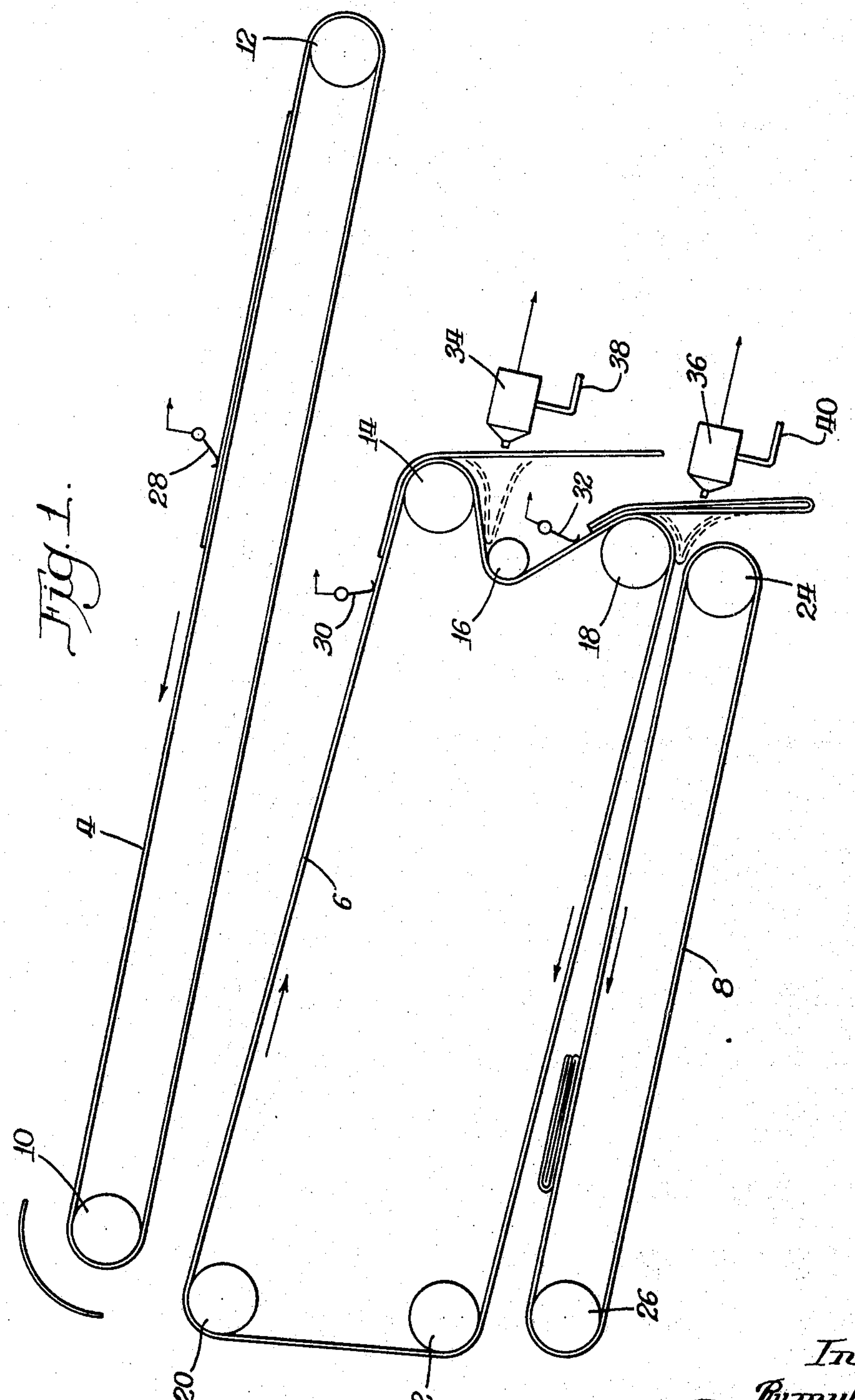
Dec. 23, 1969 R. ILTIS 3,485,492

CONTROL SYSTEM FOR A FOLDING MACHINE

Filed Aug. 14, 1967 3 Sheets-Sheet 1



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CONTROL SYSTEM FOR A FOLDING MACHINE

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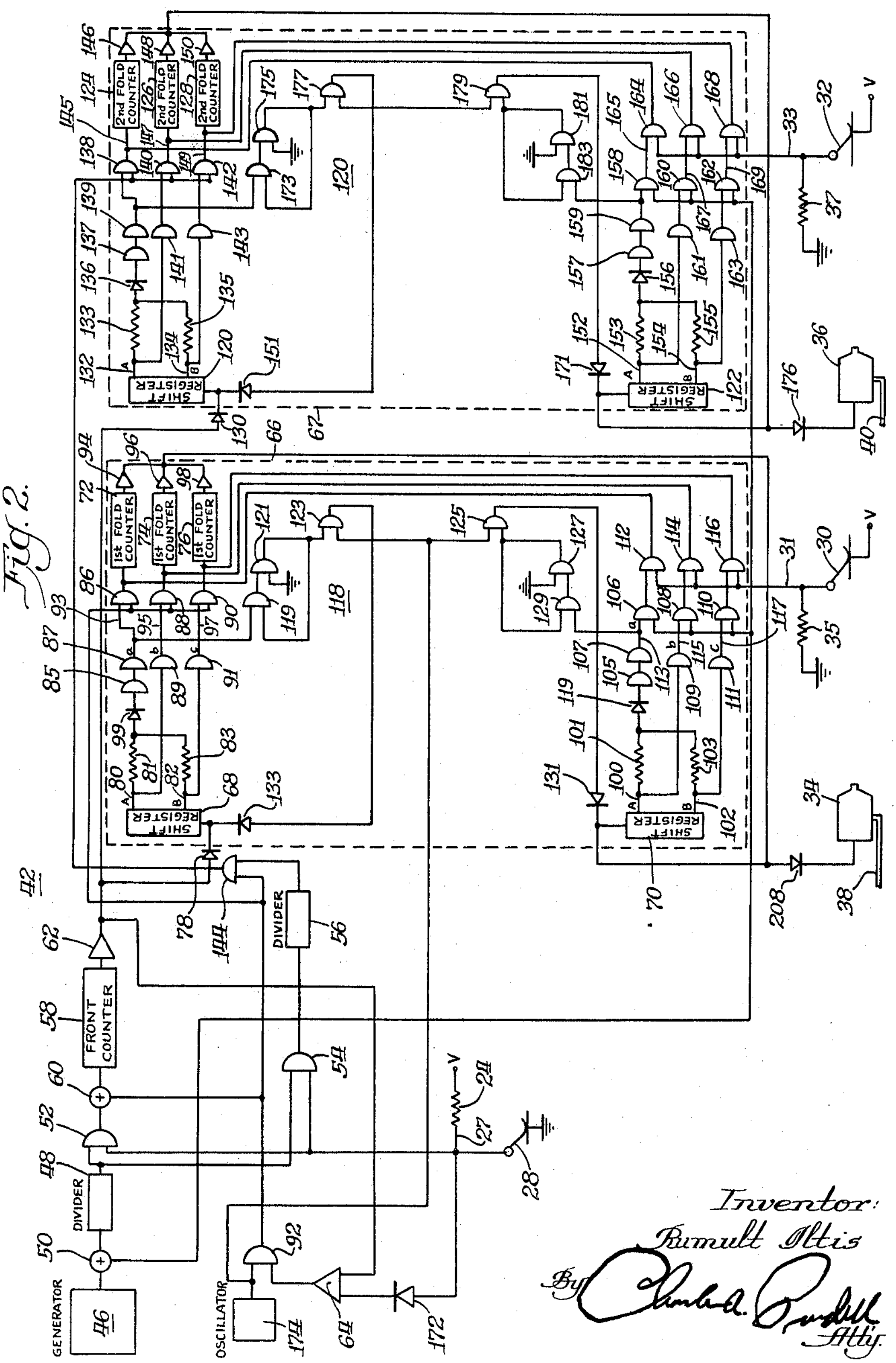

Fig. 2.

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CONTROL SYSTEM FOR A FOLDING MACHINE

