

Sept. 30, 1958

L. H. GROEPER
PAPER FOLDING MACHINE

2,854,233

Filed June 19, 1956

3 Sheets-Sheet 1

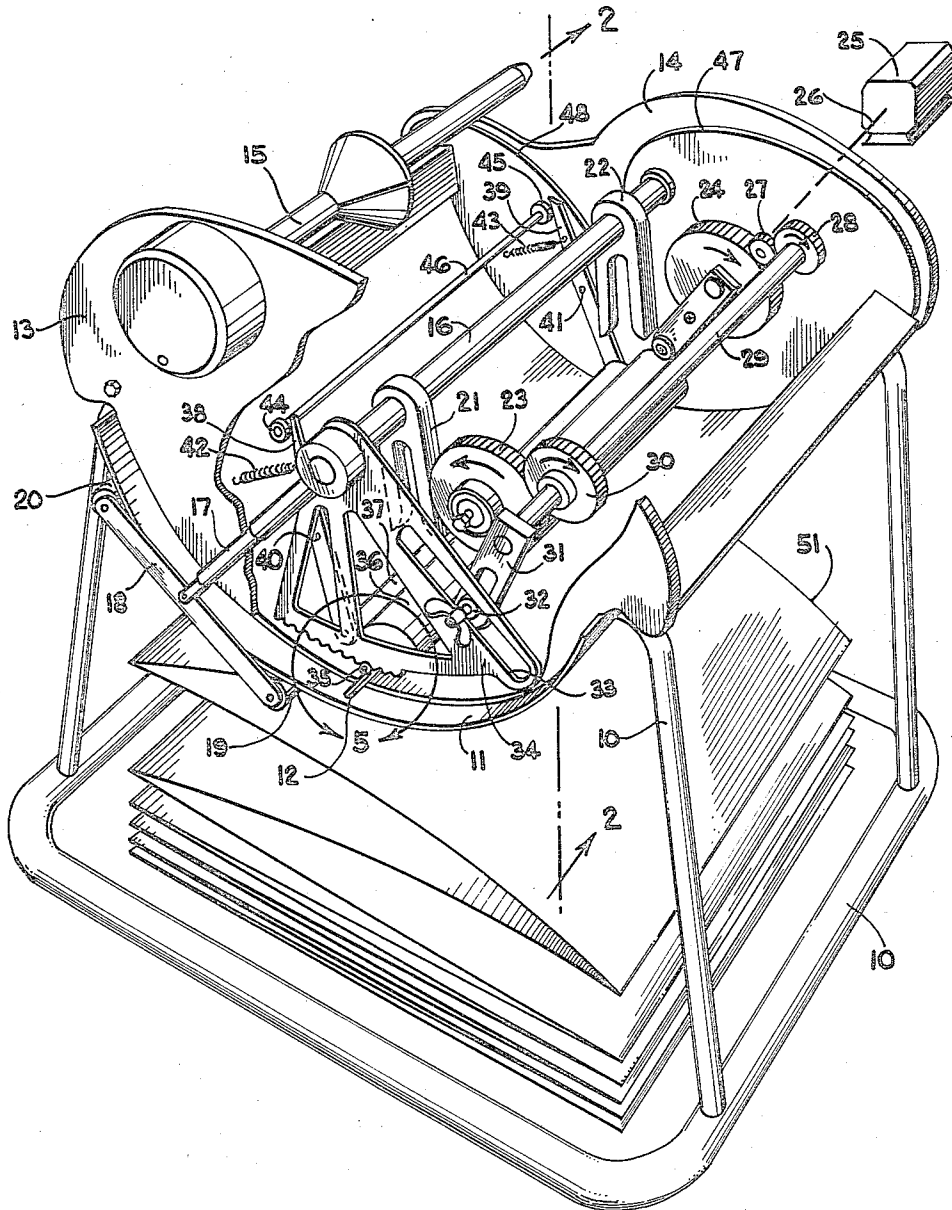


FIG. 1

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3 Sheets-Sheet 2

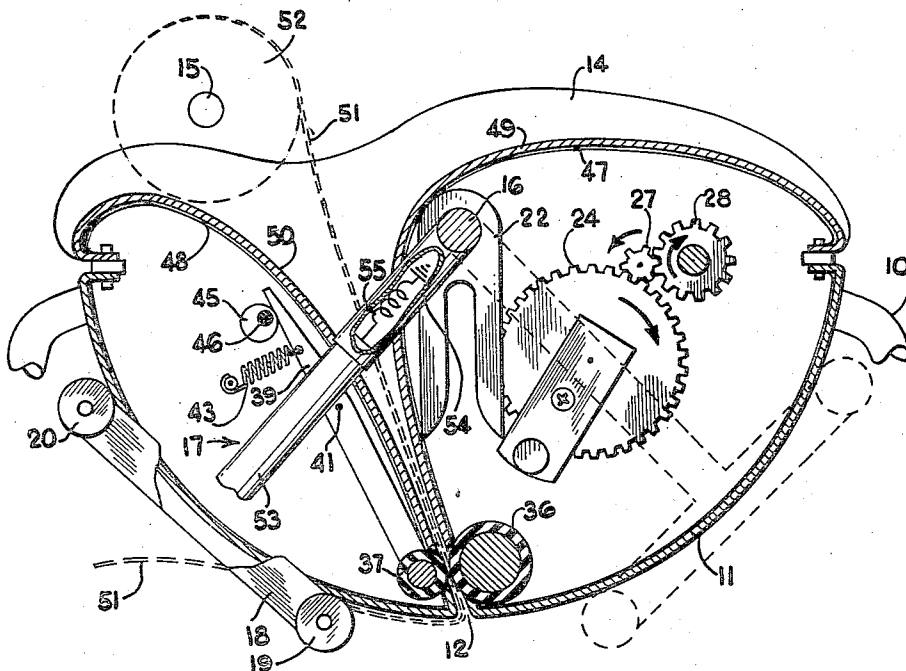


FIG. 2

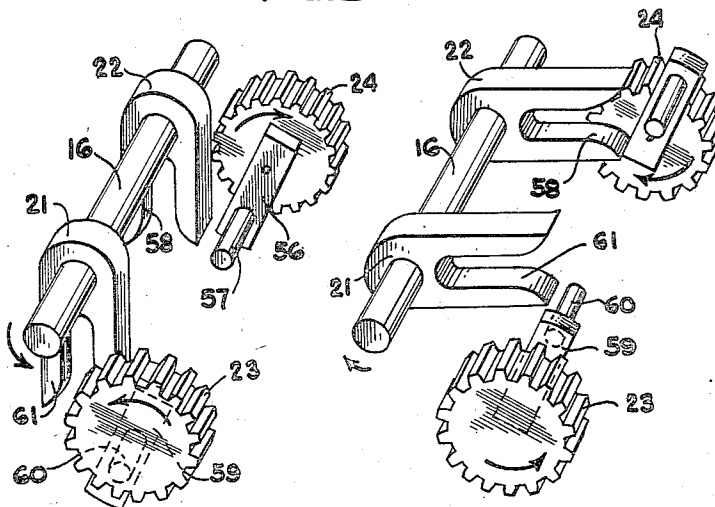


FIG. 3

FIG. 4

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3 Sheets-Sheet 3

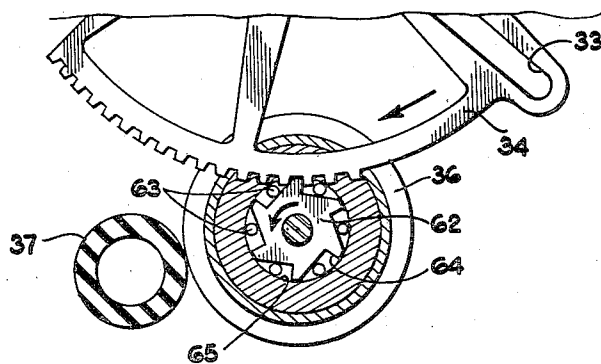


FIG. 5

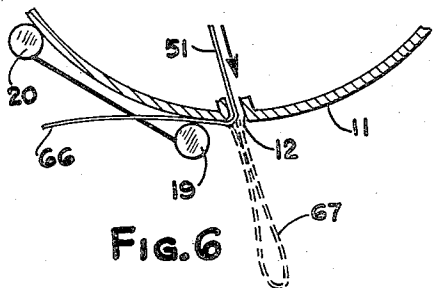


FIG. 6

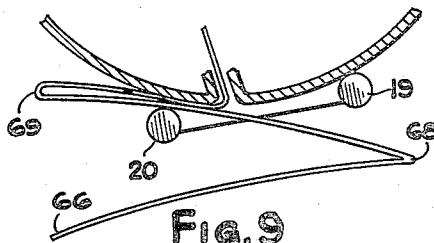


FIG. 9

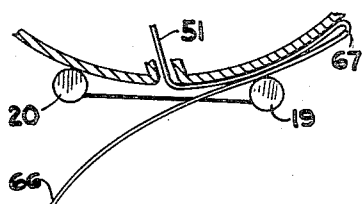


FIG. 7

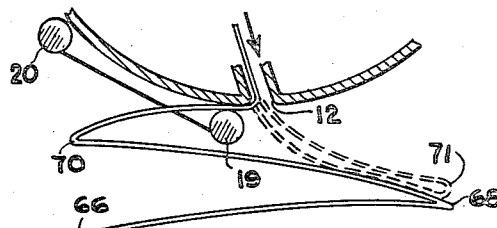


FIG. 10

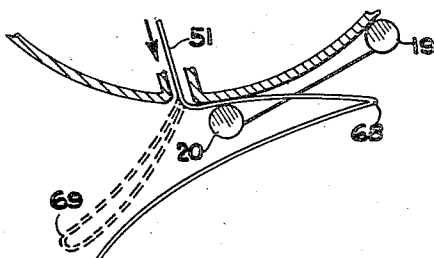


FIG. 8

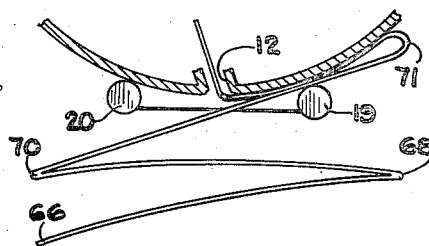


FIG. 11

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PAPER FOLDING MACHINE

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Application June 19, 1956, Serial No. 592,364

