United States Patent [19]

Gerstenberger et al.

[11] **3,926,424**

[45] **Dec. 16, 1975**

[54] **FOLDING APPARATUS**

[75] Inventors: **Roland W. Gerstenberger; William E. Field,** both of Fort Lauderdale, Fla.

[73] Assignee: **Jensen Corporation,** Fort Lauderdale, Fla.

[22] Filed: **Dec. 13, 1973**

[21] Appl. No.: **424,479**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 266,604, June 27, 1972, abandoned, which is a continuation-in-part of Ser. No. 190,812, Oct. 20, 1971, Pat. No. 3,714,459.

[52] **U.S. Cl.** ..... **270/62;** 270/68 R; 270/86

[51] **Int. Cl.**[2] **B65H 45/12**

[58] **Field of Search** ..... 270/61 R, 62, 66, 69, 67, 270/80–82

[56] **References Cited**

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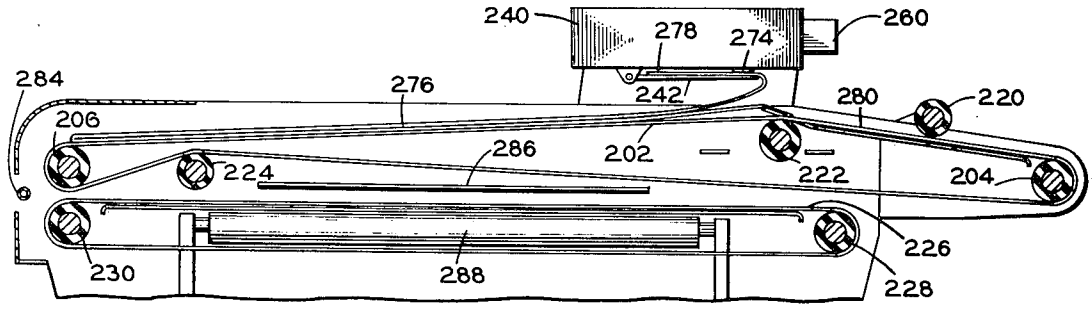
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Primary Examiner—Melvin D. Rein
Assistant Examiner—A. Heinz
Attorney, Agent, or Firm—Oltman and Flynn

[57] **ABSTRACT**

An improved folding apparatus for laundry articles being advanced by a conveyor having a pick up and drop, first folder, and leading and trailing photoelectric sensors at this folder for controlling its operation in response to the arrival of the leading and trailing edges of the article. The sensors also control a timing circuit for a second folder operating in two stages: beginning with the movement of the leading edge of the article past the trailing sensor; and beginning with the movement of the trailing edge of the article past the leading sensor.

6 Claims, 19 Drawing Figures



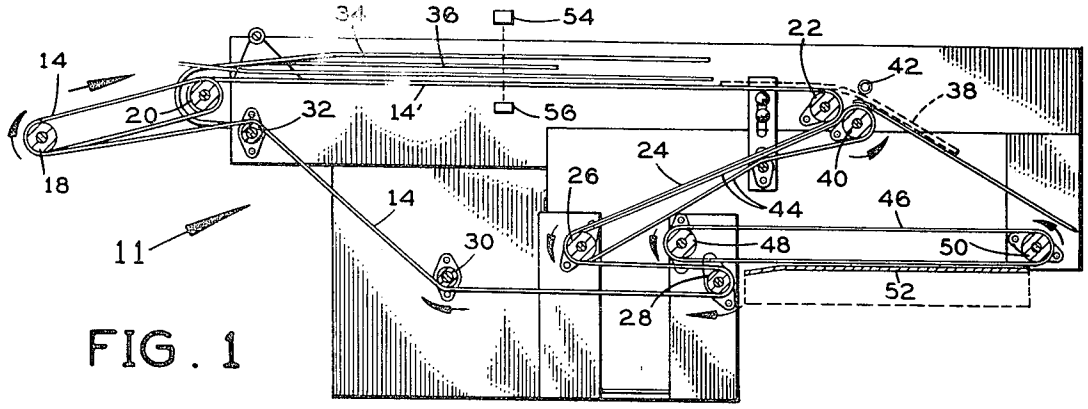

34
36
54
22
14
42
38
20
32
14'
56
24
26
40
18
44
46
14
48
50
11
30
52
28

FIG. 1

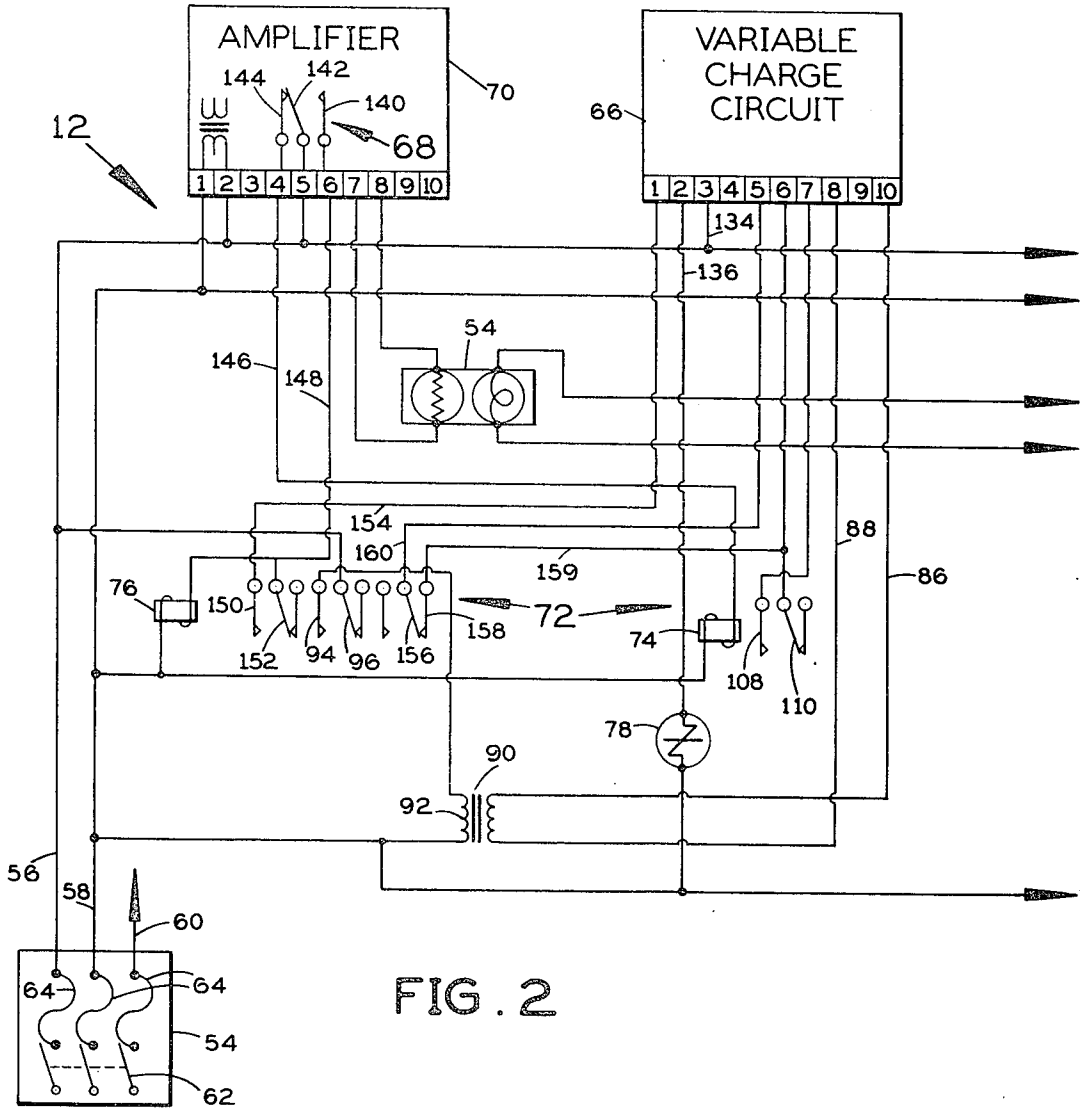

AMPLIFIER
144
142
140
70
68
12
1 2 3 4 5 6 7 8 9 10
VARIABLE CHARGE CIRCUIT
66
1 2 3 4 5 6 7 8 9 10
134
136
54
146
148
154
160
159
88
86
76
150
72
158
74
152
94
96
156
108
110
78
90
92
56
58
60
64
64
54
62

