June 20, 1961 G. SMITH 2,989,305

SHEET FOLDING MACHINES

Filed May 12, 1959 3 Sheets-Sheet 1

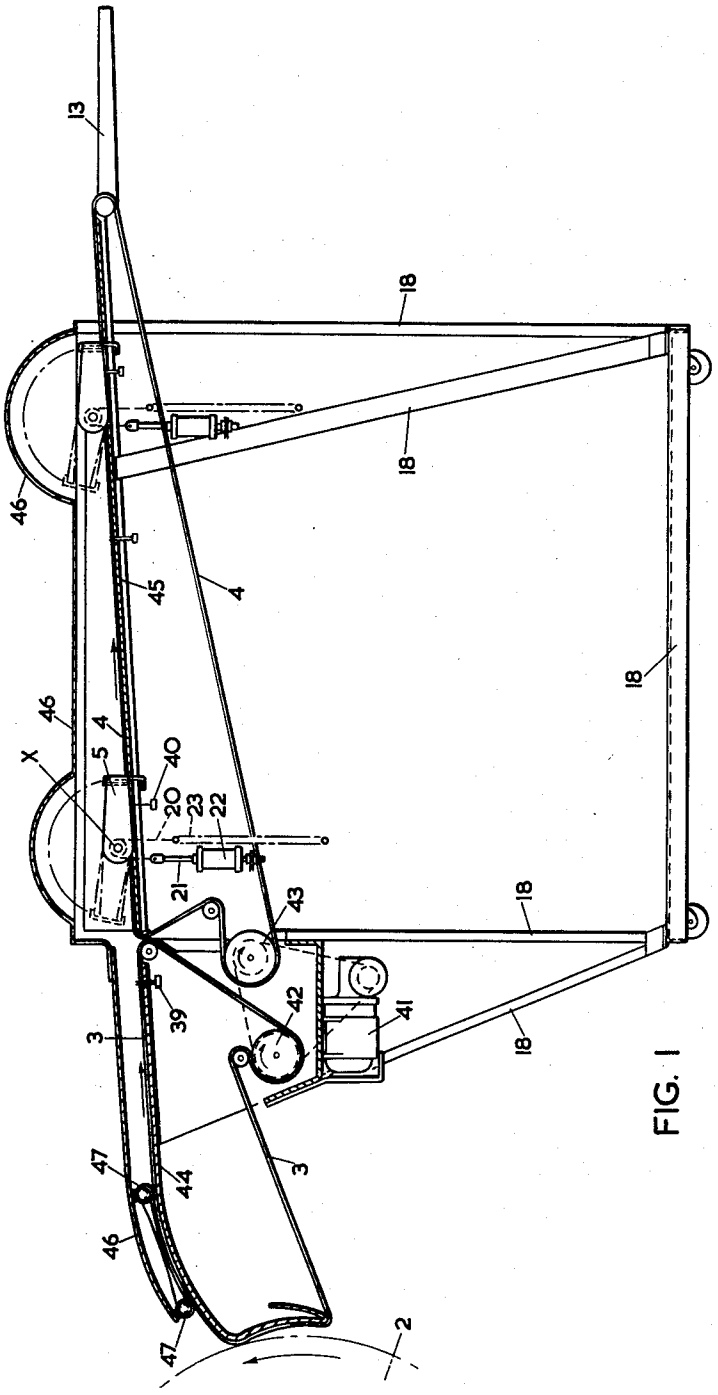


FIG. 1

June 20, 1961 G. SMITH 2,989,305

SHEET FOLDING MACHINES

Filed May 12, 1959 3 Sheets-Sheet 2

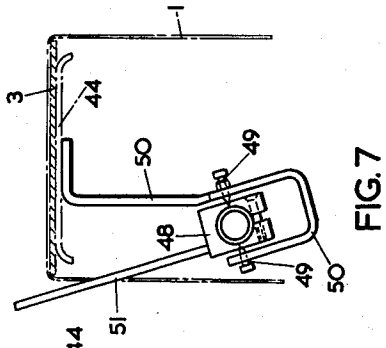


FIG. 7

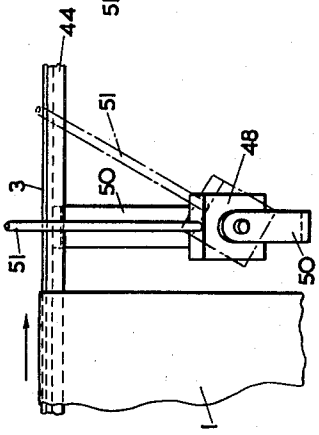


FIG. 6

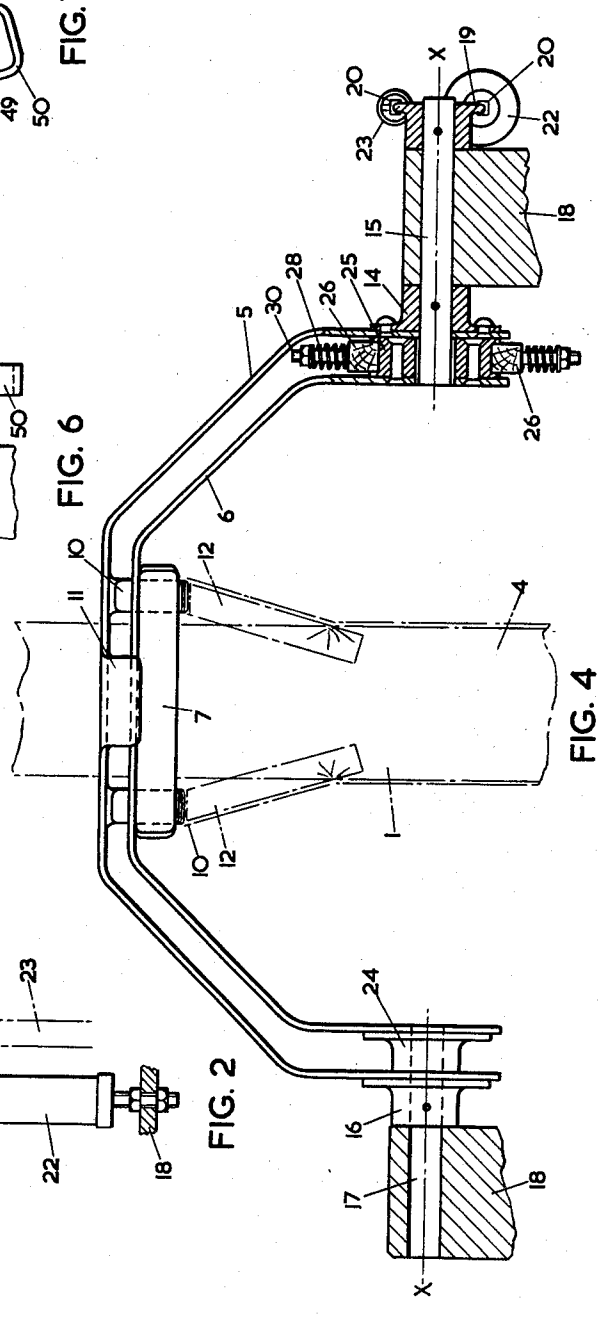


FIG. 4