14 Claims. (Cl. 270—79)

This invention relates to paper folding machines and more particularly, to an improved machine for automatically and continuously folding long strips or rolls of paper in zig-zag or accordion fashion.

Many recording devices employed in industry today utilize long strips or rolls of paper as a recording medium. For example, in graphic recorders such as oscillographs, a roll of recording paper is fed through the machine so as to enable a continuous record to be kept for a relatively long period of time. Usually there is provided a take-up roll for receiving the paper with the data recorded thereon as it leaves the machine. In order to subsequently examine any portion of the record, it is necessary to unroll the paper and if the vital portion of the record to be examined is on the initial portion of the paper, the entire record must be unrolled.

Accordingly, in order to facilitate the examination of long strip or roll papers, it is customary to fold these records in accordion or zig-zag fashion rather than maintain them in a rolled form. The accordion folds are usually hand made and spaced to suit the particular storage facilities available. This hand folding operation is both burdensome and time consuming.

Bearing the above in mind, it is a primary object of the present invention to provide an improved machine for automatically and continuously folding paper in zig-zag or accordion fashion from either a roll or elongated strip whereby considerable time is saved in preparing records for ready examination of any portion or for storage.

More particularly, an object is to provide a machine of the above type which is mechanically rugged, reliable, and foolproof in operation.

Still another object is to provide a machine for folding paper in zig-zag fashion which may be readily operated by unskilled personnel.

