

April 3, 1956

S. WOODWARD ET AL

2,740,627

MACHINES FOR FOLDING SHEETS AND LIKE ARTICLES

Filed Sept. 5, 1951

5 Sheets-Sheet 1

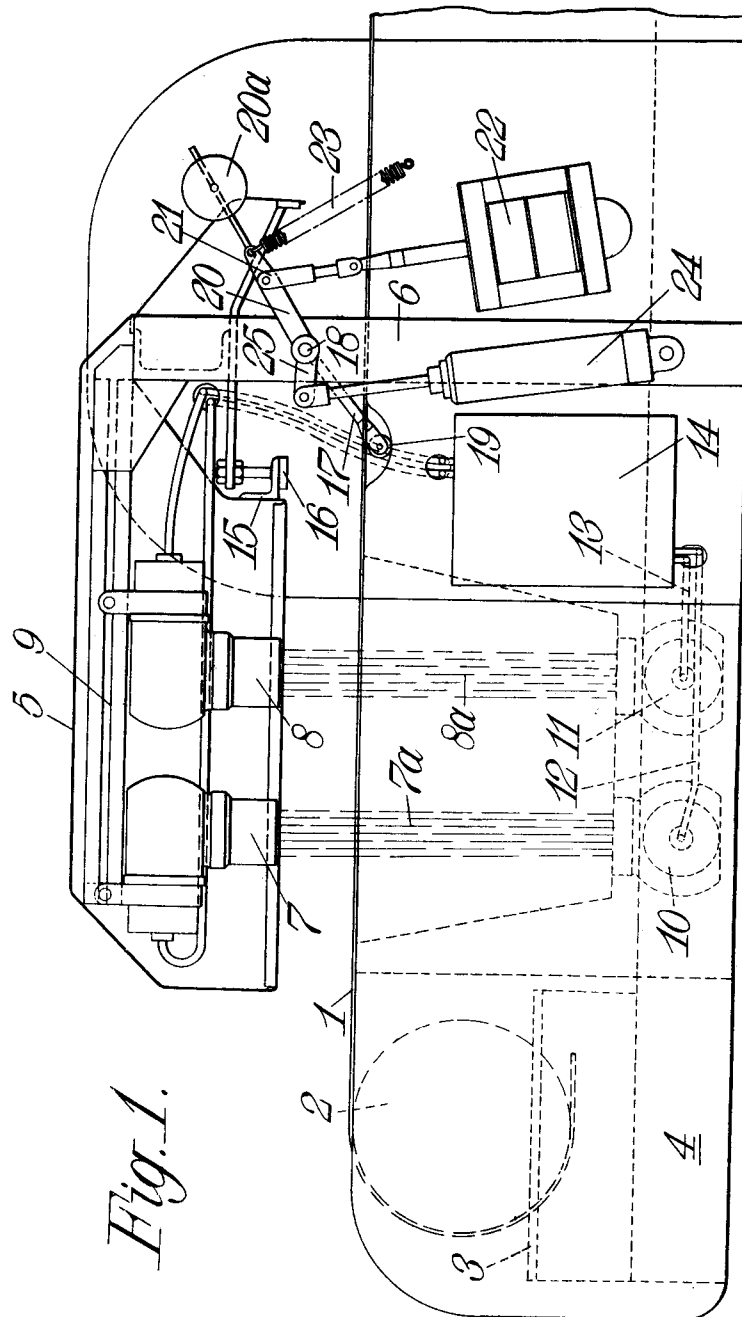


Fig. 1.

