This invention relates to apparatus for continuously printing and blanking paper board boxes and, in particular, to such apparatus having multi-color rotary printing presses and rotary blankers.

Efficient continuous multi-roll rotary printing and blanking of paper board of the character of soap box fiber has hitherto been extremely difficult and, in fact, has not been achieved. The board is of substantial thickness and high tensile strength. Obtaining proper registry of the printing rolls is particularly troublesome since the two sides of the board may present different frictional characteristics, and tension sufficient to produce a substantial slippage of the board through the printing rolls can be built up before the web breaks. Furthermore, the creaser, slitter and die rolls, which comprise the blanker section of the printing presses exert an influence on the printing section which is not met in presses in which light-weight paper is run to produce stamps, newspapers, and the like.

The paper board box printing and blanking machines hitherto have generally contained many of the elements of the machine of the present invention, including a feed roll, a printing section comprising a number of separate printing presses each printing a different color, a pull roll following the printing section and a blanker section following the pull roll. In certain of the prior art machines the registry of the presses has been governed, though somewhat unsuccessfully heretofore, by electronic means wherein "electric eyes" responding to marks printed at intervals along the web by the first printing cylinder operate to speed up or slow down the subsequent printing cylinders. A narrow range of adjustment of the speed of the feed roll with respect to the rest of the system was also included in certain of the prior art machines.

However, the object of the designers of the prior art machines was to make the machines as inflexible as possible, to which end the effort has been directly to gear together all of the elements of the machine. In certain of the prior art machines the various elements are crowded together as closely as possible in an attempt to eliminate difficulties arising from sections of board with different surface characteristics being in the machine at the same time.

In other machines of the prior art the web is extended between the several printing rolls and between the printing section and the blanker section in an attempt to use the resilience of the web to compensate for variations in tension between the various elements. In any event, in the paper board printing rotary presses and blankers hitherto there has been such a great deal of trouble with breakage of the web, with slippage between the printing rolls and the web, with improper blanking and with looping or blistering of the web, as to make the machines almost impractical.

One of the objects of this invention is to provide a paper board rotary press and blanker having a high capacity with high efficiency. Other objects will become apparent to those skilled in the art in the light of the following specifications and accompanying drawings.

In accordance with this invention, generally stated, a rotary press for printing and blanking paper board boxes having a feed roll, a printing section, a blanker section, and a pull roll beyond the printing section but ahead of the blanker section, is provided with a tensioning device between the printing section and the pull roll for introducing a known and substantially uniform tension in the web. The tension device is so constructed as to move when the tension of the web tends to change, and is equipped to indicate the tendency of the tension of the web to change, either visually or otherwise, so that the tension balance in the web can be restored. The pull roll and a blanker pull roll are so constructed and controlled as to be instrumental in regulating the tension of the web and in dampening the pulse of the web set up by the driven rolls of the blanker section.

In the drawing:
- Figure 1 is a diagrammatic view in two parts of a device constructed in accordance with this invention;
- Figure 2 is a detail view in side elevation of an intermediate pull roll;
- Figure 3 is a sectional view taken along the line 3-3 of Figure 2;
- Figure 4 is a plan view of one embodiment of tensioning means; and
- Figure 5 is a view in side elevation of the tensioning device shown in Figure 4.

Referring now to the drawings for an illustrative embodiment of this invention, and in particular to Figure 1, a stand 1 carries a roll 2 of paper board being fed to the press. A driven pull roll 3 pulls the board from the roll 2. The paper board web 4 from roll 2 passes over the tower roll 5 and through driven roll 6 to produce a loop 7 in the web 4. The tower mechanism is provided in connection with a splicer, not here shown, and forms no part of the present invention. From the loop 7 in which there is, of necessity, no tension, the web passes between the nip and driven rolls of the main feed roll 8. From the main feed roll 8 the web passes into a printing section 100, in which there are, in the embodiment shown, four intaglio presses. The web passes over idler roll 9, and then between impression roller 10 and an intaglio printing cylinder 11 which comprise first printer 12. The web then passes successively through second printer 13, third printer 14, and fourth printer 15. In the diagrammatic view shown, the arrangement of rolls and cylinders in each of the subsequent printers is identical with those of first printer 12 and they are so numbered. From the final printer 15 the web passes under an idler 16 and through a tension device 17. In Figure 1 the tension device 17 is shown diagrammatically as consisting of an upper idle roll 20 and a lower idle roll 21, mounted on a swinging frame 22. The swinging frame 22 is pivoted at a point equi-distant from the axes of rotation of rolls 20 and 21.

Connected to the swinging frame 22 in such a way as to bias the upper roll 20 in a direction away from the printing section 100 is a weight 25. Also attached to swinging frame 22 is an indicator 26 of a gauge 29. From the tensioning device 17 the web passes over an idler 30, between an air-loaded bottom nip roll 31 and an intermediate pull roll 32, and between intermediate pull roll 32 and an air-loaded upper nip roll 33. The term "air-loaded" is used to describe an arrangement whereby a roll is biased by means of compressed air as contrasted for example with a spring biased or loaded roll. From upper nip roll 33 the web passes over a series of idler rolls 34 to the blanker section 40. At the head of the
blanker section 49 is a polished, chromium-plated blanker pull roll 41 followed by creaser rolls 42, slitter rolls 43, die rolls 44, waste cut-off rolls 45, turning roll 46, and Carson conveyor 47 upon which the printed, knock-down boxes emerge for stacking.

Power for the entire machine is supplied by a large motor 50 through a main line shaft, divided into two sections (Fig. 3) in the embodiment shown, pull roll 3, roll 6, feed roll 8, and the driven rolls of the printing section 100 are driven by the main line shaft 51. All of the blanker rolls except the blanker pull roll 41 are geared directly to section 52, and pull roll 22 and blanker pull roll 41 are driven by that section. The sections 51 and 52 of the main line shaft are divided by a variable speed transmission 55 and a differential gear 56 to which is attached an air motor 57. Between the section 52 of the main line shaft and the intermediate pull roll 32 is a variable speed transmission 60. Between the section 52 of the main line shaft and the blanker pull roll 41 is a variable speed transmission 61. Between the feed roll 8 and the section 51 of the main line shaft is a variable speed transmission 62. Variable speed transmissions 55, 60, 61, and 62 may be of any suitable sort.

The so-called "P. I. V." of the Link Belt Company, models of which are described in Book No. 2274, copyrighted by that company in 1930, has been found to be entirely satisfactory, but other variable speed drives such as the Reeves may be used. The differential gear 56 may be of the type commonly used in automobiles (though the differential gear 56 should be of sturdy construction) or of any other well-known design to perform the same function in a similar way.

Referring now to Figures 4 and 5 for a detailed description of the tensioning means 17 shown diagrammatically in Figure 1, the swinging frame 22 is made up of side channels 150 top channel 151 and bottom channel 152. Upper roll 20 and lower roll 21 are mounted to rotate freely on shafts 155 which extend between side channels 150. The swinging frame 22 is itself mounted on a pair of stub shafts 156 carried by pillow blocks 157 mounted on the frame of the machine. A cable 161 passes over a sheave 162 and over a sheave 163 to support the weight 25. The weight 25 is made up of a number of removable disks 165. By adding or removing disks 165 the total weight can be varied. The sheaves 162 and 163 are mounted on a vertical frame 166. Attached to the upper end of one of the side channels 150 is a cable 170. The cable 170 passes over sheave 171 and serves to operate the indicator 28 of the gauge 29. The indicator 25 may be weighted as at 172 so that it responds to movement of the swinging frame 22 in either direction. A hydraulic cylinder 175 is pivoted on the main frame of the machine at 176. Piston 177 of the hydraulic cylinder 175 is jolted at 178 and connected with the swinging frame 22 at the center of the lower channel 152. In actual operation, a weight 25 of 512 pounds has been found to provide sufficient tension in a web with a breaking strength of approximately 3000 pounds. The advantages in operation, in economy of board, and in upkeep of the machine, of a tension of approximately 10% of the breaking strength of the web over which, as indicated by the breakage of the web in the machines of the prior art, often exceeded the breaking strength, are clear.

Referring now to Figures 2 and 3 for a detailed description of the intermediate pull roll 32 shown diagrammatically in Figure 1. The roll is mounted on a driven shaft 33. The roll 32 is, however, free to rotate on shaft 75, being mounted on ball bearings 76. The shaft is journaled in bearings 92 supported by standoffs 93. Keyed to the shaft 75 is a spider 77 on each of the four arms 78 of which is a yoke 79. Secured to the end 80 of the roll 32 are pairs of ears 81. Loosely mounted within holes in the ears 81 are spring bolts 82 threaded at both ends and held in place against longitudinal movement by jam nuts 83. Springs 84, taking into spring cups 85 and 86, are carried by each of spring bolts 82. When the roll drive is assembled, the yokes 79 of the arms 78 of the spider 77 fit over the spring bolts 82 between springs 84 and between spring cups 85. The pull roll 32 is covered with rubber or similar material 90 to provide a better gripping surface than that afforded by a polished metal roll. In the embodiment shown, one of the arms 78 is provided with a pointer 88 while a graduated plate 89 is fastened to the side 80 of the roll adjacent the pointer, by which a shift in the relative positions of the spider and the roll from a central neutral position is indicated. It will, of course, be necessary to use a stroboscope to observe such a shift while the pull roll is in operation.

