United States Patent

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[54] SOLID-STATE PULSED ELECTRONIC CONTROL FOR HIGH-SPEED CONVEYOR SORTING DEVICE

15 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **209/73,** 209/74, 209/111.7
[51] **Int. Cl.** **B07c 5/342**
[50] **Field of Search** 209/73, 74, 111.7; 250/223, 224

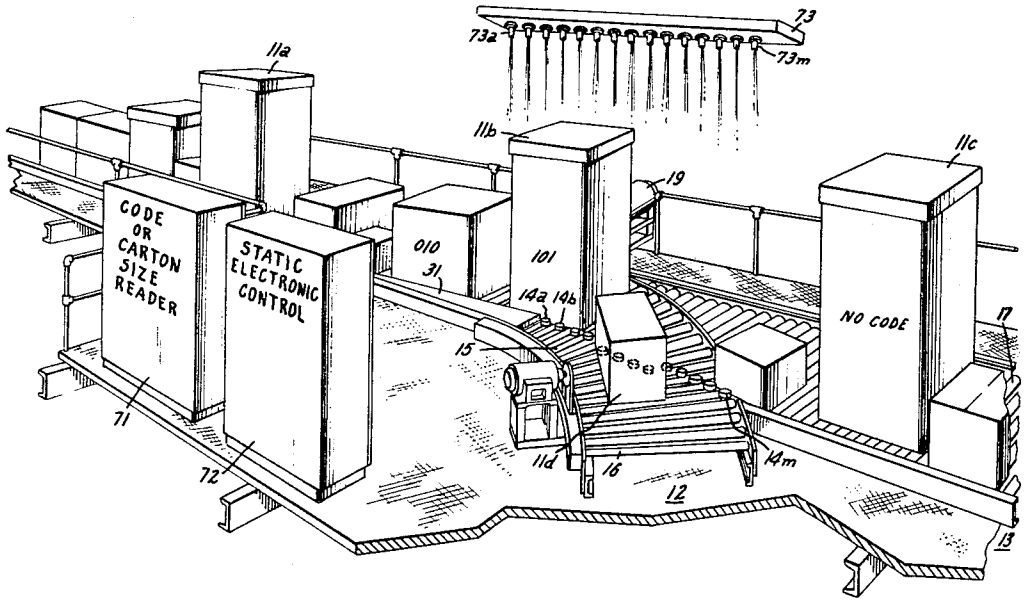
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ABSTRACT: This invention comprises a static electronic control for a high-speed conveyor sorting device of the type having a plurality of serially arranged, electrically operable diverter pins which are selectively raised and lowered between the rollers of at least two conveyor paths to selectively control which conveyor path a particular carton passing through the device is caused to follow. For this purpose a classifying signal is developed by a code reader, carton size measuring circuit, or the like for developing signals indicative of the classification and hence which conveyor path cartons or other objects are to follow. In addition, electro-optical scanning devices are provided for identifying the position or location of a carton traveling along the conveyor sorting device and for developing electric signals indicative of such positions. The electric signals thus developed are processed in a logic circuit which derives output pulsed electric signals that can be applied to the actuating solenoid of a clutch release mechanism or a brake release mechanism of a constant speed apparatus for raising and lowering diverter pins along the conveyor path selectively in accordance with the pulsed electric signals supplied from the static electronic control.



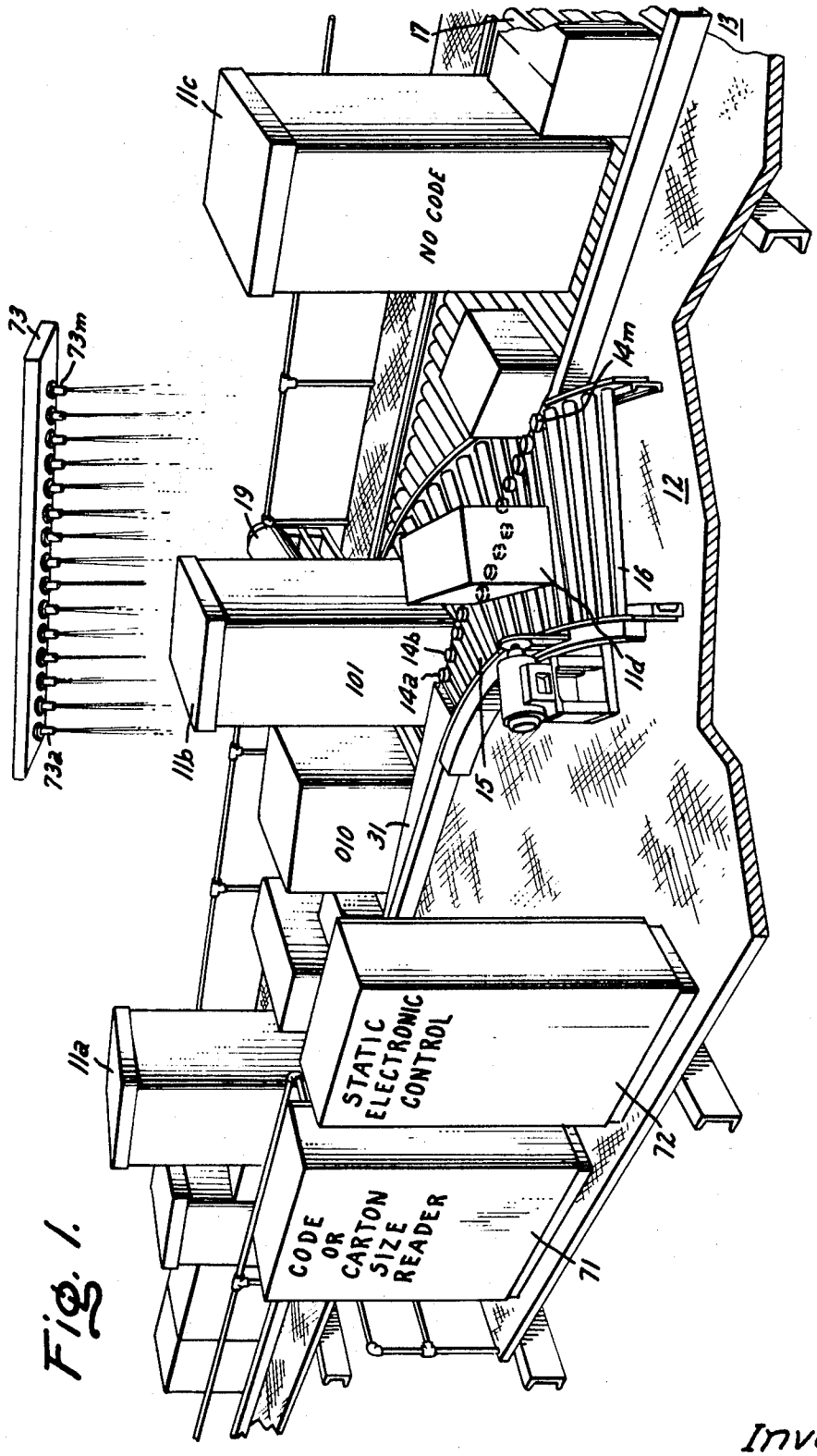


Fig. 1.