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5 Sheets-Sheet 2

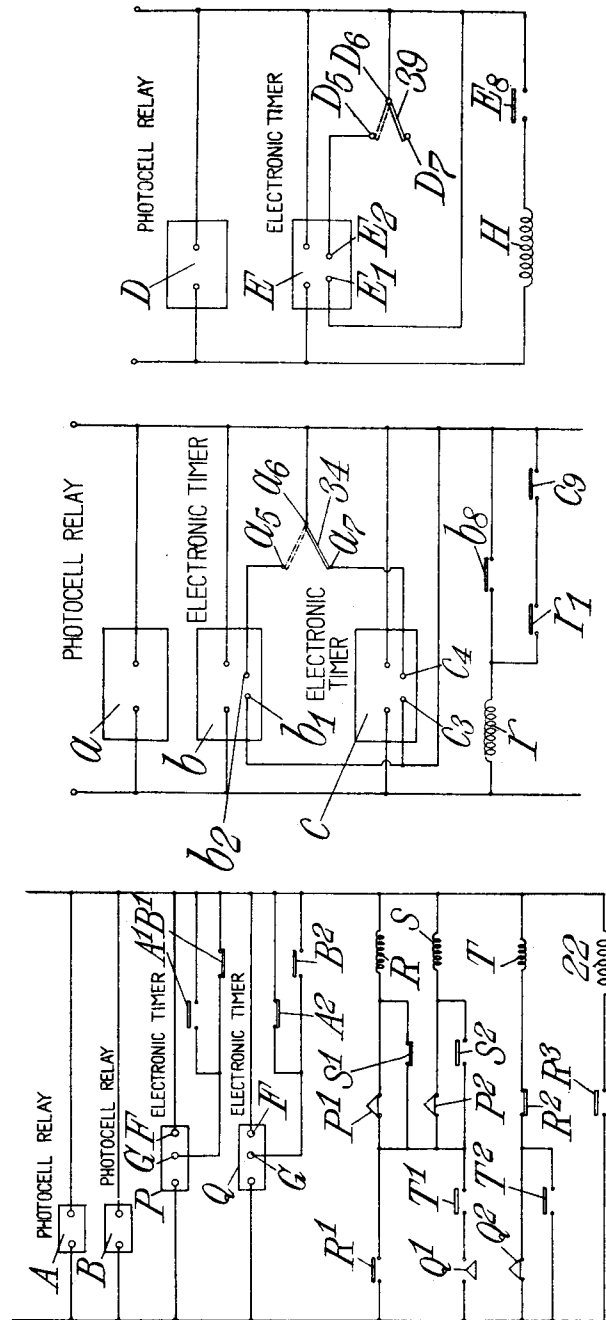


Fig. 6.

Fig. 4

Fig. 2.

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5 Sheets-Sheet 3

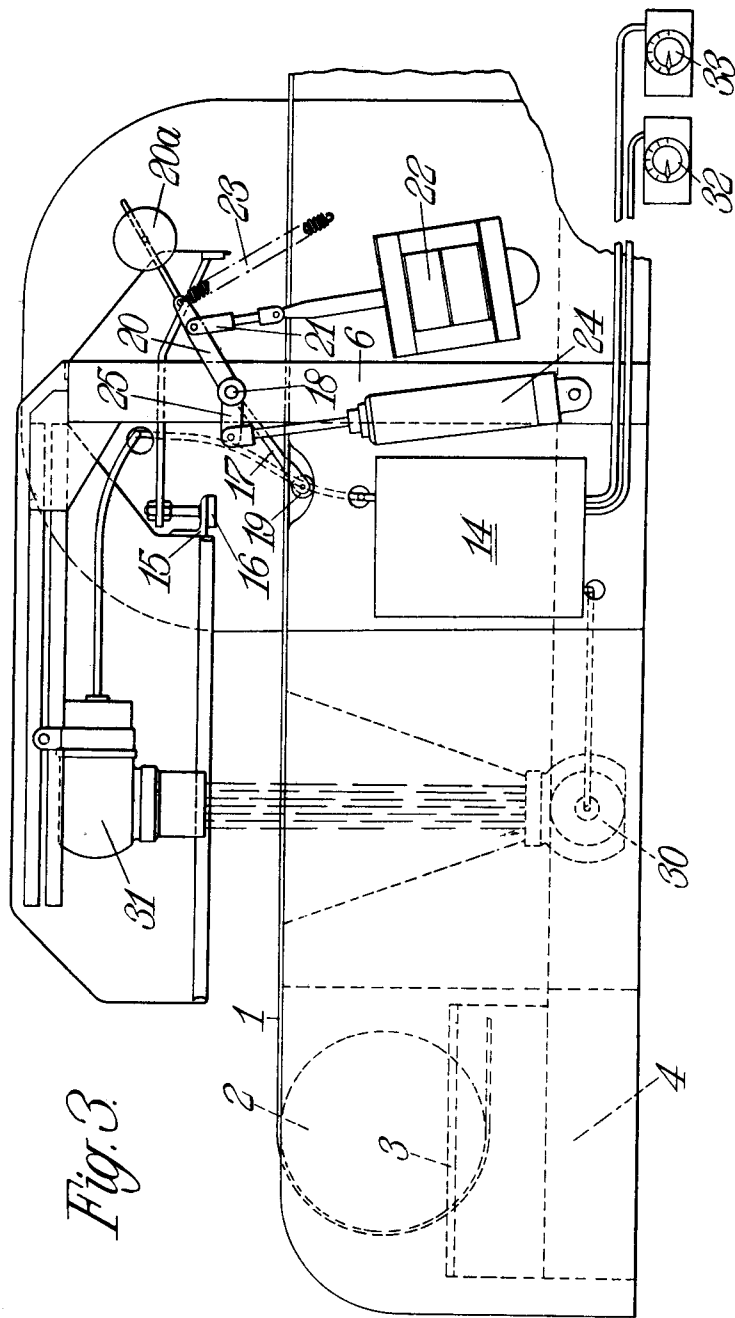


Fig. 3.