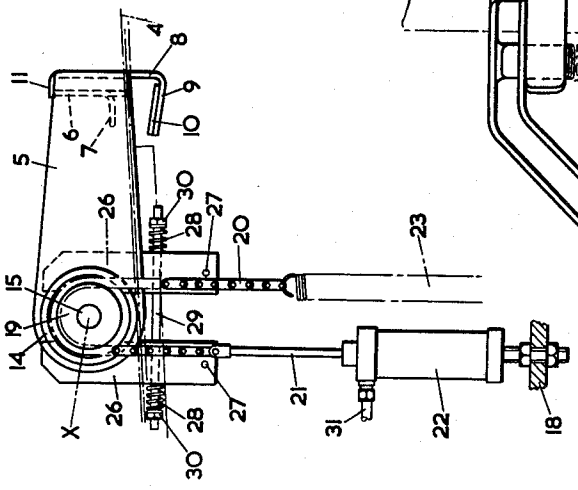


FIG. 2

June 20, 1961 G. SMITH 2,989,305

SHEET FOLDING MACHINES

Filed May 12, 1959 3 Sheets-Sheet 3

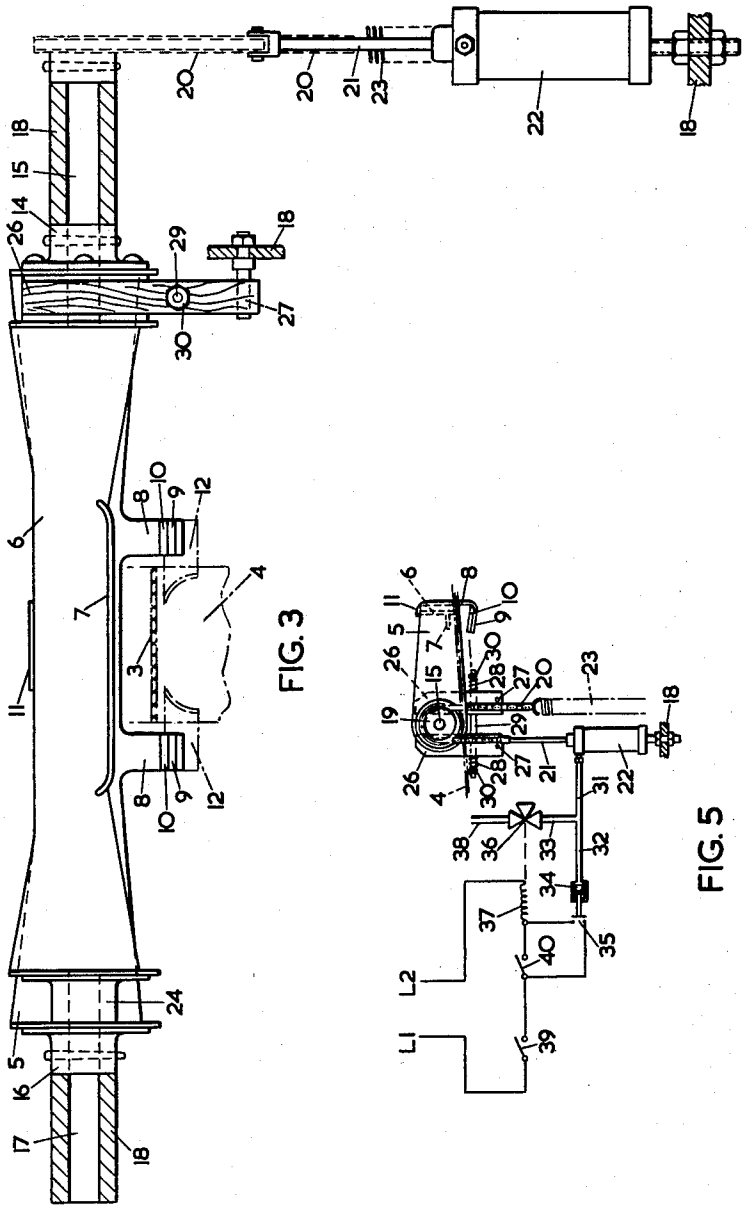


FIG. 3

FIG. 5

United States Patent Office 2,989,305 Patented June 20, 1961

2,989,305

SHEET FOLDING MACHINES

Geoffrey Smith, 46 E. India Dock Road, London E.14, England, assignor of one-half to James Armstrong & Company Limited, London, England, a British company

Filed May 12, 1959, Ser. No. 812,728
8 Claims. (Cl. 270—68)

This invention relates to sheet folding machines or machines for folding bed sheets or other fabric sheets. The invention is primarily intended for use in laundries, for folding bed sheets after they have been delivered from the calender in a condition ready for return to the customers.