FIG. 2

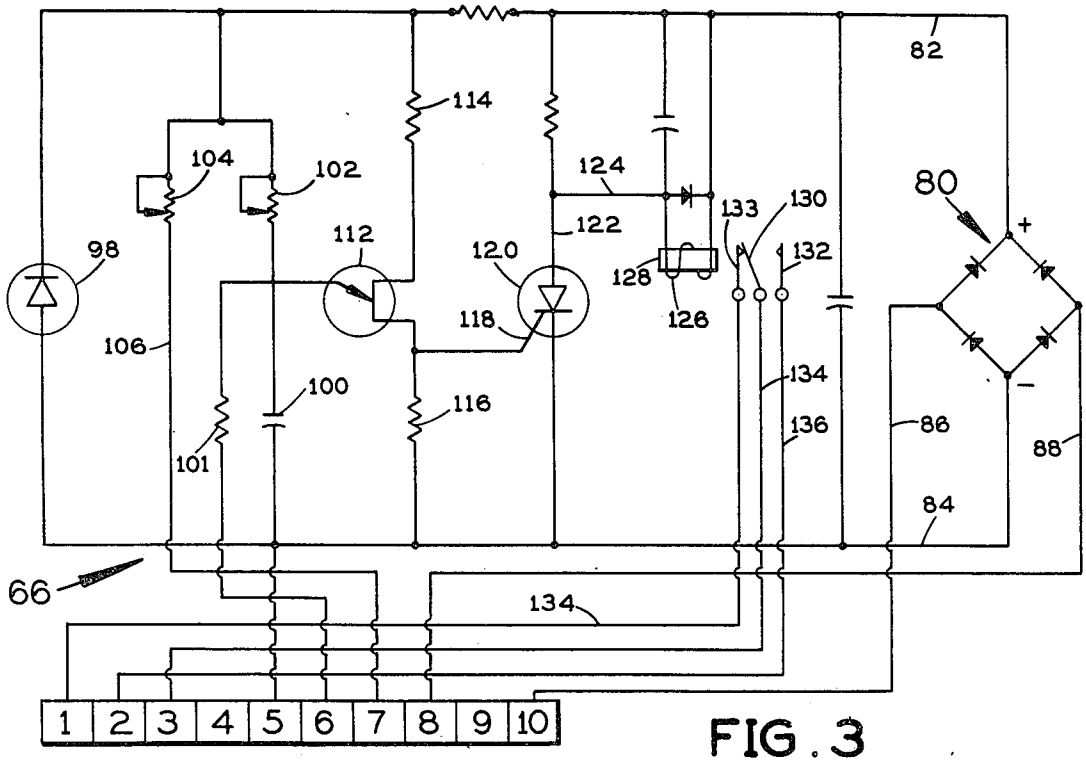


FIG. 3

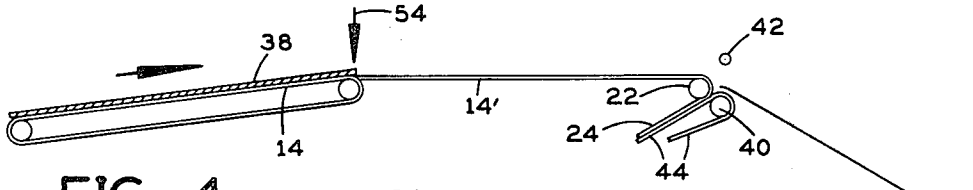


FIG. 4

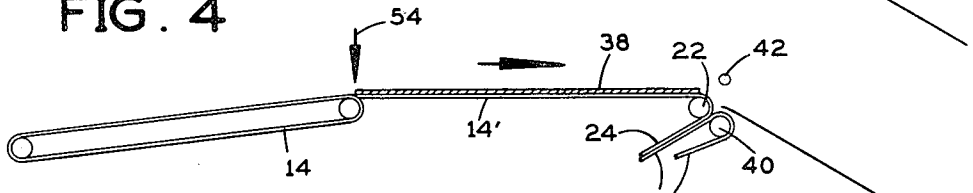


FIG. 5

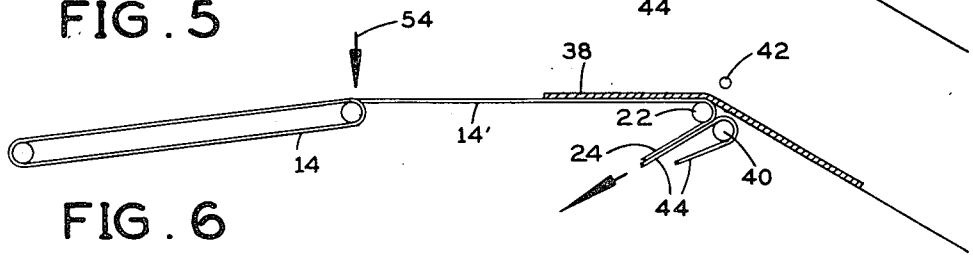


FIG. 6

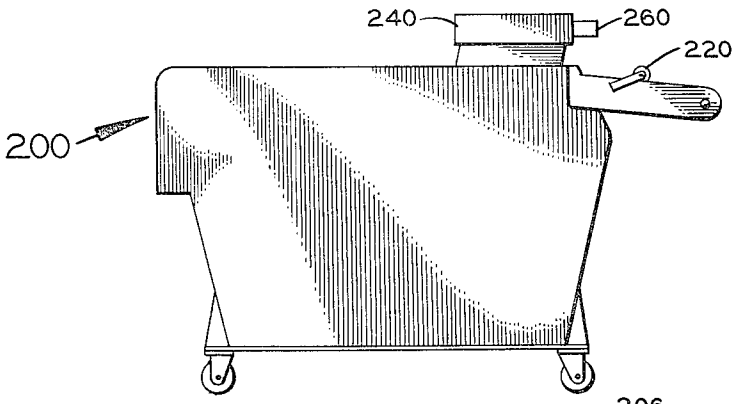


FIG. 7

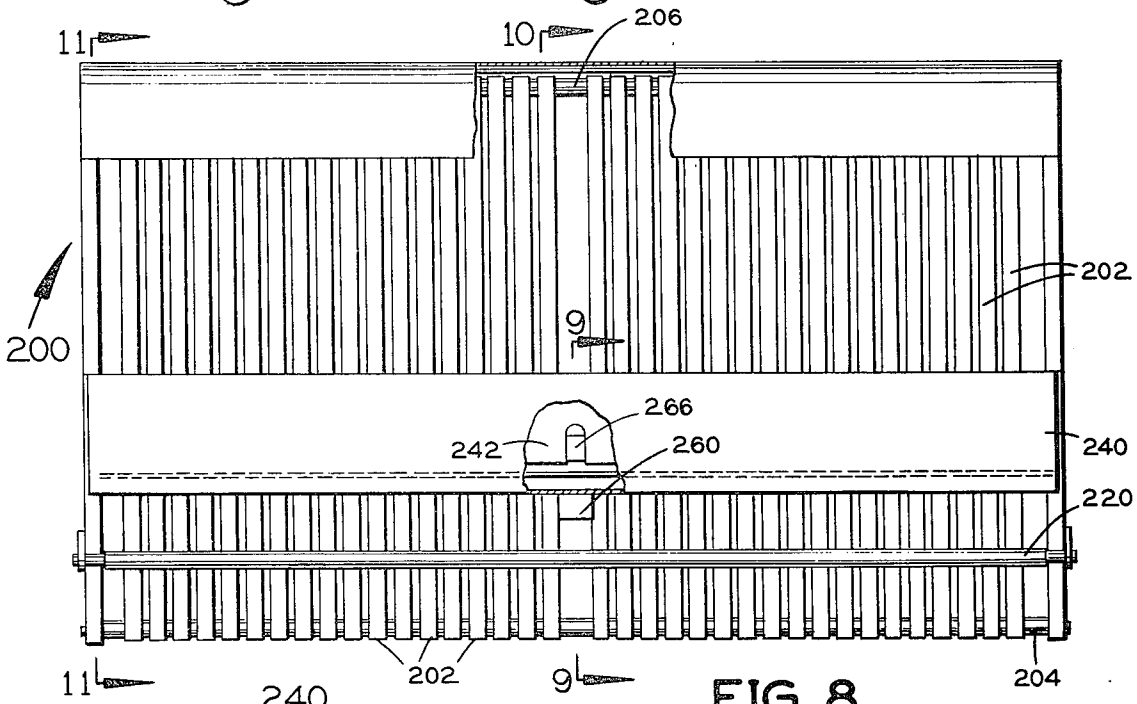


FIG. 8

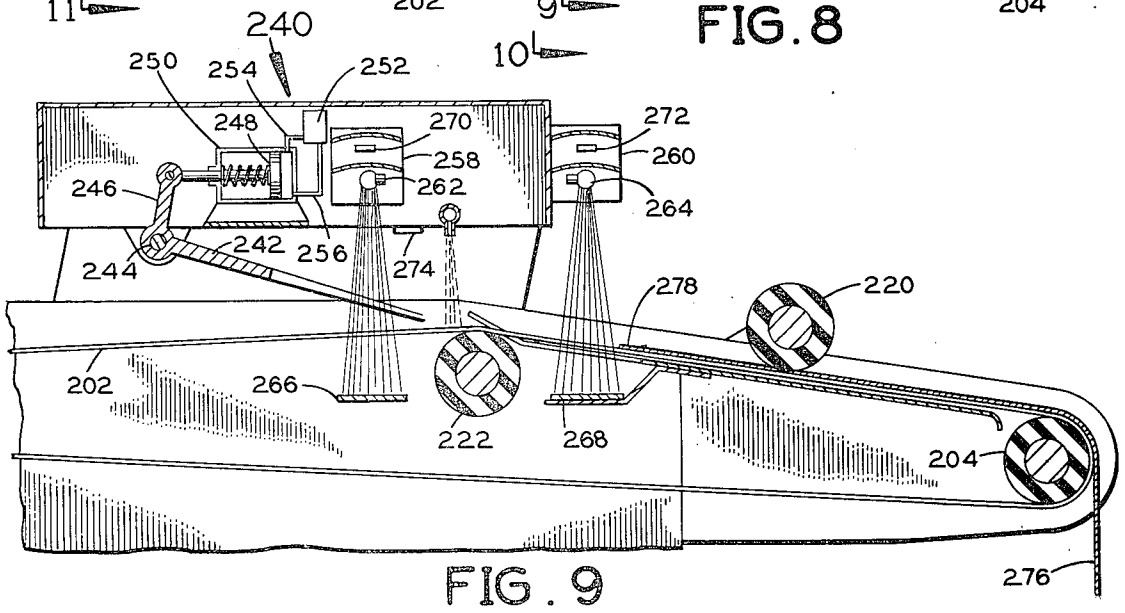


