

March 10, 1970

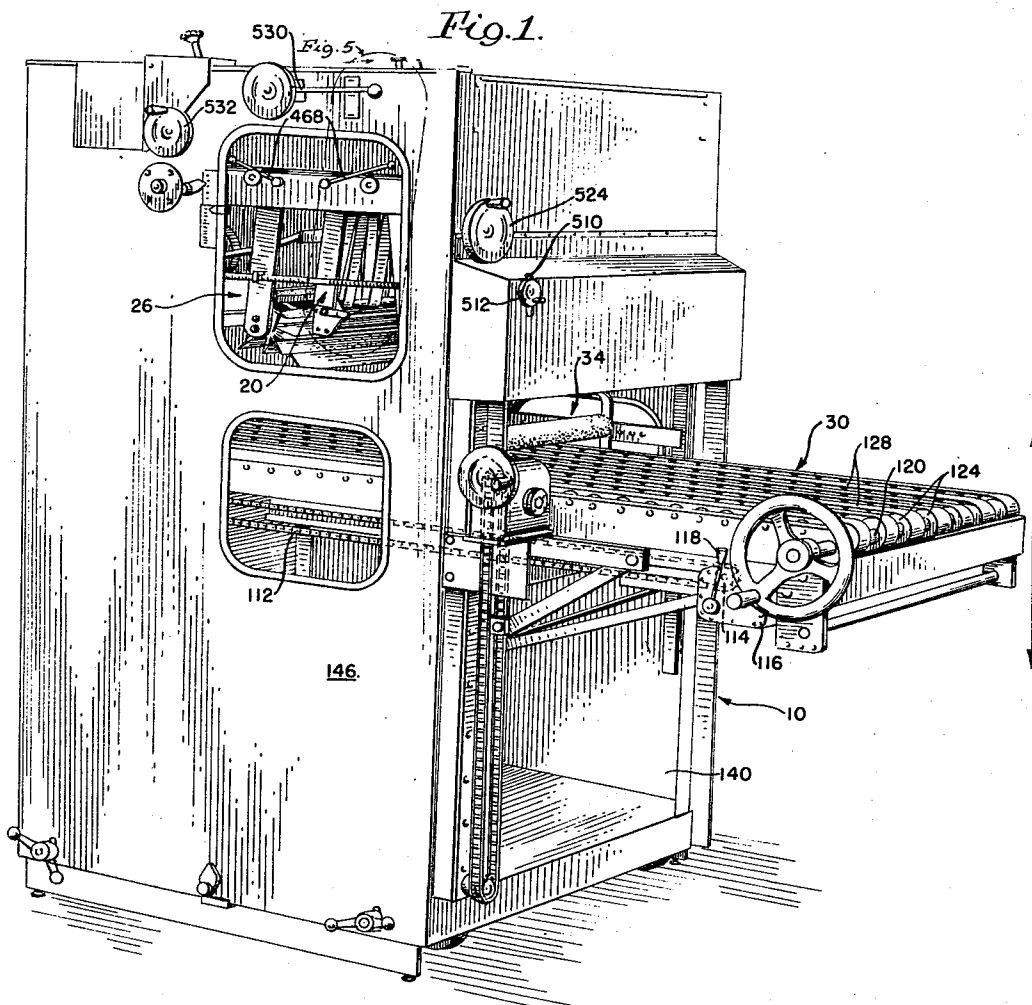
F. M. BIGGAR, JR

3,499,643

MACHINE FOR FOLDING WEBS OF INDEFINITE LENGTH

Filed Oct. 4, 1967

9 Sheets-Sheet 1



INVENTOR.

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BY

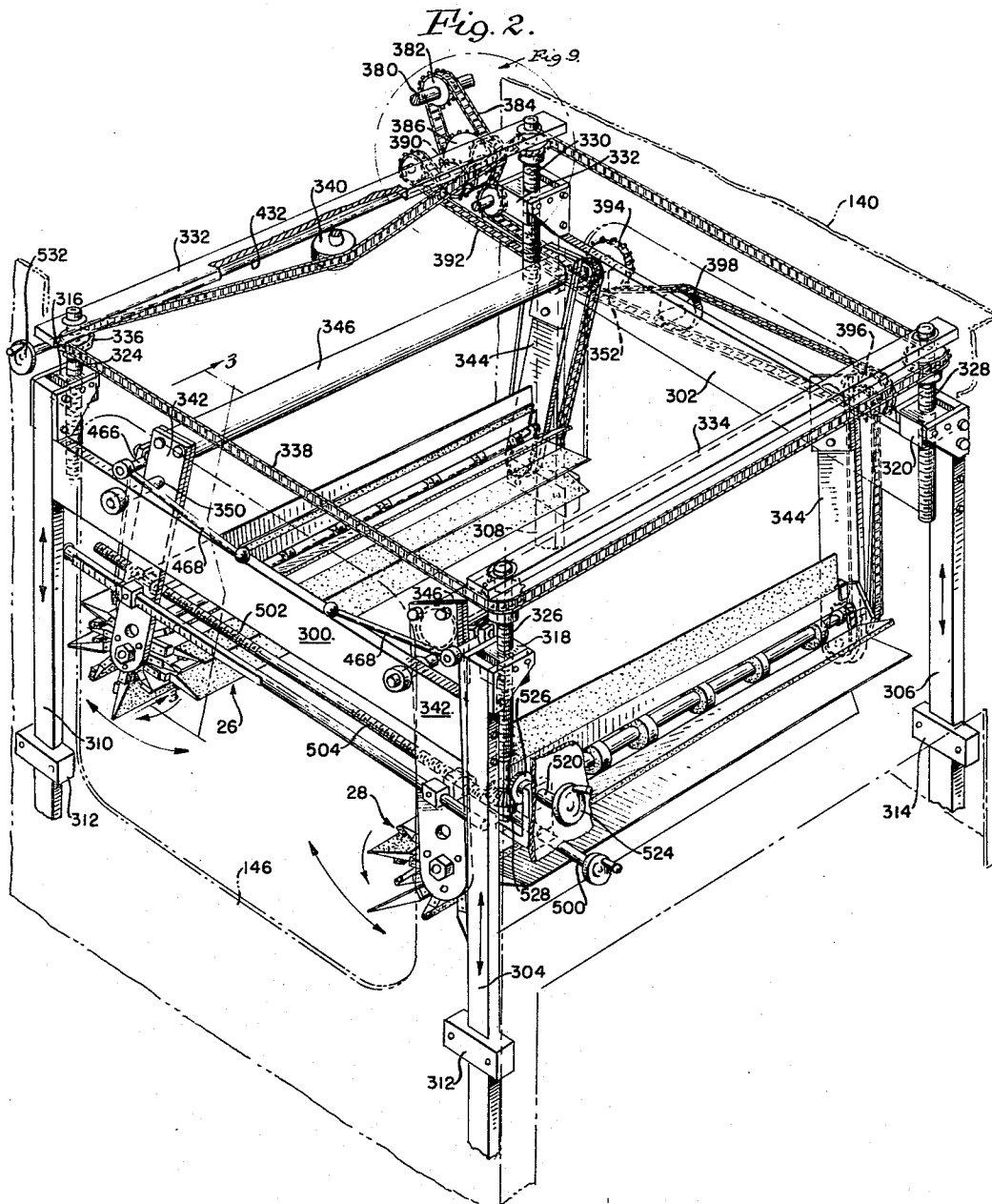
*Beau. Brooke, Buckley & Beau*  
ATTORNEYS

