

June 18, 1963

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3,094,320

MULTIPLE WEB COLLATING AND FOLDING APPARATUS

Filed Dec. 20, 1957

4 Sheets-Sheet 1

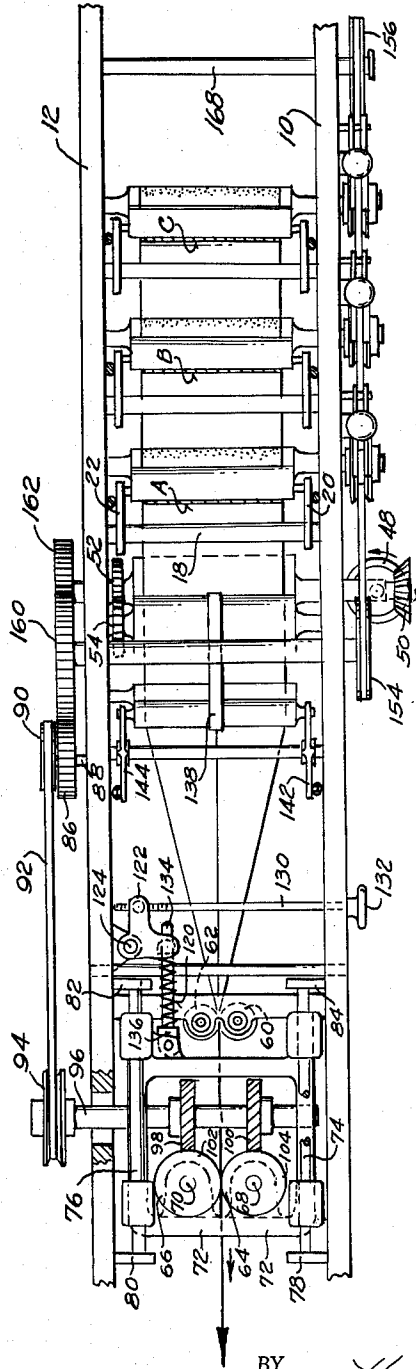


Fig. 1

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4 Sheets-Sheet 2