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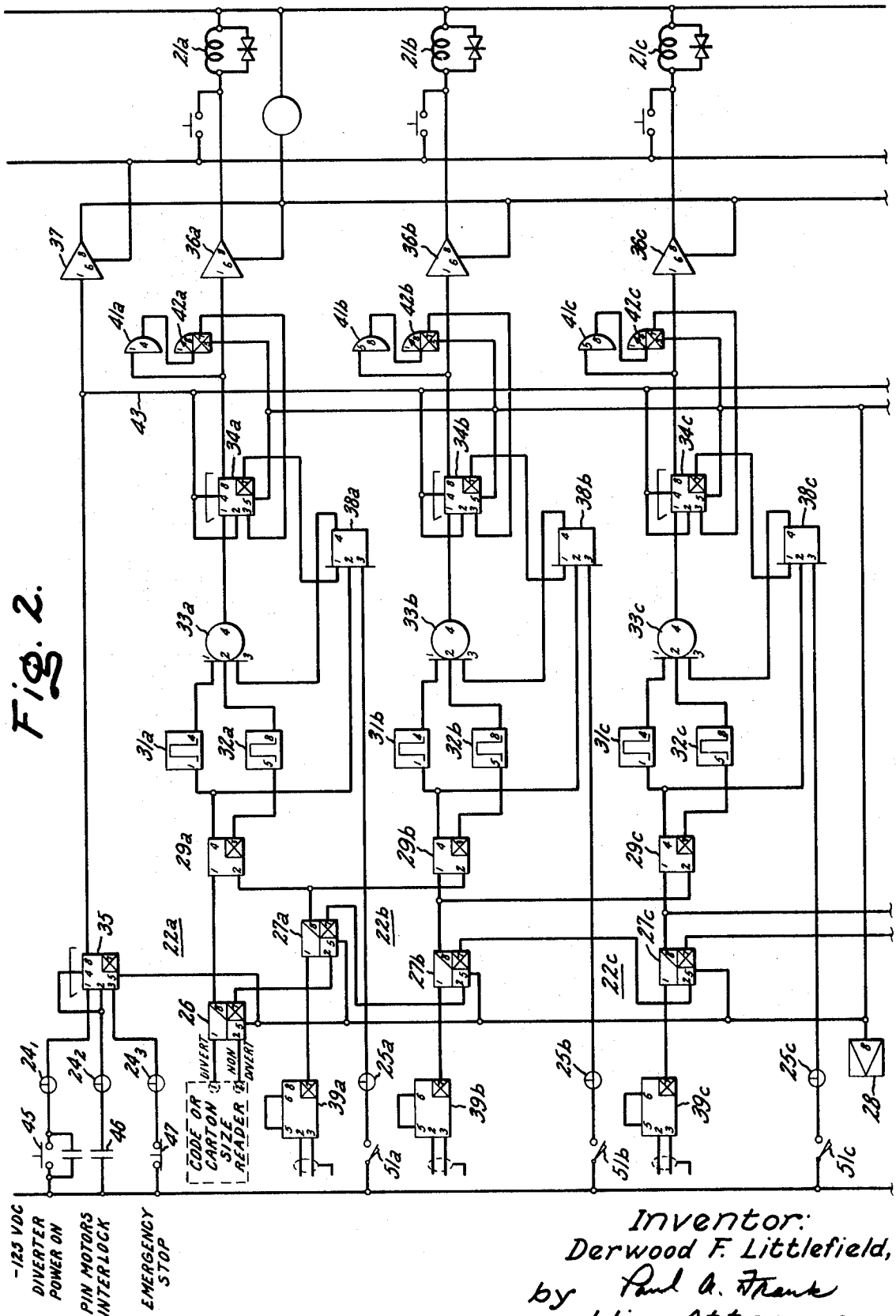


Fig. 2.

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SOLID-STATE PULSED ELECTRONIC CONTROL FOR HIGH-SPEED CONVEYOR SORTING DEVICE

This invention relates to a new and improved, pulsed, electronic control for high-speed conveyor sorting devices.

More particularly, the invention provides a solid-state electronic control of hybrid, modularized construction for producing controlled, short pulses of electric energy of predetermined time duration and used to actuate the diverter pin actuating assembly of a high-speed sorting device such as that described in U.S. Pat. application Ser. No. 869,121, entitled "-High-Speed Sorting Device," James. L. Chengges and Benjamin F. Hart, inventors, filed concurrently with this invention, and assigned to the General Electric Company.

The high-speed conveyor sorting device described in the above-referenced copending application Ser. No. 869,121 comprises a plurality of serially arranged diverter pins each of which is driven through a crank connecting rod from a continuously rotating motor by means of a one-way clutch employing a trip release. The diverter pins may be driven between two stable positions, either up (raised) or down (retracted). The final positions of the diverter pin either in the raised or retracted condition are determined accurately and held firmly by means of a positive brake mechanism actuated by the same solenoid winding that actuates the clutch trip release. The present invention provides a pulsed electronic control for use in properly controlling operation of the solenoid winding that in turn controls operation of the clutch trip release and brake mechanism.

It is therefore a primary purpose of the present invention to provide a new and improved, static, solid-state, pulsed electronic control circuit for use in controlling the operation of a high-speed conveyor sorting device of the type that employs a solenoid trip release for a clutch and/or brake mechanism for driving high-speed diverter pins between an up (raised) position and a down (retracted) position.