FIG. 9

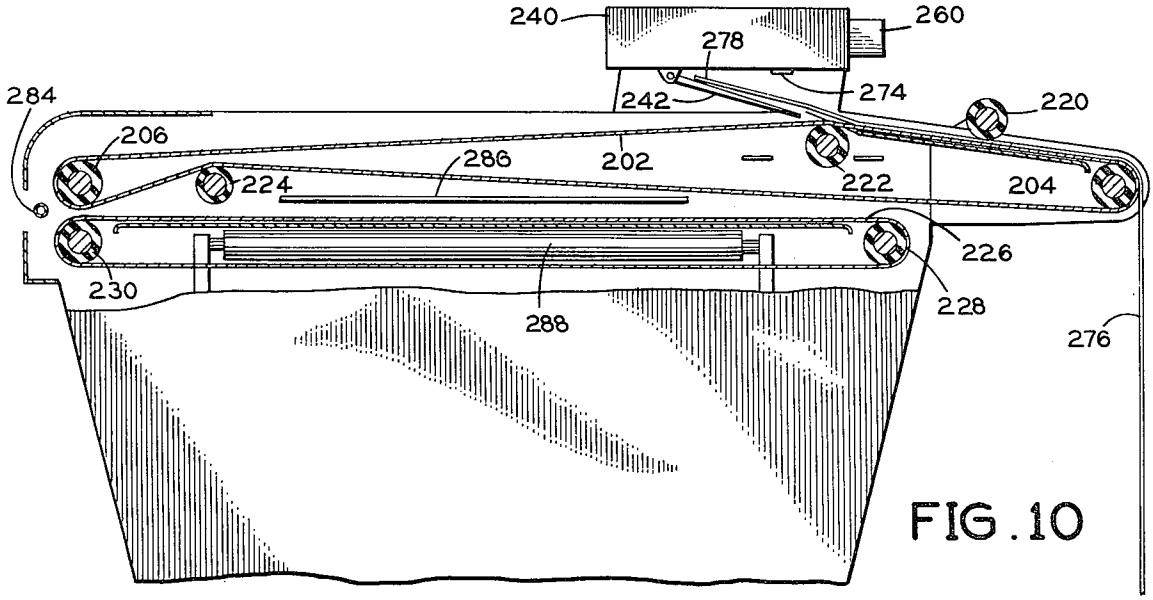


FIG. 10

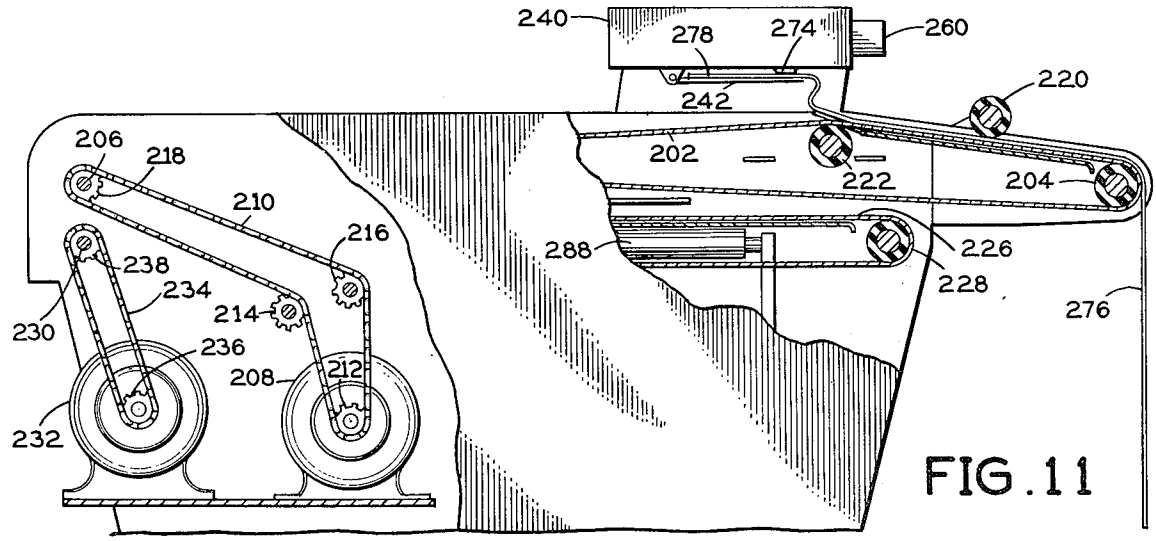


FIG. 11

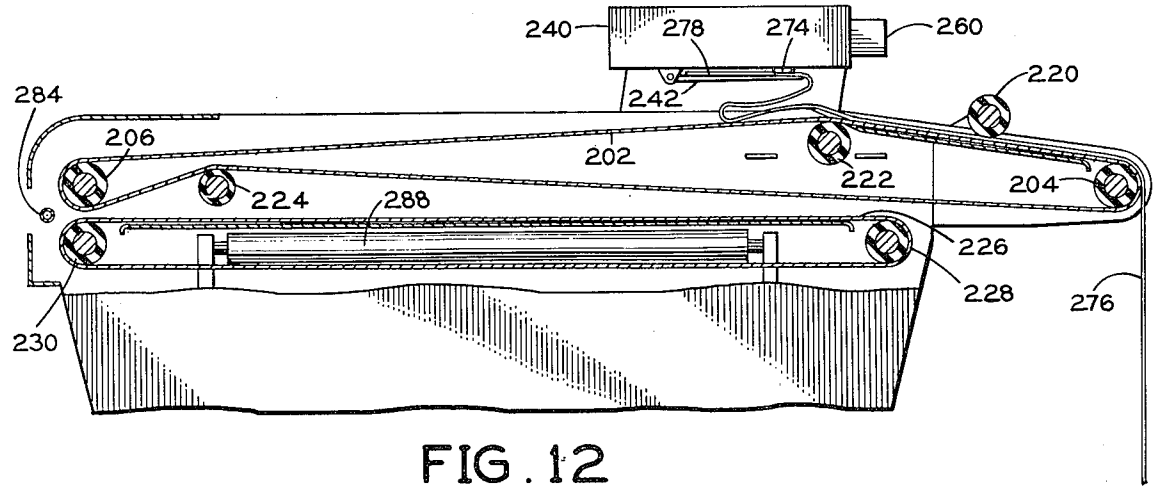


FIG. 12

FIG. 13

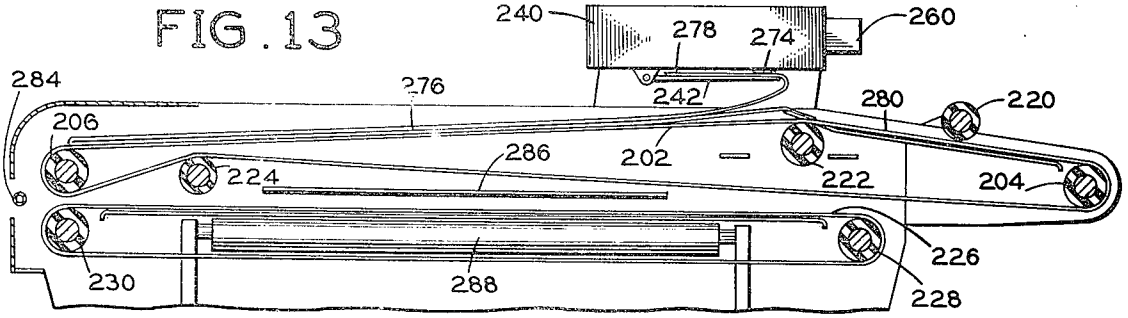


FIG. 14

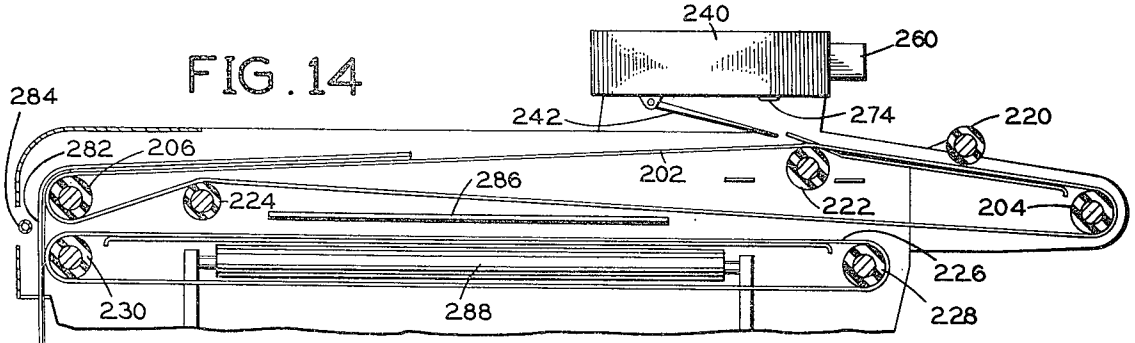


FIG. 15

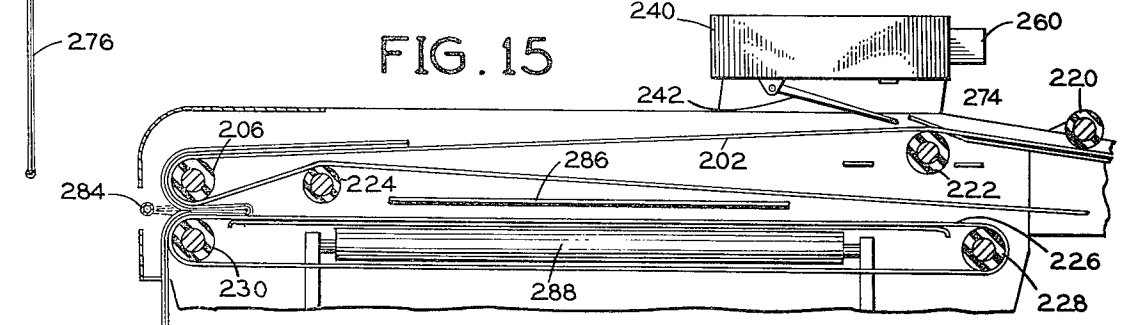
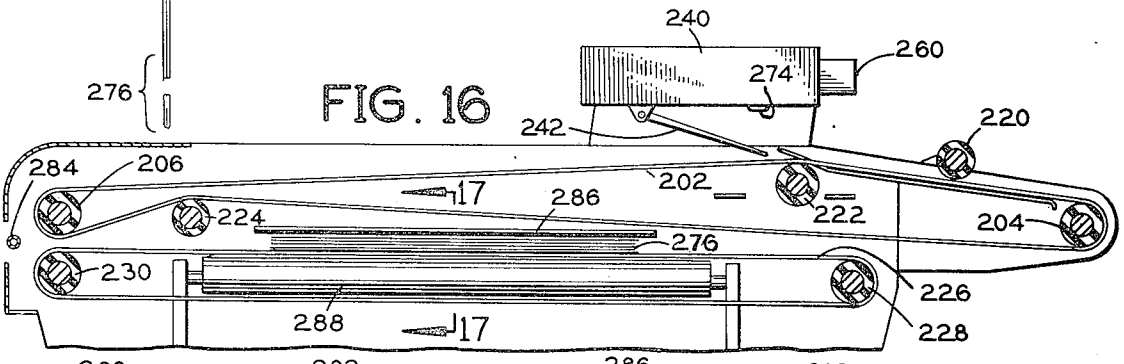