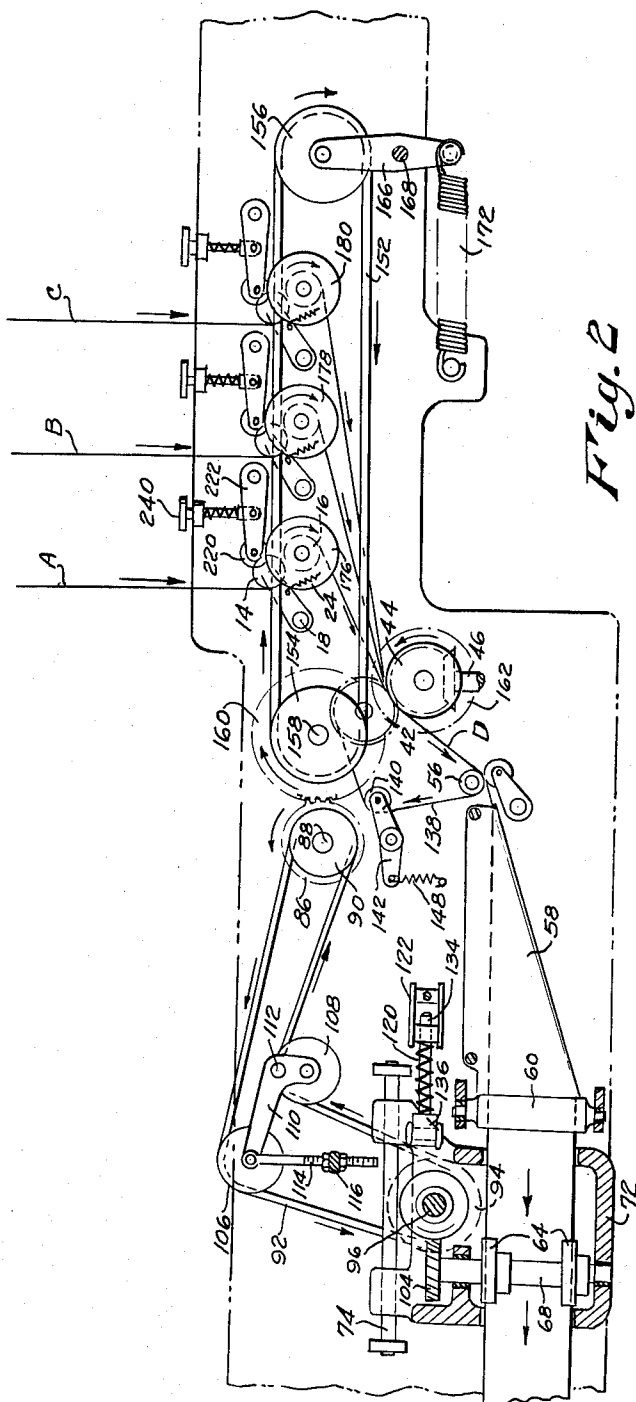


Fig. 2

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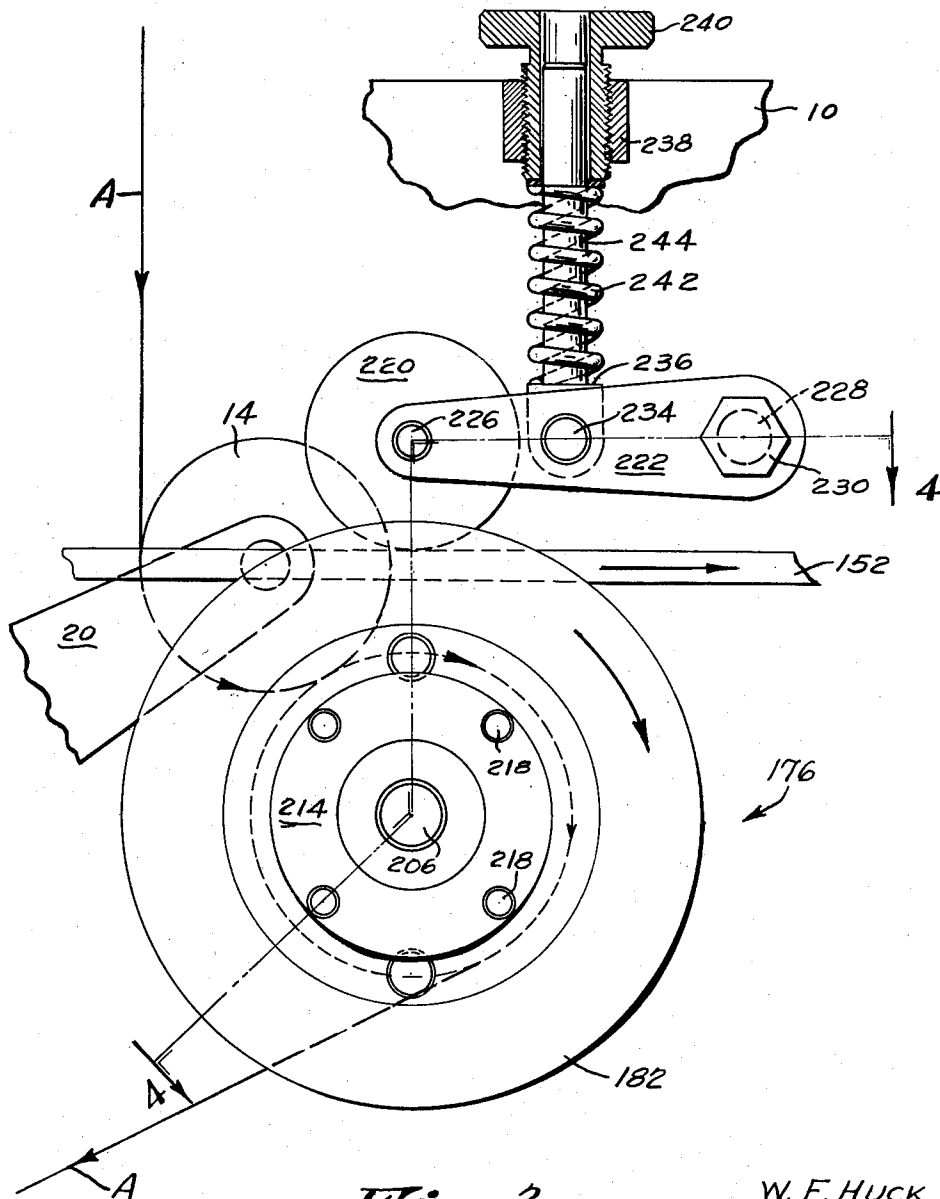
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4 Sheets-Sheet 3