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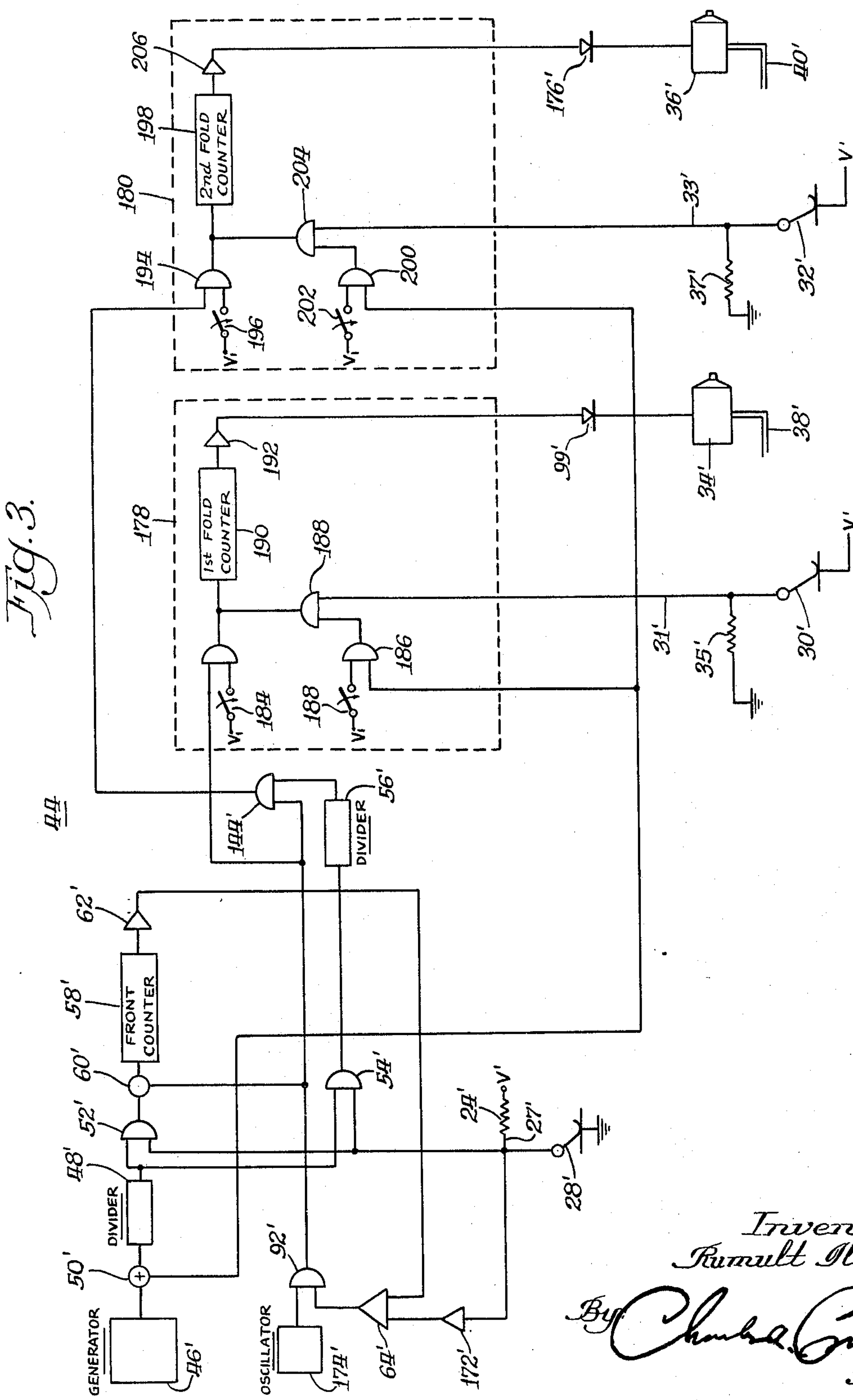

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United States Patent Office

3,485,492
Patented Dec. 23, 1969

3,485,492

CONTROL SYSTEM FOR A FOLDING MACHINE

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Filed Aug. 14, 1967, Ser. No. 667,877
Int. Cl. G01r *11/00;* B65h *45/10*
U.S. Cl. 270—84 24 Claims

ABSTRACT OF THE DISCLOSURE

A circuit for locating fractional lengths of articles moving on a belt in synchronization with high, intermediate and low rate pulses having a 4:2:1 ratio. First, second and third counters having equal count capacities are provided. The pulse rates are applied to the first and third counters so that they respectively accumulate a count representative of the full length and one-half length of an article. A very high repetitive frequency pulse train is then applied to all three counters until the count capacity of the first counter is filled. By applying the high rate pulse to the second counter and then to the third counter, the mid-length and the quarter-length of the article may be located.

This invention relates to apparatus and method for locating predetermined positions along the length of an article. More particularly, the invention is directed to control apparatus for actuating a device for folding moving articles at a time related to the position and length of the article.

One type of folding device intended for use with the invention is a laundry folding machine for folding flat cloth articles traveling on a continuous conveyor belt. Such folding machines are well-known and typically have at least one endless conveyor belt which carries an article past one or more measuring and folding stations. A folding means is located at each folding station and is usually of an air blast or mechanical blade type. The article is measured as it moves past the first measuring station and is then folded at the folding station. The measuring and folding operation is repeated by the machine as many times as desired at additional measuring and folding stations for each fold.

There have been various types of control arrangements suggested by the prior art for use in measuring and folding a moving article in a laundry folding machine. These have included mechanical apparatus such as multi-speed motor driven timers, moving measuring stations, and two-speed motor driven conveyor belts. More recently, control circuits employing electromechanical relays and vacuum tube analogue electronic timing methods or solid-state digital timing methods have been used. These circuits include at least one sensor for each fold to be made which senses the presence of the article moving on the conveyor belt. In general, the length of the article is measured by determining the time it takes to move past the sensor at one time measuring rate or by determining the number of pulses per unit of length. The time measuring rate or pulse repetition rate is then increased until the total time or total number of pulses of the measuring cycle is completed. The two measuring rates are so related that when the cycle is completed the position at which a fold is to be made in the article will be opposite the folding means of the folding machine. Completing of the measuring cycle causes the control circuit to actuate the folding means to fold the moving article.

There are a number of disadvantages in the use of the aforementioned control methods. These disadvantages involve the need for a folding machine that is compact

in size and therefore requires a relatively short conveyor belt that will readily handle large as well as very small successive articles at close intervals. Other disadvantages relate to the need for a folding machine that will accurately locate the folding point and that is simple in operation and low in cost. The mechanical control apparatus suggested by the prior art has not proved to be simple in operation or low in cost, particularly when adapted to the handling of small, closely following articles. Control circuits using electronic timing means have been more accurate than mechanical control apparatus. However, electronic timing means of analogue form require elaborate circuitry for stability of operation. Control circuits using digital methods generally are simpler in operation, and lower in cost. The prior art control circuits utilizing digital methods are nevertheless not economically or easily adaptable to provide repeated folding of a series of small, closely following articles. In addition, the article sensing and timing requirements of present electronic control circuits necessitate conveyor belt lengths and article travel distances which do not permit the desired folding machine compactness. In particular, those control circuits using one sensing station per fold require that successive articles must be spaced at sufficient intervals to allow the complete measuring and folding of an article before another article reaches the sensing station. Furthermore, the maximum length article that can be folded is dependent on the distance between the sensing station and the folding station, thus machine compactness must be sacrificed if it is desired to handle long articles. The control circuits using two sensing stations per fold also require an unsatisfactorily long conveyor belt thus increasing machine size when a number of folds are to be made, e.g., if three folds are to be made, six sensing stations and the corresponding conveyor belt length for these stations is required. When a number of closely following small articles are to be folded and the articles are of such size that several of them will fit between the two sensing stations, problems occur relating to the storing of the full length information obtained at the first sensing station for each small article and then matching the full length information of a particular article with that same article at the second sensing station. Although the prior art suggests that several duplicate measuring circuits can be used to measure a series of closely following small articles, there is no reliable and easily accomplished method or apparatus suggested matching the measured length with the article itself at subsequent measuring stations.

A principal object of this invention is to provide an improved apparatus and method for locating predetermined positions along the length of a moving article.

A further object of the invention is to provide an accurate and economical apparatus for locating predetermined positions along the length of a moving article.

Another object of the invention is to provide an apparatus requiring a minimum amount of space and distance of article travel for locating predetermined positions along the length of a moving article.

Another object of the invention is to provide an apparatus having essentially no minimum distance requirement between moving articles for locating predetermined positions along the lengths of the moving articles.

Another object of thei nvention is to provide a coincidence network for determining when a particular position is reached on a moving article in an apparatus for locating predetermined positions along the length of the moving article.

A further object of the invention is to provide an economical apparatus for matching length information obtained at two different locations along the path of movement of a moving article for locating predetermined positions along the length of the article.

A further object of the invention is to provide an improved apparatus and method for folding a moving laundry article at predetermined positions along its length.

A further object of the invention is to provide an accurate and economical apparatus for folding a moving laundry article at predetermined positions along its length.

Another object of the invention is to provide a laundry article folder requiring a minimum amount of space and distance of laundry article travel.

In the embodiment of the invention shown and described herein, first, second and third digital electronic counters are provided. Each of these counters have an equal maximum count capacity. Low, intermediate and high rate electrical pulses are generated and connected to one of the counters in response to the presence of a flat cloth article moving at a constant rate beneath one of three sensors. The rates of the electrical pulses relative to each other are determined by the position which is to be located or the position at which a fold is to be made along the length of the article, e.g., if a fold is to be made at the mid-length and quarter-length of an article, the low rate will be one-half that of the intermediate rate and the high rate will be twice that of the intermediate rate. While the moving article is between a first sensor the intermediate rate pulses are connected to the first counter and the low rate pulses are connected to the third counter. Upon the passing of the article from beneath the first sensor, the intermediate and low electrical pulse rates are disconnected from the first and third counters and a high frequency oscillator is connected to all three counters until the count capacity of the first counter is filled. The first counter now resets itself to zero count. The second counter has an unfiilled count capacity equal to the number of counts accumulated on the first counter while connected to the intermediate rate pulses.

The third counter has an unfilled count capacity equal to one-half the number of counts accumulated on the first counter while connected to the intermediate frequency pulses. When the article moves beneath a second sensor, the high rate pulses are connected to the second counter until the maximum count capacity of the second counter is filled. The second counter then resets itself to zero count and produces an output signal which actuates a first article folding mechanism. Since the high rate pulses have a rate twice that of the intermediate rate pulses which were applied to the first counter, the article will have moved only halfway past the second sensor when the maximum count capacity of the second counter is filled and thus the article will be folded at a midpoint of its length. After being folded, the article moves on to pass beneath a third sensor. While the article is beneath the third sensor, the high rate pulses are connected to the third counter until the maximum count capacity of the third counter is filled. The third counter then resets itself to zero count and produces an output signal which actuates a second article folding mechanism. Again, since the high rate pulses have a rate twice that of the intermediate rate pulses which were applied to the first counter, and because the third counter has an unfilled count capacity equal to one-half the number of counts accumulated by the first counter while connected to the intermediate rate pulses, the once folded article will have moved only halfway, i.e., one-fourth of its full, unfolded article length, past the third sensor when the maximum count capacity of the third counter is filled. The article is thus folded at the midpoint of its half length.

Closely following articles of short length are measured and folded by providing a plurality of second and a plurality of third counters respectively equal in number to the number of short articles that will be moving intermediate the first and second sensors. After a first article has passed the first sensor, the first counter will reset itself to zero count to thereby prepare for a second immediately following article. The first article continues on to the second sensor where the high rate pulses are connected to the same second counter that the oscillator was connected to immediately following the passing of the first article for the first sensor. After the first article is folded it continues on beneath the third sensor to cause the high rate pulses to be connected to the same third counter that the low frequency pulses and the oscillator were connected to during and subsequent to the passing of the first article beneath the first sensor. This sequence of operation is repeated with each closely following short article. A shift register means is utilized with both the second counters and the third counters to match the same second counter and the same third counter with a particular article when the article passes beneath the first, second and third sensors.

