the measurable ratios to effect automatic and correct setting of all adjustable switches and contacts by the setting of but a single control means.

Suitable failure or alarm circuits suitably connected may be utilized for any desired component or circuit portion of the apparatus, as will be understood by persons in the art, to provide a visible or audible indication of a break down, and such indication may stop the machine or actuate continuous product rejection until the failure remedied.

The control apparatus of this invention has been described in association with film inspection, chopping and sorting apparatus.

The inspection apparatus is not critical and may be of any type which is capable of producing an electrical signal in response to a stimulus initiated by a product variation, change, irregularity or defect. For example, if the product being inspected is a web or film of varying electrical conductivity, conducting feelers or contact sensors may be utilized in a known manner to signal a change in web properties which may be indicative of defects.

On the other hand, the product may be incapable of examination by such a contact method for some reason or the variable of interest may not be detectable by changes in conductivity. For example, the product may be a stream of fluid, i.e., liquid or gas, including slurries, dispersions, etc., of variable properties, e.g., purity, color viscosity, temperature, degree of polymerization, etc., with respect to which it is desired to divert or otherwise sort or change the course at some point downstream upon the occasion of the presence of a foreign body, impurity, or change in color or other property. In such a case, as well as in the case of films, web, etc., the inspection device may comprise a radiation emitting and cooperative radiation sensitive apparatus, e.g., a source of infrared,

visible, ultraviolet, X-ray, gamma ray, beta ray or other radiation and a corresponding photoelectric cell, phototransistor, photomultiplier, ionization chamber or other device which is sensitive to the particular radiation used. A pyrometer or colorimeter or similar device could be used. A particularly suitable inspection apparatus is disclosed in Harrison et al. U.S. Patent No. 2,393,631.

The apparatus which performs an operation on the product is likewise not critical and for purposes of illustration is described above as a film chopping mechanism. As such, for use on a web, film, filament or similar material, the chopping, severing, punching, scoring, marking or other mechanism can be of the intermittent or of the rotary or of the elliptically oscillating types. Instead of chopping, etc., the apparatus could be a wrapping or packaging mechanism, or a device for periodic addition to the product of indicia, e.g., labels, coloring matter, foreign elements, etc.

The sorting or reject mechanism, one type of which is described above, is likewise not critical and may comprise any automatic, signal-actuated gate, valve, door or other regulatory or sorting device.

It will therefore be understood that the control apparatus of this invention may be applied to any product processing arrangement wherein the product is handled in a steady flow, wherein such product is inspected or otherwise examined and subsequently cut or otherwise divided or separated into portions or products of discrete length, quantity or amount, which are then sorted or otherwise classified automatically pursuant to the inspection results. The apparatus is likewise applicable to the inspection of a continuous flow of product and rejection from the continuous flow of a discrete length, quantity or amount at a reject mechanism. For example, in the continuous inspection of a product, e.g., grain, coal, etc., passing on its way to storage or shipping location, as the hold of a ship or railroad car, a discrete portion found to contain a "defect" could be automatically removed from the rest of the acceptable product in the continuous flow. The control apparatus of this invention is applicable to systems in which one or more inspection devices give a signal suitable for interpreting to determine whether the product at any particular point is acceptable or not acceptable, i.e., inspection devices which give binary information. It may be readily adapted by known methods to devices which give analog defect information.

By way of further explanation, the control apparatus of this invention is applicable to systems in which the existence of any defect (or other criterion) within any particular one of the discrete unit products is cause for rejecting that particular unit product. As long as one such serious defect exists, it is immaterial whether additional defects exist in the same unit product. The apparatus can be readily adapted to systems in which it is necessary to have more than one or any given number of defects before rejection is warranted. It is also readily adapted to systems in which defects of only a particular type or degree or combination of type, degree, number, etc., of defects is cause for rejection.

Suitable equivalent components for certain of the elements utilized in the novel control apparatus will readily occur to persons in the art and such are of course contemplated within the scope of this invention.

Any suitable storage elements may be used. A storage element may be composed of vacuum tubes, relays, magnetic cores, ferro-electric elements or other devices arranged in the circuit configuration known in the art as a storage element. The preferred storage elements are ferromagnetic devices of the type disclosed in An Wang U.S. Patent No. 2,708,722.

In place of crank arm 30, any suitable positive no-slip connection between shear knife 32 and wheel 28 can be used. For example, a belt or chain drive means common to the driving means for the chopper and to the hub

would be satisfactory, provided wheel 28 is rotated once per chop, i.e., per unit product.

The invention claimed is:

1. Apparatus comprising a film inspection device for detecting defects in a moving film and delivering a defect signal for each detected defect, a continuously operating film chopping means for severing said moving film transversely into sheets of a predetermined length, a first information storage group connected to receive said defect signal, means to deliver said defect signal to said first information storage group, shift pulse delivery means for effecting the transfer of all stored information concerning each predetermined length out of said first storage group simultaneously as each said inspected, predetermined length of film passes a preselected point, said first storage group characterized by being capable of receiving a defect signal and being unaffected by any additionally received defect signals until after the transfer of all the stored information out of said storage group is effected, a second information storage group connected to receive the output information signal of said first storage group, a defective sheet reject device connected to receive the output information signal of said second information storage group and to reject those sheets indicated by the information received as being defective, said second information storage group characterized by being made up of a series of shift-register information storage elements, one for each whole predetermined length of film present in the interval between the said preselected point and the said defective sheet reject device, and by being capable of shifting the stored information in stepwise fashion through the individual storage elements of said second information storage group in response to a signal, said shift pulse delivery means capable of effecting the transfer of stored information out of said second storage group and of simultaneously signaling the stepwise shift of stored information within said second information storage group, adjustable means to actuate said shift pulse delivery means each time the leading edge of each inspected sheet arrives at said reject device said shift pulse delivery means being actuated by said film chopping means and having adjustable computing means for varying the interval of delivery of said shift pulses.

2. Apparatus as set forth in claim 1 wherein said shift pulse delivery means for effecting the transfer of stored information out of said first storage group is adapted to effect such transfer once per sheet immediately after the arrival in said first storage group of the last possible defect signal with respect to each sheet.

3. Control apparatus comprising a first shift register group which comprises at least one storage element, a second shift register group which comprises at least one storage element, said first shift register group electrically connected in series with said second shift register group, each of said shift register groups having separate means for receiving shifting pulses, and means for effecting the delivery of separate shifting pulses to said first and second shift register groups, said last-mentioned means having variably adjustable computing means to vary the interval of delivery of said separate shifting pulse to said second shift register group.

4. Control apparatus comprising a plurality of parallel shift register groups, an additional shift register group, each of said plurality of parallel shift register groups being series connected with said additional shift register group, each of said shift register groups being capable of receiving separate shift pulses, and means for effecting the delivery of separate shifting pulses to said plurality of parallel shift register groups and to said additional shift register group, said means having variably adjustable computing means to vary the interval of delivery of said separate shifting pulse to said additional shift register group.

5. Apparatus as set forth in claim 4 wherein said addi-

tional shift register group comprises a multiple of series connected storage elements.

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