Oct. 24, 1961 L. O. BERGMAN ET AL 3,005,630

APPARATUS FOR FOLDING BED SHEETS AND LIKE ARTICLES

Filed May 26, 1958 4 Sheets-Sheet 1

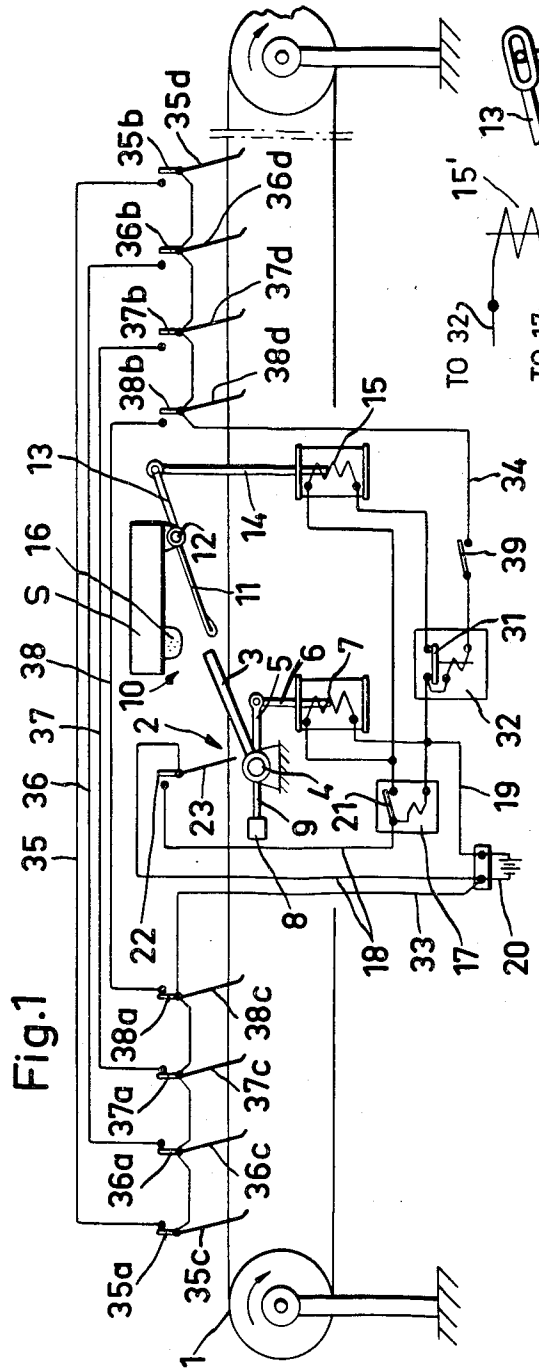

Fig.1

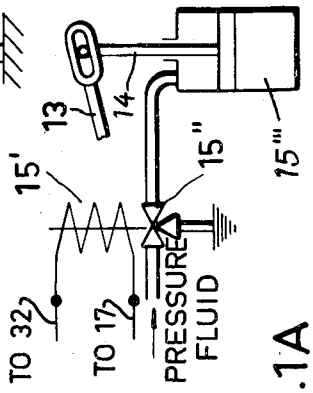

Fig.1A

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APPARATUS FOR FOLDING BED SHEETS AND LIKE ARTICLES

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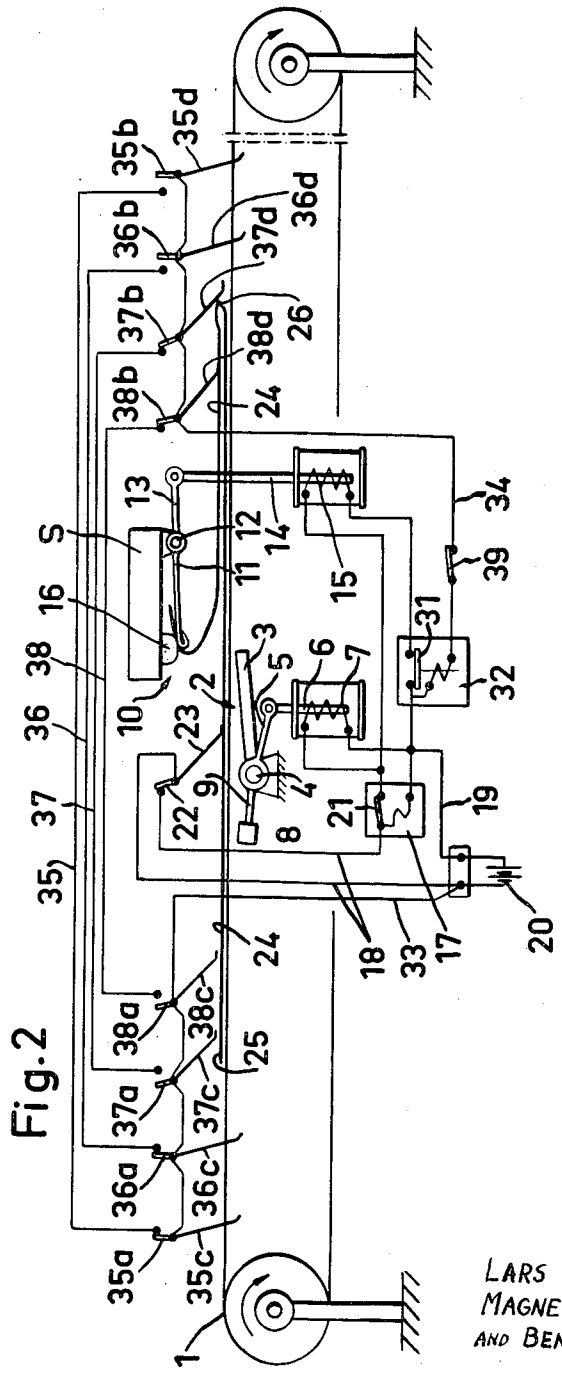

