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[54] **WEB TENSIONING WITH ADJUSTABLE COUNTERWEIGHTS FOR CONTROLLING THE SPACING OF IMPRINTS**
3 Claims, 1 Drawing Fig.

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[50] **Field of Search** ..... 101/219-—228, 178—182, (Web Tensioning Digest), 426; 226/27—29, 2, 195; 242/75, 75—2

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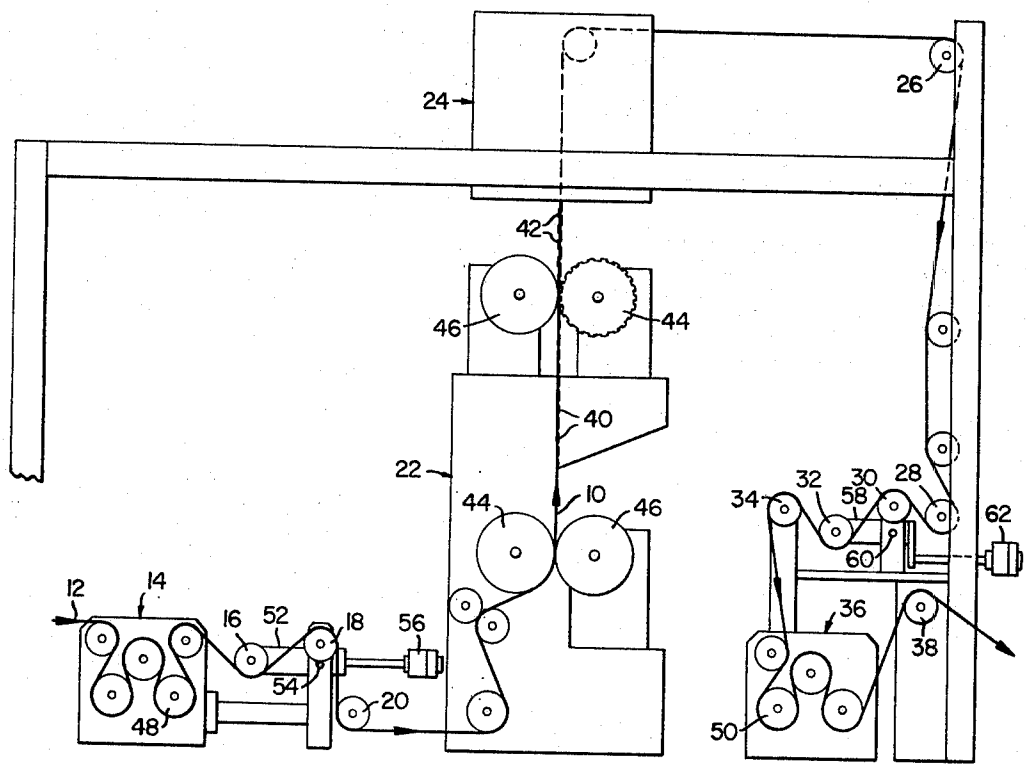
ABSTRACT: A sheet-handling apparatus in which a sheet is moved past a printing assembly and which has independent first and second variable force sheet tensioning devices disposed upstream and downstream, respectively, of the printing assembly. The forces exerted by the tensioning devices are varied as determined by control means to increase or decrease the speed with which the sheet moves past the printing assembly and thereby control the relative position of imprints from the assembly on the sheet.