The invention has for its object the provision of an improved sheet folding machine, and the invention consists broadly of a machine for folding bed sheets or other fabric sheets, comprising a belt conveyor on which the sheets are fed in succession, in such a way that they hang down on each side of the belt, and means for holding back the forward edge of each sheet, so that, by the conveying action of the belt, said forward edge becomes progressively doubled back, and for subsequently releasing said forward edge, so that, thereafter, the doubled sheet as a whole, still hanging down on each side of the belt is conveyed by said belt.

The word "belt" occurring in the above paragraph and throughout the claims is to be understood as covering belts of all suitable kinds including chain-like structures, and as covering not only a single belt but also a plurality of separate relatively narrow belts side by side, which again may be of any suitable form such as wires or chains.

In order that the invention may be the more clearly understood, a sheet folding machine in accordance therewith will now be described reference being made to the accompanying drawings wherein:

FIGURE 1 is a side elevation of the machine, shown partly in section;

FIGURE 2 is a similar side elevation, to a larger scale of a portion of the machine;

FIGURE 3 is an end elevation looking from the left of FIGURE 2;

FIGURE 4 is a plan of the parts shown in FIGURES 2 and 3;

FIGURE 5 is a partly diagrammatic view illustrating the electro-pneumatic control system employed in the machine;

FIGURE 6 is a side view, to a large scale, of a switch employed in the machine;

FIGURE 7 is an end view of the same.

Referring to the drawings, the sheets 1 (FIGURES 4, 6 and 7) are fed in succession from the calender 2 on to a belt conveyor having a rather narrow belt 3, in such a way that the sheets hang down equally on each side of said belt. This conveyor conveys the sheets on to a second conveyor which forms a continuation of the first and has a similar belt 4. Said belt 4 travels at a higher speed than the belt 3, in order to ensure that any ruckles which the sheet may have acquired in passing on to the belt 3 will be smoothed out.

At a suitable distance forwardly from the calender 2, a sheet-folding mechanism is provided which comprises two roughly U-shaped or bridge shaped folding elements 5 and 6, each formed of a bent sheet metal strip. One (5) of said folding elements is of larger dimensions than the other (6), and said elements are both rotatable about the same axis X—X, passing through both legs of both elements near the ends thereof, with

the larger element 5 outside the smaller element 6 as best shown in FIGURE 4.

The axis X—X passes transversely and horizontally a little above the belt 4, and the legs of the folding elements 5 and 6 are symmetrically on each side of said belt. Normally, the position is as shown in FIGURES 2, 3, 4 and the full line position of FIGURE 1, said folding elements being in a roughly horizontal plane, with the middle portions forwardly of the axis X—X and passing over the belt 4.

The middle portion of the inner folding element 6 has a flange 7 bent over rearwardly from its lower edge, assuming the position to be normal, said flange extending right over the belt 4 and beyond each side thereof. The outer folding element 5 has two lugs 8 extending downwards from its lower edge, one on each side of the belt 4, said lugs, at a level beneath said belt being bent over rearwardly at 9, and having soft pads 10 of, say, rubber mounted on said rearwardly bent portions 9. The outer folding element 5 also has a central flange 11 bent over rearwardly from its upper edge, said flange 11 overhanging, and being in contact with, the upper edge of the inner folding element 6. Thus the mechanism which has been described can be said to be comprised of a pair of jaws on each side of the belt which grip the front edge portions of each sheet which depend at the sides of the belt. Each pair of jaws is constituted by one of the lugs 9 with its pad 10 and the appertaining end portion of flange 7.

As each sheet, hanging over the belt 4, as above described, approaches the forward portions of the elements 5 and 6, the leading edge portion of the sheet is spread somewhat by passing over two guides 12 so that it passes over the two pads 10. At the same time, in response to the sheet reaching the appropriate position, the outer folding element 5 is rotated counter clockwise about the axis X—X by means which will be hereinafter described.