Fig. 2

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Fig.3

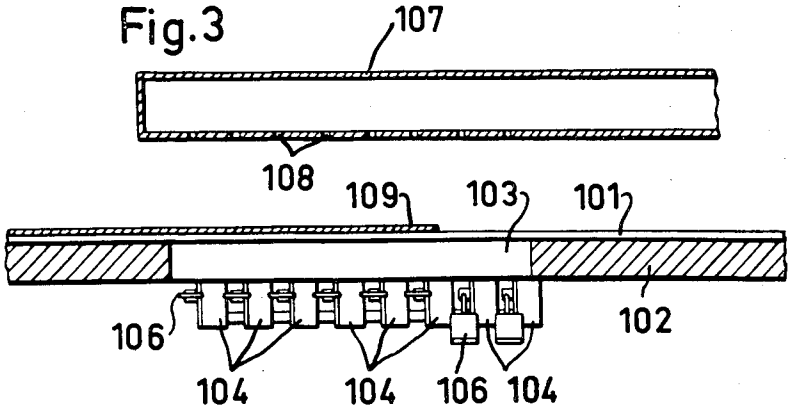

Fig.4

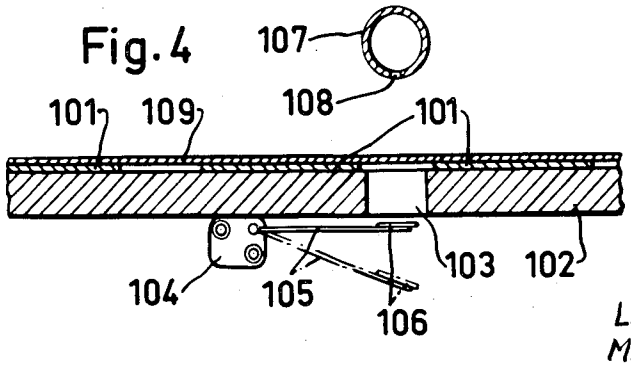

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Fig.5

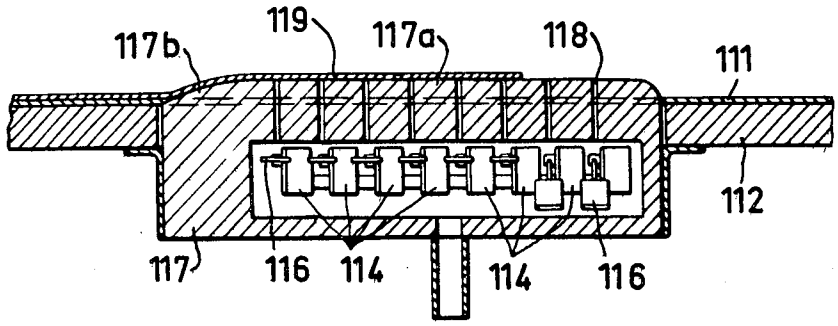


Fig.6

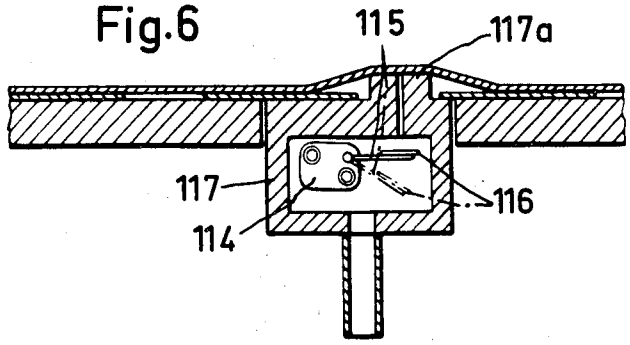
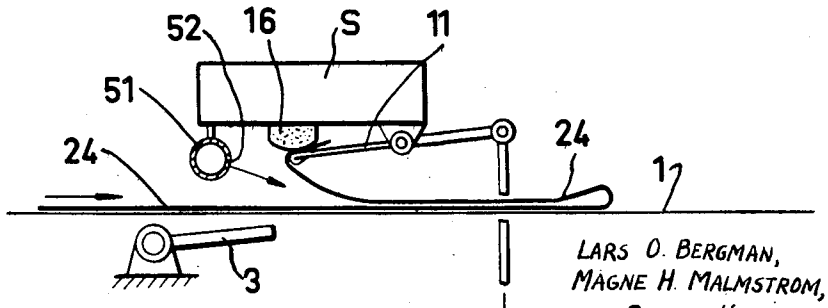


Fig.7



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3,005,630

APPARATUS FOR FOLDING BED SHEETS AND LIKE ARTICLES

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9 Claims. (Cl. 270—68)

This invention relates to a folding apparatus of the type used in laundries for folding bed sheets and other rectangular articles and usually associated with a roller in which the articles are rolled transversely so that they emerge from the roller with one longitudinal edge as the leading edge. The folding apparatus has a belt conveyor on which it receives and forwards the articles, and lifting and gripping means arranged at said belt conveyor and adapted to lift the grip, respectively, and temporarily to retain the leading edge of for instance a bed sheet arriving on said conveyor. In a prior art design of such an apparatus said means are actuated by sensing means which senses the leading edge of the bed sheet and then the trailing edge thereof and which causes the gripping means to release the leading edge of the article so that it falls down onto and coincides with the trailing edge, whereby the bed sheet is thus folded into two equal parts. The apparatus usually comprises two sets of lifting and gripping means arranged one after the other at the belt conveyor so that the bed sheets can be folded twice, that is to say into four equal parts.

However, many housewives want to have their bed sheets folded into three parts instead of four, and this is true also of other articles, such as table cloths, napkins and towels. Such folding cannot be practically realized in the apparatus outlined in the foregoing, as the release of the leading edge always occurs in a certain position of the trailing edge irrespective of the width of the article. It is true that the apparatus can be adjusted with the aid of adjustable delaying means so that it will fold in a third instead of half of a predetermined width, but it would be too complicated and inconvenient to effect such adjustment for each particular width and possibly to sort the articles according to their width before rolling them.

The general object of the invention is to provide an apparatus for folding bed sheets and like articles, which apparatus is capable of folding in a part of any desired proportion e.g. a third of the width of the article.

Another object is to equip a folding apparatus having a belt conveyor and lifting and gripping means for folding in a leading portion of an article carried by the conveyor over another portion of said article, with sensing means for sensing the position of both the front and the back of the article relative to the gripping means during the folding operation and causing the gripping means to release its grip, letting down any desired portion of the article onto the portion of the article remaining on the conveyor.