FIG. 16



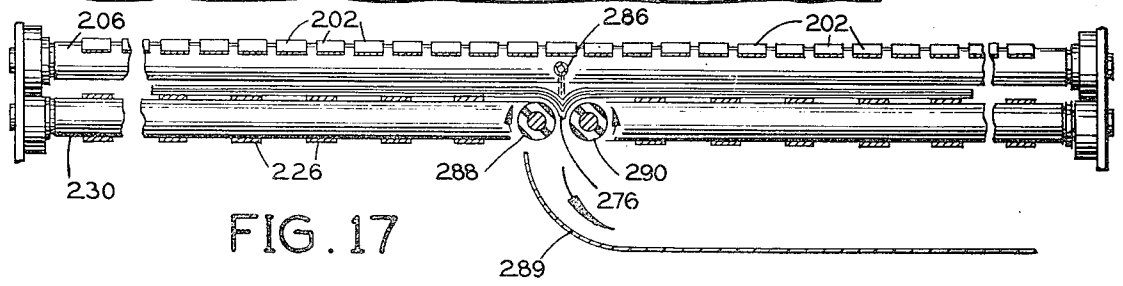


FIG. 17

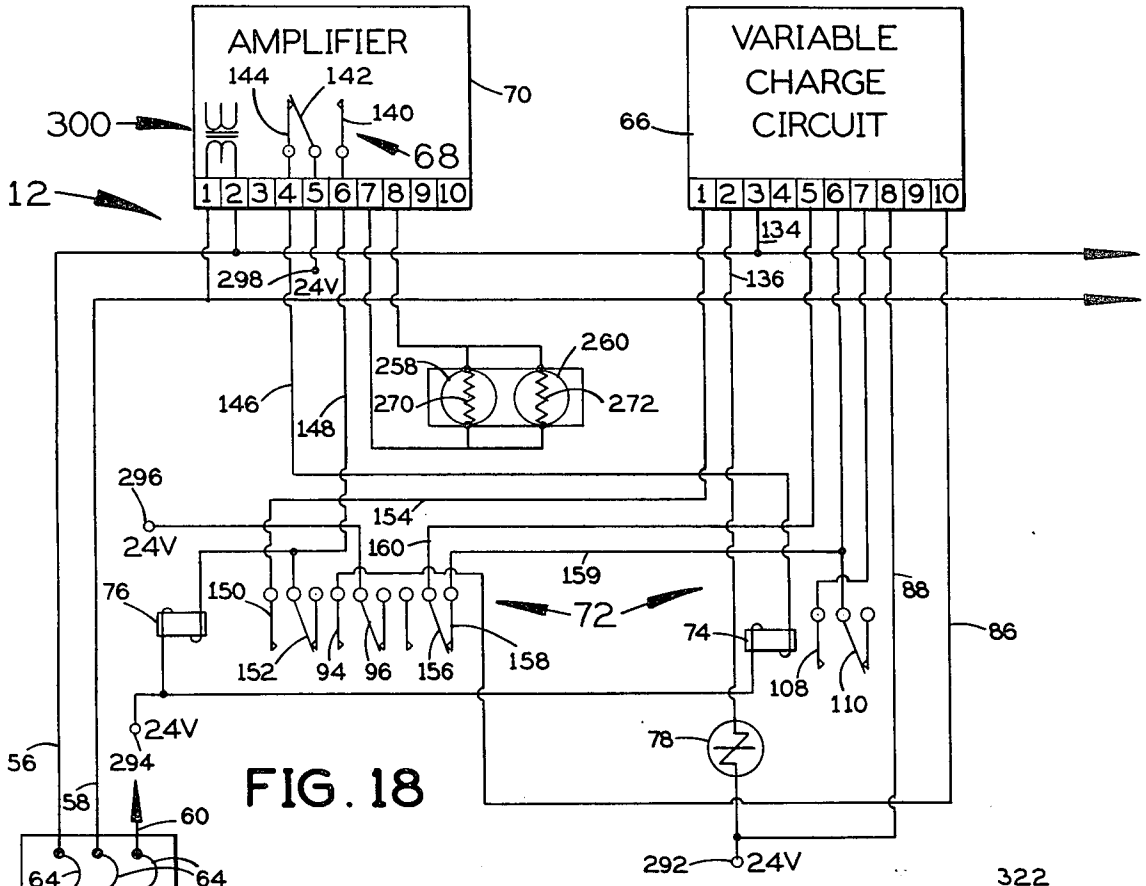

AMPLIFIER
144
142
140
70
300
68
12
1 2 3 4 5 6 7 8 9 10
VARIABLE
CHARGE
CIRCUIT
66
1 2 3 4 5 6 7 8 9 10
134
298
24V
136
260
258
270
272
146
148
296
24V
154
160
159
72
88
76
150
74
86
152
94
96
156
158
108
110
24V
56
294
78
58
60
64
64
62
292
24V