**3,499,643**

# MACHINE FOR FOLDING WEBS OF INDEFINITE LENGTH

Filed Oct. 4, 1967

9 Sheets-Sheet 2



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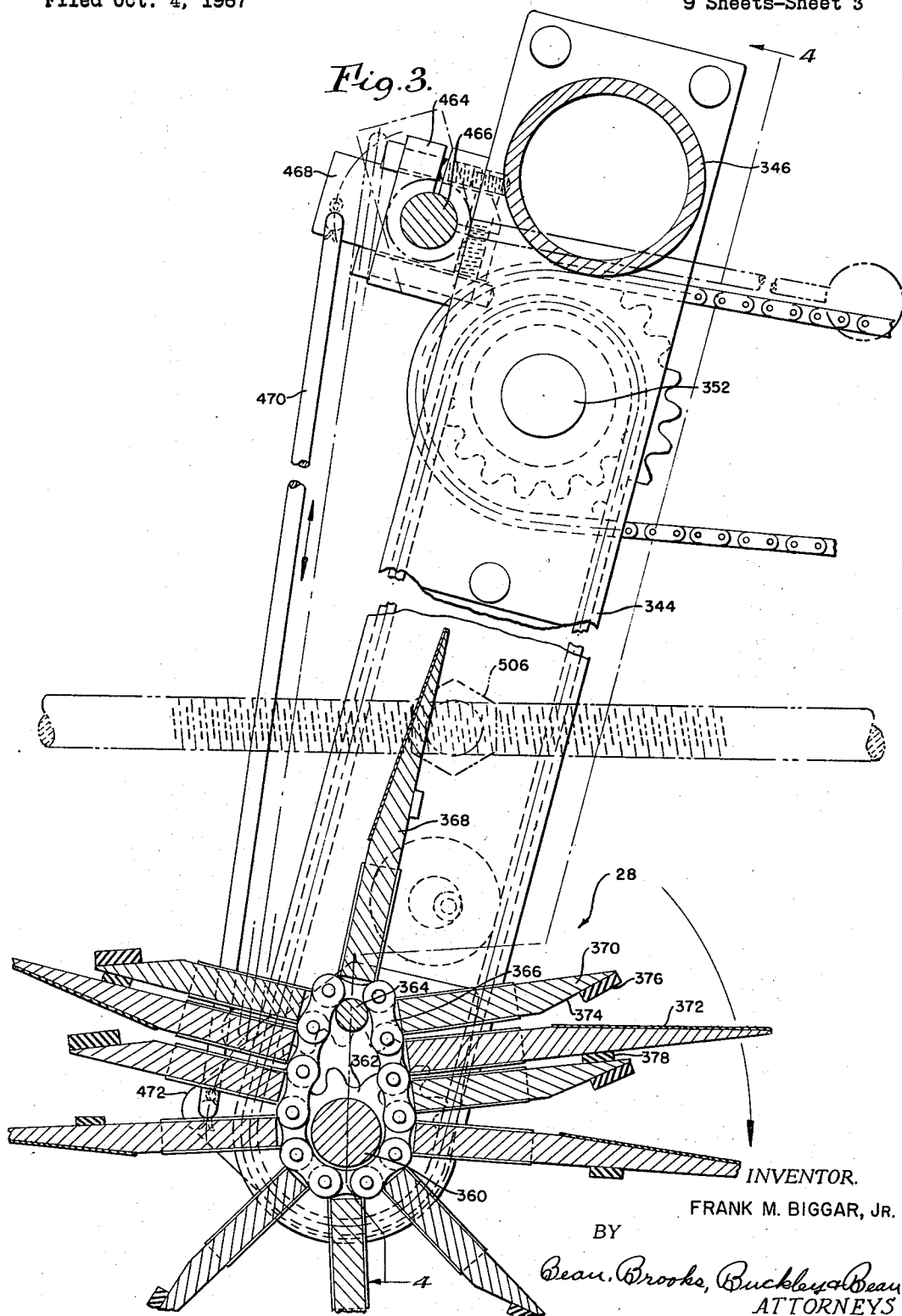
F. M. BIGGAR, JR