The above and other objects and features of the invention will become apparent from the following detailed description and drawings which form a part of this specification and in which:

FIG. 1 is a diagrammatic view of a laundry folding machine illustrating the conveyor belts and folding mechanism;

FIG. 2 is a detailed block and flow diagram of one embodiment of the invention; and

FIG. 3 is a detailed block and flow diagram of another embodiment of the invention.

Principal parts and connection of folder and control circuit

A conventional laundry folding machine **2** is shown generally in FIG. 1. The conveyor belts **4**, **6** and **8** are respectively shown supported on rollers **10** and **12**, **14**, **16**, **18**, **20** and **22**, and **24** and **26**. Each of the conveyor belts **4**, **6** and **8** travels at the same linear speed in the direction of the arrows shown in FIG. 1. A succession of flat laundry articles are shown being carried by the conveyor belts, **4**, **6** and **8** beneath the sensors **28**, **30** and **32** and in front of the first fold mechanism **34** and second fold mechanism **36**. The fold mechanism **34** and **36** are of the air blast type and are connected at pipes **38** and **40** to a source of high pressure air (not shown) and are well known in the art. Any other type of suitable folding means may also be used, for example, a mechanical folding blade. As hereinafter explained, the sensors **28**, **30** and **32**, operating through the control circuit **42** (see FIG. 2) cause actuation of the fold mechanisms **34** and **36**. As an article moves past the fold mechanism **34**, the fold mechanism **34** is operated to place a first fold in the article at the midpoint of its length. The air blast which makes the fold in the article also moves the article between conveyor belt **6** and roller **16**, as shown in dotted lines in FIG. 1, to enable the conveyor belt **6** to move the article toward and beneath sensor **32**. When the once folded article moves in front of the second fold mechanism **36**, the second fold mechanism operates to make a second fold at the midpoint of the length of the once folded article. The air blast which makes the second fold of the article also moves the article between the conveyor belts **6** and **8** to enable conveyor belt **6** to carry the article away from the folding station.

With reference to FIG. 2, the connection to the control circuit **42** of a source of positive D.C. voltage, indicated by the symbol V is controlled by the sensors **28**, **30** and**32**. The sensors **28**, **30** and **32** are shown as being of the mechanical switch type, however, various other types of sensing means such as photocells may be used. When a laundry article is not present beneath the sensor **28**, the sensor **28** is closed to connect the positive D.C. voltage V to ground through the resistor **29**. When the positive D.C. voltage V is thus connected to ground, no gating signal will be carried to the control circuit **42** on lead **27**. When a laundry article is present beneath sensor **28**, the sensor **28** will open to remove the ground connection so that a gating signal is fed to the control circuit **42** on lead **27**. When a laundry article is not present beneath the sensors **30** and **32**, the sensors **30** and 32 are closed to connect the positive D.C. voltage V to the control circuit on leads 31 and 33. When a laundry article passes beneath either sensor 30 or 32, the sensors 30 and 32 will open to allow discharge of any residual voltage charge on the parts of control circuit 42 connected to leads 31 and 33 through resistors 35 and 37 to ground.

A pulse generator 46, utilizing a rotating light chopping disc, is provided for supplying voltage pulses at a fixed rate per inch of article length in synchronization with the rate of travel of the laundry articles on the conveyor belts. The generator 46 may be driven by the drive means (not shown) for the rollers shown in FIG. 1, or the generator 46 may be driven by independent drive means synchronized with the drive rate of the rollers. The generator 46 includes a conventional wave squarer. The voltage pulses may be generated at a rate per unit of travel of the laundry articles dictated primarily by the maximum length of the laundry articles to be folded and the precision with which it is desired to locate the fold. In the embodiments of the invention described herein, a pulse rate of 20 pulses per inch of article travel is utilized.

A frequency or rate divider 48 and a summing network 50 are connected between the generator 46 and an input of AND gate 52. Another AND gate 54 is connected to the output of the divider 48 and AND gate 54 in turn has its output connected to a frequency or rate divider 56. The dividers 48 and 56 both divide the pulse rate received at their respective inputs at a ratio of 2:1. The dividers 48 and 56 may be of any conventional form of unit known to those skilled in the art. The pulse rates respectively available from the generator 46 and the dividers 48 and 56, when the proper gates are open are 20 pulses per inch of article travel, 10 pulses per inch of article travel and 5 pulses per inch of article travel.

A front counter 58 has an input connected through summing network 60 to the output of AND gate 52 and an output connected through one-shot multivibrator 62 to an input of flip-flop 64. The flip-flop 64 is a conventional type of flip-flop which is turned ON and will remain ON to continuously produce an output signal when a signal is applied at an input and which is turned OFF to stop producing the output signal when a signal is applied to another input. The front counter 58 has a maximum count capacity which may be set at a value capable of handling the longest size article which it is desired to fold. The front counter 58 counts in response to voltage pulses applied to it and when its maximum capacity is filled it will reset itself to zero count and produce an output signal.

The elements shown in block 66 of FIG. 2 include shift registers 68 and 70, decoding matrices 84 and 104 and first fold counters 72, 74 and 76. The shift register 68 has an input connected through diode 78 and one-shot multivibrator 62 to the front counter 58 and two output leads 80 and 82. The output lead 80 is connected to the input of gate 89 in the decoding matrix 84 and through the isolating resistor 81 and isolating diode 99 to the input of gate 85. The output lead 82 is connected to the input of gate 91 in the decoding matrix 84 and through isolating resistor 83 and isolating diode 99 to the input of gate 85. The output of gate 85 is connected to the input of gate 87. The gates 85, 87, 89 and 91 are of the type that is closed, i.e., does not produce an output signal, when a gating signal is present at an input and open when a gating signal is not present at an input. The gate 87 has an output lead 93 connected to an input of AND gate 86 and gate 89 has an output lead 95 connected to an input of AND gate 88. The output lead 97 of gate 91 is connected to an input of AND gate 90. The AND gates 86, 88 and 90 are of the type that is normally closed when no gating signal is present at an input. Each of the AND gates 86, 88 and 90 also have a second input commonly connected to the output of AND gate 92. The outputs of AND gates 86, 88 and 90 are respectively connected to the inputs of first fold counter 72, 74 and 76. The outputs of first fold counters 72, 74 and 76 are respectively fed through one-shot multivibrator 94, 96 and 98 and commonly connected to an input of shift register 70.

The shift register 70 has two output leads 100 and 102 connected to the decoding matrix 104. The output lead 100 is connected to the input of gate 109 of the decoding matrix 104 and through the isolating resistor 101 and isolating diode 119 to the input of gate 105. The output lead 102 is connected to the input of gate 111 of the decoding matrix 104 and through isolating resistor 103 and isolating diode 119 to the input of gate 105. The output of gate 105 is connected to the input of gate 107. The gates 105, 107, 109 and 111 are of the type that is closed, i.e., does not produce an output signal, when a gating signal is present at an input and open when a gating signal is not present at an input. The gate 107 has an output lead 113 connected to an input of AND gate 106 and gate 109 has an output lead 115 connected to an input of AND gate 108. The output lead 117 of gate 111 is connected to an input of AND gate 110. The AND gates 106, 108 and 110 are of the type that is closed when all required gating signals are not present at the gating. A second input of each of the AND gates 106, 108 and 110 is connected through summing network 50 to the generator 46. The output of AND gate 106 is connected to an input of AND gate 112 and the output of AND gate 108 is connected to input of AND gate 114. The output of AND gate 110 is connected to the input of AND gate 116. The output of AND gate 112 is connected to the input of the first fold counter 72 and the output of AND gate 114 is connected to the input of first fold counter 74. The output of AND gate 116 is connected to the input of first fold counter 76. The AND gates 112, 114 and 116 are of the type that is closed when a signal is present at a gating input.

Each of the shift registers 68 and 70 in block 66 of FIG. 2 are identical in construction and operation. Each shift register 68 and 70 is connected to a synchronizer, shown generally at 118, which shifts both of the shift registers 68 and 70 into the same state so that only one of the output leads 93, 95 and 97 and a corresponding one of the output leads 113, 115 and 117 will carry a signal when the control circuit 42 is initially energized. For example, in the initial state chosen for the control circuit 42, the output lead 93 associated with shift register 68 will carry a signal and the output lead 113 associated with shift register 70 will carry a signal while the remainder of the output leads 95, 97, 115 and 117 will not carry a signal. The synchronizer 118 includes a flip-flop 119 having an input connected to output lead 93 and an output connected to an input of gate 121. The output of gate 121 is connected to another input of flip-flop 119 and to an input of gate 123. The 500 kilocycle per second pulse frequency from the oscillator 174 is fed to another input of gate 123 and the output of gate 123 is connected through diode 133 to an input of shift register 68. The flip-flop 129 has an input connected to the output lead 113 and an output connected to an input of gate 127. The flip-flops 119 and 129 are both of a conventional type of flip-flop which is turned ON and will remain ON to continuously produce an output signal when a momentary signal is applied at an input and which is turned OFF to stop producing the output signal when a momentary signal is applied to another input. The output of gate 127 is connected to another input of flip-flop 129 and to an input of gate 125. Another input of gate 125 is connected to the oscillator 174 and to an input of gate 123. The output of gate 125 is connected through diode 131 to an input of shift register 70.