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5 Sheets-Sheet 4

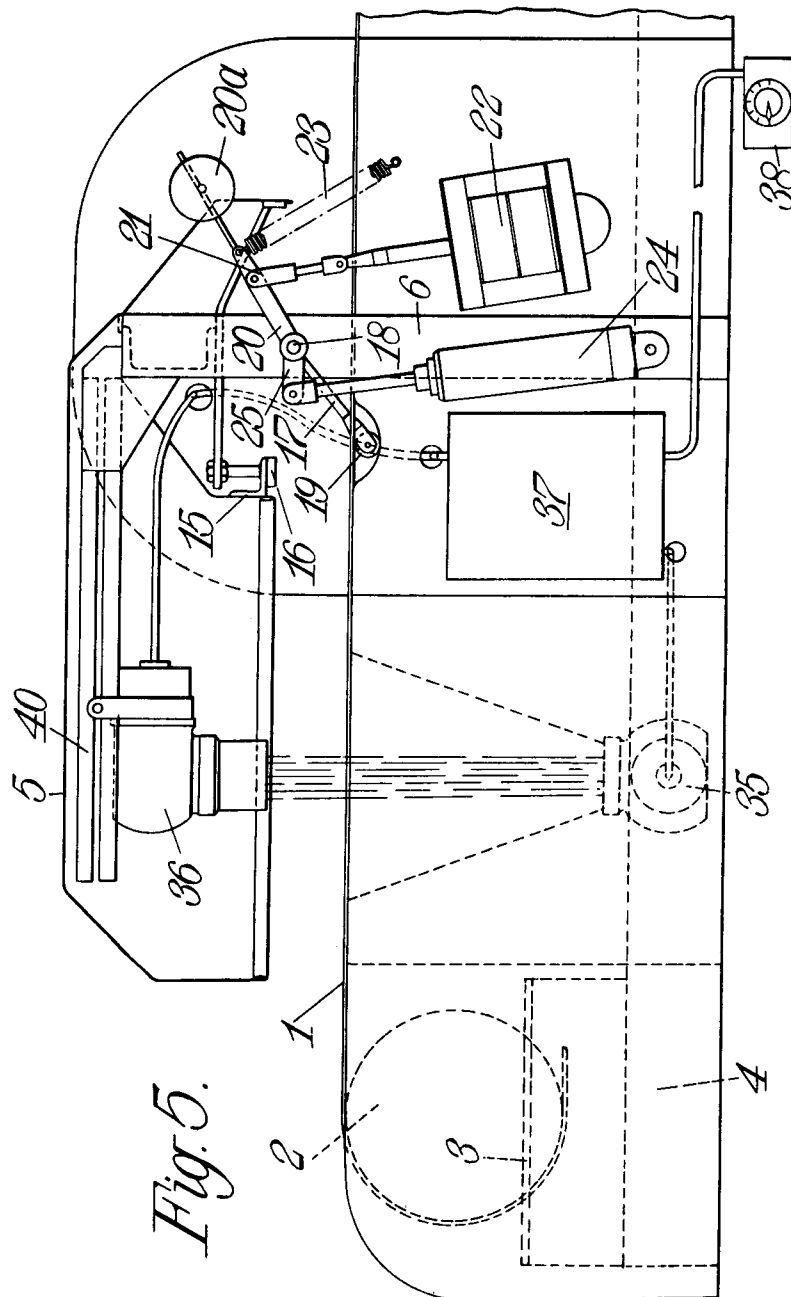


Fig. 5.

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5 Sheets-Sheet 5

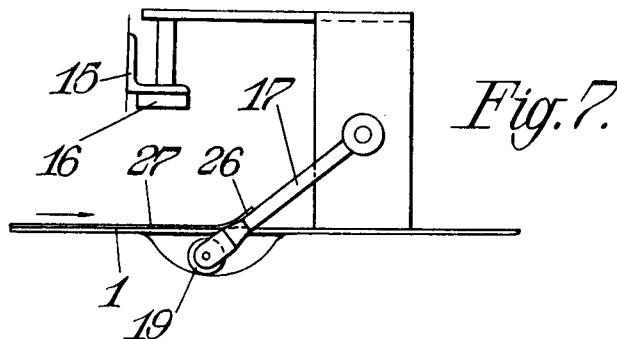


Fig. 7.

