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Macke

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[54] METHOD AND APPARATUS FOR FOLDING PAPER

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 814,704, April 9, 1969, abandoned.

[52] **U.S. Cl.** ..... **270/68 A**

[51] **Int. Cl.** **B65h 45/14**

[58] **Field of Search** ..... 270/68 R, 68 A; 83/6, 7; 74/354

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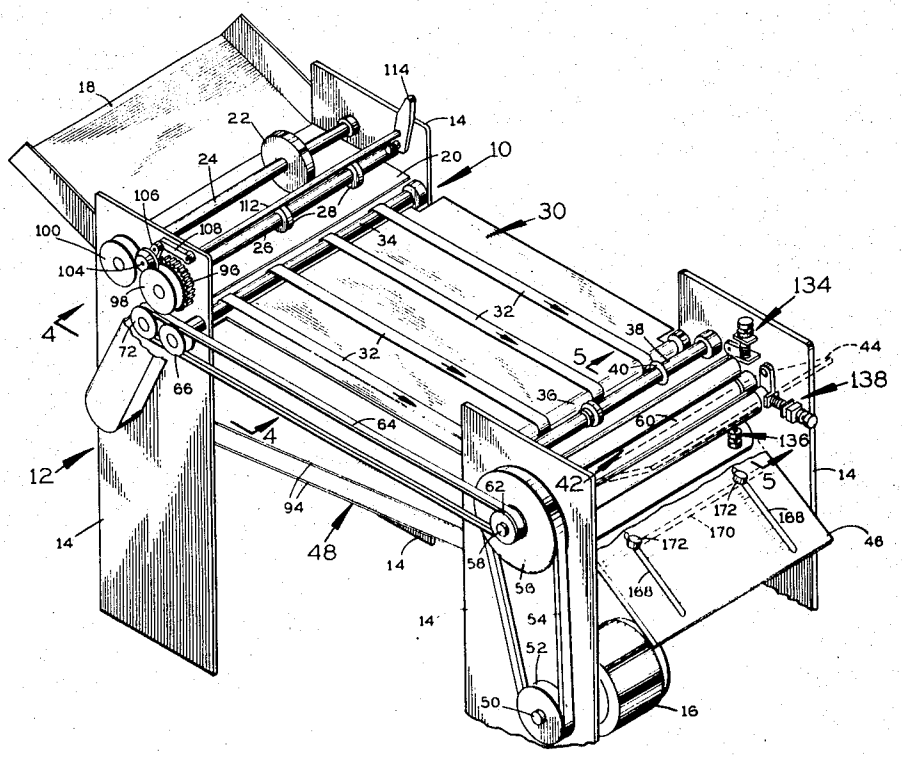
[57] **ABSTRACT**

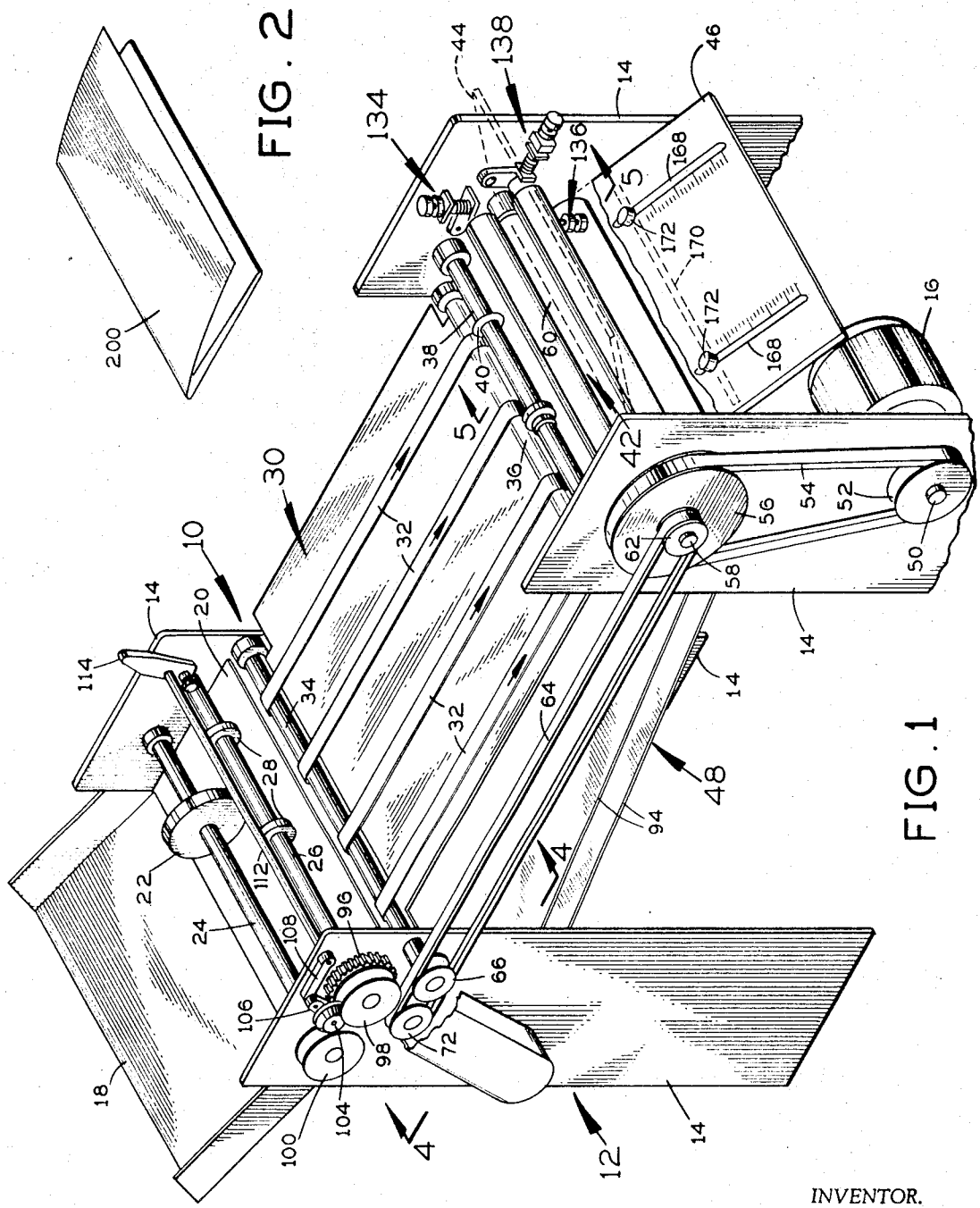
A method of and apparatus for folding paper wherein sheets of paper are folded by a plurality of rolls including three horizontal rolls which are stacked vertically with respect to each other and a fourth roll directly laterally adjacent the middle roll of the stack. The middle roll os driven and in turn rotates the other rolls which idle. With this arrangement of rolls, a sheet may be folded in different ways, and sheets can be handled efficiently and rapidly. The middle roll preferably is in a fixed position, and the other rolls are preferably adjustable, thus facilitating independent adjustment of the latter rolls relative to the middle roll. A feed system for transporting sheets to and from the rolls is disclosed, which system includes a simple clutch device.