Another object of the invention is to provide a solid-state electronic control having the above characteristics and which minimizes the duty cycle of the electromechanical, high-speed diverter pin drive mechanism so as to extend and maximize the operating life of the overall high-speed conveyor sorting device.

A further object of the invention is to provide such a control which is highly reliable in operation due to its solid state character, operates at high speeds, is relatively simple and inexpensive to manufacture, and is reliable in operation and readily maintained.

Other objects, features, and many of the attendant advantages of this invention will be appreciated more readily as the same becomes better understood by reference to the following detailed description, when considered in connection with the accompanying drawings, wherein like parts in each of the several figures are identified by the same reference character, and wherein:

FIG. 1 is a schematic, perspective view of a conveyor sorting device with which the present static, electronic control is used, and illustrates the relative location of the various component parts of the conveyor sorting device; and

FIG. 2 is a detailed, logical circuit diagram of the solid-state, modularized electronic control comprising the present invention.

FIG. 1 is a schematic, perspective view of a high-speed conveyor sorting device which employs the new and improved, static, solid-state pulsed electronic control of the present invention. The high-speed conveyor sorting device comprises a conveyor transfer mechanism for transferring objects such as cartons illustrated at **11***a*, **11***b*, **11***c*, **11***d*, etc. from a first, main line (nondivert) conveyor path **12** to a second divert conveyor path **13**. During operation, the high-speed conveyor sorting device causes incoming carton goods to follow either a main line (nondivert) generally curved first conveyor path **12** in the manner of carton **11***d*, or to follow a generally straight, divert second path **13** in the manner of carton **11***c*. The multiplicity of cartons **11***a*, **11***b*, etc., supplied to the high-speed conveyor

sorting device are classified into one of two different categories (divert or nondivert), and thereafter are transported to and along either one of the first or second conveyor paths **12** or **13**.

To cause the incoming cartons **11***a*, **11***b*, etc., to be transported along either the first (nondivert) conveyor path **12** or the second (divert) conveyor path **13**, a plurality of diverter pins **14***a* through **14***m* are disposed intermediate a plurality of first rollers **15** that comprise the first conveyor path **12**. The diverter pins **14***a* through **14***m* are raised and lowered selectively by a suitable diverter pin, electromechanical drive mechanism (not shown) for selectively raising and lowering the diverter pins **14***a* through **14***m* individually. With the diverter pins **14***a* through **14***m* in the raised position, the cartons such as **11***a*, **11***b*, etc., will be caused to follow along a generally straightline (divert) path comprised by the second conveyor **13** in the manner indicated by carton **11***c*. With the diverter pins **14***a* through **14***m* in their lowered position, the incoming cartons **11***a* and **11***b* are transported along a generally curved, main line (nondivert) path defined by the first conveyor **12** in the manner shown by carton **11***d*. The raising and lowering of the diverter coins **14***a* through **14***m* is accomplished by individual associate diverter pin actuating devices which are relay controlled. The present static, pulsed, electronic control circuit is intended for use in selectively actuating the several solenoid windings of the diverter pin actuating devices with a pulsed electric signal of predetermined time duration to thereby selectively raise or lower the diverter pins **14***a* through **14***m*. For a more detailed description of the construction and operation of the diverter pins and the electromechanical drive mechanism for physically raising and lowering the diverter pins, reference is made to the above identified copending U.S. Pat. application Ser. No. 869,121.

The high-speed conveyor sorting device shown in FIG. **1** is further comprised by either a commercially available, sequential code reader **71** such as that manufactured and sold by the Specialty Control Department of the General Electric Company, Waynesboro, Virginia, and identified as specialty control sequential code reader model No. 35760SA102B1. This commercially available code reader, reads eight different combinations of a three-bit binary code, or the absence of a code, and develops and output first control signal in accordance with such code markings (or their absence) which serve to classify a given carton as either a divert carton or a nondivert carton. Alternatively, the code reader **71** could comprise a carton size reader which views each carton as it travels along the input side of he conveyor device, and classifies it according to size as being either a divert or nondivert carton.

The high-speed conveyor sorting device shown in FIG. **1** also includes an array of electro-optical scanning devices shown at **73**. In the particular embodiment of the invention shown in FIG. **1**, there are 13 photoelectric coaxial scanners (one for each of the diverter pins **14***a* through **14***m*) which are installed above the high-speed conveyor sorting device and are spaced apart by distance comparable to that of the spacing of the rollers comprising the conveyor. Associated retroreflectors are located below and between the conveyor rollers for establishing a light beam path between the photoelectric scanners **73** and their associated retroreflectors. With this arrangement, as a carton passes through the high-speed conveyor sorting device, the carton will intercept each of the 13 light beam paths sequentially. Hence, in effect, the photoelectric scanners **73** serve to establish the location or position of each carton with respect to the diverter pins **14***a* through **14***m* as the carton is transported through the high-speed conveyor sorting device.

The output second control signals from the 13 photoelectric scanners **73** are supplied to the static electronic control (shown at **72**) and comprising the present invention along with the first (divert or nondivert) control signals from the code or carton size reader **71**. The static electronic control then serves to process the input first and second control

signals supplied thereto from the code or carton size reader **71** and the photoelectric scanning means **73**, and to derive output, pulsed, control signals in accordance with the intelligence contained in these first and second input control signals. The output, pulsed control signals are then employed to control selective raising and lowering of the diverter pins **14***a* through **14***m* in a manner to be described more fully hereinafter in connection with FIG. 12 of the drawings.

FIG. 2 of the drawings is a detailed logical circuit diagram of the new and improved, pulsed, static electronic control constructed in accordance with the invention. The control shown in FIG. 2 is comprised by a plurality of electrically operable, diverter pin actuating devices **21***a*, **21***b*, **21***c*, etc. which constitute the solenoid actuating windings of the trip release mechanism for the clutch and/or brake of the electromechanical drive apparatus driving each of the respective diverter pins **14***a* through **14***m*. It is believed obvious that the solenoid winding **21***a* will control raising and lowering of the diverter pin **14***a*, **21***b* controls diverter pin **14***b* etc. For convenience, the construction of the control circuits for the first three diverter pins **21***a* through **21***c* has been illustrated. Because the remaining diverter pin control circuitry is identical in construction and operation to that shown for the first three, only the first three diverter pin control circuits have been described in detail.