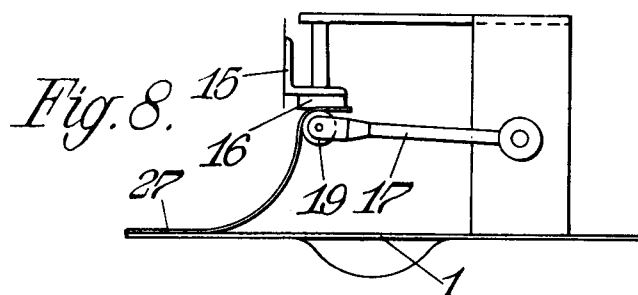


Fig. 8.

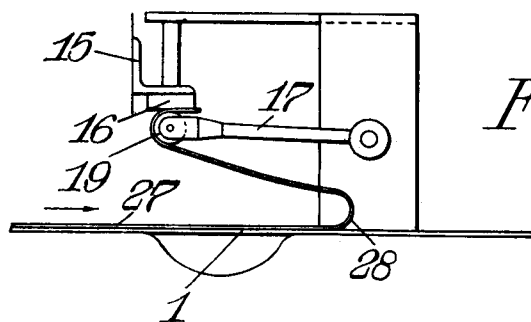


Fig. 9.

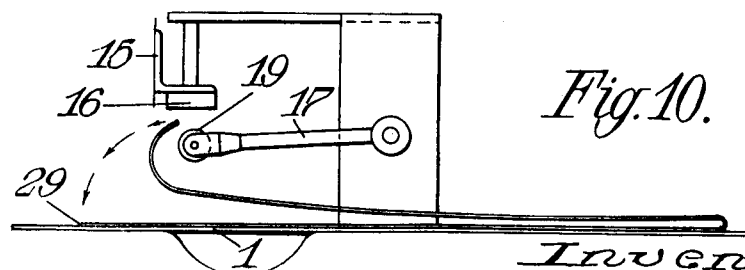


Fig. 10.

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2,740,627

## MACHINES FOR FOLDING SHEETS AND LIKE ARTICLES

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Application September 5, 1951, Serial No. 245,208

Claims priority, application Great Britain  
September 6, 1950

3 Claims. (Cl. 270—68)

This invention relates to machines for folding sheets or the like articles as they are delivered from a laundry ironing machine. More particularly the invention is concerned with sheet folding machines of the kind in which gripping means are controlled by means actuated by photo-electric means in which the leading and trailing edges of the sheet break and make the light rays. For example, in British patent specification No. 618,157 the leading edge of a sheet is gripped by means of fingers operated by solenoids under the control of photo-electric cell means having spaced light sources, the rays from which are adapted to be broken in turn by the sheet so that the gripping means does not act on the leading edge until the second ray is broken whereas the release of the gripping means occurs when the trailing edge of the sheet uncovers the light sensitive means to the first ray.

An object of the invention is to provide control means wherein there is a variable delay in the operation of sheet gripping means depending upon the speed of approach of an article to be folded.

The gripping means may be actuated or controlled by a solenoid and preferably the variation in the delay in the operation of the solenoid is automatic by the use of electronic timer means which are preset in accordance with the speed of the ironer. The electronic timer means are of known character, such as, for example, the device described in U. S. patent specification No. 2,171,347.

The sheet gripping means may be of the character disclosed in the specification referred to, but may be of other forms such as co-operating jaw or like means.

Further, while solenoid means are preferred for actuating the gripping means the latter may be actuated through fluid or air operated means controlled by suitable valve means adapted to be actuated by an electrical relay device.

In the accompanying drawings:

Figure 1 is an elevation of a sheet folder arranged for fully automatic control.

Figure 2 is a block diagram of the electric control units of Figure 1.

Figure 3 is an elevation of a sheet folder arranged for manual control and incorporating two timer devices.

Figure 4 is a block diagram of the electric control units of Figure 3.

Figure 5 is an elevation of a sheet folder arranged for manual control and incorporating one timer device.

Figure 6 is a block diagram of the electric control units of Figure 5.

Figures 7 to 10 are diagrammatic views showing various stages in the sheet folding operation.

In carrying the invention into effect according to the preferred arrangement of automatic control, the gripping means are actuated by a counterweight and are held out of operation by the energizing of the solenoid.

Referring to Figure 1, 1 is the conveyor of the folding machine comprising a series of spaced endless bands or tapes which are supported by terminal drums of which only one is shown at 2. The tapes are driven by any

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suitable known means. The terminal drums are supported in suitable bearings 3 carried by the framing 4 of the machine.