In accordance with the method and apparatus of the invention, the sheets are slit, perforated or creased in a preliminary step prior to folding of the sheets. This is accomplished by feeding the sheets through a slitter, perforator or creaser before they enter the rolls, after which the sheets pass through successive pairs of rolls which make successive folds in the sheet. The folded sheets are transported back to the initial feed point so that only one operator is required.

It has been found that this pre-treatment of the sheets can be accomplished in alternate embodiments; for example, an embodiment employing a different arrangement of rolls than that referred to above. In connection with all embodiments, the pre-treatment device, whether for slitting, perforating, creasing or the like, will sometimes be referred to herein as line scoring means.

2 Claims, 10 Drawing Figures





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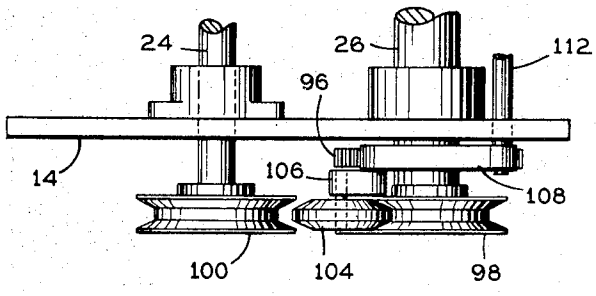