FIG. 18

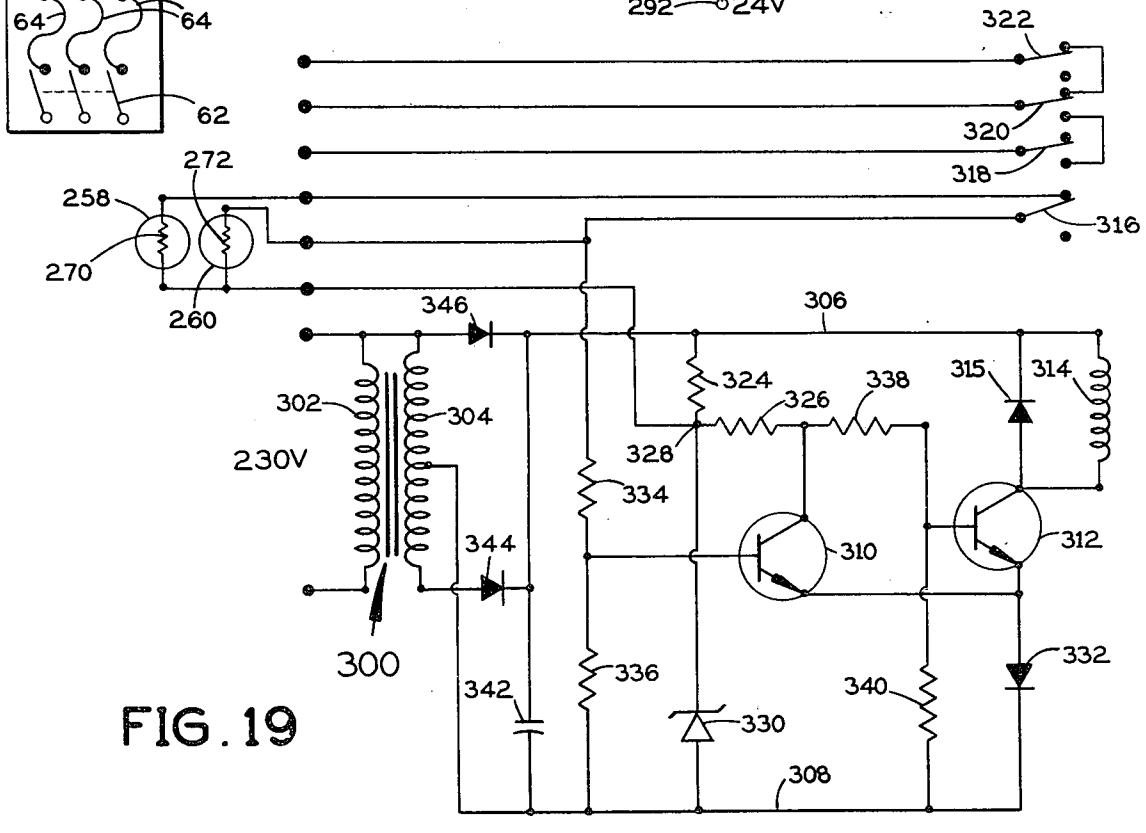

322
320
318
316
272
258
270
260
346
306
302
304
230V
324
326
338
315
314
328
334
310
312
344
300
336
342
340
332
330
308

FIG. 19

FOLDING APPARATUS

RELATED APPLICATION

This application is a continuation-in part of our co-pending U.S. patent application Ser. No. 266,604, filed June 27. 1972 now abandoned, which was a continuation-in-part of our earlier filed U.S. Pat. application Ser. No. 190,812, filed Oct. 20, 1971, now U.S. Pat. No. 3,714,459.

BACKGROUND OF THE INVENTION

Folding apparatus is known wherein two pick up and drop folders are employed to fold a laundry article in half and then in quarters. Sometimes cross folds are then made by further folding devices. In these known folders, the first two folding devices are in series on the same level of the apparatus, and they take up considerable space, thus making the apparatus quite wide. In commercial laundries where the folder is usually fed from an ironer, the width of the folder is not usually a critical consideration. However, some laundry articles do not require ironing and can be fed directly into the folder as by hand feeding. In such applications, a folder may be used in an establishment such as a hotel laundry where space is an important consideration, and here the excess width of known folders is a disadvantage.

SUMMARY OF THE INVENTION

In accordance with the present invention, a folder apparatus is provided with a first folding device of the pick up and drop type and a second folding device of the roll type which substantially reduces the width of the apparatus as compared to known apparatus. Cooperating with these two folding devices is a timer which works in response to sensors at the first folder but controls the actuation of the second folder. The timer is preferably a variable charge rate type which measures a laundry article and then actuates the second folding device when the midpoint of the article reaches the fold point for the second folding device. The timer includes a capacitance which charges at one rate while measuring the article and then charges at a faster rate while tracking the midpoint (or other point) of the article to the fold point for the second folder.

Accordingly, it is an object of the present invention to provide a compact and reliable folding apparatus which is reduced in width as compared to known folding apparatus.

Another object of the invention is to combine a pick up and drop folder with a roll folder in a folding apparatus and time the roll folder off the pick up and drop folder.

Another object of the present invention is to actuate a timer by means of a sensor at a first folding device, with the timer in turn actuating a second folding device.

Another object of the invention is to measure an article while it is being folded in half.

A further object of the invention is to track the midpoint of the half folded article for a predetermined time at the end of which a folding device is actuated to fold the article in quarters.

Still another object of the invention is to tie a variable charge rate timer into a pick up and drop folding device so as to control a second folding device.

Other objects of this invention will appear from the following description and appended claims, reference

being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic view of a laundry apparatus in which a variable charge rate timer is incorporated;

FIG. **2** is a schematic diagram of a variable charge rate timer apparatus;

FIG. **3** is a schematic diagram of a portion of the circuit of FIG. **2**;

FIG. **4** is a fragmentary schematic view of a portion of the apparatus of FIG. **1** showing a laundry article as its leading edge reaches a sensing means;

FIG. **5** is a schematic diagram similar to FIG. **4**, but showing the laundry article when its trailing edge reaches the sensing means;

FIG. **6** is also a schematic diagram similar to FIG. **4**, but showing the laundry article when its mid-portion reaches a predetermined position when folding of the article commences;

FIG. **7** is an elevational view of a laundry apparatus which includes a pick up and drop folding device followed by a roll type folding device and a timer operated by the first folding device to control the second folding device in accordance with the present invention;

FIG. **8** is a top plan view of the apparatus of FIG. **7**;

FIG. **9** is a fragmentary sectional view of a portion of the apparatus taken along line **9—9** of FIG. **8** and looking in the direction of the arrows;

FIG. **10** is a cross sectional view of the apparatus taken along **10—10** of FIG. **8** and looking in the direction of the arrows;

FIG. **11** is a cross sectional view taken along line **11—11** of FIG. **8** and looking in the direction of the arrows;

FIG. **12** is a fragmentary cross sectional view similar to FIG. **10** showing a laundry article while it is being folded in half by the pick up and drop folding device;

FIG. **13** is another fragmentary sectional view showing the laundry article after it has been folded in half;

FIG. **14** shows the condition of the same apparatus after the half-folded laundry article has travelled until its midpoint has reached the fold point of the second or roll type folder;

FIG. **15** is another fragmentary sectional view showing the laundry article being folded into quarters by the second or roll type folder;

FIG. **16** is another fragmentary sectional view showing the laundry article after it has travelled to a third folder which is also a roll type folder for making a cross fold;

FIG. **17** is a cross sectional view taken along line **17—17** of FIG. **16** showing a cross fold being made by the third folder;

FIG. **18** is a circuit diagram which is similar to FIG. **2** but involves certain modifications; and

FIG. **19** is a circuit diagram of an amplifier included in FIG. **18.**

Before explaining the presnet invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

DETAILED DESCRIPTION

A laundry apparatus **11** is shown schematically in FIG. **1.** Included in the apparatus **11** is a variable charge rate timer **12,** schematic diagrams for which are shown in FIGS. **2** and **3.** It will be understood that the timer **12** is not limited in its utility to the particular laundry apparatus of FIG. **1,** but this apparatus is a typical example of a suitable application for the variable charge rate timer.

In the laudnry apparatus **11,** there is a conveyor loop **14** which passes around several rollers and includes an upper, generally horizontal flight **14'** on which a laundry article is conveyed. The laundry article might be a towel, by way of example. At the entrance end of the apparatus, the conveyor **14** passes around a roller **18** and runs on an incline to another roller **20** where the horizontal upper flight **14'** of the conveyor **14** begins. From roller **20,** the upper flight **14'** of the coveyor **14** extends to a roller **22** at the trailing end of the upper flight **14'.** From roller **22,** the conveyor has a portion **24** extending generally downwardly and at an angle toward the front of the apparatus. The portion **24** terminates at a roller **26,** and the conveyor passes around roller **26** to another roller **28,** around roller **28,** and back over rollers **30** and **32** to the entrance of the apparatus.

Two folding members **34** and **36** are mounted above the upper horizontal flight **14'.** As the laundry article moves along the upper flight of the conveyor, its side edge portions ride upon folding members **34** and **36.** These folding members are designed to fold the side edge portions of the article up, over and down on the mid-portion of the article to form a French fold. After the article is folded, it leaves the folding members **34** and **36** and continues to a position near the right end of the apparatus where the article **38** is shown in dashed lines in FIG. **1.** At this position, the article is folded in half transversely by forcing it between rollers **22** and **40** with an air blast from a pneumatic device **42.** It is the function of the variable charge rate timer to assure that the air blast from pneumatic device **42** is delivered at exactly the right time to force the mid-portion of the article between rollers **22** and **40.** Of course, if the fold were desired at some point other than the mid-portion, the timer would be suitably adjusted to accomplish that, but in the illustrated embodiment the fold is made at the center of the article.

A separate conveyor loop **44** passes around rollers **40** and **26,** and the upper flight of conveyor **44** contacts and runs parallel with conveyor flight **24.** As the article passes between rollers **22** and **40,** it is gripped between the conveyor portions **24** and **44,** so the article passes down and to the left while travelling to roller **26.** Then the article passes around roller **26** and into a discharge portion of the apparatus which includes still another k conveyor **46** which passes around rollers **48** and **50.** The conveyor **46** presses on the top of the article and drags it along over a pair of plates **52** which are capable of opening in the manner of a trap door. The conveyor **46** stops at a proper time, and the doors **52** open to drop the article onto a table or into a bin or other suitable receptacle.