At the entry of the machine a casing 5 is mounted above the conveyor tapes 1 in spaced relation by brackets 6 located at the sides of the framing. The casing 5 supports a pair of lamps 7 and 8 by means of guide members 9 so that the lamps may be adjusted in the direction of the conveyor travel.

The lamps 7 and 8 are so positioned that the rays 7a and 8a therefrom which are projected downwardly through the space between a pair of adjacent tapes 1 will be cut by the passage of a sheet to be folded by the machine.

The light rays 7a and 8a project on to the spaced photo-electric cells 10 and 11 respectively which are connected by leads 12 and 13 to photo-cell relays in the control panel or cabinet 14 secured on the side of the framing 4.

Supported upon the casing 5 and extending across the machine is an angle iron 15 which carries a rubber strip or pad 16. Co-operating with this pad is a transverse series of gripping fingers 17 which are pivotally mounted on a transverse spindle 18 carried by the brackets 6. The fingers 17 carry fibre rollers 19 adapted to move into gripping relationship with the pad. The fingers normally lie with the rollers 19 beneath the level of the conveyor tapes 1.

Secured to the spindle adjacent one end thereof is an arm 20 to which a link 21 is pivotally connected, said link being coupled to the core of a solenoid 22 mounted in the framing 4. The arm 20 is connected to a spring 23 which imparts a bias urging the fingers to move to their gripping position. Normally the fingers are held down by the solenoid 22 being energized.

The arm 20 is provided with a weight 20a to balance the fingers 17.

A dash pot 24 is connected by an arm 25 to the spindle to control the opening movement of the fingers 17.

The photo-electric cells 10 and 11 are spaced according to the maximum speed of the article to be folded, i. e. the speed of the ironer machine. The conveyor 1 of the folding machine is run at a speed somewhat higher than said maximum speed.

Referring to Figure 2, the photo-cell relay A is located in a circuit including an electronic timer Q of known character, such as disclosed in U. S. Patent No. 2,171,347 and which provides the delay in stopping i. e. releasing the gripping means. The photo-cell relay B is located in a parallel circuit including a similar electronic timer P which provides the delay in starting i. e. in moving the gripper to gripping position.

In the automatic form of the invention a pair of photo-electric cells is provided, one cell controlling a circuit having an electronic timer as aforesaid to delay the gripper operation, the second cell controlling a parallel circuit having a similar electronic timer for delay in releasing the gripping operation.

The said electronic timers P and Q control the contact members P<sub>1</sub> and P<sub>2</sub>, and Q<sub>1</sub> and Q<sub>2</sub> respectively.

In the diagram, FG represents a switch and when it is closed and the circuit is completed the condenser in the associated timer is charged and when circuit FG is broken then the timing period commences and the time delay is dependent on the charge in condenser.

The photo-electric cell relays control the contacts A<sub>1</sub>, A<sub>2</sub> and B<sub>1</sub>, B<sub>2</sub> in the timer circuits.

Contacts P<sub>1</sub>, P<sub>2</sub>, Q<sub>2</sub> have a time delay on opening but a quick closing movement.

Contact Q<sub>1</sub> has a time delay on closing but opens rapidly.

When the current is switched on there will be some delay in the electronic timers P and Q warming up so

that in the meantime relay T will be energized closing contacts T<sub>1</sub>, T<sub>2</sub>.

When the valves in timers P, Q and photo-cells A and B have reached their normal state the photo-cells A and B will operate causing contacts A<sub>1</sub>, B<sub>2</sub> to close and A<sub>2</sub>, B<sub>1</sub> to open. The circuits through FG in the timers P and Q being complete and pass current, contacts P<sub>1</sub>, P<sub>2</sub> and Q<sub>2</sub> will open and contact Q<sub>1</sub> close.

When contact Q<sub>1</sub> closes current will still flow through T<sub>2</sub> to energize relay T.

Current will also flow through Q<sub>1</sub>, T<sub>1</sub> and S<sub>1</sub> to energize relay R thereby closing contacts R<sub>1</sub>, R<sub>3</sub> and opening contact R<sub>2</sub>.

The opening of contact R<sub>2</sub> (Q<sub>2</sub> being open) de-energizes relay T and contacts T<sub>1</sub>, T<sub>2</sub> open. The supply to relay R is, however, maintained through contacts R<sub>1</sub>, S<sub>1</sub> so that contact R<sub>3</sub> remains closed and the gripper solenoid 22 is energized to hold the grippers 17 open.