FIG. 3

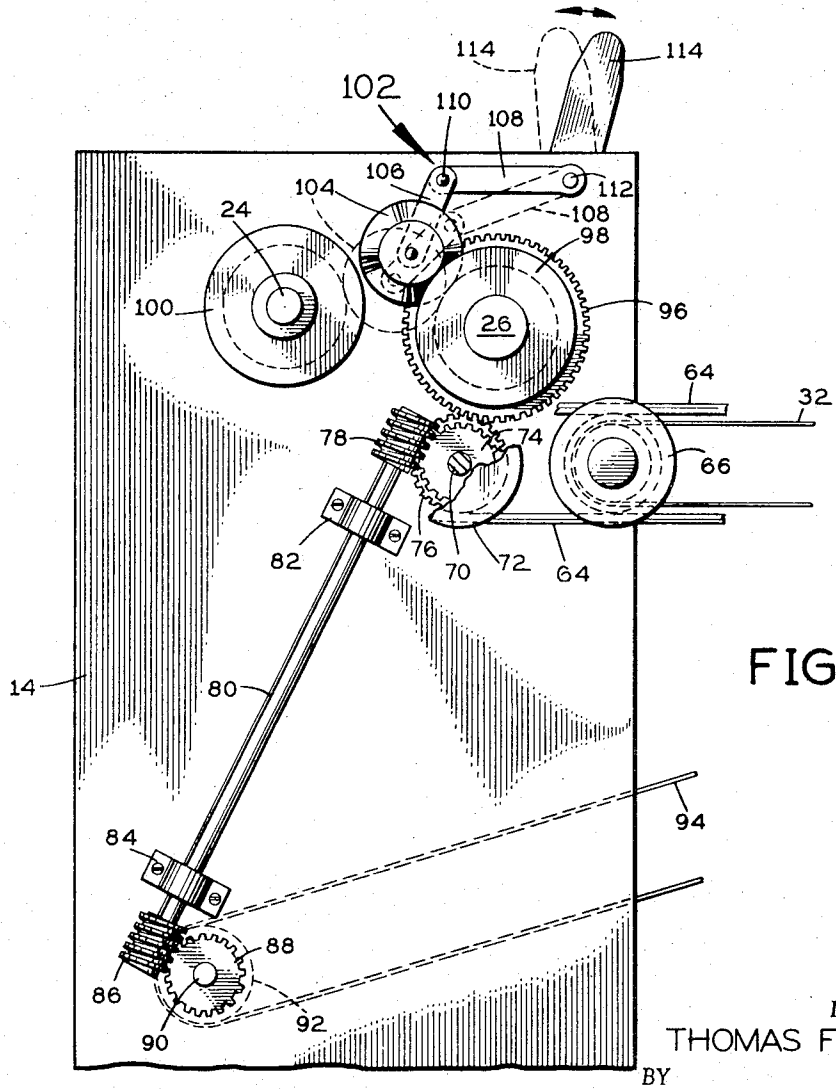

FIG. 4

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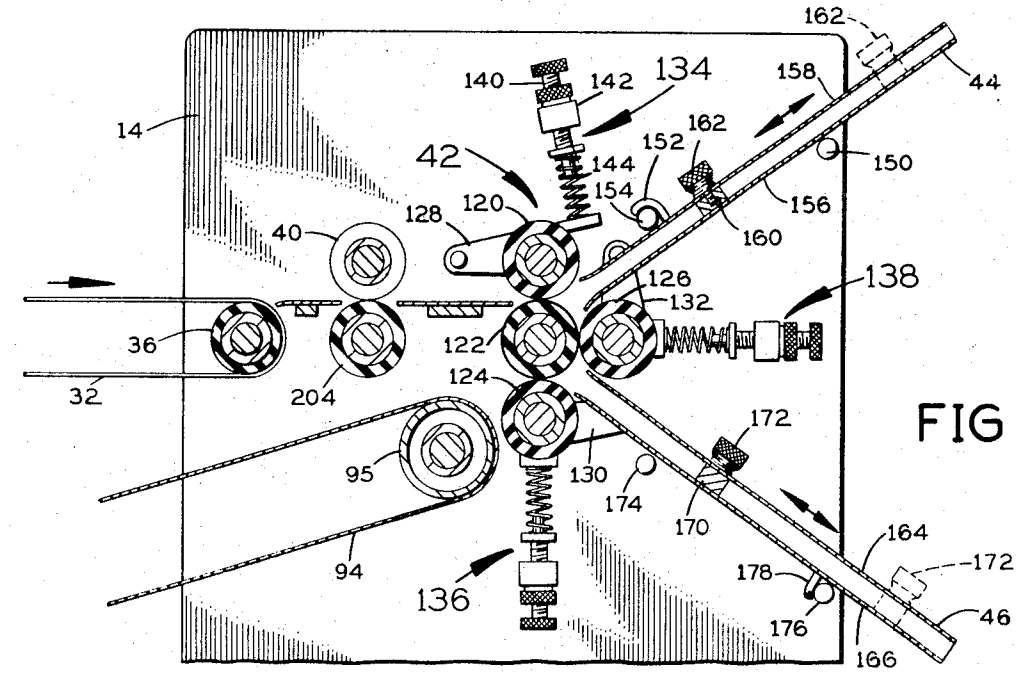

FIG. 5

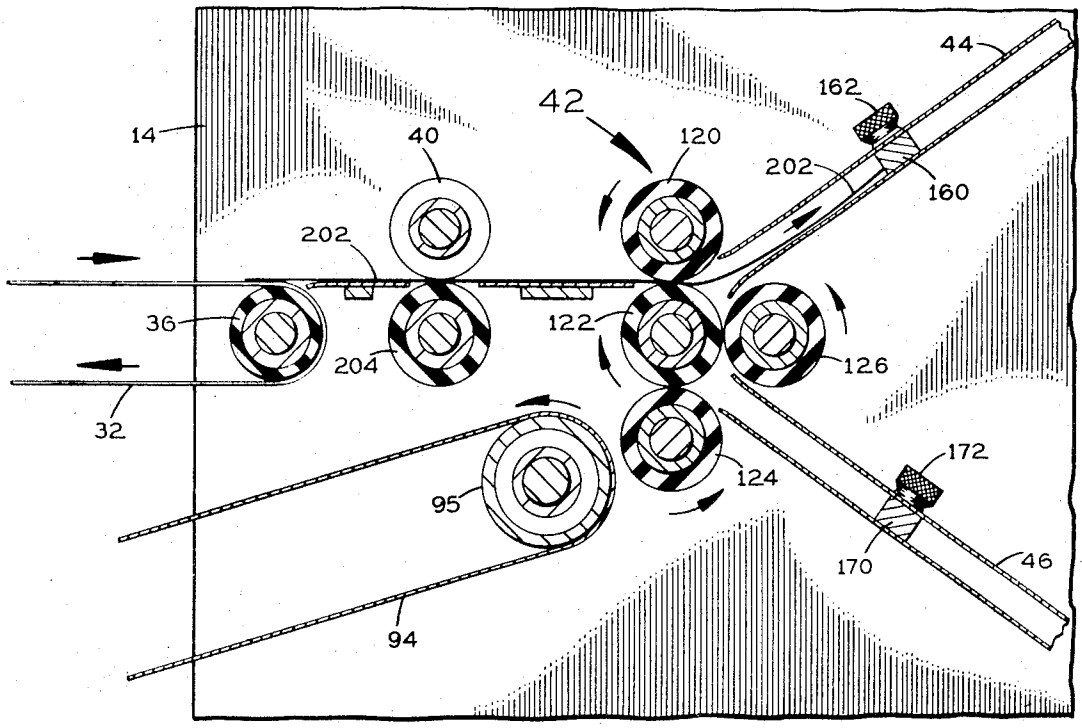

FIG. 6

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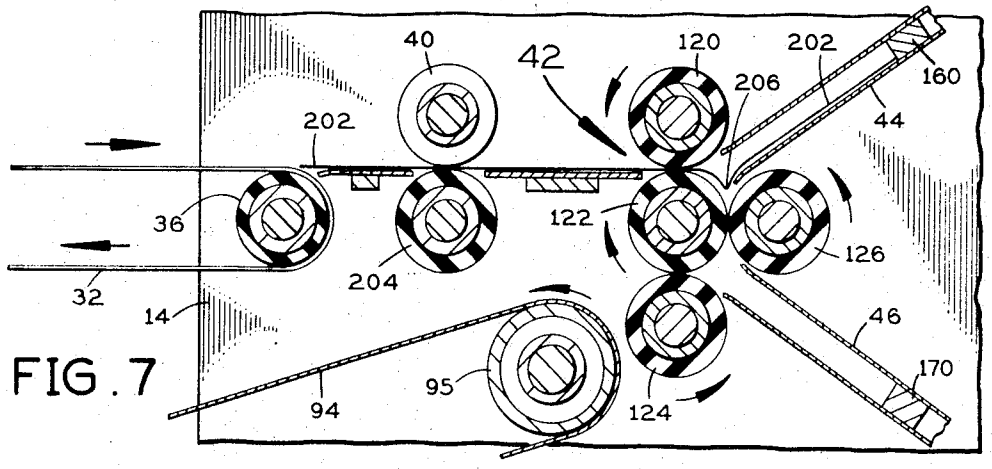