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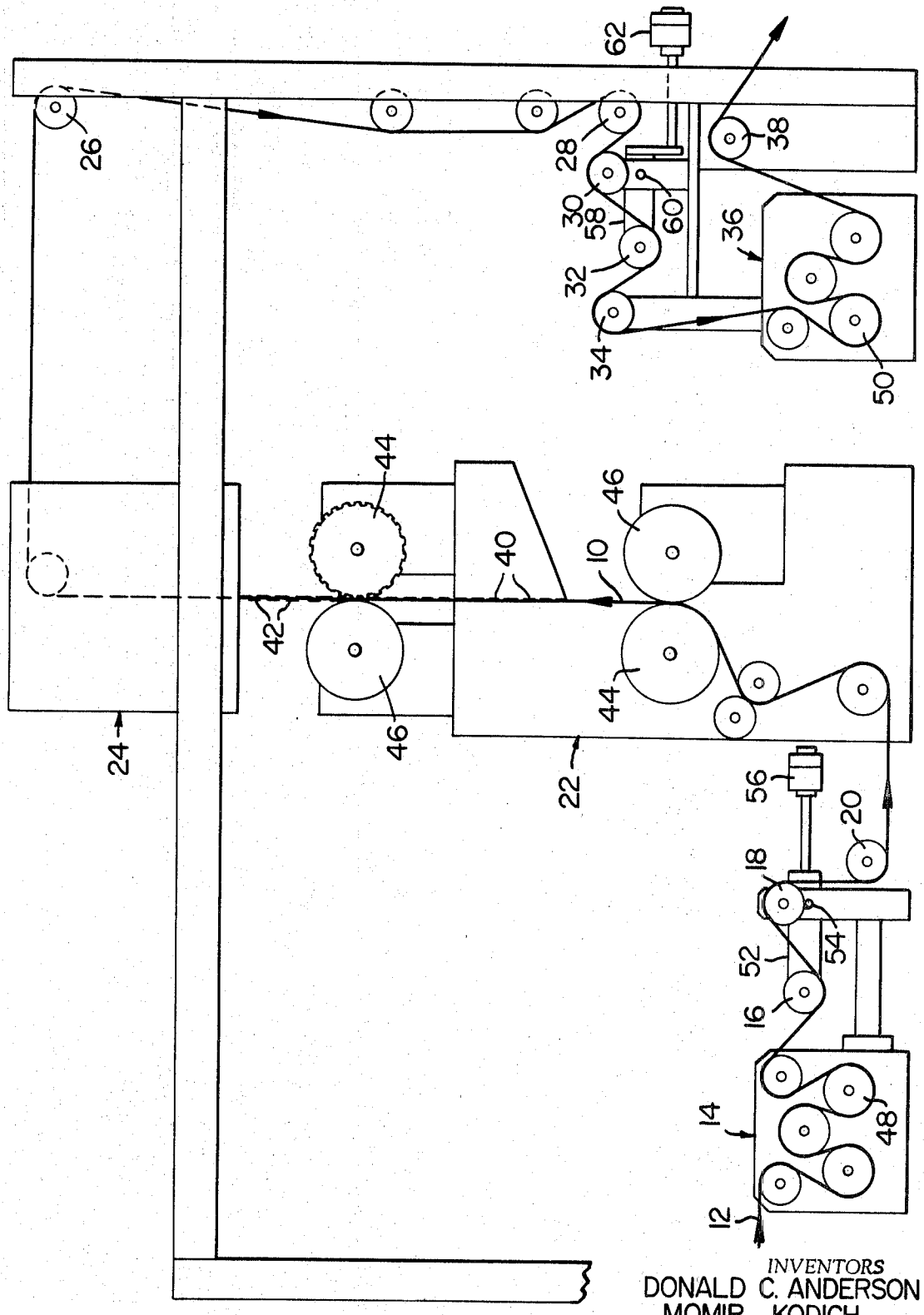

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WEB TENSIONING WITH ADJUSTABLE COUNTERWEIGHTS FOR CONTROLLING THE SPACING OF IMPRINTS

This is a continuation of Ser. No. 587,716, filed Oct. 19, 1966 now abandoned.

This invention relates to improvements in sheet-handling apparatus and, more particularly, to apparatus and a method for accurately controlling the spacing of transverse printed lines on a movable web.

The present invention resides in apparatus and a method for applying controllable tension forces to a movable sheet or web to which transverse printed lines are applied as the web moves through a printing station. The purpose of controlling the tension is to permit minute changes to be made in the speed of web relative to the printing structure. These speed changes have a direct effect on the precise spacing of lines on the web. Thus, to increase the line spacing, the web speed is increased, with respect to the printing roll surface speed and to decrease the line spacing, the web speed is decreased. The speed changes result from changing the tension in the web upstream or downstream of the printing station. Extremely fine control in the line spacing can be attained since the change in the tension force on the web can, in practice, occur in relatively small increments.