Each of the diverter pin solenoid actuating windings **21***a*, **21***b*, etc. is controlled by its respective associated diverter pin logic circuit means **22***a*, **22***b*, etc. The first diverter pin logic circuit means **22***a* is different in construction from the remaining logic circuit means **22***b*, **22***c*, etc. in that it is designed to receive the carton classification information bearing signals derived from the code or carton size reader **71**. It should be noted with respect to the following discussion that it is immaterial which output terminal of the code or carton size reader **71** operates through the logic circuit means **22***a*, etc., to raise or lower the diverter pins. However, for convenience of illustration, the following convention has been established whereby the appearance of an ON signal at the No. **2** output terminal shall be considered to be a nondivert (lower diverter pins) control signal. Thus, the appearance of an ON signal at the No. **1** output terminal of the code or carton size reader **71**, will result in raising all of the diverter pins for a particular carton in question so that it is caused to follow the straight through (divert) path **13** shown in FIG. **1**. Conversely, the appearance of an ON signal at the No. **2** output terminal of code or carton size reader **71** will result in lowering all of the diverter pins **14***a* through **14***m* so that the particular carton in question will be transported through the conveyor sorting device along the curved, mainline (nondivert) path **12** shown in FIG. **1**. This convention has been adopted for convenience and if desired a reverse arrangement would be equally good.

In addition to the above established convention, it should be noted that in the static electronic control described hereinafter, an ON signal is considered to be a signal having a value of 0 volts DC and an OFF signal is considered to be a signal having a value of −4 volts DC. Whenever it is stated that "there is an input" or "an output exists," this statement means that a 0 volt ON signal is present at the respective terminal point in question.

Electric power is supplied to the static electronic control circuit of FIG. **2** through a 125 volt direct current bus **23** having a negative polarity. This input voltage is stepped down at appropriate points in the control circuit through the media of original input voltage conversion devices such as those shown at 24_1 through 24_3 and **25***a* through **25***c*. The original input voltage conversion devices are conventional, commercially available, solid-state semiconductor, modularized circuit structures which are manufactured and sold commercially by the General Purpose Control Department of the General Electric Company located in Bloomington, Illinois. These integrated circuit structures along with the additional logic circuit structure described hereinafter in conjunction with the present static electronic control such as the OFF return memory logic means shown at **26** and **27***a* through **27***c*, a reset logic circuit means **28**, a 2 input AND and additional NOT output circuit **29***a* through **29***c*, a one short multivibrator circuit **31***a* and **32***a* through **31***c* and **32***c*, and OR gate **33***a* through **33***c*, and sealed AND gate **34***a* through **34***c* and **35**, an output amplifier **36***a* through **36***c* and **37** and an AND gate **38***a* through **38***c*. All of these logic circuit elements comprise modularized, solid-state semiconductor circuit structures which are manufactured and sold commercially by the General Purpose Control Department of the General Electric Company located in Bloomington, Illinois and are described more fully in a publication GPC-B53D entitled "-Transistorized Static Control" published by that department. Accordingly, it will be appreciated that the logic circuit structures listed above and described more fully hereinafter are commercially available items which can be obtained from the General Purpose Control Department in much the same manner as conventional vacuum tubes, transistors or other electronic circuit components.

As stated before, the first logic circuit means **22***a* for the first solenoid actuating winding **21***a* of the first diverter pin **14***a* is different from the others in that it includes an additional OFF return memory logic module **26** having its No. 1 input terminal connected to the No. 1 output terminal of the code or carton size reader **71**, and has its No. 2 input terminal connected to the No. 2 output terminal of the reader **71**. The No. 8 output terminal of OFF return memory unit **26** is connected to the No. 1 input terminal of a two input AND gate with addition NOT output shown at **29***a*. OFF return memory unit **27***a* has its No. 1 input terminal connected to the No. 7 output terminal of a photoelectric module **39***a*, its No. 8 output connected to the No. 2 input terminals of AND gates **29***a* and **29***b*, and its No. 7 output terminal connected to the No. 2 input terminal of the next successive OFF return memory unit **27***b*. The photoelectric module is a solid-state, modularized semiconductor logic circuit structure manufactured and sold commercially by the Specialty Control Department of the General Electric Company located in Waynesboro, Virginia. This module is intended to be used with the photoelectric scanner marketed by the Specialty Control Department and is a commercially available item. The photoelectric modules **39***a*, **39***b*, etc. each possess operating characteristics such that the application of enabling ON potentials at the No. 2 and 3 input terminals thereof results in the production of an ON output signal at its No. 7 output terminal.

The two input AND gate **29***a* has its No. 4 terminal connected to the No. 1 input terminal of the one shot multivibrator module **31***a* and is also connected to the No. 2 input terminal of the AND gate **38***a*. The No. 3 output terminal of 2 input AND gate **29***a* is connected to the No. 5 input terminal of a one shot multivibrator module **32***a* which is companion dual circuit in the same module with the one shot multivibrator circuit **31***a*. The two multivibrator modules **31***a* and **32***a* operate independently of each other, however, and have their outputs connected to the No. 1 and No. 2 input terminals of OR gate **33***a* which has its remaining input terminal connected to the output of AND gate **38***a*. The circuit elements **26** through **33***a* form a trigger circuit means for developing a trigger signal at the output of OR gate **33***a* as will be described more fully hereinafter.

The output of OR gate **33***a* is supplied to the No. 1 input terminal of a sealed AND gate **34***a*. Sealed AND gate **34***a* has its No. 8 output terminal connected to the No. 1 input terminal of a power amplifier **36***a* whose output in turn excites the solenoid winding **21***a*. The output terminal **8** also is connected to the No. 1 input terminal of a fixed delay module **41***a* having its No. 4 output terminal connected to the No. 1 input terminal of a variable or adjustable delay module **41***a*. The No. 7 output terminal of the adjustable delay module **42***a* is connected back to the No. 3 input terminal of the sealed AND gate **34***a*. Sealed AND gate **34***a* has its No. 7 output terminal connected back to the No. 1 input terminal of AND gate **38***a* for a purpose to be described more fully hereinafter. The No. 2 and 4 input ter-