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4 Sheets-Sheet 4

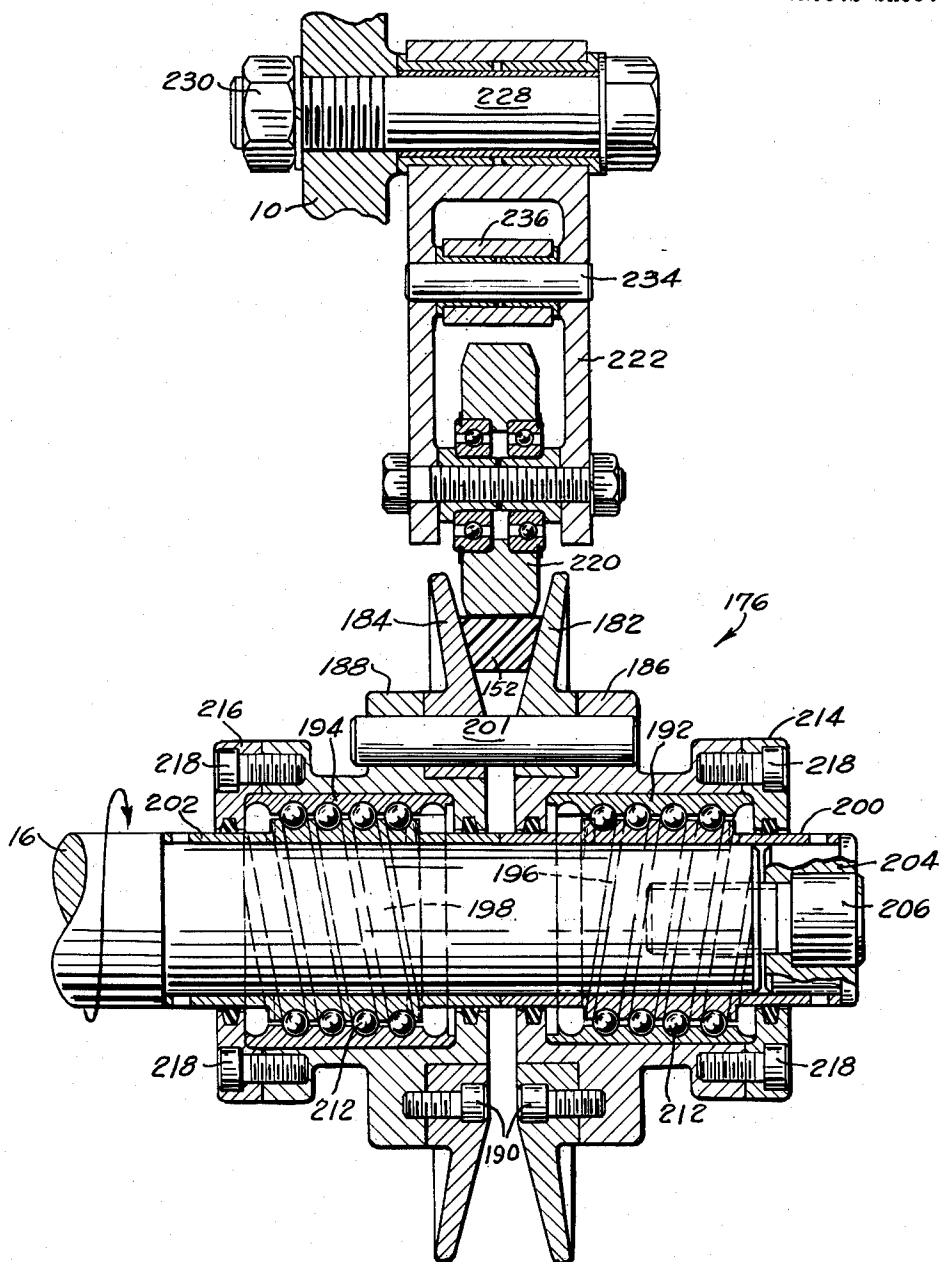


Fig. 4

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1

3,094,320 MULTIPLE WEB COLLATING AND FOLDING APPARATUS

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This invention relates to apparatus for handling a plurality of webs or ribbons, and more particularly to apparatus for the independent and joint control of tension in plural webs or ribbons that are being processed in a manner requiring that the webs or ribbons be collated into superposed relationship and then folded, as a group, longitudinally of the direction of web or ribbon travel.

A difficult problem exists in the handling of webs under the conditions noted, because not only must the individual web tensions be closely regulated to achieve efficient continuous operation without spoilage, but in view of the longitudinal folding operation the group tension of the collated webs must also be carefully controlled. An example of this problem occurs where a plurality of relatively narrow webs or ribbons have first undergone some processing such as printing, perforating, coating or the like, and are then to be combined into a collated or superposed group in good registry, which group is then to be folded about a longitudinal line with reference to web travel. Close individual tension control is necessary to avoid wrinkling, breakage and loss of register, and in view of the entirely different elastic or stiffness properties of the folded group (and which properties are not even the same at the open side of the folded group as at the closed or "spine" side), it is also necessary to provide a group tension control which can function independently but in a related manner with reference to the individual tension controls.

It is accordingly a principal object of the invention to provide web or ribbon handling apparatus incorporating individual automatic tension controls for the webs making up a collated group, a folding station for the collated group, and a separate automatic tension control for the collated web group leaving the folding station.