This operation is timed so that the two pads 10 engage underneath the front i.e. the leading edge portion of the sheet before the latter has reached the middle or transverse portion of the folding element 5. Said pads 10 then raise said front edge portion of the sheet until said pads engage the underside of the flange 7 (with said front edge portion of the sheet in between) and, thereafter, the folding element 5 carries the folding element 6 with it around the axis X—X. The movement of said folding element 6 around said axis is subject to a friction drag, as will be hereinafter described, and thus, as said two folding elements 5 and 6 rotate together counter clockwise around said axis X—X, the said front edge portion of the sheet will be nipped fairly tightly between the pads 10 on the one hand and the flange 7 on the other, and said front edge portion of the sheet will be folded back. The said elements 5 and 6 rotate through approximately 180° and then stop, and thus the said front edge portion of the sheet is folded or doubled back roughly two right angles and is accordingly held at level a little above the belt 4.

The position now is that what was at first the front edge of the sheet is folded back and held stationary, still, of course, hanging down on each side of the gripper constituted by the pads 10 and the flange 7, i.e. on both sides of the belt 4 outside the hanging-down i.e. the depending portion of the major portion of the sheet still on the belt, but the belt is still moving forwards and conveying with it said major portion of the sheet. The consequence is that more and more of the sheet becomes folded back until, by the time the rear i.e. the trailing edge of the sheet comes level with what was originally the front edge, the sheet is folded double.

At approximately this point, as will hereinafter appear, the outer folding element **5** is rotated clockwise back to the original position shown in FIGURE 2. During the initial part of such rotation, the pads **10** are separated from the flange **7**. The flange **11** of the folding element **5** then engages the folding element **6** and thereafter said folding element **6** is carried back with said folding element **5** to the original position. As soon as the pads **10** are separated from the flange **7** the edge of the doubled back portion of the sheet is left simply resting on said flange **7**, and it accordingly slides off said flange **7**—either before or after the latter commences to move, and said doubled back portion falls down onto the portion of the sheet still on the belt **4**. The doubled sheet as a whole, still hanging over the belt **4**, is now conveyed forwards.

At a position a little further forwards, a second sheet-folding mechanism similar to the first is provided, as will be clear from FIGURE 1, so that the sheet is again doubled, and finally the sheet is delivered from the forward end of the conveyor on to a slide **13** of the same width as the belt on which the twice doubled sheet is supported still hanging down on each side of said slide. The sheet has now been twice doubled by lateral folds, and, by virtue of its hanging down on each side of the slide **13**, it is, in effect, again doubled by a longitudinal fold, and it can be removed by hand in that condition.

Describing now in more detail the manner in which the folding elements **5** and **6** are mounted and operated, the outer folding element **5** has one of its legs secured fast, by means of a boss **14** to a trunnion **15**, and has its other leg secured fast by means of a boss **16** to a trunnion **17**. Said two trunnions **15** and **17**, which are, of course, coaxial with the axis X—X, rotate in bearing holes in portions of the main frame **18** of the machine. The trunnion **15** has its extremity projecting beyond its bearing hole, and, mounted fast on said extremity is a sprocket wheel **19** over which passes a chain **20** whose two ends depend down vertically. One end of said chain **20** is connected to the upper end of a vertical piston rod **21** whose lower end is connected to a piston in a vertical cylinder **22**, mounted on a part of the fixed frame **18**. The other end of said chain **20** is connected to the upper end of a vertical tension spring **23** whose lower end is connected to a part of said fixed frame. Thus, when air under pressure is admitted to the upper end of the cylinder **2**, the piston moves to the lower end of its stroke and thereby, through the chain **21**, rotates the sprocket wheel **19**, and therefore the outer folding element **5**, counter clockwise to the folding position, this operation also stretching the spring **23**. When air is exhausted from the upper end of the cylinder **22**, the spring **23** operates to return the sprocket wheel **19** and the outer folding element **5** to the normal position.