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MACHINE FOR FOLDING WEBS OF INDEFINITE LENGTH

Filed Oct. 4, 1967

9 Sheets-Sheet 3





**March 10, 1970**

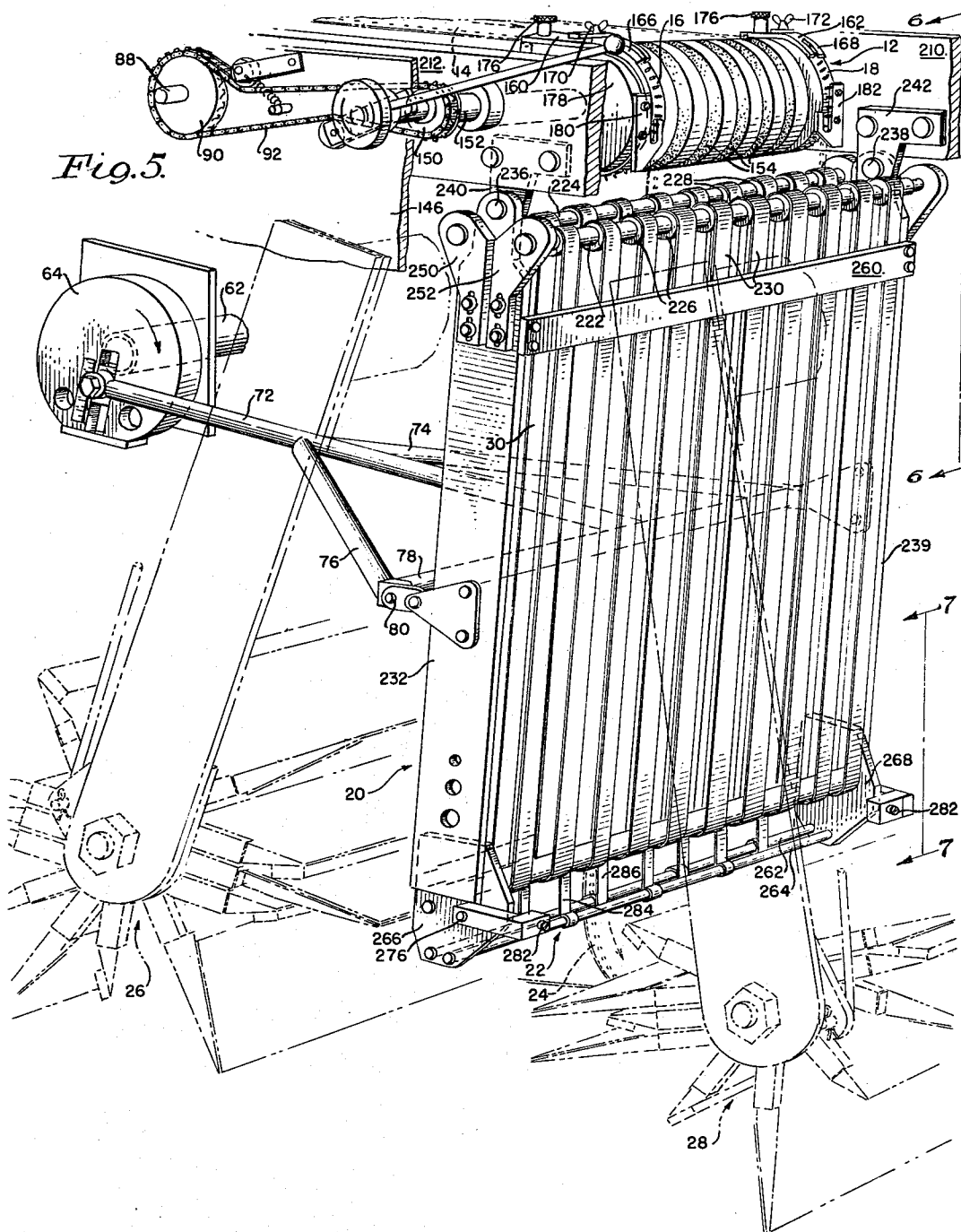
**F. M. BIGGAR, JR**

**3,499,643**

# MACHINE FOR FOLDING WEBS OF INDEFINITE LENGTH

Filed Oct. 4, 1967

9 Sheets-Sheet 5



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**March 10, 1970**

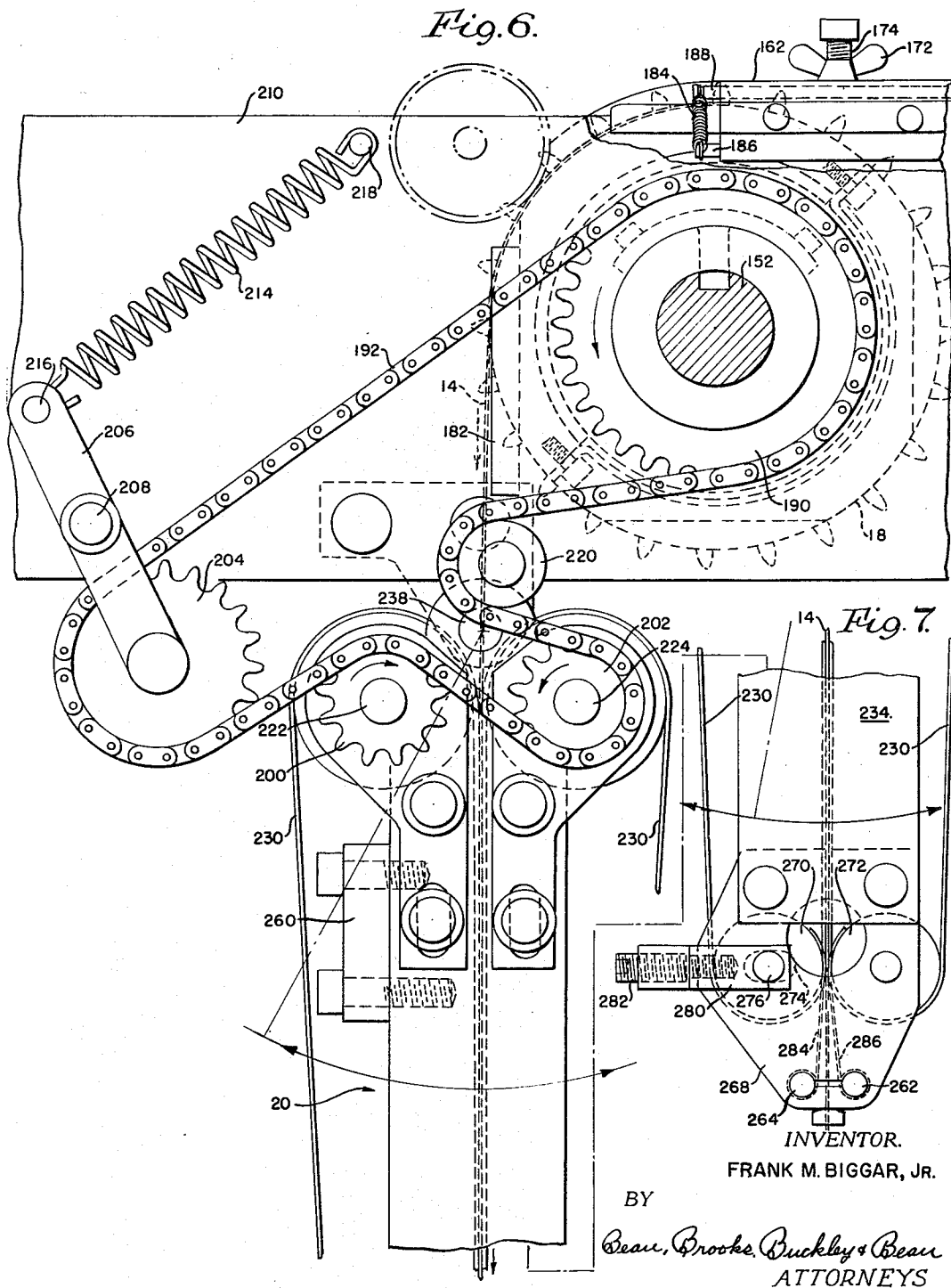
**F. M. BIGGAR, JR**

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# MACHINE FOR FOLDING WEBS OF INDEFINITE LENGTH

Filed Oct. 4, 1967

9 Sheets-Sheet 6



**March 10, 1970**

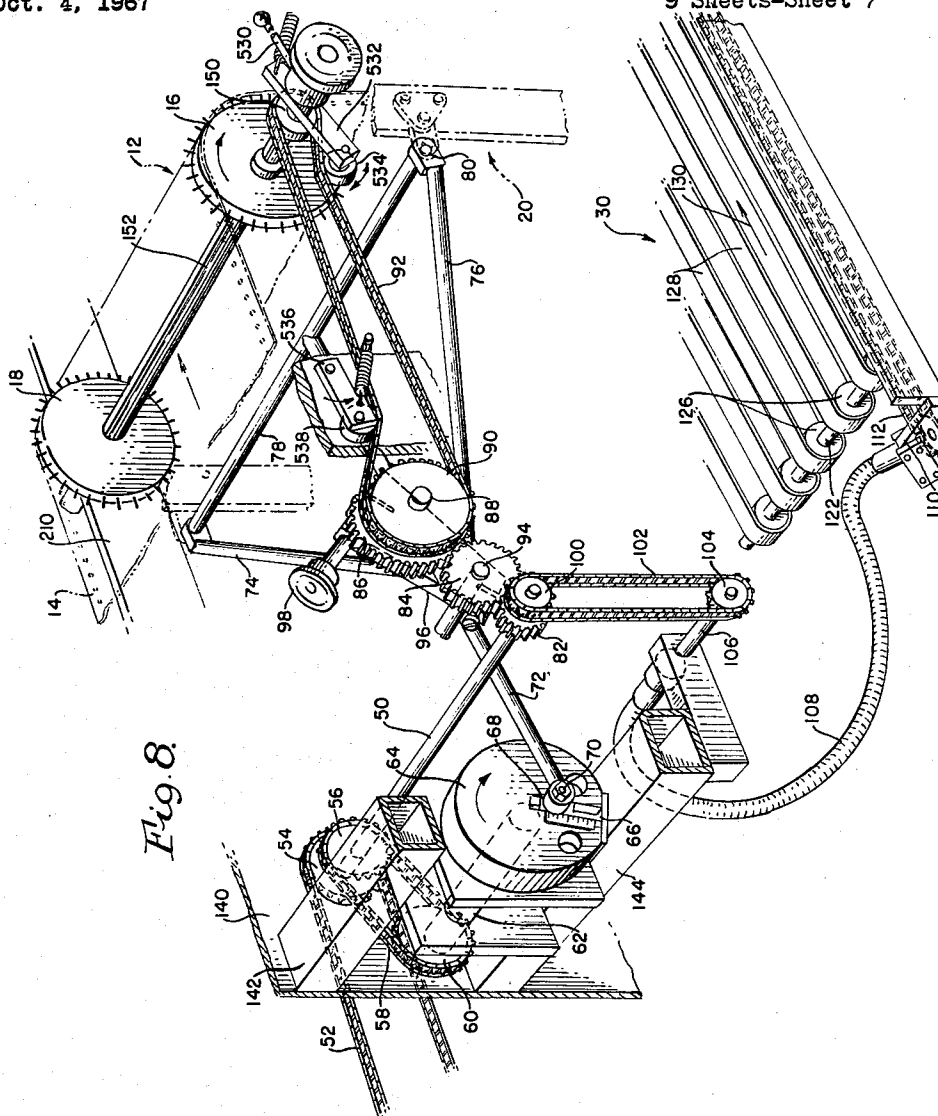
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**3,499,643**