A further object of the invention is to provide apparatus of the above type in which individual web or ribbon tension regulators are provided, which may be manually (or otherwise) adjusted so as to maintain the desired feeding characteristics for a variety of different materials and conditions, numbers of collated webs, and other variables.

Another object of the invention is to provide a novel form of web tension regulating pulley, particularly adapted for joint control in groups by a single drive belt furnishing driving power for individual webs being fed into superposed or collated relationship.

In general, the above objects of the invention are accomplished by means of web handling elements driven by a common drive shaft and including separate provisions for feeding each of a plurality of webs or ribbons from separate supplies into a common plane or direction, the feeding means having individual automatic tension controls for the respective ribbons in the form of variable speed drive or feed pulleys. The collated ribbons then pass about a folding plate or guide and are thereby folded along a line which is longitudinal to the direction of collated web travel, being fed in this operation under the control of other tension regulating devices also of the automatic variable speed type. Finally, the collated and folded webs or ribbons are delivered to a station for further processing, cutting into desired lengths, or other operations.

The above and other objects and advantages of the invention will best be understood by referring now to the following detailed specification of a preferred embodiment

2

of the invention, given by way of example, and taken in connection with the accompanying drawings, in which:

FIGURE 1 is a top plan view of a complete ribbon handling apparatus in accordance with the invention.

5 FIGURE 2 is a schematic side elevation view of the same apparatus, parts being omitted, broken away or in section to clarify the showing.

FIGURE 3 is an enlarged elevational view, also partly in section, of one of the individual automatic tension con-
10 trols of the apparatus.

FIGURE 4 is a sectional view, taken along line 4—4 of FIGURE 3, illustrating details of the novel tension-controlling pulley of the invention.

In the embodiment of the invention to be described by way of example, three individual webs or ribbons are combined into a unitary collated group, but it is to be understood that the same principles will apply to different numbers of webs, and that they may be of cloth, paper, plastic, or even thin metal or the like so long as the necessary
15 bending and folding can be carried out.

The apparatus to be described may be used in various situations in which it is desired to perform certain operations upon each web of a plurality of webs and then to combine the individual webs into a unitary collated or superposed group, fold the group, and feed the product to
20 another location for further processing. One example of such use would be in the printing art where each individual web or ribbon has printed thereon certain material, and the webs are then brought together and superimposed in proper order to form the collated group which is then
25 folded in the desired manner and moved off for further processing such as cutting, stitching or otherwise binding the collated sections into booklets or the like. The original webs or ribbons may also or alternatively have been punched, perforated or the like to produce a final book of tickets. From such examples, it will be appreciated that properly correlated individual and group tension controls are required to maintain registry and alignment and to minimize spoilage. The individual web or ribbon tension
30 controls are also important because of the necessity, in practice, of using a common drive shaft for their feeding devices.

Referring now to the drawings, and first particularly to FIGS. 1 and 2 thereof, reference numerals 10 and 12 designate spaced side frame members for the entire apparatus. These side frame members may be extensions of the frames of a machine in which the individual webs or ribbons have had some operation performed upon them, or they may be entirely separate from other apparatus;
35 for example, where the individual webs or ribbons were completely printed, punched or otherwise prepared prior to the commencement of the collating and folding operations. The three individual webs or ribbons are designated A, B and C, and are led into the apparatus, as shown in FIGURE 2, in a downward direction. The web A passes between a pair of superposed pressure rollers 14 and 16 mounted on horizontal axes and located between the side frames 10 and 12. The upper pressure roller 14 is pivotally mounted by means of a pair of short pivot arms 20 and 22 which extend from the ends of the horizontal pivot shaft 18 supported in the side frames. The pivotally mounted pressure roller 14 is urged against the lower, fixedly mounted pressure roller 16 by a spring 24, one end of which is fastened to a side frame member, and the other end of which is fastened to the pivot arm 20.
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Webs B and C pass between roller pairs which are identical to those just described, further detailed reference to these additional roller pairs being deemed unnecessary, except to say that all of the rollers such as 16 are preferably on the same horizontal center line.

After each of the webs A, B and C has passed between its respective pressure roll sets in the manner described,

it is then directed laterally and downwardly (in FIG. 2) to a single pair of drive rollers 42 and 44 where the three webs are combined in a superposed fashion to form a unitary collated web group D. The drive rollers 42 and 44 are mounted on horizontal axes between the side frames and spaced apart in the vertical direction. The power for driving rollers 42 and 44 is taken from the main machine drive through a vertical shaft 46, bevel gears 48 and 50, and the spur gears 52 and 54.