The folding element **6** has one of its legs secured fast to a boss **24** which rotates freely on the trunnion **17**, and has its other leg secured fast to a brake drum **25** which rotates freely on the trunnion **15**. Two brake shoes **26** engage said brake drum **25** on opposite sides thereof, said brake shoes being pivoted at points **27** to a part of the fixed frame **18**, and being biased about said pivot points towards each other by means of helical springs **28** coiled on a coupling rod **29** which passes through holes in said brake shoes, each spring, as clearly shown in FIGURE 2, being in compression between a respective brake shoe and a nut **30** screwed on the extremity of said coupling rod.

Thus, as before stated, the rotation of the inner folding element **6** takes place in both directions in opposition to a friction drag.

Describing now, with reference to FIGURE 5 the manner in which the supply of compressed air to, and its exhaust from, the cylinder **22** is effected, a pipe **31**, connected to the upper end of the cylinder **22** is connected to two branch pipes **32** and **33**. The branch pipe **32** leads to the expansible air chamber **34** of an electric switch **35** which closes when compressed air is admitted to said air chamber and opens when compressed air is exhausted from said air chamber. The branch pipe **33** leads to an air valve **36** which is controlled by a solenoid **37** in such a way that, when said solenoid is energised, the branch pipe **33** is connected to a pipe **38** which is in communication with a source of compressed air supply, and, when said solenoid is de-energised, said branch pipe **33** is connected to exhaust and the pipe **38** is closed. Two switches **39** and **40** are provided arranged alongside the belts **3** and **4** at longitudinal positions as shown in FIGURE 1. Each of these switches is normally open and is closed by being overlaid by each sheet as it is carried along by the belts. These switches **39** and **40** are connected in series with each other, and with the solenoid **37** across a source of electric supply **L1**, **L2**, and the switch **35** is connected in parallel with the switch **40**.

It will now be seen that, normally both switches **39** and **40** are open; the solenoid **37** is deenergised; the supply pipe **38** is cut off, and the top end of the cylinder **22** is connected to exhaust. Thus the piston will be at its upper end and both folding elements **5** and **6** will be at their normal positions. As each sheet is conveyed from the calender **2**, first along the belt **3** and then along the belt **4**, its forward edge will first overlie the switch **39** and close it. This however, will, for the moment be without effect. Subsequently said forward edge will reach, and overlie, the switch **40**, and said switch **40** will also close, and thereby a circuit will be established, from the source L1, L2, through the solenoid **37**. The supply pipe **38** will accordingly be connected both to the chamber **34** and to the upper end of the cylinder **22**, and thus the switch **35** will close and the piston in the cylinder **22** will move downwards, causing the folding elements **5** and **6** to rotate clockwise and thus double back the forward portion of the sheet as heretofore described.

It will be noticed that the doubling back of the forward portion of the sheet will cause the switch **40** to open, but, owing to the switch **35** being now closed, this will be without effect.

When the rear edge of the sheet reaches the appropriate position, it will uncover the switch **39** and the latter will open, thereby deenergising the solenoid **37**. Consequently the valve **36** will be operated to close the supply pipe **38** and connect the pipe **33** to exhaust, thereby opening the switch **35** and connecting the upper end of the cylinder **22** to exhaust, so that the spring **23** will operate to return the folding elements **5** and **6** to the normal position. The folded sheet will now be conveyed onwards as before described.

The second sheet-folding mechanism is in every respect similar to the first, and no further description thereof is therefore necessary.

It will be seen that both belts are driven by a common electric motor **41**. Thus said motor drives two equal pulley wheels **42** and **43**, the latter at a higher speed than the former. The belt **3** runs over, and is driven by, the pulley wheel **42** and the belt **4** runs over, and is driven by the pulley wheel **43**.