minals of the sealed AND gate **34***a* are connected through the conductor **43** and **44** back to the No. 8 output terminal of a sealed AND gate **35**. The sealed AND gate **35** has its No. 1 input terminal connected through the original input voltage conversion device **24**, to the switch contacts of a diverter power ON switch **45**, the No. 2 input terminal connected through conversion device 24_2 to the switch contacts **46** of a pin motor interlock relay, and the No. 3 input terminal connected through the conversion device 24_3 to the switch contacts of an emergency stop switch **47**. By this arrangement, the sealed AND gate **35** conditions sealed AND gate **34***a* for operation where it is desired that the conveyor sorting device operate in a sorting mode whereby cartons can be either diverted or not diverted. Such conditioning of the circuitry is achieved by depressing the diverter power ON switch **45** and this in turn conditions the sealed AND gate **34***a* as well as the remaining, corresponding sealed AND gates **34***b*, **34***c*, etc., for operation. The sealed AND gate **34***a* in conjunction with the fixed and variable time delay modules **41***a* and **42***a* then operate as a pulse generator circuit means upon receipt of an ON signal from the No. 4 output terminal of OR gate **33***a* to supply a pulse of energizing current to the solenoid winding **21***a* through the output power amplifier **36***a*.

It should be noted that turn-on of the sealed AND gate **35** also serves to turn on the enabling output power amplifier **37** which operates to condition output power amplifiers **36***a*, **36***b*, etc., for operation in the above briefly mentioned manner.

In operation, the circuit of FIG. **2** functions in the following manner. Assume that a carton which is classified to be diverted, is passing through the high-speed conveyor sorter and that the diverter ON switch has been depressed in the above briefly described manner and that the circuit otherwise is conditioned to operate selectively in either a divert or nondivert mode depending upon the output signal from the code or carton size reader **71**. Upon the code or carton size reader **71** determining that the carton is to be diverted, an ON signal appears at its No. 1 output terminal and is applied to the No. 1 input terminal of OFF return memory unit **26**. This causes the No. 8 output terminal of OFF return memory **26** to turn ON and apply an ON enabling potential to the **2** input AND gate **29***a*. As the carton continues through the high-speed sorter it will approach the first photoelectric cell causing pins **2** and **3** of the photoelectric module **39***a* to turn on. This results in producing an ON output signal at the No. 7 output terminal which is applied to the No. 1 input terminal of OFF return memory unit **27***a*. At this point, the No. 8 output terminal of OFF return memory unit **27***a* turns on and supplies an enabling on potential to the No. 2 input terminal of **2** input AND gate of **29***a*.

With both the No. 1 and No. 2 input terminals having ON enabling potentials supplied thereto, AND gate **29***a* produces an ON output potential at its No. 4 output terminal which results in turning on the one shot multivibrator module **31***a*. The single shot multivibrator module **31***a* will provide an "ON" pulse of 100 microseconds duration each time that an ON signal is applied at its No. 1 input terminal and then automatically turns off. This 100 microsecond timing or trigger pulse then is supplied through the OR gate **33***a* to the No. 1 input terminal of the sealed AND gate **34***a*. From the above brief description, it will be appreciated that the circuit elements **26***a* through **33***a* function in the manner of trigger circuit means to develop a timed trigger for turning on the sealed AND gate **34***a*.

The sealed AND gate **34***a* previously has been enabled in the above briefly mentioned manner by sealed AND gate **35** which applies enabling potential to its No. 2 and No. 4 input terminals, and by the adjustable time delay circuit **42***a* which supplies an enabling ON potential from its No. 7 output terminal to the No. 3 input terminal of sealed AND gate **34***a*. Thus, upon the occurrence of the ON pulse supplied from the output of OR gate **33***a*, output terminal No. 8 of sealed AND gate **34***a* turns ON and supplies an enabling ON potential to the No. 1 input terminal of the output amplifier **36***a*. This results in turning on output power amplifier **36***a* and energizing the solenoid actuating winding **21***a* of the first diverter pin **14***a* shown in FIG. **1**. The ON output signal from terminal **8** of sealed AND gate **34***a* also is supplied to the No. 1 input terminal of the fixed time delay **41***a*. Fixed time delay **41***a* provides a time delay of 15 milliseconds and then turns on to supply an ON enabling potential to the No. 1 input of the adjustable time delay **41***a*. After a second delay period determined by the adjustable time setting of the adjustable time delay module **42***a*, terminal No. 7 of time delay module **42***a* will turn off thereby disenabling sealed AND gate **34***a* and causing it to turn off the No. 8 output terminal. Turn off of the No. 8 output terminal of sealed AND gate **34***a* causes the output power amplifier **36***a* to turn off and deenergizes the solenoid actuating winding **21***a*. The setting of the adjustable time delay module **42***a* determines the time duration of the energization of the solenoid winding **21***a*. This time delay must be set to allow only time enough to pull the trip mechanism and allow the motor and clutch assembly of Ser. No. 869,121 to drive the first diverter pin **14***a* up to its divert position, or down to its nondivert position, depending upon where it is set at the time of energization of winding **21***a*.

In addition to the above-described pulsing operation, the electronic control circuit of FIG. **2** further includes a diverter pin position monitor circuit and automatic reset to assure that the diverter pins are properly sequenced. For this purpose, each diverter pin logic means for the respective diverter pins includes a limit switch **51***a*, **51***b*, **51***c*, etc., which is connected through an original voltage conversion unit **25***a*, **25***b*, etc., to the No. 3 input terminal of the three input AND gate **38***a*, **38***b*, etc., respectively. The limit switches **51***a*, **51***b*, etc., are closed only when the respective diverter pin with which they are associated is in down (retracted) position. Thus, if the diverter pin **14***a* is in the down (nondivert) position, its associated limit switch **51***a*, etc., will be closed thereby providing an ON enabling potential to the No. 3 input terminal of AND gate **38***a*. If at the same time the 2 input AND gate **29***a* has an ON output signal at its No. 4 output terminal, all 3 inputs of the AND gates **38***a* will be in the ON condition and will produce an ON output that will be supplied to the No. 3 input terminal of OR gate **33***a*. This results in producing an ON enabling signal that is supplied to the No. 1 input terminal of sealed AND gate **34***a* thereby initiating an operation of the single pulse generating circuit comprised by sealed AND gate **34***a* and the time delay modules **41***a* and **42**. As a result, an output signal pulse will be produced that energizes the solenoid **21***a* and drives the diverter pin back into the correct sequence in accordance with the commands of the code or carton size reader **71**.