After passing between the drive rollers 42 and 44, the collated or unitary ribbon group D travels to the left under a guide roller 56 mounted on a horizontal axis between the side frames so as to enter a triangular shaped or plow share folder 58 which folds the group D about its longitudinal center line (or even an offset line parallel to the center line), after which the partly folded web group, passes between the vertical-axis pinch rollers 60 and 62. These rollers complete the folding and crease the group as desired. The web group D then passes laterally between pairs of edge nipping rollers 64 and 66 rotatably mounted upon vertical shafts 68 and 70, the entire assembly of such nipping rollers being mounted on a carriage 72 arranged for horizontal lateral motion along a pair of horizontal guide rods or rails 74 and 76. The guide rails are supported from the side frames 10 and 12 by suitable brackets 78, 80, 82 and 84 as best shown in FIG. 1.

The nipping rollers 64 and 66 are driven from the main machine drive by means of a spur gear 86 carried by shaft 88 on which is also mounted a V pulley 90. A V belt 92 passes around the pulley 90 and a pulley 94 mounted on a horizontal shaft 96 which is mounted in a carriage 72 and also carries a pair of helical gears 98 and 100. The gears 98 and 100 mesh with a corresponding set of helical gears 102 and 104 which are mounted upon the upper ends of vertical shafts 68 and 70 respectively. Any slack in the V belt 92 is taken up by the idler pulleys 106 and 108 mounted on opposite ends of a crank lever 110, which is pivotally mounted on a horizontally disposed shaft 112 affixed to the frame member 12. The amount of slack in V belt 92 is adjusted by the threaded rod 114 connected to one end of crank 110 and which rod passes loosely through a fixed stud 116 to which the rod is secured by lock nuts on the rod. This arrangement is provided so that any change in the length of the V belt 92, and the effective diameter of the variable speed pulley 94, may be compensated for so that the proper position of the movable carriage 72 may be maintained. The movable carriage 72 is constantly urged to the left by a spring 120, the compression of which may be adjusted by varying the amount of force applied to the end of the spring which abuts against a crank arm 122 pivotally mounted on a stub shaft 124. The stub shaft 124 extends from a bracket carried by side frame 12. The pivotally mounted crank 122 is provided with a threaded opening to receive one end of an elongated threaded rod 130 horizontally mounted for rotation in side frame 10. The threaded rod 130 extends beyond side frame 10 and terminates in a hand wheel 132 for rotating the rod to adjust the compression of spring 120 by moving the crank 122 about its pivot 124.

The spring 120 is carried about a horizontal rod 134 one end of which is pivotally mounted in the bracket 122, the other end being held in a pivotally mounted abutment member 136 on the carriage 72. Thus by rotating hand-wheel 132 the crank is pivoted and adjusts the compression of spring 120 and thereby the force biasing the movable carriage (and rollers 64, 66) to the left.

The positive movement of the combined or collated web group D from roller 44 to roller 56 is aided by a narrow endless belt 138 which passes around roller 42 and roller 56. An idler pulley 140 is provided to maintain proper tension in belt 138. The idler pulley or roller 140 is carried on two pivot arms 142 and 144 as shown in FIG. 1, the pivot arms being center mounted upon a horizontal shaft situated between the side frames of the machine.

Each of the pivot arms is biased by a spring as at 148 so that the end of each pivot arm which carries the idler roller 140 is urged upwardly to maintain the endless belt 138 at proper tension.

The mechanisms for controlling the tension in each of the individual webs or ribbons A, B and C will now be described. As stated previously, each individual web is provided with its own tension control, and all the drives are powered from a common source. The power for all of the web drives is obtained from an endless V belt 152 which passes around two pulleys 154 and 156. Pulley 154 is carried upon one end of a shaft 158 mounted horizontally between the machine side frames. The other end of shaft 158 is provided with a spur gear 160 which meshes with spur gear 162 carried by the roller 44 driven from the main power source as already explained. The pulley 156 is rotatably mounted upon a stub shaft carried on one end of a crank arm 166 arranged to rotate about a shaft 168 situated between the side frames. The lower end of crank arm 166 is provided with a lug to which is anchored one end of a spring 172. The other end of the spring is connected to a pin extending from side frame 10. The crank 166 is thus urged clockwise about the shaft 168 to maintain the V belt 152 under proper tension.

The V belt 152 travels laterally to the right on its upper stretch, through a plurality of variable speed pulleys, the number of such being equal to the number of individual webs being processed. In the form illustrated and described herein, there are thus three of such variable speed pulleys, and they are designated 176, 178 and 180. These pulleys are identical in structure and operation, so that a description of one of them will suffice for a clear understanding. The construction of the pulley 176 is shown to larger scale in FIGS. 3 and 4 of the drawings, to which reference is now made.