It will be seen that the belt **3**, throughout the region where it supports the sheets, slides over a supporting underplate **44**, and the belt **4** in like manner slides over a supporting underplate **45**, both underplates being, of course, supported from the main frame **18** of the machine. The aforesaid guides **12** are mounted on the underplate **45**. The conveyors and also the folding elements are covered by a protective cover **46**, and this, at its end nearest the calender **2** carries a pair of idler rollers **47** which press yieldably on the belt **3** and thus afford a positive grip for the forward end of the sheet as this leaves the calender.

Turning now to FIGURES 6 and 7, these illustrate one of the switches **39**, **40** (say the switch **39**). This switch

is a mercury switch and comprises a container 48 having a body of mercury therein. Said container is supported beneath the belt 3 by means of two opposite coaxial pointed members 49, in such a way as to be rotatable about the common axis of said members, which axis is transverse to said belt. Said members 49 are in turn carried by a bracket 50 supported from the underplate 44. A finger 51 extends upwards and at an angle outwards from the container 48, and said container and finger are biased to the normal position illustrated, at which said finger extends up just past the side edge of the belt 3. This is the open position of the switch. When the forward edge of the sheet 1 arrives, it engages said finger 51 and rocks the same, together with the container 48, to the chain dotted position of FIGURE 6, i.e. the closed position of the switch, and the sheet retains said finger and container at this position so long as it is overlying the switch. As soon as the rear end of the sheet passes, the finger and container return to the normal open position of the switch.

The above described sheet-folding machine may be modified in various ways. For example, in place of the air cylinders, hydraulic cylinders or electric solenoids could be employed.

I claim:

1. In a machine for folding flexible fabric sheets, the combination comprising a conveyor belt, means feeding the sheets in succession forwardly along said belt, said belt being relatively narrow as compared with the width of the sheets whereby the sheets are supported by and depend from each side of said belt, jaw means located at each side of said belt in such position as to engage the leading edge of said sheet along the corresponding depending portion thereof, means actuating said jaw means upon engagement by said leading edge of the sheet for gripping said leading edge at said depending portions and arresting its forward motion whereby said leading edge is progressively folded back over the remaining portion of the sheet as the latter continues its forward travel along said belt, and means releasing said jaw means from said leading edge of the sheet when the trailing edge thereof reaches approximate alignment with said leading edge thereby leaving the sheet folded on said belt and depending at each side thereof.

2. A folding machine as defined in claim 1 wherein said jaw means are constituted by two pairs of jaws, said pairs of jaws being located respectively laterally outward from each side of said belt and which further includes guide means engaging the leading edge of those portions of the sheet which depend at each side of said belt for spreading and guiding the same into their respective pairs of jaws.

3. A folding machine as defined in claim 2 wherein each said pair of jaws comprises an under jaw and an over jaw between which said leading edge portion of the sheet is fed, and means raising said under jaw to grip said leading edge portion of the sheet between said under jaw and over jaw.

4. A folding machine as defined in claim 1 and which further includes a stationary slide extending beyond the delivery end of said conveyor belt as a continuation of the path of said conveyor belt, whereby said conveyor belt operates to transfer said folded sheet onto said slide and with the said depending portions thereof also depending at each side of said slide.

5. In a machine for folding flexible fabric sheets, the combination comprising a conveyor belt, means feeding the sheets in succession forwardly along said belt, said belt being relatively narrow as compared with the width of the sheets whereby the sheets are supported by and hang down on each side of said belt, a first jaw-supporting structure rotatable about an axis transverse to said belt, a second jaw-supporting structure rotatable about the same axis, each of said jaw-supporting structures having a normal angular position, two under jaws carried by said first supporting structure and positioned laterally to each side of said belt and forwardly from said axis at the normal position of said first supporting structure, two over jaws carried by said second supporting structure and positioned respectively above said under jaws at the normal position of said second supporting structure, guide means along said belt for spreading laterally away from said belt the leading edge portions of each sheet which overhang the sides of said belt, whereby said leading edge portions are fed by said belt above said under jaws and beneath said over jaws, means actuated upon presentation of said leading edge portions of the sheet between said under jaws and over jaws for thereupon rotating said first supporting structure about said axis in the direction such that said under jaws are first raised to grip said leading edge portions between said under jaws and said over jaws, whereafter said second supporting structure is rotated about said axis by said first supporting structure to a given position, and the leading edge of the sheet is thereby folded back and held for further folding back owing to the conveying action of said belt, means controlled by the trailing edge portion of the sheet for subsequently rotating said first jaw-supporting structure in the return direction to its normal position, and co-engaging means on said jaw-supporting structures effective upon a rotation of said first jaw-supporting structure in said return direction to its normal position to first separate said under jaws from said over jaws thereby releasing said folded back leading edge portion of the sheet and then to carry said second jaw-supporting structure back to its normal position.