# MACHINE FOR FOLDING WEBS OF INDEFINITE LENGTH

Filed Oct. 4, 1967

9 Sheets-Sheet 7



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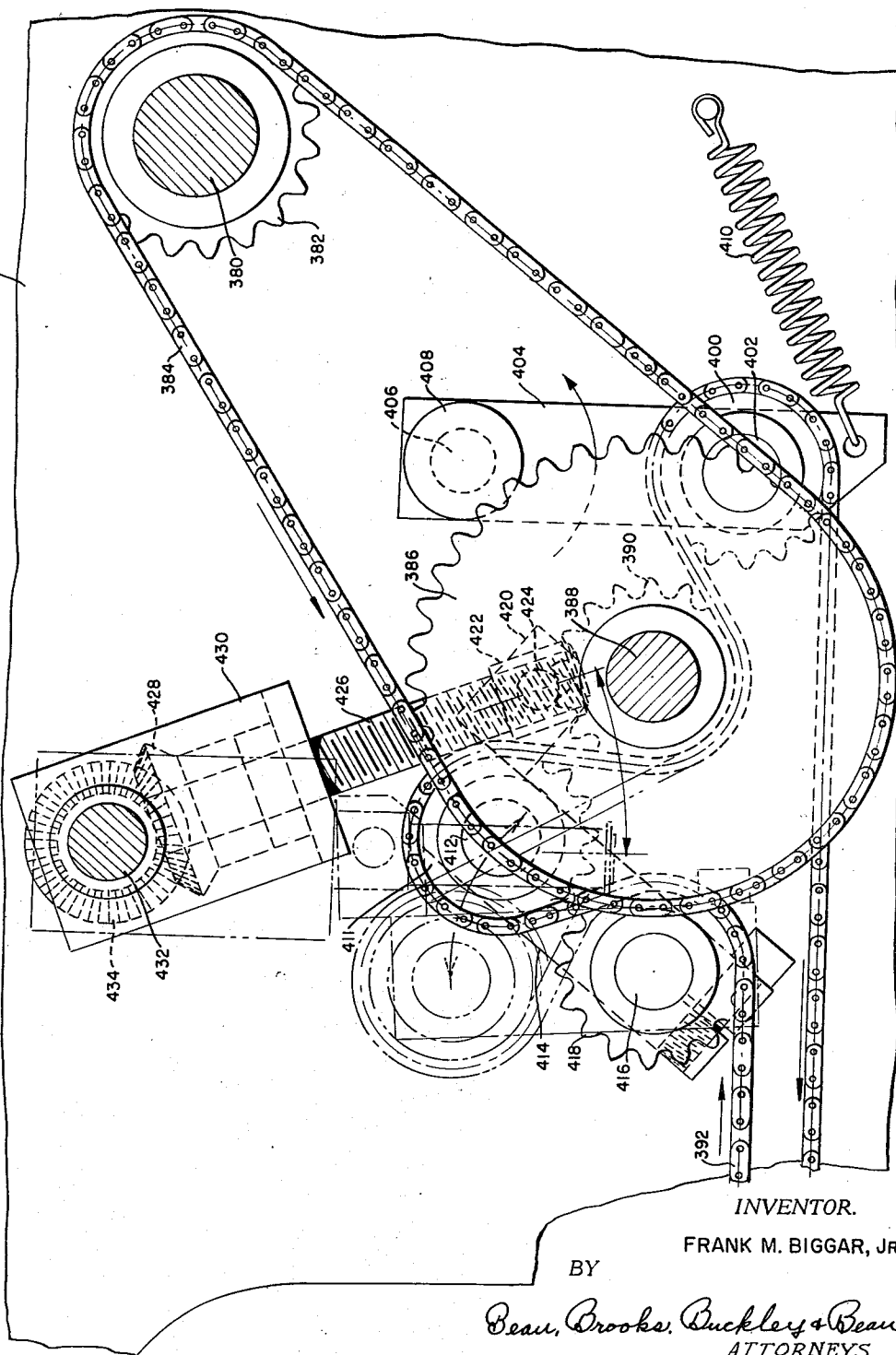
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MACHINE FOR FOLDING WEBS OF INDEFINITE LENGTH

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9 Sheets-Sheet 8

Fig. 9.



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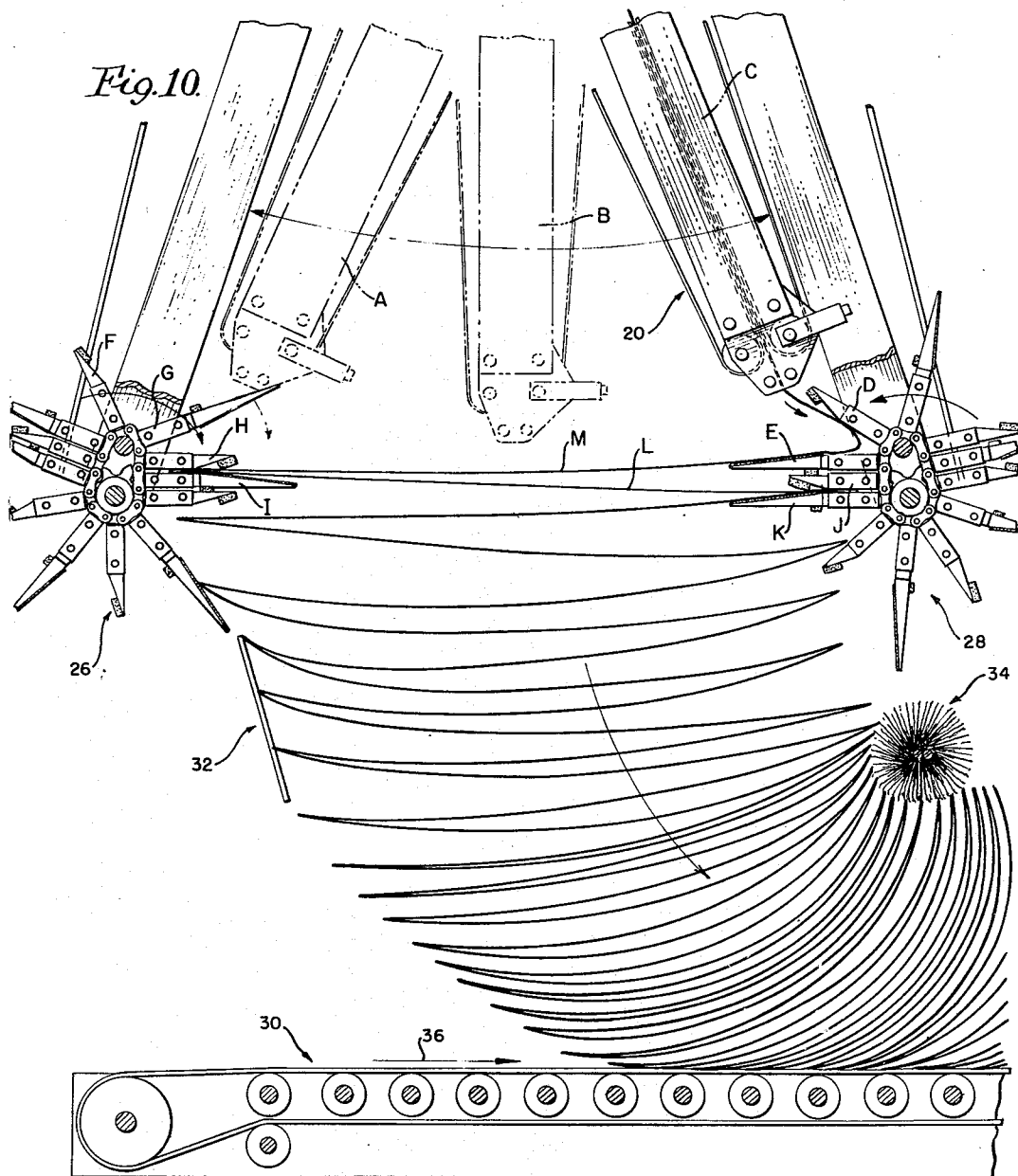
F. M. BIGGAR, JR

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MACHINE FOR FOLDING WEBS OF INDEFINITE LENGTH

Filed Oct. 4, 1967

9 Sheets-Sheet 9



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3,499,643

## MACHINE FOR FOLDING WEBS OF INDEFINITE LENGTH

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Continuation-in-part of application Ser. No. 609,181,  
Jan. 13, 1967. This application Oct. 4, 1967, Ser.  
No. 672,858

Int. Cl. B65h 45/20

U.S. Cl. 270—79

11 Claims

### ABSTRACT OF THE DISCLOSURE

A web of indefinite length is caused to issue lengthwise at a predetermined rate and simultaneously to be fed back and forth between a pair of spaced folding assemblies. At each end of the feed stroke a loop is formed in the web at a corresponding folding assembly, whereafter the folder closes upon to fold the web and hold it until the other folder folds the web at the other end of the stroke, whereafter the first folder releases the web. The machine is adjustable to accommodate for different lengths between folds.

### BACKGROUND OF THE INVENTION

This application forms a continuation-in-part of my co-pending application Ser. No. 609,181, filed Jan. 13, 1967, now abandoned.

In the art of folding webs of indefinite length, there is a need for effecting the folding operation in rapid fashion while also providing for adjustment of the length of the web between folds.

In the present invention, the manner in which the web is moved and handled allows the length between folds to be varied widely. Basically, the invention involves the combination of a web feeding mechanism in cooperation with a pair of folding assemblies. The feeding mechanism positively grips and feeds the web and issues it from an oscillating end of the feeding mechanism back and forth between the folding assemblies. The drives to the feeding mechanism and the folding assemblies are coordinated so that at the end of each stroke of the feeding mechanism, the loop of web formed by the reversal of feeding mechanism motion is laid within the mouth formed by a corresponding folding assembly which thereafter closes and folds the web loop and also holds it in tension in opposition to the retreating feed mechanism until the other folding assembly folds and holds the web, whereupon the first fold is released in readiness for another folding operation.

There are many instances when it is desirable to fold a web of indefinite length in zig-zag fashion to form serially edge-connected rectangular sheets. Commonly, although not necessarily, the web may be issuing from a printing press and the invention herein concerns means for feeding the web back and forth within a fixed path, which means operates in conjunction with mechanism for capturing, folding and temporarily holding the sheets along their connected edges.

The lengthwise feed of the web is under strict control by the folding machine and thus can be adjusted to be compatible with the speed of any machine or machines processing the web prior to its entry into the folding machine. The web is positively controlled up to the point at which the folds are released, whereafter the zig-zag folded web is allowed to fall free to be gathered. The gathering, however, is effected in such fashion as to maintain control over the freely falling web and assure smooth and continuous flow of the web through the machine.

It is an object of this invention to provide improved folding assemblies for capturing, folding and temporarily holding the web. These means are in the form of blade

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assemblies located at the ends of the fixed path swept back and forth by the feed means and the construction is such that adjacent blades are effective to rapidly and positively move from a position in which they are widely spaced so as to readily allow the loop portions of the web effected by the reversal of motion of the feed means at its opposite ends of travel to be received and wherein the blades move from this position quickly and positively to closed position to capture, fold and temporarily hold the folded web.

Essentially, each blade assembly utilizes an endless chain or its equivalent trained over a drive sprocket and an idler, in which the idler is of such dimensions relative to the links of the chain to cause the rapid action as aforesaid in response to relatively minute movement of the chain along its path. Adjacent blades open wide as they pass over the idler but very rapidly and positively close upon the loop of the continuous web fed thereto so that the transition between wide open to closed as regards adjacent blades is effected as quickly as possible so as to permit positive disposition of the loop between adjacent blades while at the same time allowing the blades to close quickly thereupon so as to allow high speed operation without the danger of withdrawing the loop of the web from between the blades.

In the drawing:

FIGURE 1 is a perspective view of the machine constructed according to this invention;

FIGURE 2 is a perspective view showing certain of the internal drive arrangements of the machine;

FIGURE 3 is an enlarged section of the folding device, as indicated by section line 3—3 in FIGURE 2;

FIGURE 4 is a view, partly in section, taken along the plane of section line 4—4 in FIGURE 3;

FIGURE 5 is a perspective view of the feeding mechanism;

FIGURE 6 is an enlarged side elevation, partly in section, as seen from section line 6—6 in FIGURE 5;

FIGURE 7 is an enlarged side elevation of the feeding mechanism as indicated along section line 7—7 in FIGURE 5;

FIGURE 8 is a diagrammatic perspective of the main drive components;

FIGURE 9 is an enlarged section of a part of the adjustment mechanism corresponding to the circled portion in FIGURE 2; and

FIGURE 10 is an interior vertical section illustrating the operation of the machine.

Basically, the machine consists of a frame indicated generally by the reference character 10 in FIGURE 1 which forms the support for the various working parts of the machine. As viewed in FIGURE 1, the web of indefinite length enters the machine in horizontal fashion over the top left upper edge of the machine and passes downwardly over a speed control assembly which is indicated generally by the reference character 12 in FIGURE 5, the web of indefinite length being indicated generally by the reference character 14 in that figure. Whereas it will be seen that the speed control mechanism 12 in the specific form of the invention shown includes a pair of pin wheels 16 and 18 hereinafter more particularly described, it will be appreciated that the speed control assembly may be formed in other and different fashions as for example by a pair of nip rollers or any other suitable means driven in such a fashion and engaging the web of indefinite length in such manner as to control the speed of passage thereof through the machine.

The web of indefinite length 14 passes downwardly from the mechanism 12 to a web feeding mechanism indicated generally by the reference character 20 which

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terminates at its lower end in a mouth indicated generally by the reference character 22 from which the web issues as indicated by the reference character 24, the mouth end of the feed mechanism 20 being swept back and forth in an oscillatory path between the two folding assemblies indicated generally by the reference characters 26 and 28 in FIGURE 5.

The mechanism 20 includes pairs of opposed belts 30 across its width which, for each pair, have coextensive flight portions which are in or substantially in contact with each other and between which the web passes in its passage through the mechanism 20. The belts may be slightly overdriven with respect to the speed of the mechanism 12 so that the web is maintained under slight tension within the mechanism 20.

As the web is fed back and forth between the two folding assemblies 26 and 28, the transverse folds at predetermined longitudinal spacing on the web are made as will hereinafter be more particularly explained and as is illustrated perhaps best in FIGURE 10 whereafter the serially edge-connected rectangular sheets formed by the folding are released to fall freely from the assemblies 26 and 28 onto a gathering table indicated generally by the reference character 30 in FIGURE 10 and as is also shown in FIGURE 1. In falling from the folding assemblies 26 and 28 to the gathering means 30, the edge-connected rectangular sheets encounter a deflecting plate indicated generally by the reference character 32 and a retarding brush 34 as are shown in FIGURE 10 positioned in such fashion that the sheets upon falling on the means 30 which is, in essence, an endless conveyor moving in the direction of the arrow 36, are caused to assume a substantially vertical position as is shown in the right hand side of FIGURE 10 after passage from beneath the retarding means 34.

As much as is possible, the above-mentioned components of the machine are identified in FIGURE 1 so as to provide a unifying effect for that particular figure since the above components comprise the essential and main working parts of the machine constructed and coordinated as hereinafter more particularly defined so as to achieve the requisite folding action upon a web of indefinite length.

Referring now to FIGURE 8, the machine may be driven from a suitable power source, not shown, which may drive the shaft 50 to a suitable chain 52 engaging the sprocket wheel 54. The shaft 50 may carry a further sprocket 56 which, through chain 58, drives the sprocket 60 fixed to the counter shaft 62. The shaft 62 carries a fly wheel 64 provided with a diametrically extending slot 66 within which a slide 68 is located and which slide may be adjusted and fixed within a predetermined and definite position within the slot 66 eccentrically of the center of the shaft 62. The slide 68 carries a suitable stub shaft 70 upon which is journaled one end of the oscillating rod 72 which is bifurcated at its opposite end as indicated by the reference characters 74 and 76 and suitably cross-braced as at 78 and the ends of the bifurcations 74 and 76 thus braced are journaled or pivotally secured, as at 80, to the oscillating mechanism 20.

The shaft 50 carries a spur gear 82 which meshes with gear set 84 and 86 ultimately to drive the shaft 88 of the sprocket 90 carried thereby for imparting drive, through the chain 92 to the feed wheel assembly 12 which includes the two pin wheels 16 and 18. The stub shaft 94 which carries the gear 84 is carried by the block 96 which is clampingly adjusted, through the mechanism 98, for rotational adjustment about the axis of the shaft 88. The gear 84 of the gear set 84, 86 may be replaced by larger or smaller gears for the purpose of driving the feed wheel mechanism 12 at different speeds corresponding to the length between folds desired.

The shaft 50 also carries a sprocket 100 which drives, through the chain 102, the sprocket 104 carried by the

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shaft 106 which shaft is connected through the flexible cable drive 108 to a sprocket 110 which drives the chain 112. The opposite end of the chain, as can be best seen in FIGURE 1, passes over a sprocket 114 which drives the variable speed mechanism 116 having a suitable control handle 118 and which variable speed mechanism 116 drives through its output shaft to the drive shaft 120 of the table mechanism 30, the connection not being specifically shown. Parallel to the drive shaft 120 and at the opposite end of the table as is shown in FIGURE 8, there is provided an idler shaft 122 and these two shafts are provided with pulley devices 124 and 126 respectively which support the endless belt mechanisms 128 which are driven in the direction of the arrow 130 for transporting the folding paper as hereinafter more particularly described.

FIGURE 8 also shows portions of the main frame of the machine as, for example, the side wall 140 and certain of the cross braces 142 and 144 which extend from this side wall to the opposite side wall 146 as shown in FIGURE 1.

The previously mentioned chain 92 passes over a sprocket 150 fixed to the feed wheel drive shaft 152, which shaft carries the previously mentioned pin wheels 16 and 18. The pin wheels are rotated by the shaft 152 but are keyed thereto so as to be longitudinally slidable thereon to various adjusted positions for the purpose of accommodating for different widths of the web which may be handled by the machine and, as is shown in FIGURE 5, a series of resilient discs 154 are interposed between the two pin wheels 16 and 18 to support the web between the pin wheels, it being appreciated that the discs may be positioned as desired on the shaft 152 to accommodate for the variable spacing between the pin wheels 16 and 18. FIGURE 5 also shows the two guide bars 160 and 162 beneath which the web passes and which guide bars assure that the web positively engages the pin wheels 16 and 18. The bars 160 and 162 are slotted at their arcuate ends 166 and 168 to clear the pins on the wheels 16 and 18 and these bars are mounted about horizontal axes to swing to one side when placing the web in the machine. The bars are held down by wing nuts 170 and 172 respectively carried by associated studs 174 which engage through side slots in the bars and each bar is provided with a knurled handle 176 so that it may be easily manipulated to swing sideways as previously defined.

The bars 160 and 162 are carried by suitable supports 178 which also carry the web guide plates 180 and 182 which prevent the web from wrapping around the pin wheels as it issues therefrom to the feeding mechanism 20 and suitable biasing springs 184 as shown in FIGURE 6 may be provided to extend between the pins 186 and 188 on the supports 178 and the bars 160 and 162 normally to bias the bars to their closed position.

The opposite end of the feed wheel shaft 152, as is shown in FIGURE 6, is provided with a sprocket 190 over which the chain 192 is trained and this constitutes the web drive for the oscillating feed assembly 20. The feed assembly 20 is provided with a pair of driven sprockets 200 and 202 over which the chain 192 passes as shown in FIGURE 6 so as to impart the directions of rotation to these sprockets as indicated by the arrows in that figure. An idler sprocket 204 is carried by the lever 206 pivoted at 208 to the frame side piece 210, the opposite counterpart of which is the frame piece 212, see particularly FIGURE 5, and a biasing spring 214 extends between the pins 216 and 218 normally to tension the drive chain 192 as will be clearly evident. To assure good drive connection between the chain 192 and the sprocket 202, an idler 220 is journaled on the frame piece 210 substantially as is shown. The two sprockets 200 and 202 drive the shafts 222 and 224 and, as can be seen in FIGURE 5, these two shafts carry the respective pulleys 226 and 228 over which the endless belts 230 are trained.

The assembly 20 as shown in FIGURE 5 includes the opposite depending side pieces 232 and 234 which, at their upper ends, are pivotally mounted as at 236 and 238 to suitable brackets 240 and 242 on the frame side pieces 210 and 212 so as to rock about the axes of these pivot pins 236 and 238 under the influence of the oscillating drive previously described. Adjustable bracket ears 250 and 252 are provided on each side piece 232 and 234 serving as supports for the drive shafts 222 and 224 and the upper ends of the frame pieces 232 and 234 are tied together by means of a suitable cross bar 260 whereas the lower ends of the side pieces are tied together by the cross bars 262 and 264 extending between the extension brackets 266 and 268 carried by the lower ends of the side pieces 232 and 234.

As can be best seen in FIGURE 7, the lower ends of the belts 230 are trained over the cross bar 270 and 272 which extend between and are carried by the bracket extensions 266 and 268 previously mentioned. The brackets mount the bar 270 in fixed position but allow the bar 272 to be moved relative thereto. For this purpose, the bracket extensions 266 and 268 are slotted as at 274 to receive adjustably the reduced end portions 276 of the bar 270 which reduced end portions are engaged by blocks 280 which are fixed to the bracket extensions by means of threaded members 282 so as to movably position and adjust the bar 270 relative to the bar 272.

FIGURE 7 also shows the manner in which the lower ends of the guide strips 284 and 286 form a mouth for the issuing web, these strips being anchored at their lower ends to the cross bars 262 and 264 as is also shown in FIGURE 5.

As previously described, the belts 230 are overdriven slightly with respect to the speed of the feed wheel assembly so that the web is tensioned between the feed wheel and the mouth of the assembly 20 from which the web issues.

The two folding means 26 and 28 are carried on a sub-frame between the side plates 140 and 146 of the machine for vertical adjustment in the fashion indicated in FIGURE 2. The sub-frame for the folding means includes a pair of side members 300 and 302 having depending corner posts 304, 306, 308 and 310 received in guide brackets 312 and 314. The upper ends of the corner posts carry the nut members 316, 318, 320 and 322 which engage the respective screw members 324, 326, 328, and 330. The screw members are journaled at their upper ends in the cross brace members 332 and 334 fixed to and extending between the side plates 140 and 146 and these members also secure the threaded members against longitudinal movement. Each of the screw members carries a sprocket such as that indicated by the reference character 336 and an endless chain 338 trains about all of these sprockets so that the screw members are simultaneously rotated in a fashion hereinafter described to move the sub-frame vertically as indicated by the arrows in FIGURE 2. A suitable adjustable idler roller 340 is carried by the cross member 332 for maintaining the proper tension on the chain 338.

Each of the folding means 26 and 28 is in the form of a blade assembly carried by the lower ends of a pair of arms 342 and 344, the blade assemblies being in all essential details identical. A cross frame piece 346 interconnects the arms 342 and 344 in each case and, on one side, the arm 342 is journaled by stub shaft 350 to the frame member 300 and at the opposite side, a stub drive shaft 352, see particularly FIGURE 3, journals the arm 344 to the side piece 302. The lower end of each of the arms 342, 344 carry a blade drive shaft 360 as can be best seen in FIGURE 3 which, adjacent its opposite ends, carries sprockets such as that shown by the reference character 362 and in spaced relation above this shaft 360 in each case, is a much smaller shaft 364. Endless chains 366 are trained about each sprocket 362 and a correspond-

ing portion of the small shaft 364. Each of the links of the chain 366 rigidly carry a corresponding end of the blades of which there are two types shown respectively by the reference characters 368 and 370. Because the shaft 264 is much smaller than the pitch diameter of the sprocket 362, adjacent blades very rapidly move from wide open positions to closed positions as they travel over the shaft 364, as will be evident from a study of FIGURE 3. The larger of the blades 268 in each case is bevelled on one side and provided with a resilient cover as indicated by the reference character 372 and the next succeeding short blade 370 is also bevelled as indicated by the reference character 374 and is provided with a resilient strip 376 which engages the covering 372 to capture, fold and temporarily hold the web as will hereinafter be described in more detail.

The underside of each of the large paddle wheels 368 is provided with a bumper such as that indicated by the reference character 378 to stabilize the assembly and prevent direct contact between adjacent blades, it being appreciated that the fold in each case is effected between the mouth or nip formed between adjacent short and long blades as is shown more clearly in FIGURE 10.

The blade assembly drive can be seen best in FIGURE 2. In FIGURE 2, a drive shaft 380 is provided with a sprocket wheel 382 which drives, through the endless chain 384, the sprocket 386 on a lay shaft 388, see also FIGURE 9. The lay shaft 388 also carries a drive sprocket 390 which engages with the endless chain 392, the upper flight of which contacts and drives the sprocket 394 for imparting drive to the blade assembly 26 whereas this same chain 392 is trained over the drive sprocket 396 for imparting drive to the blade assembly 28. A suitable idler 398 is journaled on the frame piece 302 to assure proper contact between the endless chain 392 and the sprocket 394.

As can be seen best in FIGURE 9, a tensioning idler sprocket 400 is journaled on a shaft 402 carried by a tensioning arm 404 journaled to the side frame piece 302 about the pivot axis 406 as established by a suitable retaining and journalling pin assembly 408. It will be understood that the shafts 380 and 388 are journaled and fixed to the side frame piece 140 of the machine whereas the pivot axis 406 is established relative to the movable frame piece 302. A tensioning spring 410 normally biases the arm 404 and maintains the proper tension on the chain 392. The chain 392 also passes over a sprocket 411 journaled on the shaft 412 carried by an arm 414. The arm 414 is carried by a shaft 416 on the frame piece 302 and is thus free to swing about the axis established by the shaft 416. The shaft 416 also journals an idler sprocket 418 engaging the chain 392 as shown and for the purpose of swinging the arm 414, a lateral extension 420 is provided thereon which carries a threaded nut member 422 about a swivel pin 414. The nut 422 is engaged by the threaded member 426, the opposite end of which has a miter gear 428 fixed thereto and located within the swivel block 430. The swivel block 430 is rotatable about the axis of shaft 432 which has the mating miter gear 434 fixed thereto and which shaft 432 is carried by the frame side piece 140 of the machine. Thus, when the shaft 432 is rotated, the threaded member 426 is also rotated to swing the arm 414 between full and dotted line positions as shown in FIGURE 9, the purpose of which will be presently apparent. The shaft 380 is, for the sake of clarity, not shown in FIGURE 8 but it will be understood that this shaft 380 is preferably directly coupled with the main shaft 50 by a suitable sprocket and chain assembly.

The blade assembly drive in each case is completed in the fashion shown in FIGURE 4. The corresponding shaft 352 is provided with a further sprocket 450 over which an endless chain 452 is trained, the opposite end of the chain 452 being trained about a sprocket 454 carried by the corresponding shaft 360, substantially as is shown. For this purpose, a hub member 456 is fixed to the end of the

shaft 360 as by a keyway and set screw arrangement as indicated by the reference character 458. The hub 456 is thus rigidly affixed to the shaft 360. The sprocket 454 is journaled on the hub 456 but is fixed for rotation therewith by an end cap plate 460 and suitable retaining fasteners such as that indicated by the reference character 462 which serve normally to crowd the plate 460 against the corresponding end of the sprocket 454 and thus fractionally hold it for rotation with the hub 456. However, for purposes hereinafter to be described, the sprocket 454 may be released for rotation relative to the hub 456.

FIGURES 3 and 4 also illustrate the journal blocks 464 mounted on the arms 342 and 344 and which journal therein the adjustment shafts 466 which, as can be seen in FIGURE 2, are provided with manually adjustable lever portions 468 at the side of the machine opposite to the blade assembly drive just described. Adjacent the drive sides of the blade assemblies, these shafts 466 carry lateral arms 468 which are linked, as by the rods 470 to arm members 472 formed integrally on the plates 474 which, as can be seen best in FIGURE 4, mount the previously described shafts 364 and which plates 474 are journaled on the hub members 476 for rotation about the axes of the shafts 360. Manipulation of the shafts 466, therefore, operate to move the shafts 364 in arcuate paths about the axes of the shafts 360, the purpose of which will be presently apparent. FIGURE 4 also illustrates that the shafts 364 have thickened mid portions 480 which carry the resilient guide doughnuts 482 which engage the inner edges 484 of the various blades to guide them as they pass over the smaller shaft 364 as previously described. FIGURE 4 also illustrates that individual links of the endless chain 366 are provided with extensions 486 rigidly therewith which carry channel pieces 488 receiving the opposite side edges of the blades, suitable fasteners 490 serving to complete the connection between the endless chain 366 and the corresponding blade assemblies.

To complete the description of the blade assemblies, reference is had now to FIGURES 2 and 3. As shown in FIGURE 2, an adjustment shaft 500 having threaded portions 502 and 504 of opposite thread pitch engages at these threaded portions with nut members 506 (see also FIGURE 4) suitably carried on the arms 344. As can be seen in FIGURE 1, the shaft 500 passes through a suitable slot 510 in the machine frame and is free to move up and down with relation thereto and is provided with an adjustment hand wheel 512 by means of which the operative positions of the blade assemblies 26 and 28 may be adjusted spacing-wise.

Turning now to FIGURE 10, the operation of the device will be described. In FIGURE 10, three positions of the web feeding mechanism are shown, two in phantom lines and one in solid line and these positions are indicated by reference characters A, B and C respectively. The positions A and C are at the opposite ends of the oscillatory travel of the feed mechanism while the position B is in an intermediate position. Let it be assumed that a definite length between folds has been established which is, for the sake of description here, greater than the last set-up of the machine. Assuming a fixed drive speed for the shaft 50 (FIGURE 8) as compared with the last set-up, the gear set 84, 86 must be altered so as to impart a more rapid drive to the shaft 88 (FIGURE 8). The reason for this, of course, is that the feeder mechanism 20 must oscillate through a greater distance than the previous set-up. Therefore, the gear set 84, 86 is changed and the stroke of the feed mechanism is altered (increased, in this case) by making the appropriate adjustment of the sliding block 68 in the fly wheel 64 (FIGURES 5 and 8) and, at the same time, the blade assemblies 26 and 28 must be spread further apart by manipulation of the hand wheel 512 to rotate the shaft 500 (FIGURE 2). Because the sweep of the feed mechanism 20 has been altered, the

same being in an arcuate path, and because the spacing between the blade assemblies 26 and 28 has also been altered, it will be necessary to readjust the vertical positioning of the blade assemblies 26 and 28 relative to the positions of the feed mechanism 20 at its end points of travel A and C. For this purpose, as was described in conjunction with FIGURE 2, the blade assemblies are vertically adjustable. To effect this adjustment, an adjusting shaft 520 is used, see FIGURE 2. A hand wheel 524 serves to rotate this shaft and a miter gear set 526, 528 imparts drive from the shaft 520 to the threaded shaft 326 thus to operate the chain 338 and move the carriage for the blade assemblies vertically as was previously described. When a pin wheel drive is used, it may be necessary to slightly advance the feed wheels 16 and 18 relative to the main drive of the machine, that is relative to the positions of the feed mechanism 20 and for this purpose, an adjustment lever 530 (FIGURES 1 and 8) is provided swinging the arm 532 carrying the idler 534 which, operating in conjunction with the spring biased idler arm 536 and its associated idler 538, serves to impart a slight amount of retarding and advancing action of the pin wheels 16 and 18 relative to the shaft 88 by virtue of altering the path of the chain 92.