Pulley 176 comprises opposed belt discs 182 and 184 fastened to the hubs 186 and 188 respectively, by screws 190. Within the hubs 186 and 188 are fitted internal sleeves 192 and 194, each containing helical grooves on their inner surfaces as indicated at 196 and 198. As shown in FIG. 4, the helical grooves 196 and 198 are cut in opposite directions or "hand" for a purpose to be described below. Two external sleeves 200 and 202 are fitted tightly on an extension of the roller 16 by means of a plug 204 and a screw 206. The external sleeves 200 and 202 are provided with outer helical grooves to match and cooperate with the helical grooves 196 and 198 in the sleeves 192 and 194, to form a ball bearing race in which are provided a plurality of bearing balls 212. To retain the internal sleeves in proper position, end caps 214 and 216 are secured to the hubs 186 and 188 by means of screws 218.

The V belt 152 is held in firm contact with the beveled discs 182 and 184 by a pressure roller 220 which is rotatably supported at the end of a lever 222, as seen in FIG. 3. The roller 220 turns upon ball bearings carried by the lower end of the lever arm 222. The lever arm itself is pivoted about a threaded stub shaft 228 which is fastened to the side frame 10 by a nut 230 and lock washer. Lever arm 222 is also provided with a center shaft 234 about which pivots a shoulder member 236. A projection 238, see FIG. 3, on the frame member 10, is threaded to receive an adjusting sleeve 240, which together with shoulder member 236 compresses a spring 242 located upon the shoulder member rod extension 244. Thus the spring 242 and its adjusting means 240 provide an adjustable contact force between the roller 220 and the belt 152.

The variable speed pulley assemblies 176, 178 and 180 all operate in the same manner, as follows. Under normal conditions, both the sleeves on the shaft and the discs are rotating at the same speed, but if the web tension varies from normal, the rotational speed of the shaft-mounted sleeves varies, a relative motion of the sleeves with respect to the outer discs develops, and this rela-

5

tive motion, because of the ball bearing helical race arrangement, produces a relative axial movement of the two discs 182 and 184. Thus, if the shaft mounted sleeves 200 and 202 have a counterclockwise rotation (as viewed from one end) with respect to the outer discs 182 and 184, the latter will move towards one another an equal amount, thereby forcing the V belt 152 and roller 220 outward from the center of pulley 176, and vice versa. The outward or inward movement of the belt 152 thus alters the rotational speed of the discs 182 and 184 sufficiently to restore equality of speed between the shaft and the discs. A pin 201 secures discs 182 and 184 against relative rotation, while permitting the described axial shift; it is desirably fixed in one of the hub and disc assemblies, and is loose in the other.

If, during the operation of the apparatus, a reduction of tension develops in the web A, for example, as it travels downwardly toward the roller 16 (FIG. 2), the web would tend to become slack. This would immediately reduce the torque acting on roller 16 and thereby reduce the force exerted by the spring 242 (FIG. 3) through the lever arm 222 and roller 220 against the V belt 152. This action would cause the ball bearing sleeve assemblies illustrated in FIG. 4 to open the space between the belt discs 182 and 184 and thereby cause the roller 220 and the V belt 152 to enter deeper into the space between the pulley flanges 182 and 184. This would reduce the effective driving diameter of the pulley assembly and thus increase its rotational speed, taking up slack in the web A to restore the original condition of equilibrium. In a like manner, an increase in the web tension of the entering web A is compensated for in precisely reverse order. Variations in the tension of webs B and C are taken care of individually in exactly the same manner.

The magnitude of the individual web tension may be adjusted by changing the normal position of the roller 220 which forces the V belt 152 downward between the pulley discs 182 and 184. This adjustment is made by means of the threaded adjusting sleeve 240 acting on spring 242, but the same normal or nominal adjustment could equally well be made by means of a fluid pressure cylinder and piston, by an electromagnet, servomotor or equivalent means.

The foregoing has described the individual control of web tension for webs A, B and C. Control of the tension of the collated group D will now be described. If, for example, a reduction of tension in the group develops between the rollers 42, 44 and the nipping rollers 64 and 66, the group web D would tend to become slack between these points. The movable carriage 72 would then move to the left under the pressure of spring 120, and such carriage movement would reduce the effective operating radius of the V belt 92 on the pulley 94, increasing the rotational speed of the latter and of shaft 96. Rollers 64 and 66 will be driven faster through the helical gearing, and will therefore tend to take up the slack in the web group D to re-establish the original equilibrium. In a like manner any increase in the tension of group D will be automatically compensated for as the carriage moves toward the right. The nominal or equilibrium value of tension in the group D is set by adjustment of hand wheel 132 operating through the bell crank 122 to vary the rest force of spring 120 against the carriage 72. Here again, while the biasing means for the carriage has been shown as a spring, it could equally well be a fluid pressure cylinder, an electromagnet, motor drive or other form of operator.