FIG. 7

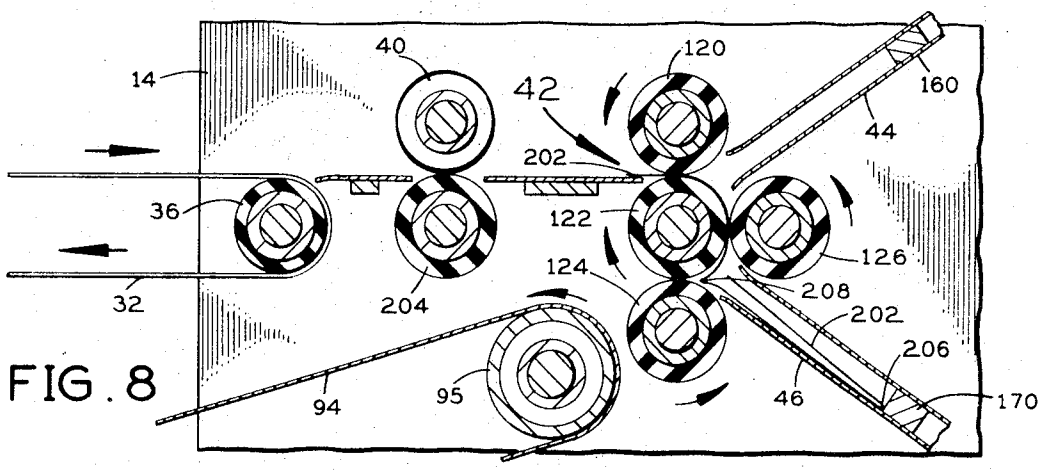

FIG. 8

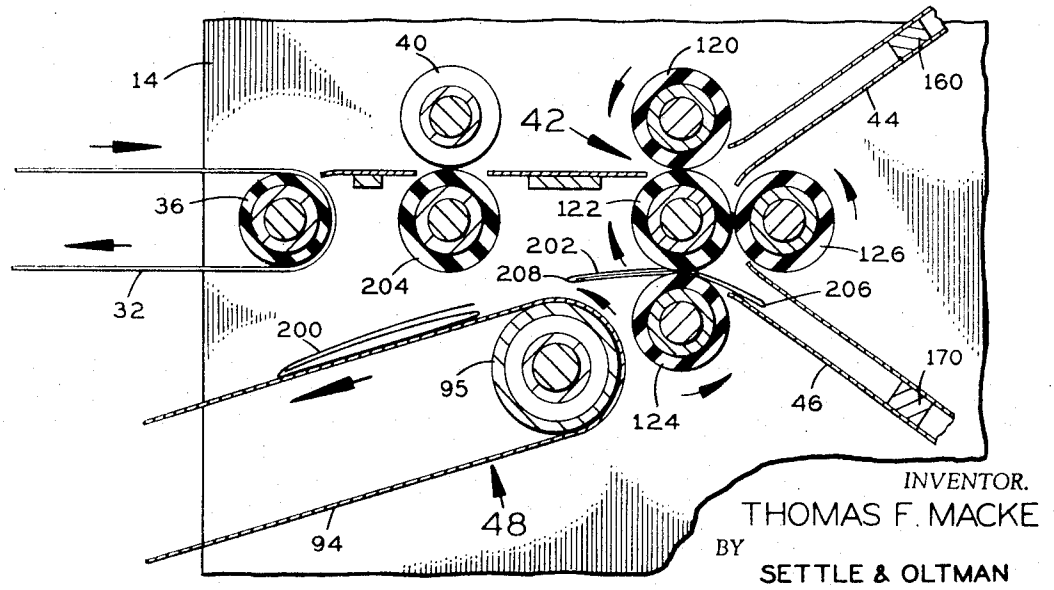

FIG. 9

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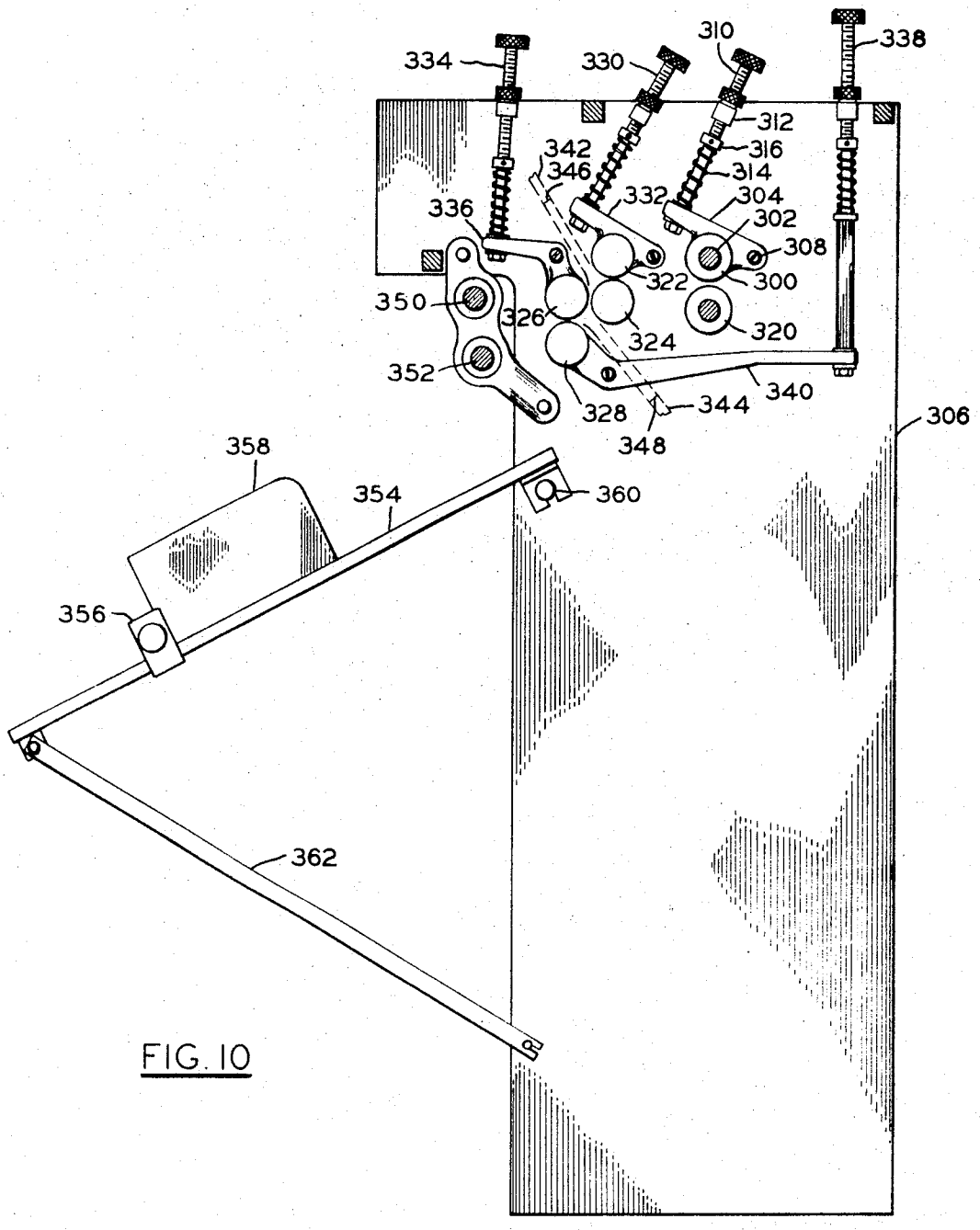

FIG. 10

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METHOD AND APPARATUS FOR FOLDING PAPER

RELATED APPLICATION

This application is a continuation-in-part of copending application Ser. No. 814,704 filed on Apr. 9, 1969 by the present inventor and now abandoned.

BACKGROUND OF THE INVENTION

Folders for paper are known which have a plurality of rolls arranged in a stairstep configuration. One difficulty with such folders is that the rolls are not independently adjustable; that is, adjustment of one roll often requires adjustment of another to compensate for the changed position of the first roll. Another drawback of the known folders is that it has generally been necessary to feed sheets to the rolls with a relatively great space between each successive pair of sheets, thus limiting the efficiency of the system. Other difficulties stem from the fact that slitting, perforating or creasing of sheets has been done after the sheets have been folded.

It is a general object of the present invention to provide a method of and apparatus for folding paper which offer improved speed and efficiency of folding.

Another object of the invention is to provide a method of and apparatus for folding paper utilizing a plurality of rolls including three vertically stacked rolls and a fourth roll laterally adjacent the middle roll of the stack.

A further object of the invention is to slit, perforate or crease paper sheets in a folder and folding method before the sheets reach the folding rolls.

Another object is to provide a feed system for a folder utilizing an unusually simple clutch device.

Among the other objects of the invention are to provide a folder which is relatively inexpensive, rugged, simple and economical to manufacture by quantity production techniques.

Other objects of this invention will appear in the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

ON THE DRAWINGS

FIG. 1 is a perspective view of a folder;

FIG. 2 shows a folded paper sheet;