Another object is to provide a paper folding machine which may handle paper rolls or strips of width at least up to seven inches and make folds spaced at least up to eleven inches and in which the machine is designed to enable the spacing between the folds to be readily adjusted to other values if desired.

These and other objects and advantages of the present invention are attained, briefly, by providing a smooth surface along which a roller means is adapted to move in a reciprocating manner. The surface is provided with an elongated slot intermediate the outside limits of movement of the roller means and extending in a direction generally parallel to the axis of the roller means. An actuating means is arranged in co-operative relationship with the roller means to feed a given length of paper through the slot from the other side of the smooth surface at intermittent intervals in accordance with the position of the roller means in relation to the slot. More particularly, the arrangement is such that a given length of paper will be fed through the slot when the roller means is on one side of the slot. The initial end of the paper is held by the roller means so that this feeding forms a loop in the paper. The feeding mechanism will then be stopped and the roller means moved across the slot to the other side whereby the looped portion of the paper is creased against

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the surface. The feeding mechanism is then again actuated to feed through another given length of paper forming a second loop. Again the feeding mechanism is stopped and the roller means then moved back to the first side of the slot causing a second crease to be made at the second looped portion of the paper. At this point in the operation, the feeding mechanism is again actuated to feed down another given length of paper forming a third loop. The feeding mechanism is then stopped and the roller means caused to pass back over the slot and form a third crease in the third loop. The cycle is continued in this manner, the creased or folded paper falling by gravity in a neat accordion-like stack under the smooth surface.

The machine may either be operated manually by a crank, or driven by an electric motor. Further, the given length of paper fed by the feeding means through the slot may be adjusted so that the spacing between the various folds will suit the dimensions of any desired storage space.

A better understanding of the invention will be had by referring to a preferred embodiment thereof as illustrated in the accompanying drawings, in which:

Figure 1 is a perspective view of the improved paper folding machine of this invention with certain portions broken away to illustrate the working parts;

Figure 2 is an enlarged cross section of the machine taken in the direction of the arrows 2—2 of Figure 1;

Figure 3 is a schematic perspective diagram showing parts of the driving means of the machine illustrated in Figures 1 and 2;

Figure 4 is a view similar to Figure 3 showing the driving means in a subsequent position;

Figure 5 is an enlarged elevational view of that portion of the machine enclosed within the circular arrow 5 of Figure 1; and,

Figures 6 through 11 schematically illustrate successive stages of the folding operation.

Referring to Figure 1, the machine comprises basically a frame structure 10 preferably formed from hollow light metal tubes. The frame 10 is arranged to support a sheet member 11 preferably bent into a semi-cylindrical shape positioned with its convex surface facing downwardly. As shown, this sheet member 11 has a longitudinal slot 12 extending across a major portion of the sheet in a direction parallel to the axis of the semi-cylindrical shape and terminating just short of the edges thereof.

A pair of side plates 13 and 14 are secured to the edges of the semi-cylindrical sheet member 11 in a position preferably normal to the axis of the semi-cylindrical shape. These plates serve as a supporting structure for various shafts and gears to be described shortly. The side plate 13 has been broken away to illustrate the interior of the machine.

In the upper portion of the drawing, there is shown a paper roll mandrel 15 for supporting a roll of paper to be folded in zig-zag fashion. The mandrel 15 may be rotatively mounted to the side plate 13 as shown, or if preferred may be held in any position above the sheet member 11 in any suitable manner so that paper may be fed down through the machine. Alternatively, a chute or tray from which an elongated strip may descend could be substituted for the mandrel.

A driving means including a drive shaft 16 is provided between the plates 13 and 14. Shaft 16 in turn, includes a laterally extending arm member at each end passing through to the exterior of each plate such as the arm member 17. Arm member 17 is connected to a roller support 18 rotatively mounting spaced rollers 19 and 20. The axes of rollers 19 and 20 extend in a direction generally parallel to the slot 12 and axis of the semi-cylindrical sheet member 11 and are of a length greater than the length of the slot 12. By this construction, oscillating

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rotative movement of the shaft 16 causes oppositely disposed arms 17 and roller supports 18 to move the rollers 19 and 20 back and forth on either side of the slot 12 in pressing engagement with the bottom convex surface of the sheet member 11.