The position of the contacts with the current on and the light rays to the cells A and B unbroken is thus:

Open	Closed
A <sub>2</sub>	A <sub>1</sub>
B <sub>1</sub>	B <sub>2</sub>
P <sub>1</sub>	R <sub>1</sub>
P <sub>2</sub>	R <sub>3</sub>
T <sub>1</sub>	Q <sub>1</sub>
T <sub>2</sub>	S <sub>1</sub>
Q <sub>2</sub>	
R <sub>2</sub>	
S <sub>2</sub>	

When the leading edge of a sheet to be folded cuts off the light from cell 10 contact A<sub>1</sub> opens and A<sub>2</sub> closes. Since contact B<sub>1</sub> is also open the circuit through FG in timer P is broken and the contacts P<sub>1</sub>, P<sub>2</sub> close. The condenser in electronic timer P will now begin charging.

The circuit to electronic timer Q will, however, be unaffected as contacts A<sub>2</sub> and B<sub>2</sub> are closed.

Relay R being energized, and contact R<sub>1</sub> closed the closing of contact P<sub>2</sub> energizes relay S opening contact S<sub>1</sub> and closing contact S<sub>2</sub>.

When the leading edge of the sheet cuts off the light from cell 11, contact B<sub>1</sub> closes and contact B<sub>2</sub> opens. The circuit through FG in timer P is now restored through contact B<sub>1</sub> and charging of its condenser ceases.

After the time delay caused by the discharging of the condenser in timer P and the circuit to timer P being complete, contacts P<sub>1</sub>, P<sub>2</sub> will be opened. Contact S<sub>1</sub> being already open, the opening of contact P<sub>1</sub>, de-energizes relay R. Contacts R<sub>1</sub> and R<sub>3</sub> will open, the latter contact causing the solenoid 22 to be de-energized so that the grippers 17 will function to hold the leading edge of the sheet. During this course of operation the circuit to the electronic timer Q has never been interrupted so that contact Q<sub>1</sub> remains closed and contact Q<sub>2</sub> open.

Thus, with the sheet obscuring the light to both cells 10 and 11, after the delayed time in discharging the condenser in timer P the timers P and Q are both energized, and relays R, S, T and solenoid 22 de-energized.

As the trailing edge of the sheet restores the light ray to photo-cell 10 contact A<sub>1</sub> closes and contact A<sub>2</sub> opens. Contact B<sub>2</sub> being already open, the circuit FG in timer Q is broken so that the condenser in Q begins to charge and contact Q<sub>1</sub> opens and contact Q<sub>2</sub> closes.

The closing of contact Q<sub>2</sub> causes the energization of relay T (as contact R<sub>2</sub> is already closed) closing contacts T<sub>1</sub>, T<sub>2</sub>.

When the trailing edge of the sheet restores the light to cell 11 contact B<sub>1</sub> opens and contact B<sub>2</sub> closes, thus restoring the circuit through FG in timer Q. When the condenser in Q has leaked away contact Q<sub>1</sub> closes and contact Q<sub>2</sub> opens so that current can flow via Q<sub>1</sub>, T<sub>1</sub> and S<sub>1</sub> to energize relay R closing contacts R<sub>1</sub> and R<sub>3</sub> whereby the solenoid 22 is energized and the gripper releases the sheet.

It will be appreciated that when contact Q<sub>2</sub> is broken relay T is still energized through T<sub>2</sub>.

There will thus be a delay in the raising of the gripper fingers 17 to grip the edge of the sheet, by the operation of electronic timer P and a delay in releasing the sheet, by the operation of electronic timer Q and such delay will be automatic corresponding to the time in charging the respective condensers which will vary according to the time the edges of the sheet take in interrupting successively the light rays to the cells 10 and 11, i. e. according to the speed of travel of the sheet as determined by the ironer machine.

After the sheet has passed the initial folding device and has attained the speed of travel of the folder conveyor 1 additional automatic correction means will not be required in subsequent folding zones.

The sheet gripping means 17 are of the form disclosed in the specification referred to, i. e. the energization of the solenoid 22 is effective to open the grippers. It will be appreciated, however, that the device according to the invention may operate so that the energization of the solenoid 22 closes the gripper fingers 17.

The phases in the operation of the gripper fingers 17 is illustrated in Figures 7 to 10.

In Figure 7 the leading edge 26 of the sheet 27 is obstructed by the fingers 17 and partly climbs the fingers.

Figure 8 shows the position when the solenoid 22 is de-energized and the fingers 17 have lifted so that the leading margin of the sheet is gripped between the rollers 19 and the pad 16.

Figure 9 shows the leading edge of the sheet raised and held so that the remainder of the sheet continues to move forwardly so that the fold 28 is formed.