In addition to the above-described circuit connections, it will be seen that each of the OFF return memory units **26** and **27***a*, **27***b*, **27***c*, etc., together with the sealed AND gate **25**, sealed AND gate **34***a*, **34***b*, **34***c*, etc., and the adjustable time delay modules **42***a*, **42***b*, **42***c*, etc. all have their No. 5 input terminals connected to the output of a reset pulsing circuit logic unit **28**. With this arrangement, upon initially placing the conveyor sorting device in operation, the reset logic module **28** is actuated to provide a turn OFF enabling signal pulse to the No. 5 input terminals of all of the units enumerated above so as to assure that these units are in the OFF condition upon initially placing the electronic control circuit in operation.

The above set forth description has carried a carton being transported through only the first diverter pin. As the carton proceeds through the conveyor it will interrupt the light path of the photoelectric scanner associated with the No. 2 diverter pin that is under control of actuating solenoid winding **21***b*. Upon this occurrence, an ON output signal will be produced at the No. 7 output terminal of the photoelectric module **39***b*. This results in turning on the No. 1 input terminal of the OFF return memory unit **27***b* and producing an ON output signal at its No. 8 output terminal which is supplied to the No. 1 input terminal of 2 input AND gate **29***b*. It should be noted that the No. 2 input terminal of 2 input AND gate **29***b* previously has

been enabled from the ON output from the No. 8 output terminal of the OFF return memory unit **27***a*. As a consequence, an ON output signal will be produced at the No. 4 output terminal of the AND gate **29***b* thereby initiating operation of the one shot multivibrator module **31***b* and producing an energizing output pulse from the pulsing circuit comprised by sealed AND gate **34***b* and the interconnected delay units **41***b* and **42***b*. This results in supplying a short pulse of energizing current to the solenoid actuating winding **21***b* of No. 2 diverter pin **14***b* thereby causing this pin to be raised to its upper position.

In a similar manner, all of the subsequent diverter pins are caused to be raised to their upper position as the carton continues to proceed down the conveyor sorting device divert path and sequentially interrupt the light beam path of the photoelectric scanners associated with each diverter pin. Accordingly, it will be appreciated that the diverter pins will raise as fast as the carton interrupts the photoelectric beam associated with each of the diverter pins. The ON enabling signal from each of the OFF return memory units such as **27***a*, **27***b*, etc., is shifted to the next successive logic circuit means such as **22***c* as described above until all of the diverter pins have been actuated by the particular carton in question as it proceeds through the conveyor sorting device. It should be remembered at this point in the description that the particular carton in question has been assumed to be classified with a divert classification, and as a result all of the diverter pins will end up in the raised or divert position.

As the trailing edge of the carton in question proceeds out of the scanning light beam path of the No. 1 electro-optical scanner associated with the photoelectric module **39***a*, the ON signal supplied to the No. 2 and No. 3 input terminals of photoelectric module **39***a* will go to an OFF signal. As a result, the No. 7 output terminal of photoelectric module **39***a* will be switched to an OFF output signal. This OFF output signal is supplied to the No. 1 input terminal of OFF return memory unit **27***a*. However, because of its characteristics, the OFF return memory unit **27***a* will remain in the condition to which it was switched by the last received ON signal so that it continues to supply an ON output signal from its No. 8 output terminal. As a consequence, ON enabling signals will be supplied to the No. 2 input terminals of the 2 input AND gate **29***a* and **29***b* thereby retaining these AND gates in their original switched conditions whereby ON output signals are provided at their No. 4 output terminal. As a consequence, the circuit does not change state so that the actuating solenoid windings **21***a*, **21***b*, etc., are not supplied with an exciting current pulse as a consequence of the trailing edge of the carton passing out of the field of view of the electro-optical scanner units. This same condition will apply to all of the remaining diverter pins **14***c* through **14***m* and all of the diverter pins will be maintained in their raised position. Accordingly, if a succeeding carton contains a "divert" classification, all of the diverter pins **14***a* through **14***m* will be maintained in the previously established raised (divert) position. Hence, it will be appreciated that the novel electronic control avoids the necessity of cycling the individual diverter pins up and down for each and every carton passing through the conveyor sorting device. The diverter pins are caused to raise or lower only in the event that the classification of a carton passing through the conveyor sorting device calls for a different position of the diverter pins than that previously established by an immediately preceding carton.

The nondivert operation of the new and improved control circuit is similar in many respects to the divert operation with the following exceptions. Upon the occurrence of a carton entering the high-speed conveyor sorting device which is classified in a manner to indicate that it should follow the curved main line (nondivert) conveyor path, the code or carton size reader **71** will supply an ON enabling signal from its No. 2 output terminal thereby indicating that the particular carton should not be diverted. This results in supplying an ON input signal to the No. 2 input terminal of the OFF return memory unit **26**. Conversely, the No. 1 input terminal of memory unit **26** will be provided with an OFF input signal so that this unit switches to provide an OFF output from its No. 8 output terminal and an ON output from its No. 7 output. Upon the No. 8 output terminal of OFF return memory unit **26** switching to an OFF condition, the 2 input AND gate **29***a* will be switched so that it provides an an OFF output signal from its No. 4 output terminal and an ON enabling signal from its No. 3 output terminal. The ON signal from the No. 3 output terminal of AND gate **29***a* is supplied to the No. 5 input terminal of a one shot multivibrator module **32***a* comprising the second half of a two section multivibrator module, and is identical in construction ann operation to the first half section comprised by multivibrator module **31***a*. Accordingly, the multivibrator module **32***a* will produce an ON output signal pulse of about 100 microseconds duration each time that its No. 5 input terminal is supplied with an ON enabling potential. This pulsed ON output signal is supplied through the OR gate **33***a* to trigger the operation of the pulse generating circuit comprised by the scaled AND module **34***a* and the time delay units **41***a* and **42***a* in the previously described manner. As a consequence, the actuating solenoid winding **21***a* will be supplied with an energizing current pulse which will cause the trip release of the electromechanical diverter pin driving assembly to be released and allow the diverter pin to be driven from its up divert position to its down nondivert position.