6. A folding machine as defined in claim 5, and which further includes drag means for resisting the rotation of said second jaw-supporting structure, whereby adequate pressure is ensured between said under jaws and said over jaws during rotation of said first supporting structure in said first-named direction, and the separation of under jaws from said over jaws is ensured at the commencement of the rotation of said first jaw supporting structure in said return direction.

7. A folding machine as defined in claim 5 wherein said means for controlling the rotation of said first jaw-supporting structure comprise means for biasing said first jaw-supporting structure to its normal position, a pneumatic cylinder and piston, means coupling said position to said first jaw-supporting structure whereby, upon admission of compressed air to said cylinder said first jaw supporting structure is rotated to said given position, a winding, first and second normally open switches in series with said winding spaced along the track of said conveyor, said first switch being closed upon the leading edge of the sheet passing a given position on said conveyor and said second switch being closed upon the leading edge of the sheet passing a second given position on said conveyor following said first position, and said first switch being reopened upon the trailing edge of said sheet passing said first given position, an air valve opened upon energization of said winding to admit compressed air to said cylinder, and a third switch, in shunt with said second switch, said third switch being closed by compressed air in response to the opening of said valve.

8. In a machine for folding flexible fabric sheets, the combination comprising a conveyor belt, means feeding the sheets in succession forwardly along said belt, said belt being relatively narrow as compared with the width of the sheets whereby the sheets are supported by and hang down on each side of said belt, a first jaw-supporting structure rotatable about an axis transverse to said belt, a second jaw-supporting structure rotatable about the same axis, each of said jaw-supporting structures having a normal angular position, two under jaws carried by said first supporting structure and positioned laterally to each side of said belt and forwardly from said axis at the normal position of said first supporting structure, two over jaws carried by said second supporting structure and positioned respectively above said under jaws at the

normal position of said second supporting structure, guide means along said belt for spreading laterally away from said belt the leading edge portions of each sheet which overhang the sides of said belt, whereby said leading edge portions are fed by said belt above said under jaws and beneath said over jaws, means actuated upon presentation of said leading edge portions of the sheet between said under jaws and over jaws for thereupon rotating said first supporting structure about said axis in the direction such that said under jaws are first raised to grip said leading edge portions between said under jaws and said over jaws and for then rotating said two supporting structures together in the said direction to a given position, whereby the leading edge of the sheet is folded back and held for further folding back owing to the conveying action of the belt, means controlled by the trailing edge portion of the

sheet for subsequently rotating said first jaw-supporting structure in the return direction and thereby separating said under jaws from said over jaws and releasing said folded back leading edge portion of the sheet, and for then rotating both jaws in said return direction back to their normal positions.

References Cited in the file of this patent

UNITED STATES PATENTS

2,650,821	Howlett	Sept. 1, 1953
2,740,627	Woodward et al.	Apr. 3, 1956
2,811,350	Cran et al.	Oct. 29, 1957
2,815,946	Cran	Dec. 10, 1957

FOREIGN PATENTS

587,593	Great Britain	Apr. 30, 1947

UNITED STATES PATENT OFFICE

CERTIFICATION OF CORRECTION

Patent No. 2,989,305 June 20, 1961

Geoffrey Smith

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, line 36, after "separation of" insert -- said --; line 44, for "position" read -- piston --.

Signed and sealed this 1st day of August 1961.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents