Jan. 13, 1970 E. D. NYSTRAND 3,489,406

FOLDING APPARATUS

Filed June 7, 1967 2 Sheets-Sheet 1

FIG. 1

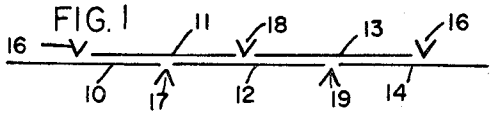


FIG. 2

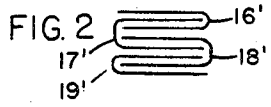


FIG. 3

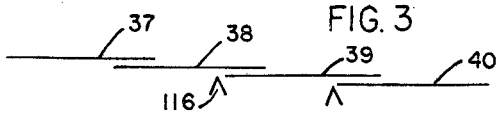


FIG. 4

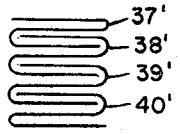


FIG. 5

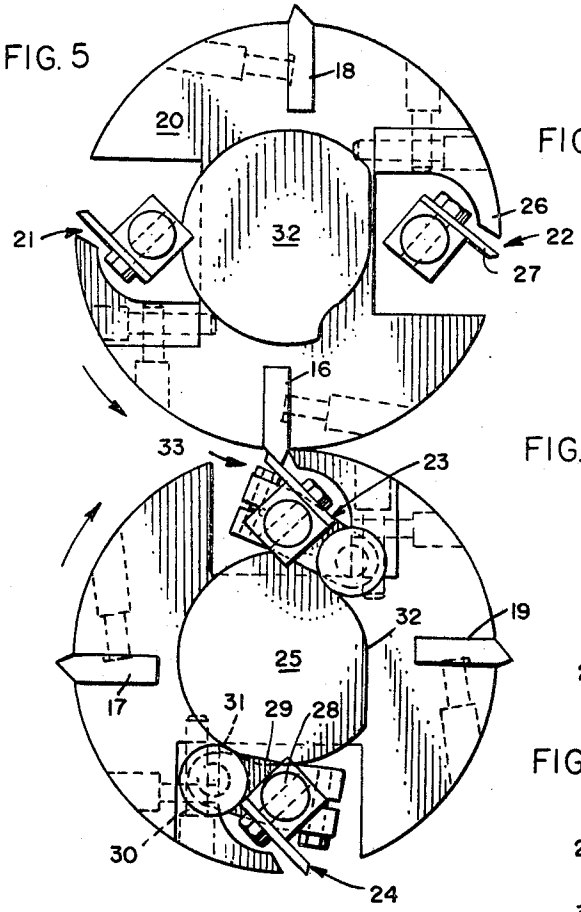


FIG. 6

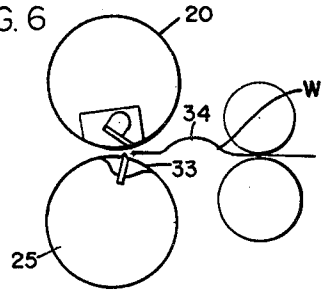


FIG. 7

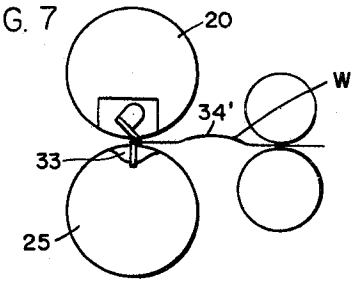


FIG. 8

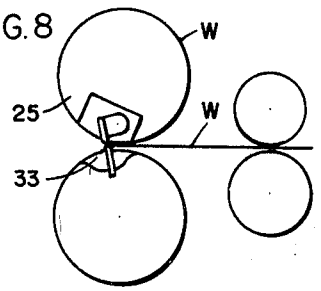
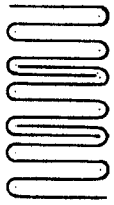


FIG. 10



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FOLDING APPARATUS

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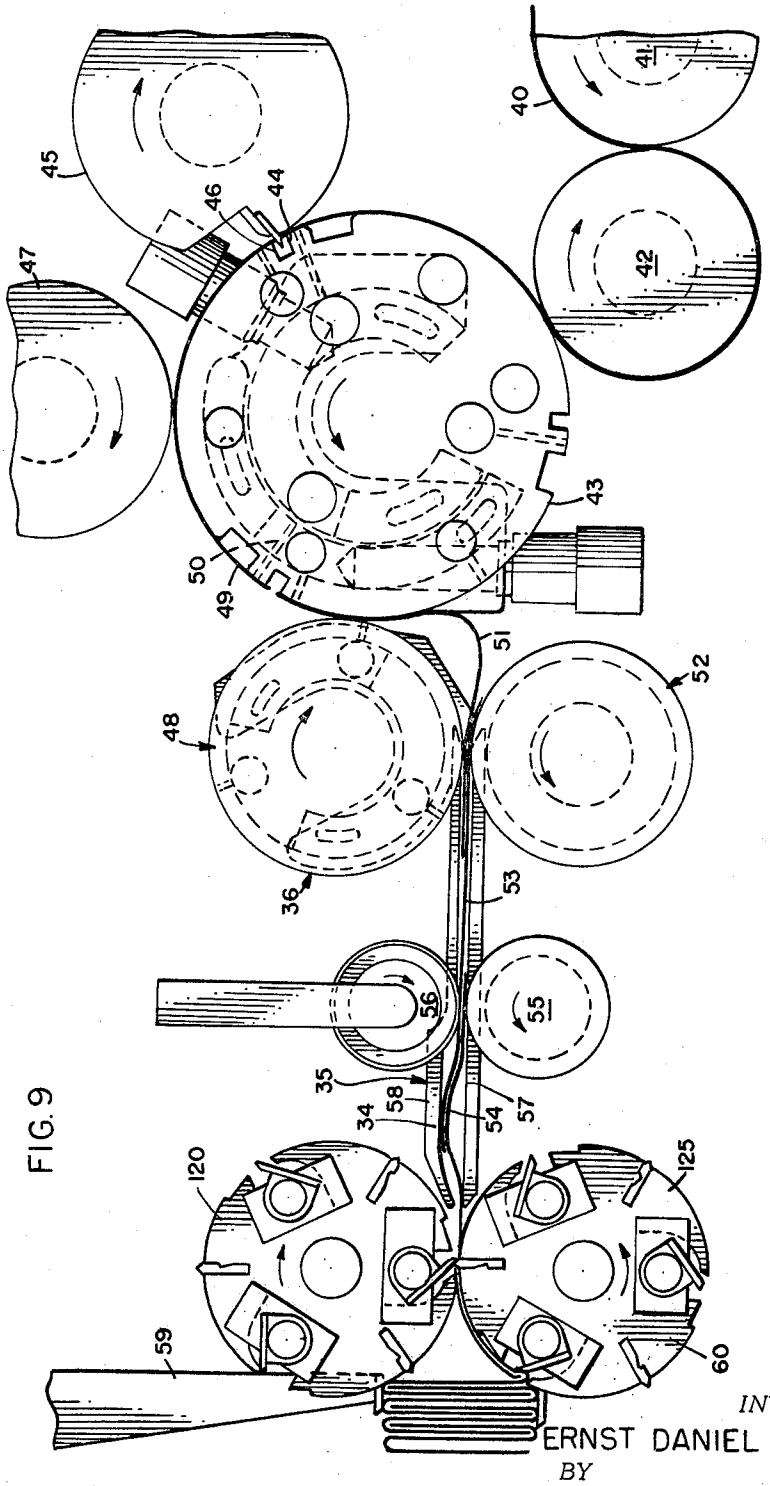


FIG. 9

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3,489,406

FOLDING APPARATUS

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Filed June 7, 1967, Ser. No. 644,375
Int. Cl. B41l *1/32;* B65h *23/02, 45/16*
U.S. Cl. 270—39 3 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus in which folding rolls are equipped with tuckers and grippers cooperating with higher lineal speed feed rolls to create an accumulation of web material between the two sets of rolls, the finger portion of the gripper trailing the anvil portion and the tucker tip having a greater lineal speed than the gripper tip, the folding rolls being relieved behind one of a cooperating tucker or gripper pair to permit slack to be taken from the accumulation both during tucking and final closing of the gripper portions.

SUMMARY OF INVENTION

The prior art has been mainly concerned with tucker tips that project radially further than the cooperative gripper tips. Previously, I determined that a reversal of this procedure provided significant advantages and this is found in my Patent No. 3,195,882. The apparatus of the above identified patent is particularly effective with zigzag folding a continuous web such as are used for copy forms. This invention, on the contrary, is concerned with the older art form wherein the tuckers project further than the grippers and is especially adapted for use with overlapped webs—sheets of discrete length such as are especially useful as towelling, tissue, etc. To obtain the precision in folding and develop satisfactory speed, I have found that it was necessary to provide a unique web accumulation arrangement, and the provision of such is a principal object of the invention.

The invention is explained in conjunction with the accompanying drawing, in which—

FIG. 1 is a schematic representation of overlapped web materials about to be folded in V-fashion;

FIG. 2 is a schematic representation of a stack of web materials developed from the folding operation indicated in FIG. 1;

FIG. 3 is another schematic representation of webs in the about to be folded from a one-third overlap condition;

FIG. 4 is a schematic representation of the Z-folded web stack resulting from the operation indicated in FIG. 3;

FIG. 5 is a fragmentary elevational view of folding rolls constructed according to the teachings of the invention and which are useful in the development of the V-folded web of FIG. 2;

FIGS. 6–8 are schematic representations of the sequence of operations in the inventive apparatus and where the accumulation is seen to be selectively withdrawn during various stages of the folding cycles;

FIG. 9 is a fragmentary elevational view of another embodiment of the invention embodying three-time folding rolls along with the previously mentioned lapping apparatus and which are useful in producing the Z-fold seen in FIG. 4; and

FIG. 10 is a schematic representation of a five-time fold which also can be developed according to the practice of the invention.

One type of fold made possible through the practice of the invention is seen in FIGS. 1 and 2. I provide a sequence of overlapped webs—and one apparatus suitable for doing this is seen in greater detail in FIG. 9. In proceeding from the left to right the overlapped webs are designated respectively **10**, **11**, **12**, **13** and **14**. These webs are indicated to be contacted by tucking means as at **16**, **17**, **18**, **19** and **16** again, corresponding to the showing and designation in FIG. 5. The folds so developed are designated **16'–19'**, respectively, in FIG. 2.

It will be seen from FIG. 5 that the tuckers **16** and **18** on the upper folding roll **20** project further, beyond the periphery of the roll **20**, than do the grippers which are generally designated **21** and **22**. In similar fashion, the grippers **23** and **24** are shorter than the tuckers **17** and **19** on the lower folding roll **25**—in practice the tips of the grippers lying within the gear pitch diameter while tips of the tuckers project beyond the pitch diameter. Each gripper includes an anvil portion as at **26** and a pivotal finger portion as at **27**. From the arrows indicating the direction of rotation of the rolls **20** and **25**—the latter referring to the lower folding roll—it will be seen at the anvil portion **26** precede or are ahead of the finger portions **27**. Each finger portion **27** is mounted on a through-shaft **28** (see the lower portion of FIG. 5) and which is journalled within the end closures of its associated roll. The finger portion **24** is anchored to a block **29** fixed to the shaft **28**. The angular orientation of the shaft **28** is controlled by a cam follower **30** which is spring urged as at **31** against a cam surface **32** provided at the ends of the roll and within the side frames, all of which can be seen typically in my above mentioned patent. The arrangement is essentially the same except for the fact that the cam followers here lead the fingers **24** instead of trailing the same. The cooperation of the cam follower **30** and the cam **32** results in opening and closing the fingers **27** against the anvils **26** and, in so doing, gripping the web materials so as to develop a fold.

As mentioned previously, a relief is provided for each cooperating set of tuckers and grippers and this is designated generally by the numeral **33** in FIG. 5. In the illustration given, I prefer to have the relief trailing each gripper. Under certain circumstances, the reliefs may be provided in a position trailing the tuckers or in both rolls, i.e., trailing both the tuckers and grippers.

The use of the relief **33** is illustrated in FIGS. 6–8, particularly FIG. 7, with respect to an accumulated web W in which slack is provided as at **34** in FIG. 6. One specific apparatus for achieving this is seen in FIG. 9 where the slack accumulator is generally designated **35** and is interposed between one pair of folding rolls **120** and **125** at the extreme left of the drawing and the advancing mechanism generally designated **36**. The mechanism **36** operates at a lineal speed greater than the surface speeds of the folding rolls **120** and **125** so that when the relief **33** is not in confronting relation to the web W, the slack is developed as at **34** in FIG. 6. The folding rolls **120** and **125** differ from the rolls **20** and **25** in being "three-time" rolls for the development of the Z-fold as seen in FIG. 4.

As a given tucker, such as that designated **16**, engages its cooperating gripper **23**, the amount of accumulated web **34** is reduced to accommodate the "tucked in" por-

tion, resulting in the configuration designated **34'** in FIG. 7. At this juncture, the relief **33** is in confronting relation to the web W and a certain portion of the web W is forced into the relief **33** so that as the tucker **16** retracts from between the portions **26** and **27** of gripper **23**, the excess web required at this stage of operation is available from the accumulation **34'** and, more particularly, the accumulated portion in the relief **33**.

Referring now to FIGS. 3 and 4, a Z-fold arrangement is provided wherein successive sheets or webs **37**, **38**, **39** and **40** resulting in folded webs **37'**, **38'**, **39'** and **40'** are developed by tuckers shown in FIG. 3 and designated generally by the numeral **116** in cooperation with grippers (not shown). This is the type of web developed by the operation of the apparatus seen in FIG. 9.

Turning now to FIG. 9, a web **40** (see the extreme righthand portion) is travelled over a spreading roll such as a Mount Hope roll (not shown) and through draw rolls **41** and **42** and over a bedroll **43**. Here the web is carried by vacuum and cut by serrated blades as at **44** mounted on a cutoff roll **45**. Each blade **44** cuts the web as it enters a mating groove **46** in the bedroll **43**. A pinch roll **47** prevents the web from backing up at the cutoff and insures better and cleaner cutoff. As the leading edge of the cut web comes close to the retard roll **48**, the vacuum holding the leading edge against the bedroll **43** is valved off and the corresponding vacuum in the retard roll **48** is valved on to transfer the leading edge from one roll to the other. The retard roll **48** has a surface speed ⅔ of the surface speed of the bedroll **43**. There is a space of approximately 0.025"–0.030" between the rolls **43** and **48**. As the leading edge slows down and travels around the roll **48**, additional vacuum ports in roll **43** try, because of the higher speed, to crowd the paper back of the leading edge through the gap between the rolls **43** and **48**. An axially oriented ditch or recess **49** following the vacuum ports **50** give this surplus paper a place into which to bend during this critical interval. As soon as the ditch or recess **49** has travelled past roll **48**, the web billows out away from the roll **48** as at **51**. The trailing edge of the cut web follows roll **43** until released (when vacuum is shut off) and the web pulled into the nip between rolls **48** and **52**.

As the rolls **48** and **52** travel slower than roll **43**, each succeeding sheet laps the previous one in amount equal to the difference in distance travelled by each cut of roll **45**. Therefore, the overlap is equal to ⅓ the cut sheet length. This method of lapping has shown a reliability at high speeds above 500 feet per minute which never before has been approximated. In this connection, the above described lapping apparatus differs significantly from that shown in the co-pending, co-owned application of Ernst Daniel Nystrand and Harvey J. Spencer, Ser. No. 438,560, filed Mar. 10, 1965, now Patent No. 3,338,-575.

The general details of the frame and roll rotating means have been omitted for ease of presentation. It will be appreciated that the disclosures of the above-mentioned patent and patent applications are applicable here in that regard and are thus incorporated by reference.

As the lapping action is completed, the overlapped webs as at **53** and **54** are passed between the slitter bedroll **55** and score slitter **56**, and then into the accumulator **35** which is seen to include a pair of plates **57** and **58** allowing slack to accumulate in the web portion **34** as shown. The following is a description of the operation of the folding rolls **120** and **125**.

OPERATION

Folding rolls **120** and **125** also have the unique gripper-and-tucker arrangement. By having each finger **27** trail its associated anvil **26** rather than lead it as in conventional folding rolls, the finger follows the more rapidly moving tucker portion that is extended beyond the gear pitch line until the tip of the tucker has disengaged itself from the mating gripper portions. At the moment of disengagement of the tucker from the gripper the gripper finger completes its closing movement, i.e., the finger moves against the anvil without any bounce or clatter. With this method, the roll bodies may be cylindrical with a nip setting that controls the web between the rolls. The surface speed of the rolls **120** and **125** must be somewhat less than the rolls **48**, **52** and **55** to make up for the amount of material tucked in and held between the tucker and the anvil. Thus, at the moment the tucker starts entering between the finger and the anvil, there has to be a surplus of material accumulated as at **34** in FIG. 6. This surplus has to be more than on conventional folding rolls as it is needed for the entering of the tucker between the finger and the anvil ahead of center as well as for the closing of the finger against the anvil past center, i.e., the line connecting the axes of the rolls **120** and **125**. On conventional folding rolls, where the finger leads the anvil and the excess material required for closing of the gripper comes from the downstream side, not the upstream side as is required on this design. The web-guiding members or strippers must therefore contain a bulge **34** to accommodate and control the surplus material. Following the gripper must be a relieved portion as at **33** on the cylindrical envelope, either on the roll carrying the gripper or on the roll carrying the tucker, or both, in order for efficient clearance between the rolls to permit closing of the gripper and for the final part of the surplus material to be pulled through the gap between the rolls. When this is accomplished, the cylindrical surfaces of the rolls again grip and control the web to prevent any of the surplus being formed from pushing itself through the exit side of the nip.

Packer fingers **59** and **60**, cam-actuated, may be used to good advantage to help disengage the gripped web portions from in between the anvil and fingers to form the package. These packer fingers also hold the formed package away from the tuckers as these sweep by.

I have determined that for optimum operation, the relieved portion as at **33** should extend slightly past center at the time the tucker is just disengaging the gripper. This insures that the above-mentioned gripping of the web occurs at just about the proper moment to maintain the surplus web always on the upstream side of the folding rolls.

While in the foregoing specification a detailed description of an embodiment of the invention has been set down for the purpose of illustration, many variations in the details herein given may be made by those skilled in the art without departing from the spirit and scope of the invention.

I claim.

1. Folding apparatus comprising a frame, a pair of folding rolls each equipped with at least one tucker and one gripper for cooperative action in zigzag folding web material, means for rotating said folding rolls, each gripper including an anvil and a pivotable finger for gripping web material tucked therebetween by the cooperating tucker, the anvil preceding said finger in the direction of rotation of said rolls, the tip of each tucker being positioned further from the axis of its associated roll than the tip of the cooperating gripper from the axis of its associated roll to develop a greater lineal speed in each tucker tip than in the cooperating gripper tip, means operatively associated with said folding rolls to feed said web material to said folding rolls at a lineal speed greater than the surface speed of said rolls, said means being spaced from said folding rolls to provide a space for accumulating slack web material, said folding rolls being equipped with confronting surface portions ahead of each corresponding tucker and gripper to selectively clamp spaced portions of said web material and thereby withdraw slack material from the accumulated web material upon tucking, at least one of said rolls being equipped with relief-providing means in the surface portion thereof im-

mediately following each cooperating tucker and gripper to accommodate web material from the accumulated web material.

2. The structure of claim 1 in which said means includes lap-providing means for supplying web material in discrete overlapping lengths.

3. The structure of claim 1 in which said relief-providing means is constructed and arranged to provide a relief extending circumferentially rearwardly from a cooperating gripper and tucker slightly past the connective center line of the two folding rolls when the tucker of the last-mentioned cooperative gripper and tucker has just withdrawn from the gripper cooperating therewith.

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EUGENE R. CAPOZIO, Primary Examiner

PAUL V. WILLIAMS, Assistant Examiner

U.S. Cl. X.R.

270—46, 72