Further objects of the invention and the advantages gained thereby will appear from the following description and claims, reference being had to the accompanying drawings which illustrate an embodiment of the folding apparatus. In the drawings:

FIGS. 1 and 2 are side elevations of the folding apparatus which is inoperative in FIG. 1 and shown during a folding operation in FIG. 2;

FIG. 1A is a fragmentary side elevation showing modified operating means;

FIGS. 3 and 4 are a longitudinal section and cross-section, respectively, of a group of pneumatic-electrical sensing means which can replace the mechanic-electrical sensing means shown in FIGS. 1 and 2;

FIGS. 5 and 6 are a longitudinal section and a cross-section, respectively, of a group of pneumatic-electrical sensing means in another embodiment;

FIG. 7 is a fragmentary side elevation of the apparatus in FIGS. 1 and 2 equipped with blowing means for controlling the performance of the article which is being folded.

FIGS. 1 and 2 show a horizontal belt conveyor **1** which is composed of several parallel belts running about common guide rollers. Mounted on the frame of the conveyor beneath the upper run thereof are lifting means **2** consisting of a number of parallel lifting fingers **3** which are secured to a common transverse shaft **4** which is mounted in the frame and provided with a lever **5** connected to an armature **6** of a solenoid **7**. The shaft **4** also has a counterweight **8** on an arm **9**, and said counterweight is so dimensioned that when the solenoid **7** is deenergized it holds the fingers **3** swung to the position shown in FIG. 1 in which they are inclined obliquely upwardly and forwardly, as seen in the direction of transport of the conveyor, and project upwardly beyond the upper run of the conveyor between the individual belts thereof. When the solenoid is energized it pulls the armature **6** down, thus swinging the fingers **3** below the level of the conveyor, as is shown in FIG. 2.

Some farther on as seen in the direction of transport of the conveyor, gripping means **10** is mounted above the conveyor. Like the lifting means said gripping means **10** consists of a row of parallel fingers **11** on a common shaft **12** which is mounted on the frame of the apparatus and has a lever **13** coupled to an armature **14** of a solenoid **15**. When the solenoid **15** is deenergized the gripping fingers **11** hang obliquely down against the direction of transport, their free ends being approximately at a level with and very close to the free ends of the upwardly swung lifting fingers **3**. When the solenoid is energized it pulls the armature **14** down, thus swinging the gripping fingers **11** upwards against an abutment in the form of a stationary bar **16** which is secured to a part S of the frame.

The two solenoids **7** and **15** are connected in parallel to a delaying relay **17** which in turn is coupled via two lines **18, 19** to a source of current **20**. The relay **17** has a contact **21** which closes with a certain delay after the supply circuit **18, 19** has been closed. Connected in one supply line **18** is a contact **22** which is mounted above the conveyor adjacent the lifting means **2** and which is provided with a feeler **23** which hangs down between a pair of the conveyor belts, thus holding the contact **22** open as long as the conveyor is empty, but which is lifted by the leading edge of an article carried by said conveyor, thus closing the contact. In FIG. 2 an article is shown which is designated **24** and assumed to be a bed sheet. The delay of the relay **17** is so chosen that the leading edge of the bed sheet has time to travel upwards along the lifting fingers **3** and some distance onto the gripping fingers **11** before the relay is energized, and when this happens the gripping fingers are swung upwards, clamping the leading edge of the bed sheet against the abutment **16** while the lifting fingers are simultaneously swung downwards, leaving the path free so that a successively decreasing portion of the bed sheet can proceed unimpededly carried by said conveyor. This is the situation shown in FIG. 2. When the trailing edge **25** of the bed sheet passes the feeler **23** the latter is swung downwards, the contact **22** being opened, the relay **17** opening its contact **21** and the gripping fingers **11** swinging down, releasing the leading edge of the bed sheet which, in case of correct adjustment of the mechanism, thereby falls down precisely onto the trailing

edge, whereafter the bed sheet which is now folded into two equal parts is carried along by the conveyor, usually to be folded once more in a similar way further on along said conveyor. When the relay **17** is cut out the lifting fingers **3** also are swung upwards, and in practice matters are preferably arranged so that this upward swinging is delayed or made so slow that the fingers **3** emerge above the conveyor only when the bed sheet has travelled on to be folded once more in the same manner, i.e. into four equal parts.