In order to actuate the shaft 16 in an oscillatory movement there is provided a cam means comprising first and second bifurcated cam members 21 and 22 rigidly secured to and axially spaced along the shaft 16. First and second driving gears 23 and 24 are respectively mounted for rotation to the side plates 13 and 14 and are provided with suitable cam pins for engaging the bifurcated cam members 21 and 22 as will be described in greater detail as the specification proceeds. As indicated by the arrows, the driving gears 23 and 24 are rotated at the same speed in opposite directions.

As shown in Figure 1, the driving gear 24 may be continuously driven in one direction by a motor 25 through a motor shaft 26 schematically illustrated. Alternatively, a crank may be mounted on the back side of the side plate 14 for rotating the driving gear 24. Driving gear 24 is arranged, among other things, to operate an actuating means for controlling the feeding of paper from the mandrel 15. This actuating means includes a small coupling gear 27 engaging a gear 28 on one end of a shaft 29 mounted between the side plates 13 and 14. The small coupling gear 27 simply serves to change the direction of rotation of the gear 28 so that it will rotate in the same direction as the driving gear 24. On the rear or front end of the shaft 29 a further star gear 30 is arranged to engage the driving gear 23 to rotate it in a direction opposite to that of the driving gear 24. Also provided on the front end of the shaft 29 is a laterally extending arm 31 on which is adjustably positioned a cam projection 32 movable in a slot 33 cut in a sector gear 34. The sector gear 34 is mounted for free rotation about an axis coincident with the axis of shaft 16. However, the sector gear 34 is not connected to the shaft 16. The sector gear teeth are positioned to engage a coupling means including a driving gear 35 coupled to a feed roller 36 mounted for rotation between the side plates 13 and 14 adjacent the slot 12.

Co-operating with the feed roller 36 is an idler roller 37 biased against the feed roller 36 by end arms 38 and 39 centrally pivoted at 40 and 41 to the side plates 13 and 14 respectively. The upper ends of the arms 38 and 39 are connected to tension springs 42 and 43 whereby the idler roller 37 is always biased into engagement with the feed roller 36. In order to retract the idler roller, there are provided cam wheels 44 and 45 connected by a central shaft 46 extending between the plates 13 and 14 which may be rotated to move the upper ends of the arms 38 and 39 in a clockwise direction as viewed from the front of the machine in Figure 1 whereby the idler roller 37 is retracted from the feed roller 36. The arrangement is such that it is a simple matter to feed the initial portion of paper from a roll of paper on the mandrel 15 down between the feed rollers 36 and 37 and through the slot 12.

This feeding arrangement of the paper roll may best be visualized by referring to Figure 2. As shown in both Figures 1 and 2, there are provided narrow ledges 47 and 48 on the insides of the side plates 13 and 14 for supporting paper guiding sheets 49 and 50. These guiding sheets 49 and 50 are not shown in Figure 1 in order to avoid obscuring the mechanism. The lower portion of the guiding sheets 49 and 50 have a plurality of elongated openings so that increased diameter lands (not shown) on the feed roller 36 and idler roller 37 may come into engagement with and securely grip a paper strip 51 passing from a roll of paper 52 mounted on the mandrel 15.

The previously described manner in which the idler roller 37 is biased against the feed roller 36 is clearly shown in Figure 2. Further, the laterally extending arm 17 from the end of the driving shaft 16 is illustrated in

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greater detail as comprising a pair of telescoping tubular members 53 and 54. The tubular member 53 telescopes within the tubular member 54 and is biased towards the axis of the shaft 16 by a tension spring 55 within the tube 54. The arrangement is such that a tension is applied to the rod 18 supporting the rollers 19 and 20 whereby these rollers are always maintained in pressing engagement with the under convex surface of the sheet member 11.