The concepts of this invention are especially adapted for use in the manufacture of honeycomb core structures by an expansion process wherein a number of sheets provided with transverse glue lines thereon are stacked so that adjacent sheets become connected together at the glue lines. It is extremely important that the glue lines of alternate sheets be accurately located to assure that the honeycomb configuration results when the stack of sheets is expanded. Otherwise the cells of the honeycomb core will be irregular in size and shape and the core itself will not be homogenous throughout. The glue line spacing is the critical parameter assuming the sheets are properly cut and stacked, since this spacing must not vary from sheet to sheet to any appreciable extent.

The present invention assures that the glue line spacing will be within a predetermined range by controlling the speed of the web through the printing station. The spacing of the lines can be monitored to determine if the lines are to be properly applied to the web so that corrections can immediately be made, if necessary, by varying the tension of the web. The web, after it has been printed, may then be cut into sheets for stacking in the manner described or may be wound on a roll for subsequent use.

Required variations in the line spacing will generally be extremely small for any given cell size, usually in the order of no more than about 0.010 to 0.020 inch per 10-foot linear web length. Provision must therefore be made for relatively small changes in the speed of the web. The present invention allows for this by providing structure for applying constant tension forces to the web upstream and downstream of the printing rolls while permitting the tension forces to be varied. The resulting tension balance or inbalance on the upstream and downstream sides of the printing rolls thus effects either an increase or a decrease in web speed. A preferred form of the structure for applying web tension is a rockable dancer arm having an adjustable counterweight thereon. A dancer roll mounted on the dancer arm applies a force of a magnitude which is determined by the setting of the counterweight to one face of the web. Relative large changes in counterweight operating position and the resulting changes in the web tensioning influence the web speed past the printing rolls in only minute increments. Thus the invention provides a simple, stepless, micro-control and adjustability of the web speed past the printing rolls and economical means for adjusting the print line spacing.

Furthermore, the present invention isolates the web portion passing the printing rolls from the upstream web payout drum and the downstream web takeup drum with capstan drive means positioned between the printing rolls and the payout and takeup rolls. Variations in the web tensioning between the capstan drive means and the payout and takeup rolls are

thereby prevented from causing an unintentional change in the tensioning balance or inbalance of the web portion disposed on the upstream and downstream sides of the printing rolls. Such a change in the web tensioning would alter the print line spacing for the above-described reasons.

The primary object of this invention is to provide a sheet printing apparatus and method wherein a movable sheet is subjected to variable tension forces as it passes through a printing station or nip so that minute changes in the speed of the sheet relative to the theoretical speed of the printer nip can be made by varying the tension forces on the sheet to thereby permit minute changes in the pattern with which the sheet is printed at said station.

Another object of this invention is to provide apparatus of the type described wherein spaced, transverse lines are printed on the sheet as it moves through the printing station and the speed of the sheet relative to the printing station can be varied by changing the tension of the web on one side of the station, whereby the rate at which the lines are applied to the sheet and thereby the line spacing can be made a function of the sheet speed and thereby the sheet tension.

Other objects of the invention will become apparent as the following specification progresses, reference being had to the accompanying drawing.

The drawing shows a schematic representation of the apparatus of the invention through which an elongated, flexible sheet or web **10** passes. One end **12** of the web is shown as it enters drive means **14**. The source of web **10** may, for example, be a roll adjacent to drive means **14**.

After leaving drive means **14**, web **10** passes beneath a dancer roll **16**, about a pair of idler rolls **18** and **20** and then into and through a printing station **22**. The web passes out of the printing station into and through a drying station **24**, out of the drying station and about idler rolls **26**, **28** and **30**, and then about a second dancer roll **32**. The web then passes about an idler roll **34** and into and through second web drive means **36** from whence it passes over an idler roll **38** and then to a point of use or to another roll on which it is wound.

As the web passes through printing station **22**, it is printed with transverse lines **40** and **42** on opposed sides thereof. The printed lines are dried in chamber **24** before the web emerges and passes to the downstream rolls and drive means. Dancer rolls **16** and **32** maintain tension on the excess web length or loops between drive means **14**, **36** and printing station **22**, on the upstream and downstream portions of the web as it is being printed. These tension forces are independent of the moving forces applied to the web by drive means **14** and drive means **36**. Thus, these tension forces act on the printer nip rolls **44** and **46** and determine the speed of the web through printing station **22** inasmuch as the upstream and downstream tensions are unequal in magnitude and thereby provide a resultant unbalanced force on the web.

The printing structure at station **22**, for purposes of illustration, includes a pair of printing zones defined by opposed nip rolls **44** and **46**. As shown in the drawing, one set of rolls is disposed above the other set but this arrangement can be changed if desired. Rolls **46** provide the means by which the lines **40** and **42** are applied to the moving web whereas rolls **44** provide backing support for respective rolls **46**. Rolls **44** and **46** are rotated under the influence of a power source which is independent of drive means **14** and drive means **36**. Thus, the speed of the web through printing station **22** can be minutely increased or decreased with respect to the surface speeds of rolls **44** and **46**, without interaction with drive means **14** and **36**.

Drive means **14** includes a drive roll **48** forming a part of an S-drive unit whereby the web is partially wound about roll **48** and is held in frictional engagement therewith. Similarly, drive means **36** has a drive roll **50** forming a part of an S-drive unit for the same purpose.

Each of the dancer rolls **16** and **32** are mounted on one end of a dancer arm pivotally mounted for rotation about a horizontal axis. Arm **52** on which roll **16** is mounted is rotata-

ble about an axis **54** and has an adjustable counterweight **56** at its opposite end. Arm **58** to which dancer roll **32** is connected is pivoted on an axis **60** and also has an adjustable counterweight **62** on its opposite end. The dancer arms are mounted for free pivotal movement on suitable supports so that dancer rolls **16** and **32** rest on and are supported by the upper face of web **10**.

In operation, the tension forces on the web upstream and downstream of station **22** are initially established by adjusting the operative positions of counterweights **56** and **62** along respective arms **52** and **58**. Thus, the weights of dancer rolls **16** and **32** as partially counteracted by counterweights **56** and **62** will be the sources of the upstream and downstream tension forces, respectively.

Drive means **14** and drive means **36** are placed in operation and simultaneously with this action, rolls **44** and **46** of printing station **22** will be caused to rotate in the proper directions to effect printing of lines **40** and **42** on the web as it moves toward the drying station.

For given upstream and downstream tension forces and given conditions of speed, impression pressure, wet thickness, etc. at rolls **44** and **46**, the spacing between adjacent lines on either face of the web will be a predetermined value. This spacing can be monitored at a convenient location downstream of printing station **22**. If the spacing departs from the desired value, it can be changed by varying either or both of the upstream and downstream tension forces.

For instance, if it is desired to increase the spacing, the downstream tension can be increased by moving counterweight **62** closer to axis **60**. This action increases the effective weight of dancer roll **32** as applied to the moving web. The spacing can also be increased by decreasing the upstream tension force on the web by moving counterweight **56** in a direction away from axis **54**. Also, the tension increase can be a combination of these two steps.

To decrease the spacing the downstream tension force can be decreased or the upstream tension force can be increased or the change can result from a combination of both of these steps. For either a net increase or a net decrease in the tension forces, there will always be a change in the operating speed of the web through the printing station and this speed change is always relative to the linear speeds of rolls **44** and **46**. Thus, the line spacing on the web is a direct function of the upstream and downstream tension forces on the web.

The advantage of using both upstream and downstream tension applied by rolls **16** and **32** is that increased sensitivity is achieved for web thicknesses of substantially any workable gauge. This is important since significant changes in line spacing are extremely small in many types of applications such as in the manufacture of honeycomb core structures. These small spacing changes can be of the order of .01 percent which could, for example, correspond to a change of .005 inch in 50 inches. It is clear, therefore, that this invention provides the sensitivity needed to maintain the web spacing at a desired value.