As stated earlier, upon a nondivert ON signal being supplied to the No. 2 input terminal of OFF return memory unit **26**, the No. 7 output terminal of this unit supplies an ON signal to the No. 2 input terminal of the OFF return memory unit **27***a*. It is assumed, however, that the previous carton which was classified for divert processing still has not passed through the conveyor sorting device so as to be cleared of the scanning field of the electro-optical scanner associated with the photoelectric module **39***a*. As a consequence, the No. 1 input terminal of the OFF return memory unit **27***a* still has supplied to it an ON enabling potential. As a consequence, because of the memory characteristics of the unit **27***a*, this unit will not be switched until such time that the trailing end of the previously sorted carton has cleared the scanning field of the photoelectric module **39***a*. This same condition will prevail with respect to the next adjacent, successive photoelectric module **39***b*, **39***c*, etc., on through all of the diverter pins. Accordingly, all of the diverter pins will remain in their raised, divert condition until such time that the earlier processed carton has passed beyond these diverter pins, and the trailing edge of the carton has cleared the respective scanning fields of the associated photoelectric modules controlling the respective diverter pins.

For so long as the module **27***a* has an ON potential supplied to its No. 1 input terminal, it will be unable to switch so as to provide an ON enabling potential to its No. 7 output terminal to the next successive OFF return memory unit **27***b*. Thereafter, upon the trailing edge of the previously processed, divert carton clearing the scanning field of the electro-optical unit controlling module **39***a*, the No. 1 input terminal of memory unit **27***a* will go to OFF. Upon this occurrence, and due to the presence of an ON enabling potential at its No. 2 input terminal, memory unit **27***a* will be switched to provide an ON output signal from its No. 7 output terminal and an OFF output signal from its No. 8 output terminal. This results in switching the 2 input AND gate **29***b* to provide an ON output signal from its No. 3 output terminal thereby triggering the one shot multivibrator module **32***b* and causing the solenoid actuating winding **21***b* of the next adjacent diverter pin to be cycled with an energizing current pulse and results in driving the diverter pin **14***b* to its lower (nondivert) position. In a similar manner, the OFF return memory unit **27***c* will be unable to activate the next successive 2 input AND gate **29***c*, until the trailing edge of the previously processed divert carton has cleared the scanning field of the electro-optical unit controlling the preceding photoelectric module **39***b*. The remaining channels controlling the several remaining diverter pins **14***c* through **14***m* all operate in a similar manner, and hence will not be described in detail.

From the above description, it is seen that the logic circuit means **22***a*, **22***b*, etc., will be switched to provide an ON enabling potential from the No. 7 output terminal of its respective OFF return memory unit **27***a*, **27***b*, etc., successively as a carton is transported past each of the respective diverter pins whereby all of the remaining diverter pins **14***b* through **14***m* will be either raised to their upper (divert) position or will be retracted to their down (nondivert) position. The diverter pins will then remain in the position to which they were last set until a carton passing through a conveyor sorting device requires a different classification, and hence different processing. Thus, once the diverter pins **14***a* through **14***m* have been positioned in either a raised position or a lowered position, they will remain in that position until a different position is called for by the classification of one of the cartons being processed. While only two stages of the multiple stage electronic control circuit have been described in detail, it is believed apparent that the remaining stages operate in exactly the same manner as the first two and, hence, a detailed description of the manner of the operation of these remaining stages is unnecessary.

To assure proper operation and sequencing of all of the logic circuit means **22***a*, **22***b*, etc., the reset logic module **28** is provided for supplying to the No. 5 reset input terminals of the sealed AND gate **35**, the OFF return memory unit **26**, the OFF return memory units **27***a*, **27***b*, etc., the sealed AND gates **34***a*, **34***b*, etc., and the adjustable time delay units **42***a*, **42***b*, etc., appropriate OFF enabling potential to condition these elements for operation in proper sequence. By reason of this arrangement, upon application of main control power to static control circuit all of the logic circuit means **22***a*, **22***b*, etc., are switched to a known OFF condition. If desired, the circuit could be readily modified to return all the diverter pins to a previously established condition following power interruption or the like through the medium of the reset logic module.

From the foregoing description it will be appreciated that the present invention provides a static, solid state, pulsed electronic control for use in controlling the operation of a high-speed conveyor sorting device of the type that employs a solenoid trip release of a clutch and/or brake mechanism for driving high-speed diverter pins from a raised position to a retracted position and vice versa. The new and improved static control by reason of its design minimizes the duty cycle of the electromechanical, high-speed conveyor sorting apparatus so as to maximize the operating life of the apparatus and increase its reliability. The control operates at high speeds, is relatively simple and inexpensive to manufacture in that it employs conventional, commercially available, solid state, integrated logic circuit modules, is reliable in operation and is readily maintained.

Having described one embodiment of a new and improved static electronic control for a high-speed conveyor sorting device constructed in accordance with the invention, it is believed obvious that other modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that changes may be made in the particular embodiment of the invention described which are within the full intended scope of the invention as defined by the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a static electronic control for a high-speed conveyor sorting device of the type having a plurality of serially arranged electrically operable diverter pins which are selectively raised and lowered between the rollers of at least two conveyor paths to selectively control which conveyor path a particular carton passing through the device is caused to follow and further including classifying means for viewing cartons to be sorted by the conveyor sorting device and deriving first control signals in accordance with predetermined classifications for the cartons, and electro-optical scanning means for scanning the cartons transported through the conveyor sorting device and deriving a plurality of timed second control signals in accordance with the position of the cartons relative to the plurality of diverter pins, there being a respective timed second control signal associated with each diverter pin, the static electronic control having the input thereof coupled to the outputs from the classifying means and the electro-optical scanning means and serving to process the first and second control signals to derive output control signals for controlling the selective raising and lowering of the diverter pins at high speed with the static electronic control comprising a plurality of electrically operable diverter pin actuating devices, diverter pin logic circuit means coupling the first control signals from the classifying means to the input of the first diverter pin logic circuit means for controlling operation of the first diverter pin actuating device, means for coupling the respective timed second control signals from the electro-optical scanning means to the respective diverter pin logic circuit means, means for coupling the carton classification information bearing first signals between each diverter pin logic circuit means and the next successive diverter pin logic circuit means to thereby condition all of the diverter pin logic circuit means in succession with the control information contained in the first control signals derived by the classifying means, and means for coupling carton location identifying second control signals between the logic circuit means of adjacent diverter pins for controlling the diverter pins successively in accordance with the position of the cartons being transported through the high speed conveyor device; the improvement wherein said diverter pin logic circuit means comprises pulsed signal producing circuit means for producing output pulsed signals of predetermined time duration for application to the respective diverter pin actuating devices, and trigger circuit means responsive to the classification information bearing first signals and the carton location identifying second control signals coupled to and controlling operation of said pulsed signal producing circuit means.