It is evident that the combination described operates to regulate in an individual manner the tension of each of the entering webs, even though the drives for these webs are taken from a single power shaft or source; in addition, the combination provides an entirely separate tension regulator for the collated group which in turn

6

is powered from the common drive source. The particular embodiment chosen for illustration herein can be varied, as to its details, without departing from the spirit of the invention as defined by the scope of the appended claims.

What is claimed is:

1. In a device for handling a plurality of separate webs that are to be combined in superposed fashion to form a unitary web group, the combination comprising means for imparting movement to said separate webs, a separate tension control means for each of said separate webs, each of said separate tension control means including a variable speed drive powered from a common source, means for combining said webs in superposed fashion to form a unitary web group, means for imparting movement to said unitary web group, means for folding said unitary web group as it is being moved, and tension control means for said unitary web group, said last mentioned tension control means including a variable speed drive that is varied upon changes in tension of the unitary web group.

2. A device in accordance with claim 1 in which the means for imparting movement to the unitary web group includes drive means mounted on a movable carriage connected to control by its movements the variable speed drive means of the unitary web group tension control means.

3. In apparatus for handling a plurality of separate webs that are to be combined in superposed collated fashion to form a unitary web group, the combination comprising means for imparting movement to said separate webs, a separate tension control means for each of said separate webs, each of said separate tension controls means including an automatically variable V belt pulley, a common V belt drive for all of said pulleys, and means for automatically varying the respective speeds of said pulleys in accordance with tension changes in the corresponding respective webs; means for collating the separate webs into a unitary web group, drive means for imparting movement to said unitary web group, and a tension control means for said unitary web group, said last mentioned tension control means including a variable speed V belt drive and a movable carriage biased in one direction and supporting the unitary web group drive means, said unitary web group tension control means being operated in response to carriage movements produced by changes in the tension of said web group.

4. A variable speed torque-responsive drive including: a variable-speed pulley comprising a pair of opposed beveled belt discs, a mounting hub for each of said discs, a sleeve within each of said hubs, continuous helical grooves of opposite pitch on the inner surfaces of said respective sleeves, second sleeve means fitted within said first mentioned sleeves, a cooperating helical groove on the outer surface of said second sleeve means to provide by their cooperating helical grooves helical races, and a plurality of bearing balls in each of said helical races; a V-belt in driving engagement with said discs, and resilient means urging said V-belt into the bite of said discs.

5. A variable speed drive as set forth in claim 4 including means connecting said discs for conjoint rotation.

6. A variable speed torque-responsive drive including: a V belt pulley comprising a pair of beveled plates in facing relationship to define therebetween a V groove, hubs mounting said plates for free motion toward and away from one another in an axial direction, means constraining said plates for conjoint rotation, shaft-mounting sleeve means within said hubs, and opposite pitch thread means connecting the respective hubs to said sleeve means, whereby the spacing of said plates is controlled by relative rotation between the hubs and the sleeve; a V-belt, and resilient means for urging said V-belt into said groove.

7. In a machine of the character described having a shaft for driving a variable load, a variable diameter pulley for driving the shaft to provide a constant torque

comprising a pair of hubs rotatably mounted on the shaft and movable axially thereon, a pair of opposing flange members mounted on the hubs respectively, and shaped to provide a V-shaped channel therebetween, a V-shaped belt between the flanges driven at constant speed, means for resiliently biasing the belt radially and into pressure engagement with the flanges tending to cause their separation and reduction of effective radius of belt contact on the flanges, and cooperating elements on the hubs and shaft engageable to drive the shaft and to move the flanges towards each other with a force dependent on the load tending to move the belt radially outwardly against its bias to increase the effective radius of belt contact, whereby the output torque of the shaft remains substantially constant under variations of shaft speed with respect to the speed of the belt.

8. In an apparatus for handling a plurality of separate webs that are to be combined into a collated web group, the combination comprising separate means for imparting movement to each of said webs, an individual tension control for each of said webs comprising a separate shaft for driving each of the separate means for imparting movement to the webs, a variable speed V belt pulley for each shaft comprising a pair of beveled plates in facing relationship to define a V groove, hubs mounting said plates on each shaft for face motion toward and away from one another in an axial direction, means constraining said plates for conjoint rotation, shaft-mounted sleeve means within said hubs, and opposite pitch thread means connecting the respective hubs to said sleeve means, whereby the spacing of said plates is controlled by relative rotation between the hubs and the sleeves.