The reason for this adjustment is that in some cases, the webs are provided with line holes along their edges and necessitate the utilization of the pin wheels 16 and 18 and this type of paper may also be provided with transverse lines of perforation precisely at which the fold lines are to be made and it is, therefore, necessary in conjunction with such webs, to provide a precise positioning of the feed mechanism relative to the position instantaneously of the feed mechanism 20 so that the folds will be achieved in the proper places relative to the web and the lines of transverse perforation as described.

Now all that remains is to constrain the blade assemblies 26 and 28 to make the folds at the proper times. It is for this purpose that the previously mentioned shaft 432 (FIGURE 9) is provided, one end of this shaft passing half-way through the machine as shown in FIGURE 1 and being provided with a hand wheel 532 (see FIGURES 1 and 2). Manipulation of this hand wheel will serve to advance or retard the drive to the blade assemblies relative to the main drive shaft 50 of the machine as well as with relation to the drive to the pin wheel assemblies 16, 18. To adjust the attitude of the blade assemblies and particularly the individual blades thereof with respect to the web, the previously mentioned adjustment of the shaft 466 by manipulation of the handle levers 468 may be made and, lastly, to provide final adjustment of the precise position of the blade assemblies relative to the pin wheel drive and the main drive of the machine, the collar plates 416 may be loosened as by backing off the fasteners 462 (see FIGURE 4) to allow the sprockets 454 to be positioned as desired relative to the main drive of the machine.

When all of the above adjustments are properly made, and as shown in FIGURE 10, the nip or mouth provided between an adjacent short and long blade as identified by reference characters D and E in FIGURE 10 will be positioned as to attitude and timing precisely to allow the web to be fed in loop fashion when the feed means is at the position C so that the feed mechanism 20 moves from the end position C toward the position B, the blade D will close quickly upon the blade E and nip the web therein at the fold line desired and will hold the web against the retreating action of the feed means 20. Preferably, there is a slight tension in the web incidental to the retreat of the feed means 20 away from the so-gripped paper web fold. At the opposite end of the travel, that is position A, the next set of short and long blades as identified by the reference characters F and G in FIGURE 10 will be positioned in a similar posi-

tion to the blades D and E shown in FIGURE 10 to provide the mouth or nip for receiving the next loop issuing from the feed means due to its reversal in motion as it approaches and retreats from the position A shown in FIGURE 10. Just after the blades F and G have nipped and folded the web, and as the feed means 20 retreats from the position A, the previously mentioned blades D and E which had just prior to that, nipped the web, will then release the web to allow it to fall as described hereinabove for ultimate disposition on means 30.

With the above description in mind, the sequence of events with respect to the web that has been shown in full line in FIGURE 10 will be described further. The blades H and I are firmly gripping the web whereas the blades J and K have or are just about to have released the web. The previously described blades D and E are just about ready to nip onto and fold the web whereafter the above described action of the blades F and G will subsequently take place. With the action thus described, there will also be one rectangular area of the web as indicated by the reference character L which is firmly gripped between opposite blade assemblies and, therefore, forms a support or platform which positively prevents the next succeeding rectangular area N, which is just being laid, from sagging or being affected such that it is not properly transmitted to the mouth or nip formed by the next blades D and E which are to grip and fold the web. Therefore, preferably the blades J and K will release the rectangular area L just after the nip and fold action has been accomplished by the blades D and E, this condition prevailing for both sides of the machine, of course.

I claim:

1. A machine for zig-zag folding a web of indefinite length to form serially edge-connected rectangular sheets comprising in combination,
  - feed means for laying the web back and forth along a substantially horizontal path,
  - first folding means adjacent one end of said path for successively and uninterruptedly capturing, folding and temporarily holding the web at said one end of said path,
  - second folding means adjacent the other end of said path for successively and uninterruptedly capturing, folding and temporarily holding said web at said other end of said path,
  - and drive means connected to said feed means and to said first and second folding means for overlapping the temporary holding actions of said folding means whereby the web issuing from said feed means is presented with a positive support as the feed means moves between the opposite end of said path,
  - each folding means including a plurality of successive paddles and means for carrying the inner ends of said paddles around a closed path having an inner flight portion extending along a generally straight and vertically disposed line, and mechanism for constraining adjacent paddles to close upon each other at the upper ends of said flight portions and to separate at the lower ends of said flight portions, whereby the web is captured and folded between adjacent paddles at the upper ends of said flight portions, temporarily held as the paddles move downwardly along said flight portions and then released at the lower ends of said flight portions.
2. The machine according to claim 1 including horizontally moving conveyor means disposed below said folding means for receiving the folded web and toward which the folded web is positively moved by the action of said paddles in passing through said flight portions.
3. The machine according to claim 2 including a deflecting member between one folding means and said conveyor means, and a retarding member between the other folding means and said conveyor means, said de-

flecting and retarding members being positioned to constrain said edge-connected sheets to assume generally vertical positions on said conveyor means.

4. The machine according to claim 1 wherein alternate paddles are of widths to project different distances outwardly from said closed path, the opposing inner edge faces of each successive pair of wider and narrower paddles being substantially parallel and closely spaced when the paddles are closed upon each other, the opposing outer edge faces being divergent when the paddles are closed, and a resilient strip of material fixed along the opposing outer edge face of the narrower paddle, said resilient strip of material being of a thickness to engage the opposing outer edge face of the wider paddle when the paddles are closed upon each other.

5. The machine according to claim 4 wherein said opposing outer edge faces of said wider paddles are covered with resilient material.

6. A machine for zig-zag folding a web of indefinite length to form serially edge-connected rectangular sheets comprising, in combination,

feed means for laying the web back and forth along a generally horizontal path,

a pair of carrier means movable along closed paths adjacent the opposite ends of said horizontal path, said closed paths including inner substantially vertical path portions and the directions of movement of said carrier means being such as to sweep said path portions from top to bottom,

and a blade assembly fixed to and projecting outwardly from each said carrier means, each blade assembly comprising a plurality of individual pairs of blades which close upon each other at the top of the associated substantially vertical path portion and separate only at the bottom of the path portion, whereby the edge-connected sheets are successively and uninterruptedly captured and then folded and temporarily held throughout the movement of each said pair of blades through said path portion.

7. The machine according to claim 6 wherein each carrier means includes a pair of drive sprockets connected for synchronous rotation, an idler spaced above each sprocket with each idler being of substantially smaller diameter than the sprockets, an endless chain trained over each sprocket and the corresponding idler, said blades being rigidly fixed to the links of said chains.

8. The machine according to claim 7 wherein the length of each link between its pivot centers is substantially equal to the diameter of the associated idler.

9. A machine for zig-zag folding a web of indefinite length to form serially edge-connected rectangular sheets, which comprises,

feed means for laying the web back and forth along a fixed path,

means for successively and uninterruptedly capturing, folding and temporarily holding the web at the ends of said path to form the serially edge-connected sheets, the last means comprising a pair of blade assemblies, each blade assembly including an endless flexible member defining a closed path adjacent a corresponding end of said fixed path and which includes an inner portion extending substantially normal to said fixed path, means for driving said flexible members to move them along said inner portions of their closed paths in a direction away from said fixed path, and a plurality of pairs of blades carried by each flexible member which close upon each other at that end of the inner portion of the closed path adjacent said fixed path and separate only at the opposite end of the inner portion of the closed path, whereby the edge-connected sheets are successively and uninterruptedly captured and then folded and temporarily held throughout the movement of each said pair of blades through said inner portions of the closed paths.

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10. The machine according to claim 9 wherein said flexible members are in the form of pivotally joined links, each pair of blades being rigidly fixed to adjacent links, an idler adjacent each end of said fixed path and a sprocket remote from each said idler, the flexible members being trained about a corresponding idler and sprocket, each idler being of substantially smaller diameter than its corresponding sprocket.

11. The machine according to claim 10 wherein the length of each link between the pivot centers at its opposite ends is substantially equal to the diameter of the associated idler.

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