2. A static electronic control according to claim 1 wherein the electrically operable diverter pin actuating devices comprise solenoid actuating windings of an electromechanical coupling assembly controlling the operation of the diverter pins and the control further includes manually operable switch means having contacts connected in circuit relationship with each of the actuating windings for selectively operating said diverter pins manually.

3. A static electronic control according to claim 1 further including interlocked sequence control circuit means coupled to and controlling operation of said pulsed signal producing circuit means for assuring proper sequencing of the diverter pins in accordance with the command signals derived by said classifying means.

4. A static electronic control according to claim 1 wherein the diverter pin logic circuit means includes the means for coupling the carton classification information bearing first control signals between the successive diverter pin logic circuits means and transfer of the first control signals to the next successive diverter pin logic circuit means is controlled by the carton location identifying second control signals whereby the up-down condition of the respective diverter pins cannot be changed until a previously processed carton has been cleared in accordance with its classification.

5. A static electronic control according to claim 1 further including reset logic circuit means coupled to all of the diverter pin logic circuit means for resetting all of the diverter pins to a known condition at the start of a power-on condition of the static electronic control.

6. A static electronic control according to claim 2 further including interlocked sequence control circuit means coupled to and controlling operation of said pulsed signal producing circuit means for assuring proper sequencing of the diverter pins in accordance with the command signals derived by said classifying means, and wherein the diverter pin logic means includes the means for coupling the carton classification information bearing first control signals between the successive diverter pin logic circuits means and transfer of the first control signals to the next successive diverter pin logic circuit

means is controlled by the carton location identifying second control signals whereby the up-down condition of the respective diverter pins cannot be changed until a previously processed carton has been cleared in accordance with its classification, and further including reset logic circuit means coupled to all of the diverter pin logic circuit means for resetting all of the diverter pins to a known condition at the start of a power-on condition of the static electronic control.

7. A static electronic control according to claim 1 wherein each of said diverter pin logic circuit means includes a solid-state semiconductor modularized memory logic means for producing an output ON signal at a first output terminal and an OFF signal at a second output terminal in response to an ON signal applied to a first input terminal and for retaining the ON signal at the first output terminal until an ON input signal is applied to a second input terminal and the ON signal to the first terminal is removed, whereupon the memory logic means switches to produce an OFF signal at its first output terminal and an ON signal at its second output terminal, the carton classification first control signals being applied to the input terminals of a first memory logic means in the diverter pin logic circuit means controlling the first diverter pin and the carton location identifying second control signals being supplied to the input terminals of a second memory logic means in the diverter pin logic circuit means controlling the first diverter pin along with the output from the second output terminal of the first memory logic means; said trigger circuit means comprises a two input AND gate having a normal output terminal and an additional NOT output terminal, said AND gate having one of its input terminals connected to the first output terminal of the first memory logic means and having its remaining input terminal connected to the first output terminal of the second memory logic means, respective single shot pulse signal generator means coupled to the normal and additional NOT output terminals respectively of the two input AND gate, and OR gates means having the input terminals thereof connected to the outputs from the respective single shot pulse signal generator means; and said diverter pin pulsed signal producing means comprises solid-state semiconductor modularized sealed AND logic means having a plurality of input terminals and an output terminal with feedback connection to seal in an output condition until the sealed AND logic means is switched by the presence of a switching input signal at one of the input terminals, the output from the OR gate means being applied to one input terminal of the sealed AND logic means and the output from the sealed AND logic means being connected to operate the electrically operable diverter pin actuating device, and delay turnoff pulse producing circuit means having its input connected to the output from the sealed AND logic means and its output connected to an input of the sealed AND logic means for turning off the sealed AND logic means after a predetermined conducting interval whereby said diverter pin actuating device is excited for only a predetermined time duration interval.

8. A static electronic control according to claim 7 further including reset logic circuit means for producing a reset to OFF signal with the reset to OFF signal from the reset logic circuit means being applied to reset input terminals of both memory logic means and the scaled AND logic means.

9. A static electronic control according to claim 8 wherein the carton classifying means has a first divert output supplying an ON electric potential to the first input terminal of the first memory logic means controlling the first diverter pin and a second nondivert output for supplying an ON electric potential to the second input terminal of the first memory logic means.

10. A static electron control according to claim 9 further including an additional sealed AND logic means having the input terminals thereof connected to a plurality of interlock and control signal circuits and having the output thereof connected to enable the first mentioned sealed AND logic means and the respective diverter pin actuating devices for enabling the devices for operation.

11. A static electronic control according to claim 10 wherein the second output terminal of the memory logic means of each diverter pin logic circuit means is connected to the second input terminal of the memory logic means of the next successive diverter pin logic circuit means and serves to supply all of the diverter pin logic circuit means in succession with the control information contained in the carton classification first control signals supplied by the carton classifying means to the input terminals of the first memory logic means in the first diverter pin logic circuit means.

12. A static electronic control according to claim 11 further including an output power amplifier connected to the output of each diverter pin logic circuit means and having the output power terminal thereof connected to excite a respective diverter pin actuating device and having a first signal input terminal connected to and controlled by the output from the sealed AND logic means of the respective diverter pin logic circuit means and a second enabling input terminal connected to the output from said additional sealed AND logic means.

13. A static electronic control according to claim 12 wherein the electrically operable diverter pin actuating devices comprise solenoid actuating windings of an electromechanical coupling assembly controlling the operation of the diverter pins and the control further includes manually operable switch means having contacts connected in circuit relationship with each of the actuating windings for selectively operating said diverter pins manually.

14. A static electronic control according to claim 13 further including interlocked sequence control circuit means coupled to and controlling operation of said pulsed signal producing circuit means for assuring proper sequencing of the diverter pins in accordance with the command signals derived by said classifying means.

15. A static electronic control according to claim 14 wherein the diverter pin logic circuit means includes the means for coupling the carton classification information bearing first control signals between the successive diverter pin logic circuits means and transfer of the first control signals to the next successive diverter pin logic circuit means is controlled by the carton location identifying second control signals whereby the up-down condition of the respective diverter pins cannot be changed until a previously processed carton has been cleared in accordance with its classification.