So far the apparatus fulfills the same task as the prior art folding apparatus, and the description will now deal with the novel arrangement which permits folding bed sheets and like articles into three equal parts in that a third of the width is folded in at the first folding operation.

In the circuit containing the solenoid **15** for the operation of the gripping fingers **11**, there is inserted a contact **31** of a relay **32** which opens the contact when it receives a current impulse. The relay is connected to the source of current **20** by a circuit consisting of a pair of main lines **33**, **34** and several branch lines **35**, **36**, **37**, **38** which are connected in parallel to the main lines each through two contacts **35***a*, **36***a*, **37***a*, **38***a* and **35***b*, **36***b*, **37***b*, **38***b*. These contacts are of the same type as the earlier described contact **22**, and like this contact they are mounted above the conveyor so that their feelers **35***c*—**38***c* and **35***d*—**38***d* hang down between a pair of the conveyor belts when the conveyor is empty. It should be observed, however, that the contacts of one group **35***a*—**38***a* connected to the main line **33** and mounted in a row ahead of the lifting and gripping means, are closed when their feelers depend freely, and open when their feelers are raised by an article on the conveyor, while the opposite is true of the contacts in the other group **35***b*—**38***b* connected to the main line **34**, which contacts are mounted in a row after the lifting and gripping means. Furthermore, the contacts are symmetrically interconnected via the lines **35**—**38** so that the first contact in one group is connected to the last contact in the other group, etc.

In the initial position shown in FIG. 1 all contacts in the *a* group are closed while the contacts in the *b* group are open, for which reason the relay **32** is deenergized and the contact **31** is closed. When a bed sheet is advanced on the conveyor its leading edge raises the feelers **35***c*—**38***c* of the group of contacts **35***a*—**38***a* so that these contacts also are opened. The feeler **23** is then raised, and the apparatus functions in the above described manner until the situation shown in FIG. 2 has arisen. There the bed sheet **24** has advanced so far with its front or fold **26** that the contact **37***b* has been closed, while the trailing edge has let down the feelers **35***c* and **36***c*, thus closing the contacts **35***a* and **36***a*. What will happen next during the continued travel is that the trailing edge of the bed sheet will let down the feeler **37***c*, thereby closing the contact **37***a*. Since the corresponding contact **37***b* is closed already, the circuit through the relay **32** is thereby closed and the contact **31** is thus opened whereby the solenoid **15** will be deenergized and the gripping fingers **11** released, swinging down and letting go the leading edge of the bed sheet, which edge falls onto the lower portion of the bed sheet which, in case the two groups of contacts with their feelers are correctly localized for threefold folding, is then twice as wide as the upper portion. However, the solenoid **7** is still energized and holds the lifting fingers **3** down until the trailing edge of the bed sheet lets down the feeler **23** of the contact **22**, thus opening this contact and opening through the relay **17** the circuit of both solenoids, the lifting fingers being thereby raised. After that the lifting and gripping means remain in the position shown in FIG. 1 until the next article has closed the contact **22** by raising its feeler **23**.

A switch **39** is inserted in one main line **34** of the sensing system, and the novel sensing system can rapidly and conveniently be cut out by means of said switch so that the apparatus can be used for different kinds of folding alternately.

It may be suitable in practice to develop the apparatus hereintofore described by employing a special power source for the work proper, i.e. the operation of the lifting and gripping means, in doing which the electric voltages and current strength can be considerably reduced and increased possibilities of modifying the movements of the lifting and gripping means can be obtained. Thus the lifting and gripping means can be operated by for instance pneumatic piston motors instead of by the solenoids **7** and **15** directly, the solenoids serving instead for the adjustment of valves which in turn control the function of the piston motors.

For the gripping means this is shown in FIG. 1A where the solenoid is designated **15'**, the valve **15''**, the pneumatic piston motor **15'''** and its piston rod **14'** which is connected to the lever **13**. For the lifting means the arrangement is similar.

On the basis of the above description and the prior art in this field it also seems possible to embody the invention in an entirely mechanical version. The electro-pneumatic version outlined above seems, however, to be the best solution.