Figure 10 shows the final phase when the trailing edge 29 of the sheet has caused the operation of the control means to cause re-energization of the solenoid 22 and return movement of the gripper fingers to release the leading edge of the sheet which falls and lines up with the trailing edge. The downward movement of the fingers 17 is controlled by the dash pot 24 to prevent trapping of the sheet.

In the embodiment of the invention as illustrated, by way of example, in Figure 3 and the block diagram, Figure 4, a single photo-electric cell 30 is provided with a single lamp 31, a change-over switch being controlled by the cell relay, such switch controlling parallel circuits to a pair of electronic timers of known character, for example as disclosed in U. S. Patent No. 2,171,347 which are controlled manually by a pair of potentiometers 32, 33 in the circuits thereof to provide the variation in charging time in accordance with the speed of the ironer machine.

The gripper fingers 17 are arranged and actuated as in the previous modification and the reference conforming thereto.

The photo-cell relay *a* (see Figure 4) controls the operation of a circuit changer or switch 34 to the said pair of electronic timers *b*, *c* in parallel circuits, one, *b*, controlled by the leading edge of a sheet for delaying actuating the gripper 17, and the other, *c*, controlled by the trailing edge of a sheet for delay in opening the gripper.

When the switch 34 is in position to connect *a*<sub>5</sub> and *a*<sub>6</sub>, the contacts *b*<sub>1</sub> and *b*<sub>2</sub> are bridged and cause the charging of the timing condenser of electronic timer *b*. Similarly the bridging of contacts *a*<sub>6</sub> and *a*<sub>7</sub> causes the bridging of contacts *c*<sub>3</sub> and *c*<sub>4</sub> of timer *c* and starts the charging of the timing condenser of said timer.

The bridging of contacts *b*<sub>1</sub> and *b*<sub>2</sub> causes *b*<sub>3</sub> to close after the delay period of charging the condenser of timer *b*, while the opening of the contacts *b*<sub>1</sub> and *b*<sub>2</sub> causes a quick opening of *b*<sub>3</sub>.

Also the openings of contacts *c*<sub>3</sub> and *c*<sub>4</sub> of timer *c* will cause the quick closing of *c*<sub>5</sub>, while closing of contacts *c*<sub>3</sub> and *c*<sub>4</sub> causes *c*<sub>5</sub> to open after the time delay of timer *c*.

The relay *r* which is the circuit of contact *b*<sub>3</sub> controls a contact in a circuit including the gripper solenoid 22.

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The circuit as shown in Figure 4 corresponds to the current being on and no work passing through the machine.

When the leading edge of the sheet cuts the light ray the switch 34 is operated to close contacts  $a_5$ ,  $a_6$  and open contacts  $a_8$  and  $a_7$  so that the electronic timer starts "charging" and after the delay period which is controlled by the setting of the potentiometer 32, the timer causes the contact  $b_8$  to close so that relay  $r$  is energized. The switch in the circuit of solenoid 22 is thereby opened, de-energizing the solenoid and allowing the fingers 17 to move to their gripping position by the spring 23.

The energizing of relay  $r$  also causes contact  $r_1$  to close so that at a later period when contact  $b_8$  opens the relay  $r$  will still be energized until the contact  $c_9$  opens.

When the trailing edge of the sheet passes the lamp and the ray is restored the cell relay  $a$  causes the switch 34 to change over and close circuit  $a_6$ ,  $a_7$  thus starting the "charging" period of electronic timer  $c$ . At the same time the change over of the switch 30 causes a quick opening of contact  $b_8$ . After the delay period controlled by the setting of the potentiometer 33, the timer  $c$  causes contact  $c_9$  to open and thus de-energize relay  $r$ , so that the switch in the circuit of the solenoid 22 is closed and the solenoid energized causing the opening of the gripper fingers 17.

According to a further embodiment, see Figures 5 and 6, the control means comprises a single photo-electric cell 35 provided with a single light source 36 and a single electronic timer of known character, for example as disclosed in U. S. Patent No. 2,171,347 which together with associated electrical equipment is enclosed within the panel or casing 37. The timing condenser of the said electronic timer is manually adjusted by a potentiometer 38 in circuit therewith.

The arrangement and actuation by solenoid means of the gripping fingers 17 is as in the previous forms of the invention and the parts thereof are similarly referenced.

Referring to Figure 6, the parts are shown in their positions with the current on and no work passing.