The action of the rollers 19 and 20 will be clear from Figure 2, the motion taking place between the solid and dotted line positions on either side of the slot 12. This oscillating or arcuate motion, as mentioned previously, is effected by the driving means including the shaft 16 and the bifurcated cam members which are schematically re-illustrated in Figures 3 and 4.

Referring first to Figure 3, the shaft 16 and bifurcated cam members 21 and 22 are shown in the positions illustrated in Figure 1. In Figure 3 it will be noted that the driving gear 24 is provided with a cam pin support 56 eccentrically mounting a cam pin 57 receivable within the bifurcated portion 58 of the cam member 22. Similarly, as best seen in Figure 4, the driving gear 23 is provided with a cam pin support 59 eccentrically mounting a cam pin 60 receivable within the bifurcated portion 61 of the cam member 21. It will be recalled from the description of Figure 1 that the coupling gear 27, star gear 23, shaft 29, and star gear 30 in engagement with the driving gear 23 result in the gears 24 and 23 rotating in opposite directions. These opposite directions are again indicated by the arrows in Figure 3. Accordingly, when the cam pin 57 is moved upon rotation of the gear 24, it will be received within the bifurcated portion 58 of the cam member 22 to cam this member in a counter-clockwise direction upwardly to the position shown in Figure 4. At this point, the cam pin 57 will leave the bifurcated portion. In the meantime, the cam pin 60 on the driving gear 23 has been rotating in a counter-clockwise direction and will be received by the bifurcated portion 61 on the cam member 21 just as the cam pin 57 leaves the cam member 22 thereby swinging the cam member 21 downwardly back to the position shown in Figure 3. This action results in a clockwise rotation of the shaft 16. Thus, the two driving gears 24 and 23 and cam pins 57 and 60 together with the cam members 22 and 21 serve to continuously oscillate the driving shaft 16 in a back and forth manner whereby the driving rollers 19 and 20 of Figure 2 are caused to move back and forth on either side of the slot 12.

Referring now to Figure 5, the manner in which the sector gear 34 of Figure 1 intermittently drives the feed roller 36 is shown in greater detail. It will be recalled from Figure 1, that rotation of the shaft 29 through the operation of the driving gear 24 and coupling gear 27 will cause the laterally extending arm 31 and cam projection 32 to swing about in a clockwise direction. The cam projection 32 will thus slide back and forth within the sector plate slot 33 causing the sector plate to arcuately swing back and forth about the shaft 16 as a center of rotation.

As shown clearly in Figure 1, this back and forth motion of the sector plate 34 causes the small driving gear 35 to rotate first in one direction and then the other. The gear 35 is in axial alignment with and rigidly secured to a coupling means in the form of an overrunning clutch including a clutch gear member 62 disposed in a recessed end of the roller 36, as clearly shown in the view of Figure 5. The clutch gear 62 is arranged to concentrically rotate within the roller 36. Positioned radially between the gear 62 and the roller 36 are a plurality of balls 63 which are, respectively, limited to movement between adjacent teeth 64 on the periphery of the gear 62. Thus, when the gear 35 and clutch gear 62 are rotated in a counter-clockwise direction as viewed in Figure 5, the balls 63 will become wedged between the

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gear 62 and the roller 36 to, in turn, effect rotation of the roller. On the other hand, when the gear 35 and clutch gear 62 are rotated in the opposite direction, the balls 63 will be free and no rotary movement will be imparted to the roller 36. Thus the feed roller will only turn when the sector gear 34 is moving from right to left as viewed in Figure 5.

Referring once again to Figure 1, the overall operation of the mechanism may be summarized briefly by stating that the drive shaft 16 together with the cam members 21 and 22 and driving gears 23 and 24 serve to cause the rollers 19 and 20 to oscillate on either side of the central slot 12 in pressing engagement with the under convex surface of the semi-cylindrical sheet member 11. The shaft 29, cam support 31, cam projection 32 operating in the slot 33 of sector plate 34 and the associated coupling mechanism between the gear teeth of the sector plate and the feed roller 36, provide for the intermittent operation of the feed roller for causing a given length of paper to be fed through the slot 12. The ratio and dimensioning of the various gears are such that the feed roller will be operated when the rollers 19 and 20 are on one side of the slot 12 or on the other, but rendered inactive when the rollers 19 and 20 are passing over the slot. In other words, when the sector plate 34 is moving from left to right as viewed in Figure 1 or Figure 5, the feed roller is not operated, but during this time the rollers 19 and 20 are moving past the slot 12 from one side of the slot over to the other side.