In practice, the registry of the cylinders of printers 12, 13, 14, and 15 is regulated by "electric eyes" which control small differential gear systems between the main shaft section 51 and the driven cylinders 11. These controls operate in increments of one-sixth of a revolution of the driven cylinders, a nontrivial task when the cylinders 11 are running at a constant speed. Pull roll 3, driven roll 5, and feed roll 8 are so synchronized as to maintain the loop 7 substantially constant, though it can be seen that there is a certain amount of leeway in that the loop 7 does not become too exaggerated or, conversely, disappear. The speed of feed roll 8 is regulated by means of its variable speed transmission 62 to govern the speed at which the paper board is fed to the printing section 100. The printing cylinders 11 are driven if the feed roll 8 is set too slow, tension will be set up in the web between the feed roll and the printing section, whereby the cylinders 11 will tend to slip ahead of the web and the web may be broken. On the other hand, if the feed roll 8 is set to run faster than driven cylinders 11 the paper will blister and produce, at least with the first printers, a tendency for the web to slip ahead of the driven cylinders 11. In either event, the resetting of paper is liable to be both smeared and out of registry. The actual printing operation does not form a part of this invention and will not be described.

After the web leaves the last printer 15 it passes over the top of the upper roll 20 and around the bottom of the lower roll 21 of the tension device 17. From the lower roll 21 the web passes over an idler 30 and into the nip of the pull roll 32. Assuming, for the moment, that the pull roll 32 represents the final pulling force on the web, it can be seen from the construction of the tensioning device that as the tension in the web between the final printer 15 and the pull roll 32 decreases, the weight 25 will rock the swinging frame 22 about its pivot 23, moving the upper roll 20 away from the printing section 100 and moving the lower roll 21 toward that section. The rocking of the swinging frame 22 will, of course, within limits, maintain the tension of the web substantially constant, by taking up the slack in the web. Conversely, as the tension in the web between the last printer 15 and the pull roll 32 increases, the tendency of the web to straighten will rock the swinging frame 22 against the weight 25 to move the upper roll 20 toward the printing section 100 and the lower roll 21 away from that section. Again, within limits, the rocking of the swinging frame will maintain the tension constant. In the first case the indicator 28 will be moved up with respect to the gauge 29; in the second case the indicator...
28 will be moved down with respect to the gauge 29. When the indicator 28 is maintained substantially in the correct position as shown on the web 4 and the feed roll 6 and driven cylinders 11 to maintain the desired tension, however, in addition to the apparatus of the character here involved, the blanker section 40, will be strong, and to some extent, independent, influence on the entire system. The relations between the pull roll 32 and the blanket section 40 are fairly stable so that once the proper relative speeds between pull roll 32 and the blanket section 40 are established the tension of the web between the feed roll 8 and pull roll 32 may generally be adjusted by varying the speed of the web between section 52 of the main line shaft, by which both pull roll 32 and blanket section 40 are driven without having to change the speed relation between pull roll 32 and blanket section 40. As has been indicated, however, this is not universally true. A change in the character of the board may produce a change in the tension balance between pull roll 32 and blanket section 40, since the characteristics of this section are not the same as those of the rubber-covered pull roll, 32, and the rubber-covered pull roll, 32, may be quite different from those with respect to the cutter, defeater, and web adjacent to the pull roll 41. In order to make the pull roll 32 adjustable with respect to the blanket section 40 the variable speed transmission 60 is provided between shaft section 52 and the pull roll 32. It has been found, however, that if it is attempted to synchronize pull roll 32 with the blanker pull roll 41 there is a tendency for the web to blister beyond the blanker pull roll 41, particularly during the part of the rotary cutter cycle during which the knives are not in contact with the web, to produce uneven blanking. Therefore, a variable speed transmission 61 is interposed between shaft section 52 and blanket pull roll 41. The blanker pull roll is given an under-travel with respect to the remaining blanking rolls so that the web between the blanker pull roll and the remainder of the blanking rolls is under tension from that source. To prevent breakage of the web from the tension between the blanker pull roll 41 and the remainder of the blanket section, blanket pull roll 41 is chrome-plated and so constructed as to allow the web to slip thereover. For example, in a press in which the web speed is approximately nine hundred feet per minute the under-travel of the blanket pull roll 41 with respect to the web and the remaining blanking rolls is, hence, the slippage of the web over the blanker pull roll, may amount to five feet per minute.

The nature of rotary blankers is such as to give rise to pulsation in the web since the knives engage the web intermittently. Even when the blanker pull roll 41 has an under-travel with respect to the remaining blanking rolls, some of the pulsing of the web may be transmitted past the blanker pull roll 41 toward the printing section 100. It may also be seen that if the speed of the pull roll 32 is slow with respect to blanket section 40, the tension is liable to be built up in the web between the blanket section 40 and the pull roll 32, or that conversely if the pull roll 32 is set faster than the blanker rolls, the web between the pull roll 32 and blanket pull roll 41 will be improperly tensioned.

The construction of pull roll 32 is such as to damp the pulsation of the web, to compensate for small variations in tension, and to permit observation of tension changes between the blanker section 40 and the press section 100. If the tension on the blanket section side of the pull roll 32 exceeds that on the printing section side of the sphere 77 of pull roll 32 will shift to the left. Since the tension on the press section side of the pull roll 32 is determined by the amount of weight 25 biasing the swinging frame 22, that weight will also determine the tension in the web between the blanket pull roll 41 and the latter rolls with respect to the blanker pull roll 41. With the construction of pull roll 32 described, variations in tension of the web between pull roll 32 and blanket pull roll 41 which are within the capacity of the springs 84, will not seriously disturb the blanking processes. The spring suspension allows the pull roll 32 to damp the pulsation of the web without, however, simply blocking the pulsation completely. If the pull roll 32 were rigidly mounted and the nip rolls 33 and 31 were sufficiently tight to block the pulse in the web from the blanker section 40 the resulting oscillation in the web between the blanker section and the pull roll 32 would tend to throw the blanker rolls out of registry with the web and to break the web. The tensioning device 17 serves as a further damper, in which role it is aided by the hydraulic cylinder 175 which simply serves to damp the oscillation of swinging frame 22.

The differential 56 between sections 51 and 52 of the main line shaft is especially advantageous. When the system is running at a constant speed, the various sections may be properly synchronized for a web of given surface characteristics. There is, however, still liable to be some variation in the surface characteristics of the paper board running through the system. At the same time they may be only temporary, as when the surface condition extends through only a few hundred yards of board or as when, during a change from one type of board to another, the imbalance obtained only until the new web occupies the whole machine. The differential 56 allows temporary correction to be made quickly. By running the air motor 59 in one direction the section 52 of the main line shaft may be slowed down with respect to the section 51, to decrease the tension between the pull roll 32 and the printer section 100. On the other hand, if the air motor 57 is run in the opposite direction the section 52 is speeded up with respect to the section 51 to increase the tension between pull roll 32 and printing section 100. In either event when the air motor 57 is stopped the original speed of rotation of the section 52 is restored. This arrangement is of particular utility when the machine is being speeded up, as in starting, or slowed down, because the co-efficient of rolling friction of the web and rolls varies with the speed at which the web is travelling. Thus if the various sections of the machine are set for a substantially proper balance at a known working speed, the initial imbalance between the press section and the pull roll 32 may be over-come while the web is being brought up to speed, by the differential 56. When the desired operating speed has been reached any minor, persistent imbalance between the pull roll 32 and the printing section 100 may be corrected by adjusting the variable speed transmission 55.

Another advantage of the differential 56 is that it responds quickly to introduce a relatively great difference in speed between the sections. In order to provide the necessity of adjustment necessary in apparatus of this character the variable speed transmission 55 must necessarily respond slowly to adjustment. Thus if a major adjustment in the speeds between the sections 51 and 52 becomes necessary while the machine is running the balance may be maintained by means of the differential 56. While the "permanent" adjustment is being made by means of the variable speed transmission 55.
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Still another use for the differential 56 in this apparatus in which the various driven rolls are geared to a shaft is in inspecting, repairing, and sharpening the knives in the blanker rolls when the machine is shut down. Instead of having to turn the main line shaft manually, the air motor 57 may be run to turn the section 52 slowly to rotate the blanker rolls.