FIG. 3 is a fragmentary plan view of a clutch included in the folder of FIG. 1;

FIG. 4 is an elevational view of part of the drive mechanism of the apparatus;

FIG. 5 is a sectional view of the folding rolls and associated devices;

FIG. 6 is a sectional view showing a sheet of paper being fed through a pre-treatment device and an upper pair of rolls preliminary to making a first fold;

FIG. 7 is similar to FIG. 6 but shows a buckled portion of the sheet entering the second pair of rolls to make a fold;

FIG. 8 is a further view of a series showing the sheet buckling at another location with the buckled portion entering a third pair of rolls, the middle roll being common to all three pairs;

FIG. 9 shows a fully folded sheet being ejected from the rolls onto a conveyor for travel back to the initial feed point; and

FIG. 10 is a schematic view of a modified embodiment of the apparatus.

Before explaining the present invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

AS SHOWN ON THE DRAWINGS

FIG. 1 shows a folding machine 10 in accordance with one embodiment of the invention. The machine 10 includes a frame 12 having legs 14 on which the operating portions of the machine are mounted. Affixed to one of the legs 14 is an electrical motor 16 which supplies driving power for the machine. The motor 16 is connected through a drive train to various rolls of the machine as will be explained.

A ramp 18 is provided at one end of the machine to receive paper which is to be fed through the machine and folded therein. The ramp 18 leads to a platform 20 on which a wheel 22 rides, the wheel 22 being mounted on a shaft 24 which is journalled in two of the legs 14. Another drive shaft 26 having wheels 28 for engaging the platform 20 is journalled in two of the legs 14 as shown. When the wheel 22 is rotated, it initially engages paper sheets fed thereto down the ramp 18 and feeds them into the machine where they are engaged by wheels 28 and fed onto a conveyor 30 located at the middle of the machine. The conveyor 30 includes belts 32 looped around shafts 34 and 36, the shaft 34 being a driven shaft and the shaft 36 being an idler shaft as will be explained further.