FIGS. 3, 4 and 5, 6, respectively, illustrate a belt conveyor in partial longitudinal section and cross-section and a pneumatic-electric sensing means arranged at said conveyor.

The conveyor shown in FIGS. 3 and 4 consists of a plurality of belts **101** which are spaced apart laterally and run in parallel over a table **102**. An opening **103** is provided in said table **102** below one of the spaces between the belts. At the underside of the table **102** there are mounted along said opening **103** some electric contacts, more exactly eight microswitches **104**, which like the switches **35**—**38** in FIGS. 1 and 2 are coupled to a source of current and relay means in order, when opened or closed, to initiate the desired movement of the lifting and gripping means of the apparatus. Each contact has a light-weight actuating lever **105** which is swingable and spring-loaded so as to be held, in the absence of external forces, in the position shown by full lines in FIG. 4. At its free end the arm **105** has a vane **106** which in said position lies approximately horizontally directly below the opening **103**.

A tube **107** is shown above said opening **103** and is mounted in a manner not shown on the frame of the apparatus and connected to a source of air under pressure. At the underside the tube has a row of holes **108** which form blowing air nozzles directed each towards one of the vanes **106**.

As long as the conveyor is empty in the locality of said opening **103** air from nozzles **108** is blown through the opening against the vanes **106**, whereby the arms **105** are held swung downwards into the position shown by dash and dot lines in FIG. 4, the contacts being thereby closed if they are open in the position previously mentioned. When an article **109** is advanced by the conveyor and successively covers the opening **103**, it interrupts the air streams from the nozzles **108** to the vanes **106**, for which reason the arms **105** are swung in sequence up to the higher position and the contacts are changed over.

FIGS. 5 and 6 also show a conveyor which consists of a plurality of conveyor belts **111** which run over a table **112**, and of a row of microswitches **114** each of which has an adjusting arm **115** which, in the absence of external forces, is held in the position shown by full lines in FIG. 6 by spring load and which is provided with a vane **116**.

In this embodiment however the microswitches are mounted in a box **117** which is incorporated with the table as part thereof and has a portion **117***a* elongated in the transport direction of the conveyor and projecting upwardly between a pair of belts **111** beyond the level

thereof. A row of passages 118 lead from the upper side of said elongated portion 117*a* downwards into the box 117 directly above and in the direction each towards one of the vanes 116. At one end the projecting portion is formed as a ramp 117*b* so that an article 119 arriving on the conveyor unimpededly slides up on said ramp.

Connected to the box 117 is a suction conduit 117*c* through which as certain vacuum can be produced in the box, air being sucked through the passages 118. Said passages thus serve as blowing air nozzles, and as long as they are open the air streams delivered by said nozzles hold the arms 115 of the microswitches swung downwardly. When an article 119 is advanced over the projecting portion 117*a* of the box, it successively covers the passages, and due to their spring load the arms 115 are swung upwards in order then to be swung down again by the air streams generated in the box according as the trailing edge of the article 119 uncovers the passages 118.

The group of sensing means shown in FIGS. 3 and 4 or FIGS. 5 and 6 is intended in the folding apparatus to sense the position of either the front or the trailing edge of the article, and its contacts are therefore connected in series with a second row of sensing means contacts which correspondingly sense the position of the opposite portion of the article so that a desired movement is initiated in dependence on the position of the article in relation to the gripping means.

Although the pneumatic-electric sensing means require more equipment than the mechanic-electric ones, viz. an air pump, they present the advantage that they do not touch the articles sensed so that the risk of damages on both the articles and the sensing means is diminished or entirely avoided.

If the articles to be folded are not sufficiently soft or if they are fluffy or otherwise have a coarse surface on the upper side, it may happen that the portion retained by the gripping means 11 impedes the advance of the portion lying on the conveyor so that the article is crinkled and cannot be sensed and folded properly. This is obviated by the arrangement shown in FIG. 7.

FIG. 7 shows a part of FIG. 2 completed with a tube 51 secured to a portion S of the frame of the apparatus and extending across the conveyor in the immediate vicinity of the gripping means 11 and ahead thereof as seen in the direction of motion of the conveyor. The tube 51 is to be connected to a conduit for air under pressure and has on one side a row of holes or nozzles 52 for blowing air against and through the space between the conveyor and the gripping means.