The shift registers 120 and 122, decoding matrices 136 and 156 and second fold counters 124, 126 and 128 are shown in block 67 of FIG. 2. The shift registers 120 and 122 are respectively connected to decoding matrices 136 and 156 and second fold counters 124, 126 and 128 with each other and with shift register 67 and 68. The shift register 120 has an input connected through rectifying element 130 and one-shot multivibrator 62 to the front counter 58 and two output leads 132 and 134. The output lead 132 is connected to the input of gate 141 of decoding matrix 136 and through the isolating resistor 133 and isolating diode 136 to the input of gate 137. The output lead 134 is connected to the input of gate 143 of decoding matrix 136 and through isolating resistor 135 and isolating diode 136 to the input of gate 137. The output of gate 137 is connected to the input of gate 139. The gates 137, 139, 141 and 143 are of the type that is closed, i.e., does not produce an output signal, when a gating signal is present at an input and open when a gating signal is not present at an input. The gate 139 has an output lead 145 connected to an input of AND gate 138 and gate 141 has an output lead 147 connected to an input of AND gate 140. The output lead 149 of gate 143 is connected to an input of AND gate 142. The AND gates 138, 140 and 142 are of the type that is normally closed when no gating signal is present at an input. The AND gates 138, 140 and 142 each also have a second input commonly connected to the output of OR gate 144. The outputs of AND gates 138, 140 and 142 are each connected to the input of one of the second fold counters 124, 126 and 128. The outputs of second fold counters 124, 126 and 128 are respectively fed through one-shot multivibrators 146, 148 and 150 and commonly connected to an input of shift register 122.

The shift register 122 has two output leads 152 and 154 connected to decoding matrix 156. The output lead 152 is connected to the input of gate 161 of decoding matrix 156 and through the isolating resistor 153 and isolating diode 156 to the input of gate 157. The output lead 154 is connected to the input of gate 163 of decoding matrix 156 and through isolating resistor 155 and isolating diode 156 to the input of gate 157. The output of gate 157 is connected to the input of gate 159. The gates 157, 159, 161 and 163 are of the type that is closed, i.e., does not produce an output signal, when a gating signal is present at an input and open when a gating signal is not present at an input. The gate 159 has an output lead 165 connected to an input of AND gate 158 and gate 161 has an output lead 167 connected to an input of AND gate 160. The output lead 169 of gate 163 is connected to an input of AND gate 162. The AND gates 158, 160 and 162 are of the type that is closed when all required gating signals are not present at the gating inputs. Each of the AND gates 158, 160 and 162 have a second input connected through the summing network 50 to the generator 46. The output of AND gate 158 is connected to an input of AND gate 164 and the output of AND gate 160 is connected to an input of AND gate 166. The output of AND gate 162 is connected to input of AND gate 168. The output of AND gates 164, 166 and 168 are respectively connected to the input of second fold counters 124, 126 and 128.

A synchronizer 170, identical in construction and operation with the synchronizer 118 shown in block 66, is illustrated in block 67. The function of the synchronizer 170 is to shift both of the shift registers 120 and 122 into the same state when the control circuit 42 is initially energized. When the shift registers 120 and 122 are in the same state, one of the output leads 145, 147 and 149 and a corresponding one of the output leads 165, 167 and 169 will carry a signal when the control circuit 42 is initially energized. The example given in the description for the synchronizer 118 also holds true for the synchronizer 170, i.e., in the initial state of the shift registers 120 and 122, the output lead 145 and the output lead 165 will each carry an output signal, while the remaining output leads 147, 149, 167 and 169 will not carry an output signal. The synchronizer 170 includes a gate 173 having an input connected to output lead 145 and an output connected to an input of gate 175. The output of gate 175 is connected to another input of gate 173 and to an input of gate 177. The 500 kilocycle per second pulse frequency from the oscillator 174 is fed to another input of gate 177 and the output of gate 177 is connected through diode 151 to an input of shift register 120. The gate 183 has an input connected to the output lead 165 and an output connected to an input of gate 181. The output of gate 181 is connected to another input of gate 183 and to an input of gate 179. Another input of gate 179 is connected to the oscillator 174 and to an input of gate 177. The output of gate 179 is connected through diode 171 to an input of shift register 122.

The lead 27 associated with sensor 28 is shown in FIG. 2 connected to an input of AND gate 52 and an input of AND gate 54. The AND gates 52 and 54 are arranged to be closed when no signal from the positive D.C. voltage V is present at their inputs and open when a laundry article passes beneath sensor 28 and the positive D.C. voltage V is applied to the inputs of AND gates 52 and 54. The output of frequency divider 56 is fed through an input of OR gate 144 to AND gates 138, 140 and 142 in block 67. The lead 27 is also connected to trailing edge signal amplifier 172 which in turn is connected to an input of flip-flop 64. The output of flip-flop 64 is connected to an input of AND gate 92. The AND gate 92 is of the type that is open when a signal is present at all gating inputs and closed when any input signal is lacking. The oscillator 174 provides a source of very high frequency pulses and is connected to another input of the AND gate 92. The frequency of the pulses supplied by the oscillator 174 should be high relative to the frequency of the pulses obtained from generator 46 and it has been found that an oscillator frequency of 500 kilocycles per second is satisfactory. The output of AND gate 92 is fed through summing network 60 to front counter 58 and to an input of the AND gates 86, 88 and 90 in block 66. The output of AND gate 92 is also fed through OR gate 144 to AND gates 138, 140 and 142 in block 67.

The lead 31 associated with sensor 30 is connected to an input of the AND gates 112, 114 and 116 in block 66. The AND gates 112, 114 and 116 are closed when the positive D.C. voltage V is applied to each of their inputs and open when the positive D.C. voltage V is removed from each of their inputs, i.e., when a laundered article moves beneath sensor 30. The output of first fold counters 72, 74 and 76, stated above to be commonly connected to shift register 70, are also connected through diode 99 to the first fold mechanism 34. Any suitable delay means (not shown) may be provided and included as part of the control circuit 42 of the first fold mechanism 34 to delay the folding of the laundered article until its mid-point has passed from beneath sensor 30 and moved to the desired position adjacent first fold mechanism 34 (see FIG. 1). When an output signal is produced by any one of first fold counters 72, 74 and 76, the first fold mechanism 34 will be actuated to place a fold in the laundered article passing the first fold mechanism 34.

The lead 33 associated with sensor 32 is connected to an input of each of the AND gates 164, 166 and 168. The AND gates 164, 166 and 168 are of the type that is closed when a gating signal is not present at a gating input. Thus, the AND gates 164, 166 and 168 are closed when the positive D.C. voltage V is connected to each of their inputs and open when the positive D.C. voltage V is removed from each of their inputs when a laundry article passes beneath the sensor 32. The outputs of second fold counters 124, 126 and 128 are connected through diode 176 and a delay means (not shown) similar to the delay means associated with first fold mechanism 34 to second fold mechanism 36. When an output signal is produced by any one of the second fold counters 124, 126 and 128, the second fold mechanism 36 will be actuated to make a second fold in a laundered article passing the second fold mechanism 36.

In the embodiment of the invention illustrated in FIG. 3, the elements of control circuit 44 identical with those elements of control circuit 42 shown in FIG. 2 are referred to by the same reference numerals with the addition of the prime (′) designation. Except for those elements shown in blocks 178 and 180, in FIG. 3, all elements illustrated in FIG. 3 are identical in structure and function to the corresponding elements shown in FIG. 2. Within the block 178, AND gate 182 has an input connected to the output of AND gate 54′. A second input of AND gate 182 is connected through switch 184 to a source of positive D.C. voltage V_1. The AND gate 186 has an input connected through the summing network 50′ to the generator 46′ and a second input connected through switch 185 to the positive D.C. voltage V_1. The output of AND gate 186 is connected to an input of AND gate 188 which in turn has an output connected to the input of the first fold counter 190. Another input of the AND gate 188 is connected to the positive D.C. voltage V′ through the sensor 30′. The AND gates 182, 186 and 188 are each in an open condition when a signal is applied to all inputs and closed when a signal is removed from any one input. The first fold counter 190 may be identical in construction and arrangement with each of the first fold counters 72, 74 and 76 and resets itself to zero count and produces an output signal when its maximum count capacity is filled. The output signal of the first fold counter 190 is fed through one-shot multivibrator 192 and diode 99′ to the first fold mechanism 34′.

In the block 180 of FIG. 3 is shown an AND gate 194 which has an input connected to the output of OR gate 144′ and another input connected through switch 196 to the positive D.C. voltage V_1. The output of the AND gate 194 is connected to the input of the second fold counter 198. The AND gate 200 has an input connected through a summing network 50′ to the generator 46′ and another input connected through switch 202 to the positive D.C. voltage V_1. The output of AND gate 200 is connected to an input of AND gate 204 which in turn has an output connected to the input of the second fold counter 198. Another input of the AND gate 204 is connected through the sensor 32′ to the positive D.C. voltage V′. The AND gates 194, 200 and 204 are each in an open condition when a signal is applied to all inputs and closed when a signal is removed from any one input. The second fold counter 191 is identical in construction and operation with the second fold counters 124, 126 and 128 shown in FIG. 2 and produces an output signal when its maximum count capacity is filled. This output signal is fed through one-shot multivibrator 206 and diode 176′ to second fold mechanism 36′.

Operation of control circuit and folder

When the control circuit 42, shown in FIG. 2, is initially energized, each of the outputs leads 80, 82, 100, 102, 132, 134, 152 and 154 connecting the shift registers 68, 70, 120, and 122 and their respective decoding matrices 84, 104, 136 and 156 may or may not be carrying an output signal. Since each shift register and associated decoding matrix is identical in operation, only the operation of the shift register 68 and decoding matrix 84 will be described. Considering first the condition of the decoding matrix 84 when the output leads 80 and 82 both carry an output signal upon initial energization of the control circuit 42, the output signal on output lead 82 will be fed to the input of gate 91 to maintain gate 91 in a closed condition. When gate 91 is closed no signal is carried by output lead 97 and AND gate 90 is also maintained in a closed condition. The output signal on output lead 82 also passes through isolating resistor 83 and isolating diode 99 to the input of gate 85. The output signal on output lead 80 passes through isolating resistor 81 and isolating diode 99 to the input of gate 85. Due to voltage drops occuring across isolating resistor 81 and 83, the output signal from either output lead 80 or 82 alone is not sufficient to have an effect on gate 85. However, when an output signal is received at the input of gate 85 from both output leads 80 and 82, the gate 85 is maintained in a closed condition in which no output signal from gate 85 is fed to the input of gate 87. When no signal is present at the input of gate 87, the gate 87 produces an output signal on output lead 93 which maintains AND gate 86 in an open condition. The output signal on output lead 80 is also fed to the input of gate 89 to maintain it in a closed condition. When gate 89 is closed, it produces no output signal on output lead 95 to thereby also maintain AND gate 88 in a closed condition.

When an output signal is not present on output lead 80 but an output signal is present on output 82, gate 89 in decoding matrix 84 will produce a signal on output lead 95 to thereby maintain AND gate 88 in an open condition. The output signal from output lead 82 will maintain gate 91 in a closed condition so that output lead 97 will not carry a signal and AND gate 90 will be closed. Since both output leads 80 and 82 do not have an output signal, the output lead 93 will not carry a signal AND gate 86 will be closed. When an output signal is present on output lead 80 but not on output lead 82, the gate 91 will be open to feed a signal to output lead 97 and maintain AND gate 90 in an open condition. The output signal on output lead 80 will maintain gate 89 in a closed condition in which no signal is fed to output lead 95 so that AND gate 88 is closed. Since both output leads 80 and 82 do not have an output signal, the output lead 93 will not carry a signal and AND gate 86 will be maintained closed. It can thus be seen that as the shift register 68 shifts through its various conditions, the combination of output signals available on the output on the output leads 80 and 82 connected to the shift register 68 vary to sequentially open AND gates 86, 88 and 90.

When the control circuit 42 is initially energized it is desired that corresponding output leads associated with shift registers 68 and 70 and shift registers 120 and 122 be in the same condition. For example, the output leads 93 and 113 should both carry a signal to maintain AND gates 86 and 106 open, while output leads 95, 97, 115 and 117 should not carry a signal so that AND gates 88, 90, 108 and 110 are closed. The synchronizers 118 and 170, respectively shown in blocks 66 and 68, are provided in order to attain this initial condition. Assuming that when the control circuit 42 is initially energized, a signal is not present on output lead 93 as desired, the gate 119 will be maintained open and will produce an output signal which is fed to an input of gate 121. When an input from gate 119 is present at gate 121, the gate 121 will not produce an output signal to gate 123 so that gate 123 is maintained in an open condition. While the gate 123 is maintained in an open condition the 500 kilocycle per second pulse frequency from oscillator 174 is fed through gate 123 and diode 131 to the shift register 68. The 500 kilocycle per second pulse frequency shifts the shift register 68 through its various states until a signal is present on output lead 93. The signal on output lead 93 will close gate 119 so that output signal will be fed to the input of gate 121. When the signal to the input of gate 121 is removed, the gate 121 is opened to produce an output signal to an input of gate 123 to thereby close gate 123 and stop the feeding of the 500 kilocycle per second pulse frequency through gate 123 to shift register 68. The output signal from gate 121 is also fed to an input of gate 119 to maintain gate 119 in a closed condition regardless of the subsequent presence or absence of a signal on output lead 93. Assuming also that the shift register 70 is not initially in a condition in which a signal is present on output lead 113, the gate 129 will be maintained in a open condition in which an output signal is fed to the input of gate **127**. A signal at the input of gate **121** maintains gate **127** in a closed condition so that it does not produce an output signal to gate **125** to thereby maintain gate **125** in an open condition. When gate **125** is open the 500 kilocycle per second pulse frequency from oscillator **174** is fed through the gate **125** and diode **131** to shift register **70**. The 500 kilocycle per second pulse frequency shifts the shift register **70** through its various states until a signal is carried by output lead **113**. When a signal is present on output lead **113** the gate **129** will be closed to thereby remove the output signal being fed to an input of gate **127**. Removal of a signal at the input of gate **127** opens gate **127** so that an output signal is fed to the input of gate **125** to thereby close gate **125** and stop the feeding of the 500 kilocycle per second pulse frequency through gate **125** to shift register **70**. The output signal from gate **127** is also fed to an input of gate **129** to maintain gate **129** closed regardless of the subsequent presence or absence of a signal on output lead **113**. The shift registers **68** and **70** are now in identical states in which the corresponding output leads **93** and **113** both carry a signal and their associated AND gates **86** and **106** are both in an open condition.

In the same manner as described above, the corresponding output leads **145** and **165**, shown in block **67** of FIG. 2, will carry a signal to maintain the AND gates **138** and **158** in an open condition. Upon energization of the control circuit **42**, the front counter **58**, the first fold counters **72**, **74**, **76** and the second fold counters **124**, **126** and **128** are all initially at zero count. The generator **46** and the oscillator **174** are both operating to provide the necessary pulse frequencies to control circuit **42**.

When a first flat laundry article is placed on conveyor belt **4**, it is moved toward sensor **28** (see FIG. 1). When the leading edge of the article passes under sensor **28**, the positive D.C. voltage V is applied to the inputs of AND gates **52** and **54** to open these gates. The 10 pulse per inch pulse gate from divider **48** then passes through AND gate **52** and summing network **60** to counter **58**. The counter **58** accumulates one count for each pulse received from the 10 pulse per inch pulse rate during the time the article is beneath sensor **28**. The 10 pulse per inch pulse frequency will also pass through AND gate **54** to frequency divider **56** where the 10 pulse per inch pulse rate is divided to 5 pulses per inch and fed through OR gate **114** to the inputs of AND gates **138**, **140** and **142** in block **67**. Since AND gate **138** is open and AND gates **140** and **142** are both closed, the 5 pulse per inch pulse rate will only pass through AND gate **138** to counter **124**. In the same manner as counter **58**, the counter **124** accumulates one count for each pulse reecived from the 5 pulse per inch pulse rate during the time the article is beneath sensor **28**.

When the trailing edge of the article passes from beneath the sensor **28** the positive D.C. voltage V is removed from the AND gates **52** and **54**. The AND gates **52** and **54** are thus closed and the 10 pulse per inch pulse rate is removed from counter **58** and from divider **56** so that the 5 pulse per inch pulse rate is no longer fed to counter **124** in block **67**. The count that has been accumulated by counter **58** is representative of the full length of the article and the count that has been accumulated by counter **124** in block **67** is representative of the half length of the article. A second effect of the passing of the trailing edge of the article from beneath sensor **28** is the removal of the positive D.C. voltage V from the flip-flop **64** to turn the flip-flop **64** ON. When the flip-flop **64** is turned ON, it produces an output signal which is fed to an input of AND gate **92** to open AND gate **92**. With AND gate **92** open, the 500 kilocycle per second frequency from oscillator **174** is fed through the AND gate **92** and summing network **60** to counter **58**, to the inputs of AND gates **86**, **88** and **90** in block **66** and through OR gate **144** to the input of AND gates **138**, **140** and **142** in block **67**. Since AND gates **86** and **138** are still open, the 500 kilocycle per second frequency will pass through them to counters **72** and **124**. The front counter **58** accumulates one count for each pulse of the 500 kilocycle per second pulse frequency until the maximum count capacity of the front counter **58** is filled. The front counter **58** then simultaneously resets itself to zero count and produces an output signal which is amplified through one-shot multivibrator **62** and fed to a second input of flip-flop **64** to turn flip-flop **64** OFF. When the flip-flop **64** is turned OFF, its output signal is removed from AND gate **92** to close AND gate **92** and stop the feeding of the 500 kilocycle per second pulse from oscillator **174** to front counter **58** and counters **72** and **124**. The output signal from front counter **58** is also fed through diodes **78** and **130** to shift the shift registers **68** and **120** into their next state. The shift register **68** will now cause a signal to be carried on output lead **95** to an input of AND gate **88** to open AND gate **88**. The AND gate **90** in block **66** remains closed and the AND gate **86** is now closed. In block **67**, the shift register **120** is shifted into its second state by the output signal from front counter **58** so that a signal is fed to output lead **95** and the input of AND gate **140** to open AND gate **140**. The AND gate **142** remains closed and the AND gate **138** is now closed. The first fold counter **72** at this time has an accumulated count on it equal to the portion of the maximum count capacity of the front counter **58** that was not filled by the 10 pulse per inch pulse rate when the article was beneath the sensor **28**. Thus, the number of counts remaining on the first fold counter **72** is representative of the full length of the article. The second fold counter **124** in block **67** has an accumulated count on it equal to one-half the number of counts that were accumulated by the front counter **58** from the 10 pulse per inch pulse rate while the article was beneath sensor **28**, plus the number of counts received by the front counter **58** from the oscillator **174**. Thus, the number of counts remaining on the second fold counter **124** is representative of one-half of the full length of the article.

In the event that the article is longer than the distance between the sensors **28** and **30**, the article will be beneath sensor **30** before the trailing edge of the article passes from beneath sensor **28**. As described in detail hereinafter, the presence of an article beneath sensor **30** will cause connection of the 20 pulse per inch pulse rate to one of the first fold counters, for example counter **72**. Under the condition where the article is beneath both sensors **28** and **30**, the front counter **58** continues to receive the 10 pulse per inch pulse rate until the trailing edge of the article passes from beneath sensor **28**. When the trailing edge of the article passes sensor **28**, the 500 kilocycle per second frequency is applied to the counter **72** simultaneously with the 20 pulse per inch pulse rate. Because of the high rate of the 500 kilocycle per second frequency, it will override the 20 pulse per inch pulse rate, although only for a very short duration. Due to this short time, no essential information is lost and counter **72** will accept the 500 kilocycle per second frequency and then continue to receive the 20 pulse per inch pulse rate until its maximum count capacity is filled.

Upon the passing of the first article from beneath sensor **28**, the maximum count capacity of front counter **58** is filled by oscillator **174** practically instantaneously relative to the speed of movement of the article on conveyor belt **4** and to the pulse rates supplied by the generator **46** and dividers **48** and **56**. As a result, the front counter **58** is immediately reset upon the passing of the first article from beneath sensor **28** and there is virtually no spacing requirement between the first article and a second closely following article. The resetting of the front counter **58** readies it for a second article.

As the second article passes beneath sensor **28** the positive D.C. voltage V is again applied to the inputs of AND gates **52** and **54** to open these gates to the passage of the 10 pulse per inch pulse rate. The operation of the circuit for the second article is exactly the same as it was for the first article except that since AND gate **88** in block **66** and AND gate **140** in block **67** are now open, pulses from the generator **46** and the oscillator **174** will now be applied to first fold counter **74** and second fold counter **126**. Upon the passing of the trailing edge of the second article from beneath the sensor **28** the AND gates **52** and **54** will close and the flip-flop **64** will be turned ON to open AND gate **92**. The 500 kilocycle per second pulse from oscillator **174** will then be connected to front counter **58**, first fold counter **74** and second fold counter **126** until the front counter **58** is filled. The front counter **58** then resets itself to zero count to be ready for a third following article and produces an output signal which turns flip-flop **64** OFF and shifts shift registers **68** and **120** to their next state. The AND gate **90** in block **66** and the AND gate **142** in block **67** now each have a signal at one of their inputs to hold them in an open condition. The portion of the count capacities now remaining unfilled on first fold counter **74** and second fold counter **126** will be similar to the unfilled count capacities of first fold counter **72** and second fold counter **124**, except that the unfilled count capacities of first fold counter **74** and second fold counter **126** will be respectively representative of the full length and half length of the second article.

The operation of the control circuit **42** in measuring the full length of a third closely following article is again the same as for the first and second articles. Upon the passing of the trailing edge of the third article from beneath the sensor **28** the unfilled portion of the maximum count capacity of the first fold counter **76** will be representative of the full length of the third article and the unfilled portion of the maximum count capacity of the second fold counter **128** will be representative of one-half of the full length of the third article.

In the control circuit **42** shown in FIG. 2, the maximum capacity or number of closely following short articles that may be handled is three articles, i.e., the lengths of three closely following short articles may be measured before the leading one of the three articles must be folded to make available fold counters for a fourth closely following short article. It will be readily apparent that more than three closely following short articles can be measured before the leading one is folded merely by providing additional first fold and second fold counters and additional outputs from the associated shift registers together with the necessary gating means. The number of first fold counters or second fold counters required for measuring closely following short articles can be calculated and is expressed by the equation.

$$K=\frac{D-L/2}{L}$$

where

K=number of counters

D=distance between sensor **28** and sensor **30**

L=length of each article.

It should be readily understood that during normal operation of the control circuit **42** the articles being folded will not always be closely following and will not necessarily all be short articles or long articles, but may be articles of mixed lengths. For example, a first article may be passing beneath sensor **32** in preparation for its second fold while a second long article is still moving beneath sensor **28**. The only limitations on the operation of the control circuit **42** are that the maximum length of an article must not be such that its mid-length passes sensor **30** at substantially the same time as its trailing edge passes sensor **28** and the closely following short article limitation, previously mentioned. For purposes best describing the operation of the control circuit **42**, however, the measuring of the full lengths of the maximum number of closely following articles that the control circuit **42** will handle has been described. Clarity in the description is added by separately describing the folding operation of these articles.

When the leading edge of the first article passes beneath sensor **30**, the positive D.C. voltage V is applied to an input of each of the AND gates **112**, **114** and **116**. Since the shift register **70** is still in its initial state in which a signal is fed by output lead **113** to an input of AND gate **106**, the 20 pulse per inch pulse rate from generator **46** will pass through AND gate **106**. The AND gate **112** has been opened by the application to one of its inputs of the positive D.C. voltage V and therefore the 20 pulse per inch pulse rate will also pass through it to first fold counter **72**. The first fold counter **72** will make one count for each pulse of the 20 pulse per inch pulse rate. As previously stated, the count capacity remaining on the first fold counter **72** is representative of the full length of the first article. Since the 20 pulse per inch pulse rate being applied to the first fold counter **72** is twice the rate of the 10 pulse per inch pulse rate applied to the front counter **58**, the full count capacity of the first fold counter **72** will be filled and an output signal produced when the mid-point of the first article passes beneath the sensor **30**. When the maximum count capacity of the first fold counter **72** is filled, it will also reset itself to zero count. The output signal of the first fold counter **72** is amplified by one-shot multivibrator **94** and connected to an input of shift register **70** to shift the shift register **70** into its next state in which an output signal is fed to an input of AND gate **108** through output lead **115**.

As shown in FIG. 2, the output signal of the first fold counter **72** is fed to the first fold mechanism **34** to actuate the first fold mechanism **34**. The first fold mechanism **34** directs an air blast at the first article to fold it and move it into engagement with the conveyor belt **6** and the roller **16**, as shown in FIG. 1. As can be seen in FIG. 1, the folding of the articles is delayed by a suitable delay means (not shown) until their mid-points have passed from beneath sensor **30** and are in a position where the air blast can effectively make a fold.

After the first article is folded a first time it continues moving on conveyor belt **6** and passes beneath sensor **32**. The moving of the first article beneath sensor **32** causes the sensor **32** to apply the positive D.C. voltage V to the input of AND gates **164**, **166** and **168**. The shift register **122** is still in its initial state in which a signal is caused to be fed on output lead **165** to an input of AND gate **158**. The AND gate **158** is thus open and the 20 pulse per inch pulse rate from the generator **46** passes through it to an input of AND gate **164**. The application of the positive D.C. voltage V to the AND gate **164** opens AND gate **164** to thereby allow passage of the 20 pulse per inch pulse rate to the input of second fold counter **124**. The second fold counter **124** makes one count for each pulse of a pulse rate applied to it until its maximum count capacity is filled when it resets itself to zero count and produces an output signal. Since the count capacity now remaining on the second fold counter **124** is representative of one half of the length of the first article and the 20 pulse per inch pulse rate now being applied to it has a rate twice that of the 10 pulse per inch pulse rate that was applied to the front counter **58**, the maximum count capacity of the second fold counter **124** will be filled when one fourth of the full length of the first article has passed beneath the sensor **32**, i.e., when the midpoint of the once folded first article is directly beneath the sensor **32**. The output signal of the second fold counter **124** is fed through one-shot multivibrator **146** and connected to an input of shift register **122**. After a delay by delay means (not shown) sufficient to allow movement of the midpoint of the folded article to a folding position adjacent the folding mechanism **36**, the output signal of the second fold counter **124** is also connected to the second fold mechanism **36**. The application of the output signal of the second fold counter **124** to the shift register **122** shifts the shift register **122** to its next state in which a signal is fed by output lead **167** to an input of the AND gate **160**. The application of the output signal from the second fold counter **124** to the second fold mechanism **36** actuates the second fold mechanism **36** and causes it to apply an air blast to the first article to fold the article and move it into engagement with conveyor belts **6** and **8**.

After the first article has passed from beneath sensor **30** and while the first article is approaching or is beneath the sensor **38**, the second article moves beneath the sensor **30** to apply the positive D.C. voltage V to the input of the AND gates **112**, **114** and **116** to open these gates. Since the shift register **70** is now in its second state in which a signal is fed on output lead **115** to an input of AND gate **108**, the AND gate **108** is open and the 20 pulse per inch pulse rate passes through it to AND gate **114**. The AND gate **114** opens when the second article passes beneath sensor **30** to allow the 20 pulse per inch pulse rate to pass through AND gate **114** to the input of first fold counter **74**. The first fold counter **74** produces one count for each pulse of the pulse rate applied to its input until the maximum count capacity of the first fold counter **74** is filled. When the maximum count capacity of the first fold counter **74** is filled, it will reset itself to zero count and produce an output signal which is fed through one-shot multivibrator **96** and connected to an input of the shift register **70**. The output signal from the first fold counter **74** is also connected through diode **99** and the delay means (not shown) to the first fold mechanism **34**. Application of the output signal from the first fold counter **74** to the shift register **70** shifts the shift register **70** to its third state in which a signal is fed on output lead **117** to an input of AND gate **110**. The application of the output signal from the first fold counter **74** to the first fold mechanism **34** actuates the first fold mechanism **34** to cause an air blast to fold the second article at its midpoint and move it into engagement with conveyor belt **6** and roller **16**. Similarly, to the first fold counter **72**, the unfilled count capacity of the first fold counter **74** is representative of the full length of the second article. However, since the 20 pulse per inch pulse rate applied to the first fold counter **74** is twice that of the 10 pulse per inch pulse rate applied to the front counter **58**, the unfilled count capacity of the first fold counter **74** will be filled when the midpoint of the second article is directly beneath the sensor **30**.

After being folded a first time, the second article moves between conveyor belt **6** and roller **16** and beneath sensor **32** to apply the positive D.C. voltage V to the inputs of AND gates **164**, **166** and **168**. Since the shift register **122** is now in its second state in which a signal is fed on output lead **167** to an input of AND gate **160** to maintain AND gate **160** in an open condition, the 20 pulse per inch pulse rate from the generator **46** will pass through AND gate **160** to AND gate **166**. Since AND gate **166** is also now open, the 20 pulse per inch pulse rate will pass through AND gate **166** to the input of the second fold counter **126**. The second fold counter **126** will produce one count for every pulse of the pulse rate applied to it and when its unfilled count capacity is filled it will reset itself to zero count and produce an output signal. Similarly, to the second fold counter **124**, the unfilled count capacity of the second fold counter **126** is representative of one-half of the full length of a second article and the 20 pulse per inch pulse rate applied to the second fold counter **126** is twice that of the 10 pulse per inch pulse rate applied to the front counter **58**. Thus, the maximum count capacity of the second fold counter **126** will be filled when one-quarter of the full length of the second article has passed beneath the sensor **32**, i.e., the maximum count capacity of the second fold counter **126** will be filled when the midpoint of the once folded second article is directly beneath the sensor **32**. The output signal of the second fold counter **126** is fed through one-shot multivibrator **148** to an input of the shift register **122** and through diode **176** and a delay means (not shown) to second fold mechanism **36**. Application of the output signal from the second fold counter **126** to the shift register **122** shifts the shift register **122** to its third state in which a signal is fed on output lead **169** to an input of AND gate **162** to maintain AND gate **162** in an open condition. Application of the output signal from the second fold counter **126** to the second fold mechanism **36** actuates the second fold mechanism to create an air blast which folds the second article at its midpoint and moves the second article onto conveyor belt **8**.

While the second article is moving toward or is beneath sensor **32**, the third article may move beneath sensor **30** to apply the positive D.C. voltage V to the inputs of AND gates **112**, **114** and **116** to thereby open these AND gates. The shift register **70** is now in its third state in which a signal is fed on output lead **117** to AND gate **110** to maintain AND gate **110** open so that the 20 pulse per inch pulse rate from the generator **46** may pass through AND gates **110** and **116** to the first fold counter **76**. The measuring and folding operation for the third article then proceeds in the same manner as the measuring and folding of the first and second articles. When the maximum count capacity of the first fold counter **76** is filled it resets itself to zero count and produces an output signal which is fed through one-shot multivibrator **98** to shift register **70** to shift the shift register **70** back to its initial state in which a signal is fed on output lead **113** to an input of AND gate **106**.

It will be understood that the operation of the control circuit **42** in general, and the shift registers and counters in blocks **66** and **67** in particular, is continuous so that an unbroken series of articles may be measured as the shift registers shift through their states to match the proper counter with the corresponding article moving through the folding machine. The front counter **58** will repeatedly accumulate a count representative of the full length of an article and reset itself to zero count in preparation for the next closely following article.

As previously stated, the control circuit **44**, shown in FIG. 3, has the same elements as the control circuit **42** shown in FIG. 2, except for those elements illustrated within blocks **178** and **180**. With the exception of the portion of the control circuit **44** shown within blocks **178** and **180**, the operation of the control circuit **44** is identical with the operation of the control circuit **42** shown in FIG. 2. The first fold counter **190** shown in block **178** and the second fold counter **198** shown in block **180** are identical in operation with the first fold counters **72**, **74** and **76** and the second fold counters **124**, **126** and **128** shown in FIG. 2. However, since only one first fold counter **190** and one second fold counter **198** is provided in the control circuit **44**, the control circuit **44** will be capable of handling only one article at a time rather than three articles, i.e., in the control circuit **44**, an article being measured and folded must pass beyond the sensor **32'** so that the second fold counter **198** has reset itself to zero count before the leading edge of a second article may move beneath sensor **28'**.

As shown in FIG. 3 a positive D.C. voltage V_1 is maintained at an input of each of the AND gates **182** and **186** in block **178** and at an input of each of the AND gates **194** and **200** in block **180** to thereby maintain these AND gates in an open condition. When the trailing edge of the article moving on conveyor belt **4** passes from beneath the sensor **28** the 500 kilocycle per second pulse frequency from oscillator **174'** is connected through AND gate **182** in block **178** to the input of the first fold counter **190** and through AND gate **194** in block **180** to the input of the second fold counter **198**. When the article reaches the sensor **30'** the positive D.C. voltage V' is applied to an input of AND gate **188** to open AND gate **188**. The 20 pulse per inch pulse rate from generator **46'** will now pass through the AND gate **186** and AND gate **188** to the input of the first fold counter 190 to cause the first fold counter 190 to count up to its maximum count capacity at which time it resets itself to zero count and produces an output signal. The output signal is fed through one-shot multivibrator 192 to the first fold mechanism 34′ to actuate the first fold mechanism 34′ and create an air blast which folds the article at its midpoint. The article then continues on to sensor 32′. When the article moves beneath sensor 32′ the positive D.C. voltage V′ is applied to AND gate 204 to open AND gate 204 and allow the 20 pulse per inch pulse rate from the generator 46′ to pass through AND gate 200 and AND gate 204 to the input of the second fold counter 198. Application of the 20 pulse per inch pulse rate to the second fold counter 198 will cause it to count up to its maximum count capacity and reset itself to zero count and produce an output signal. The output signal is fed through one-shot multivibrator 206 to the second fold mechanism 36′. The second fold mechanism 36′ is thereby actuated to create an air blast which folds the once folded article at its midpoint and moves the article on to the conveyor belt 8. At the time the second fold counter 198 resets itself to zero count, the control circuit 44 is ready to receive the next following article to be measured at sensor 28′.

While a specific embodiment of the invention has been shown herein, it will be realized that many modifications thereof are feasible without departing from the spirit and scope of the invention. Broadly stated, the control system could be implemented by the use of fluidics, mechanics or electronics. In the embodiment of the invention illustrated, the control circuitry involved may utilize electronic vacuum tubes, transistors or integrated circuitry. Gating methods may employ integrated circuits, transistors or magnetic relays. Depending on the type of general control system used, the timing means utilized could be of an electrical, electro-mechanical or electronic type using, for example, binary or decade type counters.

I claim:

1. Apparatus for measuring fractional parts of the full lengths of a succession of moving articles comprising:
- means for providing a plurality of electric pulse rates for each increment of length of a moving article;
- an oscillator for producing high frequency electric pulses;
- a first counter responsive to electric pulses applied thereto and having a fixed count capacity at which said first counter produces an output signal;
- first counter means having at least one preset count capacity equal to the fixed count capacity of said first counter and being responsive to electric pulses applied thereto for producing an output signal when said preset count capacity is filled;
- a plurality of sensing locations;
- means for connecting an intermediate one of said electric pulse rates to said first counter when a moving article is present at a first one of said sensing locations, whereby a portion of said fixed count capacity of the first counter proportionate to the full length of the moving article is filled;
- means for connecting said oscillator to said first counter and said first counter means until the fixed count capacity of said first counter is filled when said article passes from the first one of said sensing locations, whereby the unfilled portion of the fixed count capacity of said first counter is filled and a portion of the preset count capacity of said first counter means equal to the unfilled portion of the fixed count capacity of said first counter is filled;
- and means for connecting the highest one of said electric pulse rates to said first counter means when said article is present at a second one of said plurality of sensing locations, whereby the unfilled portion of the preset count capacity of said first counter means is filled and said first counter means produces an output signal indicating a measured fractional part of the full length of the moving article.

2. The apparatus of claim 1 wherein:
- said first counter means includes a plurality of second counters each having a preset count capacity equal to the fixed count capacity of said first counter;
- said means for connecting said oscillator to said first counter and said first counter means includes a first shift register means for sequentially connecting each one of said plurality of second counters of said first counter means to said oscillator, said first shift register means being responsive to the output signal of said first counter;
- said means for connecting the highest one of said plurality of frequencies to said first counter means includes a second shift register means for sequentially connecting each one of said plurality of second counters to said highest one of said plurality of frequencies in the same sequence as said first shift register connects said oscillator to each one of said plurality of second counters, said second shift register being responsive to the output signal of any one of said plurality of second counters.

3. The apparatus of claim 1 further comprising:
- second counter means having at least one preset count capacity equal to the fixed count capacity of said first counter and being responsive to electric pulses applied thereto for producing an output signal when said preset count capacity is filled;
- selector means for connecting said second counter means to a lower one of said plurality of electric pulse rates when a moving article is present at the first one of said sensing locations and to the oscillator when the moving article passes from the first one of said sensing locations until the fixed count capacity of said first counter is filled, whereby a portion of the preset count capacity of said second counter means equal to a fraction of the portion of said fixed count capacity filled by said intermediate electric pulse rate plus the portion of said fixed count capacity filled by said oscillator is filled;
- and means for connecting the highest one of said electric pulse rates to said second counter means when said article is present at a third one of said plurality of sensing locations, whereby the unfilled portion of the preset count capacity of said second counter means is filled and said second counter means produces an output signal indicating a measured fractional part of the full length of the moving article.

4. The apparatus of claim 1 wherein said means for providing a plurality of electric pulse rates includes a means for generating electric pulses at a predetermined rate and means for dividing said predetermined rate to obtain said plurality of electric pulse rates.

5. The apparatus of claim 1 wherein:
- said means for connecting an intermediate one of said plurality of electric pulse rates to said first counter includes a first means for sensing the presence of a moving article at the first one of said sensing locations and providing a first indicating signal when an article is present, and means for gating said intermediate electric pulse rate with said indicating signal;
- said means for connecting said oscillator to said first counter and said first counter means includes flip-flop means responsive to said indicating signal and to the output signal from said first counter for providing a gating signal when said moving article passes from the first one of said sensing locations, and means for gating said high frequency electric pulses with said gating signal;
- and said means for connecting the highest one of said plurality of electric pulse rates to said first counter means includes a second means for sensing the presence of a moving article at the second sens-

ing location and providing a second indication signal when an article is present and means for gating said highest electric pulse rate with said second indicating signal.

6. The apparatus of claim 2 wherein said means for connecting the highest one of said plurality of electric pulse rates to said first counter means includes synchronizing means for controlling said first and second shift register means to initially connect the same one of said plurality of second counters of said first counter means respectively to the oscillator and the highest one of said plurality of electric pulse rates for the same moving article.

7. The apparatus of claim 3 wherein:

said second counter means includes a plurality of third counters each having a preset count capacity equal to the fixed count capacity of said first counter;

said selector means includes a third shift register means for sequentially connecting each one of said plurality of third counters to the lower one of said plurality of electric pulse rates and to the oscillator, said third shift register means being responsive to the output signal of said first counter;

and said means for connecting the highest one of said plurality of electric pulse rates to said second counter means includes a fourth shift register means for sequentially connecting each one of said plurality of third counters to said highest one of said plurality of electric pulse rates in the same sequence as said third shift register connects each one of said plurality of third counters to the lower one of said plurality of electric pulse rates and the oscillator, said fourth shift register being responsive to the output signal of any one of said plurality of third counters.

8. The apparatus of claim 7 wherein said means for connecting the highest one of said plurality of electric pulse rates to said second counter means includes synchronizing means for controlling said third and fourth shift register means to initially connect the same one of said plurality of third counters of said second counter means respectively to the lower one of said plurality of electric pulse rates, the oscillator and the highest one of said plurality of electric pulse rates for the same moving article.

9. Apparatus for measuring and folding successive traveling articles comprising:

generating means for producing high and medium electrical pulse rates respectively proportionate to the speed of travel of said article;

interrogator means for producing a very high electrical pulse frequency;

first and second counting means for counting electrical pulses and respectively producing an output signal upon the counting of a predetermined number of electrical pulses by each of said counting means;

a first gating means responsive to the presence of a traveling article at a first position for connecting said medium pulse rate to said first counting means;

a second gating means responsive to the passing of the traveling article from said first position and to the output signal from said first counting means for connecting said very high pulse frequency to said first and second counting means and responsive to the presence of the same article at the second position for connecting said high pulse rate to said second counting means;

and first folding means responsive to the output signal of said second counting means for folding said article.

10. The apparatcs of claim 9 wherein:

said second counting means includes a plurality of counters each producing an output signal upon the counting of a predetermined number of electrical pulses, said output signals being connected to said first folding means;

and said second gating means includes a selector means for connecting said very high pulse frequency to one of said plurality of counters when said article passes from the first position and for connecting said high pulse rate to the same one of said plurality of counters when the same article is present at the second position.

11. The apparatus of claim 10 wherein said selector means includes a decoding means for sequentially developing a plurality of output signals each two of which correspond to a different one of said plurality of counters and determine which one of said plurality of counters is connected to said very high pulse frequency and said high pulse rate, and shift register means having a plurality of output states and being connected to said decoding means for controlling the decoding means to develop said plurality of output signals in a predetermined sequence.

12. The apparatus of claim 11 wherein:

said shift register means includes a first shift register device having a plurality of output states for controlling the decoding means to connect said very high pulse frequency to one of said plurality of counters when said article passes from said first position and a second shift register device having a plurality of output states each corresponding to an output state of said second shift register device for controlling the decoding means to connect said high pulse rate to the same one of said plurality of counters when the same article is present at said second position;

and said decoding means includes a first synchronizing means connected to the second and third shift register devices for initially shifting the second and third shift register devices into corresponding output states.

13. The apparatus of claim 12 wherein said first synchronizing means includes a plurality of gates and a plurality of flip-flops and is responsive to said very high pulse frequency and to the two output signals of said decoding means corresponding to one of said plurality of counters.

14. The apparatus of claim 12 wherein:

said second gating means includes a gating device for gating said very high pulse frequency and said high pulse rate with said plurality of output signals developed by said decoding means;

said generating means includes a generator producing said high electrical pulse rate at a predetermined rate per unit of travel of said article and a divider connected to said generator for dividing said high electrical pulse rate to said medium electrical pulse rate;

said plurality of counters includes first, second and third counters;

and said decoding means develops first, second and third pairs of output signals corresponding to said first, second and third counters, said pairs of output signals being applied to said gating device to sequentially gate both said very high pulse frequency and said high pulse rate to said first, second and third counters.

15. The apparatus of claim 9 wherein:

said generating means includes a generator producing said high electrical pulse rate at a predetermined rate of travel of said article and a first divider connected to said generator for dividing said high electrical pulse rate to said medium electrical pulse rate;

and said first counting means comprises a first counter and said second counting means comprises a second counter.

16. The apparatus of claim 15 wherein:
said first gating means includes a first article sensor located at said first position and producing an output signal when an article is present at said first position and a first gate connected to said article sensor and said first divider, said medium pulse rate being gated to said first counter by the first gate when said first gate receives an output signal from the first article sensor;
said second gating means includes said first article sensor, a first circuit interconnecting the first article sensor, the interrogator, the first counter and the second counter, said high pulse frequency being gated by said first gating circuit to said first and second counters upon the termination of the output signal from said first article sensor when said article passes from said first position, said second gating means further including a second article sensor located at said second position and producing an output signal when an article is present at said second position, a second gating circuit interconnecting said generator, the second article sensor and said second counter, said high pulse rate being gated by said second gating circuit to the second counter upon the application to said second gating circuit of an output signal from the second article sensor when said article is present at the second position.
17. The apparatus of claim 9 wherein:
said generating means produces a low electrical pulse rate respectively proportionate to the speed of travel of said article;
and further comprising a third counting means for counting electrical pulses and producing an output signal upon the counting of a predetermined number of electrical pulses;
a third gating means responsive to the passing of an article from said first position and to the output signal from said first counting means for connecting said very high pulse frequency to said third counting means and responsive to the presence of the same article at a third position for connecting said high pulse frequency to said third counting means;
and second folding means responsive to the output signal of said third counting means for folding said article.
18. The apparatus of claim 17 wherein:
said second counting means includes a plurality of counters each producing an output signal upon the counting of a predetermined number of electrical pulses, said output signals being connected to said first folding means;
said third counting means includes another plurality of counters each producing an output signal upon the counting of a predetermined number of electrical pulses, said output signals being connected to said second folding means;
said second gating means includes a selector means for connecting said very high pulse frequency to one of said plurality of counters when said article passes from said first position and for connecting said high pulse rate to the same one of said plurality of counters when the same article is present at said second position;
and said third gating means includes another selector means for connecting said very high pulse frequency to one of said other plurality of counters when said article passes from said first position and for connecting said high pulse rate to the same one of said other plurality of counters when the same article is present at said third position.
19. The apparatus of claim 18 wherein:
said selector means includes a decoding means for sequentially developing a plurality of output signals each two of which correspond to a different one of said plurality of counters and determine which one of said plurality of counters is connected to said very high pulse frequency and said high pulse rate, and shift register means having a plurality of output states and being connected to said decoding means for controlling the decoding means to develop said plurality of output signals in a predetermined sequence;
and said other selector means includes another decoding means for sequentially developing a plurality of output signals each two of which correspond to a different one of said other plurality of counters and determine which one of said other plurality of counters is connected to said very high pulse frequency and said high pulse rate, and another shift register means having a plurality of output states and being connected to said other decoding means for controlling the third decoding means to develop said plurality of output signals in a predetermined sequence.
20. The apparatus of claim 19 wherein:
said shift register means includes a first shift register device having a plurality of output states for controlling the decoding means to connect said very high pulse frequency to one of said plurality of counters when said article passes from said first position and a second shift register device having a plurality of output states each corresponding to an output state of said first shift register device for controlling the decoding means to connect said high pulse rate to the same one of said plurality of counters when the same article is present at said second position;
said other shift register means includes a third shift register device having a plurality of output states for controlling the other decoding means to connect said very high pulse frequency to one of said other plurality of counters when said article passes from said first position and a fourth shift register device having a plurality of output states each corresponding to an output state of said third shift register device for controlling the other decoding means to connect said high pulse rate to the same one of said other plurality of counters when the same article is present at said second position;
said decoding means includes a first synchronizing means connected to said first and second shift register devices for initially shifting the first and second shift register devices into corresponding output states;
and said other decoding means includes a second synchronizing means connected to said third and fourth shift register devices for initially shifting the third and fourth shift register devices into corresponding output states.
21. The apparatus of claim 20 wherein:
said first synchronizing means includes a plurality of gates and a plurality of flip-flops and is responsive to said very high pulse frequency and to the two output signals of said decoding means corresponding to one of said plurality of counters;
and said second synchronizing means includes a plurality of gates and plurality of flip-flops and is responsive to said very high pulse frequency and to the two output signals of said other decoding means corresponding to one of said other plurality of counters.
22. The apparatus of claim 21 wherein:
said second gating means includes a gating device for gating said very high pulse frequency and said high pulse rate with said plurality of output signals developed by said decoding means;
said third gating means includes another gating device for gating said very high pulse frequency and said high pulse rate with said plurality of output signals developed by said other decoding means;
said generating means includes a generator producing said high electrical pulse rate at a predetermined rate per unit of travel of said article and first and second dividers for respectively dividing said high electrical pulse rate to said medium and low electrical pulse

rates, said first divider being connected to said generator and said second divider being connected to said first divider;

said plurality of counters includes first, second and third counters and said other plurality of counters includes foruth, fifth and sixth counters;

said decoding means develops first, second and third pairs of output signals corresponding to said first, second and third counters, said pairs of output signals being applied to said gating device to sequentially gate both said very high pulse frequency and said high pulse rate to said first, second and third counters;

and said other decoding means develops a fourth, fifth and sixth pairs of output signals corresponding to said fourth, fifth and sixth counters, said fourth, fifth and sixth pairs of output signals being applied to said other gating device to sequentially gate both said very high pulse frequency and said high pulse rate to said fourth, fifth and sixth counters.

23. The apparatus of claim **22** wherein:

said generating means includes a generator producing said high electrical pulse rate at a predetermined rate of travel of said article, a first divider connected to said generator for dividing said high electrical pulse rate to said medium electrical pulse and a second divider connected to said first divider for dividing said medium electrical pulse rate to said low electrical pulse rate;

and said first counting means comprises a first counter, said second counting means comprises a second counter and said third counting means comprises a third counter.

24. The apparatus of claim **23** wherein:

said first gating means includes a first article sensor located at said first position and producing an output signal when an article is present at said first position and a first gate connected to said article sensor and said first divider, said medium pulse rate being gated to said first counter by the first gate when said first gate receives an output signal from the first article sensor,

said third gating means includes said first article sensor, a third gating circuit interconnecting the first article sensor, the interrogator, the first counter and the third counter, said high pulse frequency being gated by said third gating circuit to said first and third counters upon the termination of the output signal from said first article sensor when said article passes from said first position, said third gating means further including a third article sensor located at said third position and producing an output signal when an article is present at said third position, a fourth gating circuit interconnecting said generator, the third article sensor and said third counter, said high pulse rate being gated by said third gating circuit to the third counter upon the application to said third gating circuit of an output signal from said third article sensor when said article is present at said third position.

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