From the conveyor 30, the paper sheets are fed under a shaft 38 on which a treating device 40 is provided for slitting, perforating, or creasing the paper sheets. The device 40 may be a wheel having a sharp edge, a serated edge, a dull edge or whatever is needed to accomplish the desired line scoring treatment of the paper. A backing member is provided under device 40 as will be explained later. The backing member and the wheel device 40 are a line scoring means.

From the device 40, the paper sheets are fed to a cluster of folding rolls designated generally as 42. Associated with the folding rolls 42 are two racks 44 and 46, with rack 44 being shown in dashed lines in FIG. 1 in order to reveal the rolls 42. The paper sheets pass through successive pairs of the rolls 42 as will be explained more fully hereinafter, and the sheets travel at least part way into the racks 44 and 46 during this folding process. A complete description of a folding method will be given later with reference to FIGS. 6 through 9.

From the rolls 42, the folded paper sheets are ejected onto another conveyor 48 located under conveyor 30 and the conveyor 48 carries the sheets back to the rear end of the machine as viewed in FIG. 1 which is the same end as that from which paper sheets are initially fed into the machine. Thus, the folded sheets are returned to the initial feed point so that a single operator can both feed paper into the machine and remove folded paper from the machine, thus cutting down on the amount of labor needed to operate the machine.

The drive system of the machine will be described with reference to FIGS. 1, 3 and 4. A shaft 50 is driven by the electric motor 16 and is connected to a pulley 52 which is in turn connected by a belt 54 to another pulley 56 mounted on a shaft 58. Shaft 58 runs through the center of a middle roll 60 included in the cluster of rolls 42 and serves to rotate the roll 60. The other three rolls in the cluster of rolls 42 are idler rolls and are driven by roll 60 due to contact with that roll.

Shaft 58 has a smaller pulley 62 mounted on it, and pulley 62 is connected by a belt 64 to a pulley 66 which is mounted on shaft 34. Thus, rotation of pulley 66 causes shaft 34 to rotate in order to operate the conveyor 30. As shown in FIG. 4, the belt 64 engages pulley 66 but does not loop around that pulley. Instead, the belt 64 extends further to a pulley 72 which is not clearly visible in FIG. 1 but is mounted on a shaft 70 shown in FIG. 4. A portion of the pulley 72 affixed to shaft 70 is shown in FIG. 4. Rotation of pulley 72 rotates shaft 70 to in turn rotate gears 74 and 76 mounted on shaft 70. Gear 74 meshes with a worm screw 78 provided on a shaft 80 which is journalled in pillow blocks 82 and 84. Another worm screw 86 is provided on the lower end of shaft 80, and worm screw 86 meshes with a gear 88 mounted on shaft 90 on which a pulley 92 is mounted, the pulley 92 being located behind the leg 14 and therefore shown in dashed lines in FIG. 4. Pulley 92 is connected by a belt 94 to a shaft located at the other end of the machine, and rotation of shaft 90 causes the lower conveyor 48 to be operated.

Referring again to shaft 70 and gear 76, it may be seen in FIG. 4 that gear 76 meshes with a larger gear 96 which is mounted on drive shaft 26. A pulley or grooved wheel 98 is also affixed to shaft 26. Thus, rotation of gear 96 causes pulley or grooved wheel 98 to rotate. Another grooved wheel or pulley 100 is mounted on the drive shaft 24 and affixed thereto. A clutch device 102 is provided for selectively coupling and uncoupling wheels 98 and 100. The clutch device 102 includes a wheel 104 which is shown in FIG. 4 in solid lines in a disengaged position and is shown in dashed lines in an engaged position. Wheel 104 is mounted on a lever arm 106 which is pivotally connected to another lever arm 108, the pivot point being 110. Arm 108 is connected at its right end as viewed in FIG. 4 to a shaft 112 which extends between two of the legs 14. At the far end of shaft 112 as viewed in FIG. 1 is provided an actuating lever 114 which has two positions as shown in FIG. 4. When actuating lever 114 is in the right hand position as shown in solid lines in FIG. 4, the wheel 104 is disengaged from wheels 98 and 100 to uncouple these wheels, and when lever 114 is in its left hand position as shown in dashed lines in FIG. 4, wheel 104 is engaged with both wheels 98 and 100 to couple these wheels together so that rotation of wheel 98 causes wheel 100 to rotate also. Wheel 104 may be made of a relatively soft material so as to have good frictional engagement in the grooves of wheels 98 and 100, thereby providing an efficient clutch coupling between these wheels. The shapes of wheels 98, 100 and 104 are clearly visible in FIG. 3.

FIGS. 5 through 9 are sectional views of the forward end of the machine where the cluster of rolls 42 is located and also where the treating device 40 is located. Belts 32 and 94 and shafts 36 and 95 are also visible in these views.

Referring to the cluster of rolls 42, it may be seen that there are three rolls 120, 122 and 124 which have horizontal axes and which are stacked vertically relative to each other. A fourth roll 126 is directly laterally adjacent the middle roll 122 of the stack. Rolls 120, 124 and 126 are all in contact with the middle roll 122, and as previously mentioned, roll 122 is the only one which is actually driven, the other rolls being idlers. Rolls 120, 124 and 126 are respectively mounted on pivotal arms 128, 130 and 132. The pivotal mounting of arms 128, 130 and 132 allows movement of rolls 120, 124 and 126. Adjustment devices 134, 136 and 138 are connected respectively to arms 128, 130 and 132 to allow adjustment of the positions of these arms so as to vary the pressure exerted by the movable idler rolls 120, 124 and 126 on the stationary middle roll 122. It is thus apparent that each of the outer rolls 120, 124 and 126 is independently adjustable relative to the middle roll 122; that is, the pressure between any outer roll and the middle roll can be adjusted without affecting the pressure exerted on any other outer roll.