When the light ray is interrupted by the leading edge of a sheet, the photo-cell relay D causes the change-over switch 39 to close the contacts  $D_5$  and  $D_6$  which causes the closing of contacts  $E_1$  and  $E_2$  in the electronic timer E so that the timing condenser starts charging. After the delay period as determined by the potentiometer 38 the timer E causes the contact  $E_3$  to close thereby energizing relay H which causes the de-energization of the gripping finger solenoid 22 so that the fingers move to their gripping positions by the spring 23.

When the trailing edge of the sheet clears the ray and such is restored the switch 39 opens the circuit through  $D_5$  and  $D_6$  and the contact  $F_8$  opens so that the switch in the solenoid circuit closes and the solenoid is energized and the gripping fingers 17 are moved to their release position.

With this form of the invention the position of the lamp 36 relatively to the gripping position determines the correct releasing time of the gripping fingers. For this purpose the lamp has to be adjusted along the guide 40 and positioned by trial and error so as to get the trailing edge of the sheet and leading edge to line up to make a good fold.

When the position of the lamp has thus been determined it holds good for all time as the sheet when the trailing edge arrives at the ray interrupting position has attained the speed of the folding conveyor and is no longer under the influence of the ironer. Should the folder conveyor speed be altered it will of course be necessary to make a positional adjustment of the lamp.

The adjustment of the time charging condenser by the potentiometer 38 provides the correct time for the gripping fingers to grip the leading edge, such adjustment being made should the speed of the ironer vary. The

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potentiometer 38 will be provided with a dial calibrated according to the speeds of the ironer.

We claim:

1. In apparatus for folding flat articles such as sheets comprising conveyor means for delivering articles to a folding station, means at said folding station for raising and gripping the leading edge of an oncoming article on the conveyor means, means for actuating said raising and gripping means, a single detector means located in advance of and spaced from said folding station and susceptible to the passage of an article on said conveyor means to detect the leading edge and trailing edge of an article on said conveyor means, control means operated by said single detector means for causing actuation of said raising and gripping means actuating means, and electronic timer means operatively interposed between said single detector means and said control means impose a delay in the operation of said control means after detection of an article leading edge by said single detector means, the improvement consisting in the provision of manually presettable adjustment means in operative connection with said electronic timer means to vary the duration of said delay according to the time interval between the detection of an article leading edge by said single detector means and its arrival at the folding station and not according to the length of an article, mounting means for said single detector means permitting adjustment of the distance between the latter and the folding station and control means operated by said single detector means on detection of the passage of an article trailing edge to cause said raising and gripping means to release the article leading edge forthwith.

2. In apparatus for folding flat articles such as sheets comprising conveyor means for delivering articles to a folding station, means at said folding station for raising and gripping the leading edge of an oncoming article on the conveyor means, means for actuating said raising and gripping means, a single detector means located in advance of and spaced from said folding station and susceptible to the passing of an article on said conveyor means to detect the leading edge of an approaching article and control means operated by said single detector means for causing actuation of said raising and gripping means actuating means, the improvement consisting in the provision of mounting means for said single detector means permitting adjustment of the distance between the latter and the folding station, pre-settable electronic timer means operatively interposed between said single detector means and said control means to delay operation of said control means after detection of an article according to the time interval between detection of the leading edge of an article and its arrival at the folding station, and manually adjustable means for effecting the pre-setting of said electronic timer means.

3. In apparatus for folding flat articles such as sheets comprising conveyor means for delivering articles to a folding station, means at said folding station for raising and gripping the leading edge of an oncoming article on the conveyor means, means for actuating said raising and gripping means, a single detector means located in advance of and spaced from said folding station and susceptible to the passing of an article on said conveyor means to detect the leading edge and trailing edge of an article on said conveyor means and control means operated by said single detector means for causing actuation of said raising and gripping means actuating means, the improvement consisting in the provision of mounting means for said single detector means permitting adjustment of the distance between the latter and the folding station, pre-settable electronic timer means operatively interposed between said single detector means and said control means to delay operation of said control means after detection of an article leading edge according to the time interval between detection of the article leading edge and its arrival at the folding station, manually



adjustable means for effecting the presetting of said electronic timer means, and means operatively interposed between said single detector means and said control means to operate said control means to effect release of the article leading edge on detection of the article trailing edge by said single detector means.

References Cited in the file of this patent

UNITED STATES PATENTS

2,374,779 Preston May 1, 1945 10

2,389,458  
2,464,823  
2,516,454  
2,643,879

587,593  
618,157

Preston Nov. 20, 1945  
Malott, Jr. Mar. 22, 1949  
Doran July 25, 1950  
Spreckelmeier June 30, 1953

FOREIGN PATENTS

Great Britain Apr. 30, 1947  
Great Britain Feb. 17, 1949