Means for applying tension to the web other than that described herein can be used if desired. Thus, the invention is not limited to the use of pivotal dancer arms.

It will now be clear that the isolation of the printing station and printing rolls from the payout and takeup drums prevents relatively uncontrollable forces exerted by the payout and takeup drums from influencing the web tension on the upstream and downstream sides of the printing rolls. Variations in the relative speeds between the web passing the printing station and the printing roll surfaces from slippage due to uncontrolled inbalances in the web tension on the upstream and downstream sides of the printing rolls are thus avoided. In this manner, the web speed and the printing roll surface speed can be equalized, or varied if required, to control and maintain an exact spacing of the print lines on the web without discernible tolerances.

While one embodiment of this invention has been shown and described, it will be apparent that other adaptations and modifications can be made without departing from the true spirit and scope of the invention.

We claim:

1. Sheet-handling apparatus comprising: a support; a printing assembly on said support including a pair of rotatable rolls in proximity to each other and disposed for receiving therebetween a flexible sheet movable along a path of travel transverse to said rolls, whereby the sheet is printed as it moves between the rolls; a first dancer arm on said support upstream of said printing assembly with respect to said path, said first dancer arm being disposed for engaging the sheet to apply a first tension force thereto acting in the upstream direction thereof; a second dancer arm on said support downstream of said printing assembly and disposed for engaging the sheet to apply a second tension force thereto acting in the downstream direction thereof, each of said dancer arms being mounted intermediate its ends for free pivotal movement about a horizontal axis and having a sheet-engaging roller at one of its ends and an adjustable counterweight at its opposite end; first sheet drive means upstream of said first dancer arm for moving the sheet in the downstream direction; and second sheet drive means downstream of said second dancer arm for moving the sheet in said downstream direction.

2. Sheet-handling apparatus comprising: a sheet printing assembly adapted to be disposed in the path of travel of a movable sheet; means upstream of said assembly and engageable with said sheet on said path for applying a first tension force to the sheet; means downstream of said assembly and engageable with said sheet for applying a second tension force to the sheet; each of said upstream means and said downstream means including an arm mounted intermediate its ends for free pivotal movement about a horizontal axis, roller means on one end of the arm for engaging the sheet, and an independently adjustable counterweight on the opposite end of the arm, whereby the difference between the weight of said roller means and the counterweight will define a force exerted on the sheet to provide the respective tension force; and drive means independent of said upstream means and of said downstream means for moving said sheet in one direction along said path.

3. In a method for substantially instantaneously adjusting the speed of a sheet passing a sheet-handling station to maintain the spacing between adjacent transverse print lines imprinted on the sheet at said station constant over the length of the sheet, the method including the steps of feeding the sheet towards the sheet-handling station; passing the sheet through the sheet-handling station; withdrawing the sheet from the handling station; printing spaced lines on said sheet as it moves through said station, the lines being spaced in a direction transverse to the movement of the sheet; and adjusting the tension applied to the sheet at the upstream and downstream positions of the station, the adjustment of the tension being performed by means upstream of said station and engageable with the sheet for applying a first tension force to the sheet and by means downstream of said station and engageable with said sheet for applying a second tension force to the sheet, each of said upstream means and said downstream means including an arm mounted intermediate its ends for free pivotal movement about a horizontal axis, roller means on one end of the arm for engaging the sheet, and an independently adjustable counterweight on the opposite end of the arm, whereby the difference between the weight of said roller means and the counterweight will define a force exerted on the sheet to provide the respective tension force, the improvement comprising the steps of: applying a first tension force downstream of the station to the sheet with the downstream roller engaging means; applying a second tension force upstream of the station to the sheet with the upstream roller engaging means; monitoring the spacing between said lines printed onto the sheet; adjusting the weight on at least one of the counterweights to thus vary at least one of said tension forces in response to changes in the spacing of said lines to change the speed of the sheet moving past said station and thereby maintain said constant spacing between said lines; and maintaining the varied effective force constant until a change in said constant spacing between said print lines is again monitored.