The adjustment devices 134, 136 and 138 consist of a screw such as 140 threaded into a block 142 and connected by a coil spring 144 to a lever arm such as arm 128.

The two racks 44 and 46 are positioned respectively above and below the middle roll 122. Rack 44 rests on a rod 150 and has a hook 152 which engages over another rod 154 for holding the rack 44 in a fixed position. Rack 44 consists of spaced parallel plate members 156, 158 with a bar 160 positioned between these plates. Bar 160 is slidable longitudinally of rack 44, and is retained in a desired position by means of screws 162. The screws 162 are received in slots in plate 158 to allow movement of the bar 160, and are threaded into bar 160 so that upon turning the screws 162 the bar can be locked in place.

Rack 46 has a very similar construction. It consists of two spaced, parallel plates 164 and 166, with slots 168 being provided in plate 164. The bar 170 is movable longitudinally of rack 46, and has screws 172 threaded into it and received in the slots 168 for locking the bar in a given position. Rack 46 rests on two rods 174 and 176, and has a hook 178 for engaging rod 176 to hold the rack in place. Both rack 44 and rack 46 are removable from their supporting rods.

FIG. 2 shows a folded sheet 200 which illustrates one type of folding which may be done with the method and apparatus of the invention. It is to be understood, however, that other folds may be accomplished with the method and apparatus, and the double folded sheet illustrated in FIG. 2 is merely one example.

FIGS. 6 through 9 illustrate the steps of the method of folding in the case of folding a sheet of paper 202 into a folded sheet 200 as shown in FIG. 2. In FIG. 6, the sheet 202 is being fed through the treating device 40, and it will be assumed that the treating device 40 is a perforator, although it could just as well be a creaser or a slitter if desired. As the sheet passes under perforator 40 it is perforated thereby due to the engagement between perforator 40 and roll 204 located under the sheet 202.

It may be seen in FIG. 6 that the leading edge of the sheet 202 has passed between upper roll 120 and middle roll 122 and has come into contact with bar 160 in rack 44. It may be seen that roll 122 rotates clockwise and roll 120 rotates counterclockwise.

Referring now to FIG. 7, the sheet 202 is shown in its condition after it has advanced somewhat beyond the position shown in FIG. 6 such that the sheet buckles at portion 206 and enters between rolls 122 and 126. Roll 126 is rotating counterclockwise as shown. The buckled portion 206 then passes between rolls 122 and 126 and enters rack 46. After the buckled portion 206 has reached bar 170 as shown in FIG. 8, another portion 208 begins to buckle as shown in FIG. 8. This second buckled portion 208 enters between rolls 122 and 124 and is folded in passing through these rolls. As rolls 122 and 124 engage folded portion 208, they pull the entire folded sheet between rolls 122 and 124 and eject the sheet onto conveyor 48 as shown in FIG. 9. Conveyor 48 returns the folded sheets 200 to the initial feed point as has been described previously.

Thus, it is apparent that each sheet passes through successive pairs of rolls with one middle roll being common to each pair. By changing the positions of the bars 160 and 170, it is possible to change the size of the folds or change from a double fold to a single fold, or to achieve other combinations of folding as desired. The treating device 40 is preferably adjustable vertically to allow adjustment of the pressure exerted between device 40 and roll 204 and also to accommodate different sizes of treating devices. It is believed to be highly desirable to pass the sheets through the treating device prior to folding the sheets since this allows a considerable simplification of the equipment. Also, there is no need to provide a rack on the inner underneath side of the machine as is necessary in some machines of the prior art. It is possible to pass sheets through the machine with very little space between the sheets due to the arrangement of rolls and feeding device, and it is believed that a closer spacing of sheets can be achieved with the method and apparatus of the invention than has been available previously. The clutch mechanism of the apparatus is also a simple and desirable feature of the apparatus.

MODIFIED EMBODIMENT OF THE APPARATUS

FIG. 10 is a schematic view of the output end of an apparatus which is a modification of the apparatus of FIG. 1. The remaining portions of the apparatus of FIG. 10 may be like FIGS. 1–9, so that description will not be repeated. The structure of FIG. 10 includes an adjustable treatment device 300 which may be a slitter, perforator, or creaser like the device 40 of FIGS. 1–9. The device 300 is in the form of a wheel having a sharp cutting edge, a serrated edge, or a somewhat dull edge as is appropriate to accomplish the slitting, perforating or creasing. The shaft 302 of device 300 is journalled at opposite ends in arms 304 which are pivotally connected to the stand 306 by a pin 308. The arm 304 can be pivotally adjusted vertically to adjust the vertical position of device 300 by turning a control screw 310 which is connected to arm 304. The screw 310 is threaded through a holder 312 which is affixed to the stand 306. The screw member 310 has an unthreaded end 314 which is attached to arm 304. There is a stop 316 on the member 310, and a spring 318 is disposed between the stop 316 and the arm 304. Thus, when screw 310 is turned, the arm 304 is pivoted to vertically adjust the device 300.

The device 300 is positioned directly above a lower roll 320 which provides backing for the slitter, perforator or creaser as the case may be. The device 300 and the backing member 320 are a line scoring means. The ability to adjust the device 300 makes it possible to control the pressure of device 300 against roll 320 and also makes it possible to control the depth of the cut that is made by the device 300. It would be possible to adjust the position of the backing member in addition to or instead of the treating device.