9. In a web processing machine, a rotatably mounted shaft, a roller driven by the shaft and engageable with the web for feeding it from a drag producing device under tension, a variable diameter pulley for driving said shaft comprising a pair of annular coned disc members concentrically rotatably mounted on the shaft with their outer surfaces forming the inner walls of a substantially V-shaped channel, at least one of said disc members being axially movable, a substantially V-shaped belt within the channel for driving the pulley, resilient means for biasing the belt against the channel walls, and interengaging means on the disc members and shaft for providing an angular force for rotating the shaft and an axial force dependent on web tension for moving at least said movable disc member axially toward the other disc member to tend to move the belt radially against its resilient bias to balance the web tension against contact pressure of the belt.

10. In a web processing machine, a rotatably mounted shaft, a roller driven by the shaft and engageable with the web for feeding it from a drag producing device under tension, a variable diameter pulley for driving said shaft comprising a pair of annular coned disc members concentrically rotatably mounted on the shaft with their outer surfaces forming the inner walls of a substantially V-shaped channel, at least one of said disc members being axially movable, a substantially V-shaped belt within the channel for driving the pulley, resilient means for biasing the belt against the channel walls, interengaging cam surfaces on the disc members and shaft for driving the shaft, the interengaging surfaces on at least said axially movable disc member and shaft being in a plane passing through the axis of the shaft at an angle having an axial component relative thereto for both driving the shaft and providing an interacting axial force dependent on web tension for moving at least said one movable disc member toward the other to move the belt radially against its resilient bias, and means for adjusting the resilient bias of the belt to balance a predetermined web tension, whereby any variations from the predetermined tension will vary the axial interacting force against at least said axially moving disc member to permit relative rotation between said disc member and shaft to cause the belt to

be shifted radially to change the speed of the pulley to maintain the predetermined web tension.

11. In a web processing machine, a rotatably mounted shaft, a roller driven by the shaft and engageable with the web for feeding it from a web engaging drag producing device to place tension on the web during feeding thereof, a variable diameter pulley for driving the shaft, comprising, a pair of annular coned disc members, means supporting said disc members for both rotation and axial movement on the shaft with the outer surfaces of the disc members forming a V-shaped channel therebetween, means locking the disc members for joint rotation, a substantially V-shaped belt in the pulley channel for driving the pulley, resilient means biasing the belt radially of the pulley and into engagement with the channel walls, cooperating elements on the shaft and disc supporting means for driving the shaft upon rotation of the pulley and providing an axial force dependent on the web tension for moving the disc members axially against the belt, and means for adjusting the resilient bias on the belt to maintain a predetermined web tension, whereby a variation from the predetermined web tension will vary the axial force acting on the disc members to cause radial movement of the belt to change the pulley speed and thereby maintain the desired web tension.

12. In an apparatus for handling a plurality of separate webs which are to be combined into a collated web group, the combination comprising common drive means for feeding the collated group of webs as a unit, rotary means individual to and in driving engagement with each of the separate webs at a position in advance of the position of said common drive means with reference to the direction of web travel, mechanism for individually comparing the linear speed of each of said webs, at its said rotary means, with the common speed of said collated group of webs, and means individual to said webs and responsive to said mechanism for altering the individual instantaneous speeds of said respective rotary means relative to said common speed, so as to maintain a specified tension value in each of said webs passing from said rotary means to said common drive means.

13. In an apparatus for handling a plurality of separate webs which are to be combined into a collated web group, the combination comprising common drive means for feeding the collated group of webs as a unit, roller means individual to and in driving engagement with each of the separate webs at a position in advance of the position of said common drive means with reference to the direction of web travel, a variable radius pulley on the shaft of each roller means and connected thereto by means for altering the effective radius of each such pulley in response to differences in instantaneous speed between said shaft and the pulley, belt means connecting said pulleys to said common drive means, and means for resiliently biasing said belt means into tractive engagement with said pulleys, to alter the respective instantaneous speeds of said roller means relative to the speed of said common drive means, so as to maintain a specified tension value in each of said webs passing from said roller means to said common drive means.

14. Apparatus in accordance with claim 12, in which each of said pulleys comprises a pair of axially-movable V-belt pulley plates, and reversely-pitched anti-friction helical motion-transmitting connections between said shaft and said plates, to alter the axial spacing of said plates upon relative rotational motion of said plates and said shaft.

15. Apparatus in accordance with claim 12, in which said belt means comprises a single belt connecting all of said pulleys to said common drive means.

16. Apparatus in accordance with claim 13, in which the variable radius pulleys are V-belt pulleys, in which said belt means comprises a single V-belt connecting all of said pulleys to said common drive means, and in which said resiliently biasing means comprises pressure rollers

positioned to urge the V-belt individually into the bites of the respective V-belt pulleys.

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