It may be seen that there is a photocell device **54** cooperating with a mirror **56,** these elements being associated with the upper flight **14'** of the conveyor **14.** Referring to FIGS. **4, 5** and **6,** the pohotocell device **54** is represented by an arrow. Only a portion of the apparatus is shown here to illustrate the principle of measuring and timing functions. In FIG. **4,** a towel **38** is shown at the entrance end of the conveyor **14.** The upper flight **14'** of the conveyor is also shown, although it has been shortened relatively in FIG. **4** to simplify the drawings. The photocell **54** acts as a sensing means to sense the leading edge of the towel **38.** Light from the photocell device **54** is blocked from the mirror **56** while the towel **38** passes under the photocell **54.** As will be explained further, the variable charge rate timer **12** of FIGS. **2** and **3** measures the towel **38** while it traverses the photocell **54.**

As shown in FIG. **5,** when the trailing edge of the article **38** passes under the photocell **54,** the light from the photocell is no longer blocked. This initiates a timing function of the timer **12** which times the operation of the pneumatic device **42.**

As shown in FIG. **6,** the towel **38** continues to move to the right while the timer **12** is timing the movement, and when the center of the towel **38** reaches the pneumatic device **42** and is directly over the rollers **22** and **40,** the timer **12** actuates the pneumatic device **42** which then delivers a blast of air to force the center of the towel **38** between rollers **22** and **40.** The rollers **22** and **40** nip the article and deliver it to the conveyor portions **24** and **44** which transport the article on through the apparatus.

Referring now to FIGS. **2** and **3,** a power source **54** consists of a-c power lines **56, 58** and **60** which enter the circuit through a switch **62** and fuses **64.** Lines **56** and **58** supply a-c power to the timer **12** and also to the motor (not shown) for operating the conveyors of the apparatus **11.** The timer **12** includes a variable charge circuit **66** which is represented as a block in FIG. **2,** but which is shown in a complete schematic diagram in FIG. **3.** The terminals **1** through **10** of circuit **66** in FIG. **2** are the same as terminals **1** through **10** in FIG. **3.**

The photocell **54** is associated with a relay switch **68,** and the switch **68** and photocell **54** together constitute a switching means for sensing the laundry article **38.** The switch **68** is shown in an amplifier **70** which is represented schematically by a block since the circuit is standard.

The control means **72** of the timer includes two relays **74** and **76** which control the operation of the variable charge circuit **66** as will be explained further. Output means includes a solenoid **78** which actuates a valve of the pneumatic device **42** to deliver a blast of air from device **42** for folding the laundry article **38.** Other portions of the output means are included in the circuit **66.**

The circuit **66,** as shown in FIG. **3,** includes a bridge rectifier **80** from which lines **82** and **84** supply d-c power to the circuit **66.** The bridge rectifier **80** is connected by lines **86** and **88** through terminals **10** and **8** respectively to a transformer **90** (FIG. **2**) through which a-c power is supplied to the rectifier **80.** One end of the primary **92** of the transformer **90** is connected to line **58,** and the other end of primary **92** is connected to a contact **94** of relay **76,** and contact **94** cooperates with a movable contact **96** which is connected to the other power supply line **56.** Contacts **94** and **96** are normally open, so when relay **76** is deenergized, no power is applied to the variable charge circuit **66.**

Circuit **66** includes a zener diode **98** connected across lines **82** and **84** for regulating the voltage of the circuit. A capacitor **100** and a resistance **102** in the form of a potentiometer are connected in series with

each other across lines 82 and 84. Another resistance 104 in the form of a potentiometer is connected in parallel with resistance 102 to the capacitor 100. The line 106 which connects resistance 104 to capacitor 100 passes through terminals 7 and 6 of circuit 66, and it may be seen in FIG. 2 that terminals 7 and 6 are respectively connected to contacts 108 and 110 of relay 74. Contacts 108 and 110 are normally open when relay 74 is deenergized, so in the deenergized condition of relay 74, resistance 104 is disconnected from capacitor 100.

The relay 74 serves as a means to connect and disconnect the resistance 104 relative to the capacitor 100. When relay 74 is energized, both resistances 102 and 104 are connected in parallel with each other to capacitor 100. When relay 74 is deenergized, only resistance 102 is connected to capacitor 100. When power is applied to lines 82 and 84, capacitor 100 charges at a relatively slow rate through resistance 102. As will be explained, this charging occurs while the laundry article 38 traverses photocell 54. When photocell 54 senses the trailing edge of the article 38, the resistance 104 is connected in parallel with resistance 102 to the capacitor 100, and then the capacitor 100 charges at a faster rate while the laundry article travels to the pneumatic device 42. In this particular emobiment, the capacitor 100, when charging at the faster rate, charges twice as fast as when it is charging at the slower rate. This is because the effective resistance of resistances 102 and 104 in parallel is one-half that of resistance 102 alone. When the capacitor 100 charges to a predetermined voltage, it fires unijunction transistor 112 which is connected through resistors 114 and 116 across lines 82 and 84. The gate 118 of a silicon controlled rectifier 120 is connected to one of the base electrodes of unijunction transistor 112, and the output of unijunction transistor 112 fires the silicon controlled rectifier 120. The anode 122 of silicon controlled rectifier 120 is connected through line 124 and the coil 126 of relay 128 to the power line 82. Thus, when silicon controlled rectifier 120 fires, the relay 128 is energized. Coil 126 of relay 128 then closes contacts 130 and 132 of this relay. Contacts 130 and 132 are respectively connected by lines 134 and 136 through terminals 3 and 2 of circuit 66 to line 56 and to the solenoid 78 which in turn is connected to line 58. Thus, when relay 128 is energized, the solenoid 78 is actuated to produce the air balst which folds the article.

Transistor 112, controlled rectifier 120, relay 128 and solenoid 78 all form part of the output means of the timer.

Charging and discharging of the capacitor 100 is controlled by the control means 72 which includes relays 74 and 76. The switch 68 and photocell 54 cooperate with the control means. Switch 68 is part of a relay which includes contacts 140, 142 and 144. Contact 144 is connected through terminal 4 of amplifier 70 via line 146 to the coil of relay 74 and from there to line 58. Contacts 142 and 144 are normally closed, and contact 142 is connected through terminal 5 to line 56. With contacts l42 and 144 normally closed, the coil of relay 74 is energized. The energizing of relay 74 closes contacts 108 and 110 of that relay, thus connecting resistance 104 to capacitor 100. When the leading edge of the laundry article 38 passes under the photocell 54, light from the photocell 54 is blocked and this actuates the relay coil of switching device 68 to open contacts 142 and 144 and close contacts 140 and 142. The opening of contacts 142 and 144 deenergizes relay 74 to in turn open contacts 108 and 110 and thus disconnect resistance 104 from capacitor 100. Therefore, while the laundry article 38 is traversing the photocell 54, capacitor 100 charges through resistance 102 at a relatively slow rate. The closing of contacts 140 and 142 energizes relay 76 because contact 140 is connected through terminal 6 and line 148 to the coil of relay 76 which is in turn connected to power line 58.

The energizing of relay 76 closes contacts 94 and 96 to supply power through transformer 92 to the bridge rectifier 80. This applies power to the circuit 66 so that the capacitor 100 can charge as previously mentioned. Prior to this time no power has been applied to circuit 66, so the capacitor 100 does not charge. Relay 76 has contacts 150 and 152 which are normally open, but which close when relay 76 is energized. Contact 152 is connected to line 148, and contact 150 is connected via line 154 through terminal 1 of circuit 66 and through normally closed contacts 130 and 133 of relay 128 and line 134 through terminal 3 back to the power line 56. Thus, contacts 150 and 152 of relay 76 are latching contacts which hold the relay 76 energized, even after the laundry article finishes traversing the photocell 54.

Relay 76 also has contacts 156 and 158 which are normally closed, but which open when the relay 76 is energized. Contact 158 is connected to contact 110 which, as previously mentioned, serves to connect resistance 104 to capacitor 100. Contact 156 is connected via line 160 and terminal 5 of circuit 66 to the minus side of capacitor 100. When contacts 156 and 158 are closed, the minus side of capacitor 100 is connected through contact 158, line 159, terminal 6 and resistor 101 to the upper side of capacitor 100, so resistor 101 provides a discharge path for discharging the capacitor 100. However, when relay 76 is energized, contacts 156 and 158 open to disconnect this discharge path so that the capacitor can be charged.

As previously mentioned, relay 76 remains energized after the laundry article 38 finishes traversing photocell 54. However, switch 68 is deenergized, so contacts 142 and 144 again close and contacts 140 and 142 open. The closing of contacts 142 and 144 energizes relay 74 to close contacts 108 and 110, and thus connect resistance 104 to capacitor 100. At this time, capacitor 100 begins charging at twice the rate at which it charges when current is supplied to it only through resistance 102. The capacitor 100 continues charging at this faster rate until it reaches a voltage at which unijunction transistor 112 fires, and this ultimately operates the solenoid 78 to cause a blast of air to fold the laundry article 38 as previously described. In this sequence of operation, relay 128 is energized to close contacts 130 and 132 and open contacts 130 and 133. The opening of contacts 130 and 133 interrupts the power circuit of relay 76, so relay 76 is deenergized. This causes contacts 156 and 158 to close, thus completing the discharge path through resistor 101 for capacitor 100, and allowing the capacitor 100 to discharge back to its initial condition. Contacts 94 and 92 open to remove power from circuit 66, and contacts 150 and 152 open to unlatch the relay 76. The control means 72 has now returned to its initial condition.

With the foregoing arrangement (disregarding various time delays in the apparatus), the distance along the conveyor from the photocell 54 to the folder 22, 40, 42, where the laundry piece is to be folded at its longitudinal midpoint, is directly proportional to the

firing or triggering voltage for the unijunction **112.** This relationship is the same for laundry pieces of different lengths.