Instead of a row of holes or nozzles the tube may have a slot which delivers a coherent air veil.

The blowing device of course incorporates a valve which regulates the supply of air, and like the lifting and gripping means this valve can be controlled by sensing means sensing the position of the articles in order that the supply of air shall be shut off between the folding operations.

The device in question functions in such a way that the delivered air stream first stretches the front portion of the article which is held lifted away from the conveyor by the gripping means 11, and forms a bight thereof which is advanced under the gripping means, and then blows air in under the portion of the article retained by the gripping means so that this portion is held more or less suspended in the air and does not impede the advance of the portion lying on the conveyor.

What we claim and desire to secure by Letters Patent is:

1. In an apparatus for folding bed sheets and like articles having a leading and trailing edge, the apparatus comprising a frame, a belt conveyor on said frame for successively receiving and transporting the articles, the combination of lifting and gripping means including a gripping member for temporarily retaining above said conveyor the leading edge of each article arriving thereon, means for operating said lifting and gripping means, first sensing means immediately ahead of said lifting and gripping means and connected to said operating means and actuated by the leading edge of said articles for causing the lifting and gripping means to grip and lift the leading edge of the article arriving thereat on the conveyor and then by the trailing edge of each article arriving thereat on the conveyor for causing said gripping member to drop the leading edge of each article on the trailing edge thereof, thus folding the article in halves and forming a fold as the lead portion of the folded article which moves past the lifting and gripping means in the folded condition, a plurality of second sensing means arranged in two groups, one ahead of and one after said lifting and gripping means, to be actuated by the trailing edge and by the fold, respectively, of each article, the respective sensing means of one group being coupled with the respective sensing means in the other group in pairs with the two sensing means in each pair connected with each other and with said operating means and spaced from said lifting and gripping means on opposite sides thereof to cause, when actuated simultaneously, said gripping member to release its grip for folding the article in a predetermined ratio other than in halves, and selector means for connecting and disconnecting said second sensing means.

2. The combination according to claim 1 in which said second sensing means comprise electric contacts, and the two contacts in each of said pairs are adapted to be closed simultaneously by the trailing edge and the leading portion, respectively, of an article, and are connected in series, and in which said operating means includes a relay connected in series with all contact pairs, and a solenoid controlled by the relay and adapted, when energized, to operate said gripping member for releasing the leading edge of the article.

3. The combination according to claim 1 in which said second sensing means comprise electric contacts, and the two contacts in each of said pairs are adapted to be closed simultaneously by the trailing edge and the leading portion, respectively, of an article, and are connected in series, and in which said operating means includes a relay connected in series with all contact pairs, and a solenoid controlled by the relay, a pneumatic piston motor for operating said gripping member and a valve operable by said solenoid for controlling said pneumatic piston motor.

4. The combination according to claim 2 further including a movable actuating member on each of said contacts and spring-loaded in one direction, a vane on each actuating member, a plurality of nozzles directed each towards one of said vanes, and means for generating an air stream through each nozzle for actuating said contacts by said air streams acting on said vanes and thereby overcoming the spring load of said actuating members, said nozzles being placed so as to be prevented from delivering such air streams by the articles passing said nozzles.

5. The combination according to claim 4 in which said nozzles and said vanes are placed on opposite sides of a plane in which the articles are transported, and said nozzles are adapted to be connected to a supply of air under pressure.

6. The combination according to claim 4 in which said vanes are placed in a suction box adapted to be connected to a vacuum source, and said nozzles are passages leading into said suction box and having their inlet openings located in a plane in which the articles are transported, in order to be covered by the articles.

7. The combination according to claim 1 further including nozzle means placed above said conveyor just ahead of said gripping member to blow air forwardly

in the direction of movement of said conveyor between said conveyor and said gripping member.

8. The combination according to claim 7 in which said nozzle means consists of a tube extending across said conveyor and having a row of nozzles in one side.

9. The combination according to claim 7 in which said nozzle means consists of a tube extending across said conveyor and having a slot in one side.

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