By means of the differential 56 and the variable speed transmission 55 the indicator 23 of the gauge 29 may be kept centered within narrow limits.

Numerous variations in the various elements of this invention within the scope of the appended claims will be apparent to those skilled in the art in the light of the foregoing disclosures. For example, the swinging frame 22 of the tensioning device 17 may be replaced by a counter-balanced idle roll journaling in sliding bearings to move vertically, with a pair of rolls on either side thereof and removed vertically beyond the limit of vertical travel of the counter-balanced idle roll.

In either embodiment of tension device switch means may be used responding to movement of the device to operate either the differential gears or the variable speed transmission or both automatically to correct for the change in tension in the web. The blanker pull roll need not be chrome-plated but may be otherwise made highly-polished enough to allow a smooth slippage without undue wear.

Thus it can be seen that means are provided for maintaining a proper tension balance in a web of box board being printed and blanked throughout a machine of the character described and for damping unwanted pulsation in the web, to allow proper registry of the printing presses and of the blankers.

Having thus described the invention, what is claimed and desired to be secured by Letters Patent is:

1. A continuous, rotary, paperboard box printing press and blanker having an unwind roll and, in order from said unwind roll, a feed roll, printing rolls, a pull roll, and a blanking section containing power driven blanking rolls, said blanking section imparting a pulsating travel to a web of paperboard being processed, and means for maintaining a substantially uniform tension in the web, substantially blocking the pulsations from the blanking section and permitting the maintenance of registry of the printing rolls and blanking section, said means comprising an idle roll around which the web passes, said idle roll being mounted for translational movement in response to changes in tension in the web and being biased against the tension in said web, said idle roll being located between the last of the printing rolls and the blanking section, and a blanking section pull roll, located between the driven blanking rolls and the said idle roll, and having an under-travel with respect to the driven rolls of the blanking section and to the web.

2. The apparatus of claim 1, wherein the tension means includes upper and lower idle rolls mounted for rotation within a swinging frame and traversed by the web, said swinging frame being pivoted between the axes of said upper and lower rolls, and a tensioning device connected to said swinging frame and biasing that frame against the tension of the traversing web.

3. The apparatus of claim 1, wherein the resilient coupling means specified and the pull roll includes a spider with a plurality of radially extending arms, said spider being driven by the power means, pairs of springs mounted chordally on an end of the pull roll, the two springs of each pair being positioned on and engaged with opposite sides of an arm of said spider.

4. A continuous, rotary, paperboard box printing press and blanker having an unwind roll and, in order from said unwind roll, a feed roll, printing rolls, a pull roll, and a blanking section containing power driven blanking rolls, said blanking section imparting a pulsating travel to a web of paperboard being processed, and means for maintaining a substantially uniform tension in the web, substantially blocking the pulsations from the blanking section and permitting the maintenance of registry of the printing rolls and blanking section, said means comprising a tension device loaded to maintain a substantially constant tension on said web, responding to variations in tension in the web by movement from a normal position and located between the last of said printing rolls and said pull roll, power means connected to rotate said pull roll, and a resilient coupling between said power means and said pull roll.

5. A continuous, rotary, paperboard box printing press and blanker having an unwind roll, and in order from said unwind roll, printing rolls and a blanking section containing power driven blanking rolls, said blanking section imparting a pulsating travel to a web of paperboard being processed; and means for maintaining a substantially uniform tension in the web, substantially blocking the pulsations from the blanking section and permitting the maintenance of registry of the printing rolls and blanking section, said means comprising an idle roll around which the web passes, said idle roll being mounted for translational movement in response to changes in tension in the web and being biased against the tension in said web, said idle roll being located between the last of the printing rolls and the blanking section, and a blanking section pull roll, located between the driven blanking rolls and the said idle roll, and having an under-travel with respect to the driven rolls of the blanking section and to the web.

6. A continuous, rotary, paperboard box printing press and blanker having an unwind roll and, in order from said unwind roll, printing rolls and a blanking section containing power driven blanking rolls, said blanking section imparting a pulsating travel to a web of paperboard being processed; an idle roll around which the web passes, said idle roll being mounted for translational movement in response to changes in tension in the web and being biased against the tension in said web, said idle roll being located between the last of the printing rolls and the blanking section, whereby the length of the web between the last of the printing rolls and the blanking section is permitted to vary, and means located between the tension means and the driven blanking rolls for damping the pulsations imparted to the web from said blanking section.

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