The voltage on the capacitor **100** (which is to trigger the unijunction **112**) may be expressed as follows:

$V = RT$

where R is the charging rate, and T is the time of charging. For a constant speed conveyor, time (T) is proportional to the distance through which a laundry piece is advanced by the conveyor. All conveyors used in laundry folding equipment are operated at constant speed; otherwise, the timing of the different folding operations could not be precisely controlled in the desired manner. Therefore, $T = K \times$ distance (where K is a constant of proportionality).

With L as the length of the laundry piece, S as the distance from the photocell **54** to the folder, r_s as the slow charging rate (while the laundry piece is moving past the photocell), and $2r_s$ as the fast charging rate (after the laundry piece has moved completely past the photocell), the capacitor voltage required to trigger the unijunction **112** may be expressed as follows (in terms of charging rate and elapsed time):

$$V = r_sKL + 2r_sK\,(S - \tfrac{1}{2}L) \quad (1)$$
$$= r_sKL + 2r_sKS - r_sKL$$
$$= 2r_sKS$$

This shows the direct relationship between the unijunction triggering voltage and the distance along the conveyor from the photocell **54** to the folder, whatever the length (L) of the laundry piece.

In the foregoing equation (1), the first term, r_sKL, represents the voltage build-up on the capacitor **100** which takes place while the laundry piece is moving past the photocell **54** and the capacitor is being charged through resistor **102** only. The second term, $2r_s$K (S—½L), represents the further voltage build-up on the capacitor which takes place (at the faster charging rate, $2r_s$) between the time when the trailing edge of the laundry piece moves past the photocell **54** and the time when the longitudinal midpoint of the laundry piece reaches the location of the folding operation.

The broad principle of operating the timing circuit for a laundry folder in two stages, the first being the interval while the laundry piece is moving past a photocell or other sensor, and the second being the interval which immediately follows until the middle of this laundry piece reaches the following folder, may be understood from the disclosure in U.S. Pat. No. 2,374,779 to Preston.

FIGS. **7–19** illustrate another embodiment of the invention. Referring first to FIGS. **7** and **8,** there is shown a folding apparatus **200** which includes a motor driven conveyor in the form of belts **202** looped around shafts **204** and **206.** Conveyor belts **202** are on the upper level of the apparatus **200,** and they transport a laundry article along a generally horizontal path from shaft **204** to shaft **206.** FIG. **11** shows that shaft **206** may be driven by a motor **208** utilizing a drive chain **210** and sprockets **212, 214, 216** and **218.** Other shafts **220, 222** and **224** may be utilized in connection with the upper conveyor flight formed by belts **202.**

Referring to FIGS. **10** and **12,** it may be seen that there is a second conveyor flight **226** below the upper conveyor flight **202.** The conveyor flight **226** is similarly formed by belts looped about shafts **228** and **230.** The second conveyor flight **226** may be operated by a motor **232** (FIG. **11**) connected by a chain **234** to the shaft **230** utilizing sprockets **236** and **238.**

Above the upper conveyor flight **202,** there is a first folding device **240,** which in this embodiment is a pick up and drop type of folding device. Referring to FIG. **9,** it may be seen that the folding device **240** includes a blade **242** which is pivoted at **244** and is connected to an arm **246** that is driven by a piston **248** in a cylinder **250.** Pressure is supplied to the cylinder **250** through a valve **252** which controls the supply of fluid through a line **254** and the return of fluid through another line **256.** The valve **252** is actuated in response to switching means which in this embodiment consists of two photocells **258** and **260.** Photocells **258** and **260** have light sources **262** and **264** which shine light on mirrors **266** and **268.** The light is reflected back to sensors **270** and **272** inside the photocells **258** and **260.** When the light is shining on the mirrors and being reflected back to the sensors **270** and **272,** the electrical resistance of the sensors is relatively low, and when the light is interrupted so that it does not reach the sensors **270** and **272,** the resistance of the sensors increases. This change in resistance of the sensors is utilized to control the valve **252** so as to operate the blade **242.** When light is reaching the sensors and their resistance is low, the blade **242** is down in the position shown in FIG. **9.** When the light is interrupted so that it does not reach the sensors **270** and **272,** the sensors actuate the valve **252** which in turn supplies fluid to the cylinder **250** to push the piston **248** to the left and thus raise the blade **252** until it contacts a stop **274.** As the blade rises, it clamps the leading edge of a laundry article against the stop **274.** When the trailing edge of the article passes the photocell **260,** the resistance of sensor **272** changes again to the low value, and this causes valve **252** to reverse and allow fluid to exit from chamber **250** so that the blade **242** drops back to the position shown in FIG. **9.** This deposits the leading edge of the laundry article on the trailing edge thereof, thus folding the article in half.

The folding of a laundry article in this manner may be seen in successive stages shown in FIGS. **10, 12** and **13.** In FIG. **10,** a laundry article **276** has travelled along the upper conveyor flight **202** until the leading edge **278** of the article has ridden up on blade **242** and interrupted the light of both photocells **258** and **260.** The blade **242** then rises to clamp the leading edge **278** against the stop **274** in the manner shown in FIG. **12,** thus retaining the leading edge while the rest of the article travels along the upper conveyor flight **202.** In FIG. **13,** the article has travelled until it is almost folded in half, and the trailing edge **280** is about to pass under the photocell **260.** When this happens, the blade **242** drops down and deposits the leading edge **278** on the trailing edge **280** so that the article is folded in half and continues to travel along the upper conveyor flight **202** as shown in FIG. **14.**

In FIG. **14,** the laundry article **276** has reached a position where its quarter point **282** has reached a fold point between two rolls or shafts **206** and **230** of a second folding device which is a roll type of folder. This second folding device includes an operator means in the form of pneumatic tube **284** for forcing the quarter point **282** between the rolls **206** and **230** in the manner shown in FIG. **15.** To accomplish this, the tube **284** delivers a blast of air against the quarter point **282** exactly when that quarter point reaches the fold point between rolls **206** and **230.** It will be understood that in some applications it may be possible to employ an operator means in some other form such as a blade in order to

force the laundry article between the rolls **206** and **230.**

The timing of the actuation of the pneumatic operator means **284** is accomplished by the circuits of FIGS. **18** and **19** in conjunction with the circuit of FIG. **3** described previously. These circuits will be described in detail later herein, but at present, the description of the overall machine will be completed.

Referring to FIG. **16,** it may be seen that the laundry article **276,** after passing between the rolls **206** and **230,** is folded in quarters and travels along the second conveyor flight **226** toward the right as viewed in the drawings. The article **276** reaches a center position with respect to a second pneumatic operator means **286** which is located above the second conveyor flight **226.** The pneumatic operator means or tube **286** is shown in cross section in FIG. **17.** When the article reaches this center position, the pneumatic tube **286** is actuated to deliver a blast of air which forces the article between two rolls **288** and **290** which are located just under the upper run of the conveyor **226.** Thus, these rolls **288** and **290** make a cross fold in the article. From rolls **288** and **290,** the article travels down a curving ramp **289** which may deliver the article to still another conveyor (not shown). Additional pick up and drop folding devices may be provided along this latter conveyor if additional cross folds are desired. These additional folding devices are not shown since they do not form a part of the present invention. Also, it will be understood that the pneumatic operator means **286** is operated by a sensing means such as a photocell which is interrupted when the article reaches the center position shown in FIG. **16.** This latter photocell is not shown.

Referring now to FIGS. **18** and **19** considered together with FIG. **3,** it is to be understood that FIG. **18** is almost identical to FIG. **2,** and therefore the same reference numerals have been used for like parts. One difference is that several power supply connections have been replaced by **24** volt terminals such as **292, 294, 296** and **298** as shown in FIG. **18.** Also, the two photocell devices **258** and **260** including the sensore **270** and **272** are shown in FIG. **18.** Except for these differences, the circuit of FIG. **18** operates exactly like that described in connection with FIG. **2,** so the description will not be repeated.

FIG. **19** also shows the two photocell devices **258** and **260** with their sensors **270** and **272.** These photocell devices are the switching means of the first folding device **240,** but they also actuate the timer means which consists of the circuits of FIGS. **3, 18** and **19.** FIG. **19** actually shows the amplifier circuit which is block **70** in FIG. **18.** The input of the amplifier is a transformer **300** having a primary winding **302** and a secondary winding **304.** A voltage of about **230** volts may be developed across the secondary winding **304,** and a portion of this voltage is supplied to lines **306** and **308.**

The circuit of FIG. **19** includes two amplifying transistors **310** and **312,** the output of transistor **312** is connected to a relay which includes a coil **314.** The relay **314** also includes a contact **316** which is connected to the photocells **258** and **260,** contacts **318, 320** and **322** which control the valve **252** of FIG. **9,** and also contacts **140, 142** and **144** which are shown in FIG. **18** as being connected to the control means **72** of that circuit.

A voltage divider including resistances **324** and **326** is connected between line **306** and the collector of transistor **310.** A zener diode **330** is connected between the junction **328** of resistors **324** and **326** and the line **308** for regulating the voltage between those points. The emitters of transistors **310** and **312** are both connected through a diode **332** to the line **308.** Resistors **334** and **336** together form a bias network for the base of transistor **310,** and resistors **338** and **340** form a bias network for the transistor **312.** The sensors **270** and **272** of photocells **258** and **260** are connected in parallel with each other between junction **328** and the resistor **334** for biasing the base of transistor **310.** A capacitor **342** is connected between lines **306** and **308** for filtering, and diodes **344** and **346** are connected to secondary winding **304** to provide rectification of the voltage on that winding.