By having the treatment device 300 ahead of the folding rolls as shown in the embodiment of FIG. 10 and also as shown in the embodiment of FIGS. 1–9, the sheet material passing through the apparatus is treated while it is in a flat, unfolded condition which is advantageous. Also, it is easier to keep the sheet in proper registry with the treating device when the treating device is ahead of the rolls. It has been found that the cut made by the device 300 comes out cleaner than where the only line scoring device is provided after the folding rolls.

In the embodiment of FIG. 10, the folding rolls are designated 322, 324, 326 and 328. Roll 324 is the driven roll, and rolls 322, 326 and 328 are all idler rolls. The drive means for roll 324 may be in accordance with the description of FIGS. 1-9. Roll 324 is mounted in a fixed position on the stand 306, whereas the other three rolls are adjustable. Roll 322 is adjustable by turning screw 330 to adjust the vertical position of pivotal arm 332 on which roll 322 is journalled. Roll 326 is vertically adjustable by turning a screw 334 to adjust a pivotal arm 336 on which roll 326 is journalled. Roll 328 is adjustable by turning a screw 338 to adjust a pivotal arm 340 on which roll 328 is journalled. It should be noted that the screws 330, 334, 338 and 340 are substantially identical to the screw 310 so the description of the screw and its operation will not be repeated. Similarly, arms 332, 336 and 340 are very similar to arm 304 and function in substantially the same manner. It may be noted, however, that arm 340 extends laterally under the treatment device 300 and roll 320 in order to reach the screw member 338. It will be understood that the adjusting screws may all be duplicated on the opposite side of the apparatus.

Two racks 342 and 344 are shown schematically by dashed lines in FIG. 10, and these racks function like the racks 44 and 46 of the embodiment of FIGS. 1–9. A sheet leaving the conveyor 32 (FIGS. 1–9) enters the structure shown in FIG. 10 by first passing between treating device 300 and the roll 320. The sheet then passes through rolls 322 and 324 and into the rack 342. The sheet buckles when it butts against the stop 346 of rack 342, and the buckled portion passes downwardly between rolls 324 and 326. The sheet then enters the other rack 344 and buckles when it butts against the stop 348 of the rack 344. The buckled portion then passes between rolls 326 and 328 into the stacking side of the machine.

An additional treating device may be provided to receive the folded sheet from the rolls 326 and 328. This treating device may be mounted on one of the

shafts **350** and **352** shown in FIG. **10**. The shafts **350** and **352** are fixed and are not adjustable like the treating device **300** which precedes the folding rolls.

From the post-treating device **350**, **352**, the folded sheet may pass onto a stacking tray **354** and against a stop **356** on the tray **354**. A guide plate **358** may be provided at one side of the tray **354**. The tray may be affixed to the stand **306** as at **360** and may be supported by a strut **362**.

It is possible to pass a sheet between the treating device **300** and roll **320** and then bypass all of the other rolls so that the sheet goes directly from the treating device onto the stacking tray **354**. It is merely necessary to insert a guide just after the treating device **300** to direct the sheet over the folding rolls and over the treating device **350**, **352** onto the tray **354**.

Thus, the adjustable pre-treatment device may be combined with folding rolls of the type shown in FIGS. **1–9** and alternatively may be combined with folding rolls of the type shown in FIG. **10**. The adjustable pre-treatment device makes it possible to treat the sheet while it is flat and in proper registry with the device, and it also makes it possible to control the depth of the cut. The sheet can be delivered directly from the pre-treatment device to the stacking tray.

Having thus described my invention, I claim:

1. In an apparatus for folding sheets of paper which apparatus has a plurality of folding rolls arranged to make successive folds in a sheet, a first rack means cooperating with said rolls to receive a sheet from a first pair of said rolls and buckle the same to deliver a buckled sheet to a second pair of said rolls which fold the sheet, a second rack means cooperating with said rolls to receive the folded sheet from the second pair of rolls and buckle the same to deliver a further buckled sheet to a third pair of said rolls which again fold the sheet and supply the same as an output, said apparatus further having feed means ahead of said rolls for feeding unfolded sheets into the rolls, and drive means for said rolls, the combination therewith of adjustable line scoring means in the path of said unfolded sheets between said feed means and said folding rolls to treat the sheets by slitting, perforating or creasing them before said sheets reach said folding rolls, said line scoring means including a wheel means positioned on one side of the path of said sheets, said wheel means having a treating edge for slitting, perforating or creasing said sheets, a backing member positioned on the other side of the path of said sheets providing backing for the action of said treating edge, and means for adjusting the relative positions of said wheel means and said backing member to control the depth of the action of said treating edge and the pressure thereof against said backing member, said drive means including a motor coupled to one of said rolls to rotate the same and thereby rotate the other rolls which idle, said other rolls each having an adjusting means for adjusting the position thereof, said feed means including a driven shaft, means coupling said driven shaft to said motor, a paper feeding shaft having a wheel thereon for contacting paper sheets to feed the same, an intermediate shaft coupled to said driven shaft, said feeding shaft and said intermediate shaft having grooved wheels thereon located on one side of the apparatus, and a clutch means on said one side for coupling and uncoupling said paper feeding shaft, said clutch means including a clutch wheel made of soft material that is frictionally engageable with both of said grooved wheels and means for moving said clutch wheel into and out of engagement with said grooved wheels including a handle on the side of said apparatus opposite said one side, an arm traversing the apparatus and connected to said handle, and a linkage at said one side connecting said arm to said clutch wheel.

2. The apparatus as claimed in claim **1** in which said adjusting means for said wheel means includes an arm supporting said wheel means, means pivoting said arm, and control screw means connected to said arm for pivoting the same to controllably adjust the position of said wheel means relative to said backing member, and each of said adjusting means for said rolls is of the same construction as said adjusting means for said wheel means.

* * * * *