In operation, while light is reaching both of the sensors **270** and **272,** their effective resistance is low, and the amplifiers **310** and **312** do not pull in the relay **314.** When the light of both of the photocells **258** and **260** is blocked, the resistances of sensors **270** and **272** increase and this puts more bias resistance between the collector and base of transistor **310,** thus causing the base of transistor **310** to go more positive. Photocell **260,** when blocked alone, does not actuate relay **214** because the lower resistance of photocell **258** shunts it. Transistor **310** then conducts less current, and since the current through diode **332** is shared between transistors **310** and **312,** transistor **312** conducts more strongly, thus pulling in relay **314.** Contact **316** then opens to disconnect the trailing photocell **258.** At this time the impedance of the leading photocell is such that the bias resistance between the collector and base of transistor **310** is high enough to keep relay **314** energized. Contacts **318, 320** and **322** are operated to actuate the valve **252** as previously explained. Contacts **142** and **144** are opened, and contacts **140** and **142** are closed to start the measuring cycle which has been explained in connection with FIG. **3.** The capacitor **100** of FIG. **3** charges at a slow rate during the measuring cycle.

Ultimately the trailing edge of the laundry article passes over the leading photocell device **260,** and this then lowers the resistance in the bias circuit for the base of transistor **310.** Transistor **310** then conducts more, and transistor **312** conducts less so as to drop out the relay **314.** The contacts **316, 318, 320** and **322** and **141** then return to their original conditions. This ends the measuring cycle of the timing circuit of FIG. **18** and FIG. **3.** The capacitor **100** of FIG. **3** then charges at a rate four times as great as its initial charging rate and causes the pneumatic operator means **284** to be actuated so as to force the laundry article **276** between the rolls **206** and **230** when the quarter point **282** reaches the fold point opposite tube **284** as previously explained.

It is to be understood that the capacitor **100** of FIG. **3** must charge at a first slow rate while the laundry article traverses photocell devices **258** and **260** and then charge at quadruple this rate while the laundry article travels along conveyor **202** until the quarter point **282** of the laundry article reaches the fold point opposite pneumatic operator means **284.** The conveyor should travel at a constant speed.

It may also be noted that the unijunction transistor **112** in FIG. **3** is a discharge device, and it may be replaced by other types of discharge devices. For example, it has been found that a voltage comparator in the form of an integrated circuit can be used in place of the unijunction transistor **112,** and the voltage comparator allows easy adjustment of the firing threshold of the dis-

charge device. This adjustment is made while observing the folding operation until the quarter fold is made at the correct point.

From the foregoing description, it may be seen that the combination of a roll type folding device with a pick up and drop folding device along the upper flight of the apparatus reduces the width of the apparatus, thus making it possible to install the apparatus in cramped quarters such as are sometimes found in hotels and other establishments having limited laundry space. The laundry articles are fed by hand into the apparatus, and the articles can be folded as fast as they can be fed. The timer for controlling the actuation of the second folding device works off the switching means and blade for the first folding device, so no additional switches or sensors are required. The variable charge rate timer is well suited to the timing functions of the apparatus, and provides reliable actuation of the second folding device.

Having thus described our invention, we claim:

1. A folding apparatus for folding laundry articles and comprising:

means for transporting a laundry article along a predetermined path,

a pick up and drop folder positioned along said path, for folding the article, said folder having a blade for lifting and retaining the leading edge of the article and thereafter dropping said leading edge on the trailing edge of the article as it moves past, and means to raise said blade for lifting and retaining the leading edge of the article and to lower said blade for dropping and releasing the leading edge of the article,

a roll folder positioned along said path beyond said pick up and drop folder for folding the article again,

timer means controlling the operation of said roll folder, and

sensor means at said pick up and drop folder for sensing successively the movement of the leading and trailing edges of the article past it, said sensor means being operably coupled to both said pick up and drop folder and said timing means for the roll folder:

a. to cause said blade in the pick up and drop folder to be raised in response to the movement of the leading edge of the article past said sensor means;

b. to cause said blade to be lowered in response to the movement of the trailing edge of the article past said sensor means; and

c. in response to the movement of the leading and trailing edges of the article in succession past said sensor means, to actuate said timer means to cause said roll folder to fold the article as it moves past;

said sensor means comprising a leading sensor positioned to sense the leading edge of the article before it reaches said blade, and a trailing sensor positioned to sense the leading edge of the article after it reaches said blade, and further comprising relay means responsive to both the leading sensor and the trailing sensor to cause the blade in the pick up and drop folder to be raised when both sensors have sensed the leading edge of the article.

said relay means including contacts for automatically disconnecting the same from said trailing sensor after the latter senses the leading edge of the article and for atuomatically reconnecting the same to said trailing sensor after the leading sensor senses the trailing edge of the article, said relay means having further contacts;

said timer means including capacitance means adapted to be electrically charged and discharged, and control circuit means actuated by said further contacts of said relay means for charging said capacitance means at a slow rate beginning with the movement of the leading edge of the article past the trailing sensor and at a quadrupled rate beginning with the movement of the trailing edge of the article past the leading sensor so as to time the operation of said roll folder for folding the once-folded article again at the middle.

2. Apparatus according to claim **1** in which said relay means includes a relay, and amplifier means connected between said relay and said sensors for controlling said relay.

3. Apparatus according to claim **2** in which said amplifier means includes a pair of emitter coupled transistors having a bias network including said sensors.

4. Apparatus according to claim **3** in which said sensors are coupled in parallel with each other in said bias network, and said contacts are operable to disconnect and reconnect said trailing sensor from said bias network.

5. A folding apparatus for folding laundry articles comprising:

means for transporting a laundry article along a predetermined path,

a pick up and drop folder positioned along said path for folding the article, said folder having a blade for lifting and retaining the leading edge of the article and thereafter dropping said leading edge on the trailing edge of the article as it moves past, and means to raise said blade for lifting and retaining the leading edge of the article and to lower said blade for dropping and releasing the leading edge of the article,

a roll folder positioned along said path beyond said pick up and drop folder for folding the article again,

timer means controlling the operation of said roll folder, and

sensor means at said pick up and drop folder for sensing successively the movement of the leading and trailing edges of the article past it, said sensor means being operably coupled to both said pick up and drop folder and said timing means for the roll folder:

a. to cause said blade in the pick up and drop folder to be raised in response to the movement of the leading edge of the article past said sensor means;

b. to cause said blade to be lowered in response to the movement of the trailing edge of the article past said sensor means; and

c. in response to the movement of the leading and trailing edges of the article in succession past said sensor means, to actuate said timer means to cause said roll folder to fold the article as it moves past;

said sensor means comprising a leading sensor positioned to sense the leading edge of the article before it reaches said blade, and a trailing sensor positioned to sense the leading edge of the article after it reaches said blade;

and means responsive to both the leading sensor and the trailing sensor to cause the blade in the pick up and drop folder to be raised when both sensors have sensed the leading edge of the article, said last mentioned means being automatically disconnected from said trailing sensor after the latter senses the leading edge of the article,

said timer means including capacitance means adapted to be electrically charged and discharged, and means for changing the charge on said capacitance means at a slow rate beginning with the movement of the leading edge of the article past the trailing sensor and at a quadrupled rate beginning with the movement of the trailing edge of the article past the leading sensor so as to time the operation of said roll folder for folding the once-folded article again at the middle.

6. A folding apparatus for folding laundry articles comprising:

means for transporting a laundry article along a predetermined path,

a pick up and drop folder positioned along said path for folding the article, said folder having a blade for lifting and retaining the leading edge of the article and thereafter dropping said leading edge on the trailing edge of the article as it moves past, and means to raise said blade for lifting and retaining the leading edge of the article and to lower said blade for dropping and releasing the leading edge of the article,

a roll folder positioned along said path beyond said pick up and drop folder for folding the article again,

timer means controlling the operation of said roll folder, and

sensor means at said pick up and drop folder for sensing successively the movement of the leading and trailing edges of the article past it, said sensor means being operably coupled to both said pick up and drop folder and said timing means for the roll folder:

a. to cause said blade in the pick up and drop folder to be raised in response to the movement of the leading edge of the article past said sensor means;

b. to cause said blade to be lowered in response to the movement of the trailing edge of the article past said sensor means; and

c. in response to the movement of the leading and trailing edges of the article in succession past said sensor means, to actuate said timer means to cause said roll folder to fold the article as it moves past;

said sensor means comprising a leading sensor positioned to sense the leading edge of the article before it reaches said blade, and a trailing sensor positioned to sense the leading edge of the article after it reaches said blade, and means responsive to both the leading sensor and the trailing sensor to cause the blade in the pick up and drop folder to be raised when both sensors have sensed the leading edge of the article, said last-mentioned means being automatically disconnected from said trailing sensor after the latter senses the leading edge of the article,

said timer means including capacitance means adapted to be electrically charged and discharged, and means for changing the charge on said capacitance means at a slow rate beginning with the movement of the leading edge of the article past the trailing sensor and, beginning with the movement of the trailing edge of the article past the leading sensor, at a rate equal to said slow rate multiplied by a selected number effective to time the operation of said roll folder for folding the once-folded article again at the middle.

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