Referring now to the schematic drawings set forth in Figures 6 through 11 inclusive, the actual folding operation effected by the machine will now be described in detail.

Referring first to Figure 6, an initial length of paper has been fed through the slot 12 as indicated by the arrow. The end of this paper is designated 66 in Figure 6 and the rollers 19 and 20 are shown positioned to the left of the slot. It will be noted in this position that the rollers 19 serve to securely hold the paper adjacent the slot 12 against the convex surface of the plate 11. While the paper 51 is so held in this position, the feed roller is actuated to feed out a given length of paper, this length of paper forming a loop 67, as indicated in dotted lines. After the loop 67 is formed, the feeding mechanism is rendered inactive and the rollers 19 and 20 caused to move toward the other side of the slot 12.

Figure 7 illustrates the rollers at an intermediate position as they are moving towards the right hand side of the slot 12. As shown, the roller 19 gradually moves towards the loop 67. In Figure 8, at a still further stage of the operation, the looped portion 67 has been creased into a fold line 68 by the roller 19. Even at maximum feed, roller 19 passes far enough past fold line 68 to release.

While the rollers 20 and 19 are positioned on the right hand side of the slot 12, the feed roller mechanism is again actuated by the sector gear 34 to cause a second loop of paper designated 69 and shown in dotted lines in Figure 8 to be formed. The feeding mechanism is then stopped and the rollers 19 and 20 begin to move again toward the left hand side of the slot. Figure 9 illustrates the rollers in an intermediate position during this movement, and it will be clear that the roller 20 is moving towards the fold 69.

In Figure 10, the roller 20 has creased the loop portion 69 and continued to its extreme left hand limit whereby a fold 70 is produced and released by the roller 20. While the two rollers 19 and 20 are in their extreme left hand position shown in Figure 10, the feeding mechanism is again actuated to feed down a third loop of paper 71 as indicated in dotted lines. The feed rollers then move towards the right hand side of the slot 12 to crease the loop portion 71 and make a further fold. The making of the loop portion 71 into a fold is accomplished by

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the roller 19 and the position of the roller just prior to the making of this fold is illustrated in Figure 11.

This process is continued, the folded paper 51 simply falling by gravity in accordion fashion and stacking itself up as shown in Figure 1. By making the frame structure 10 of Figure 1 sufficiently high, the lower convex portion of the sheet member 11 may be positioned at a considerable vertical distance above the base of the frame so that a relatively thick stack of paper may be continuously folded without interference. Further, the paper roll mandrel 15, as mentioned previously, may be secured to the frame 10 by means of an extension such that a relatively large diameter roll may be accommodated. It is therefore evident that the folding operation may continue indefinitely by simply providing sufficient paper and sufficient space for the paper to stack. The provision of two rollers moving on either side of the slot 12 is necessary in the construction to enable continuous operation of the machine, since one roller must hold the paper securely, after the other roller makes the desired fold or crease while a loop of paper is being fed out.

It will be evident from the above description that the present invention provides a mechanically simple paper folding machine which may be readily operated by unskilled personnel and which will effectively and rapidly form a series of accordion folds in any elongated strip or roll of paper. In the event it is desired to change the dimensions of the folds, it is a simple matter to reposition the adjustable cam projection 32 on the arm 31 to a position closer to or further from the axis of the shaft 29. If the cam projection is positioned closer to the shaft axis, the amplitude of the arcuate swing executed by the sector gear is decreased so that the feed roller is not rotated as many revolutions as previously and the distance between folds is decreased. On the other hand, if the cam projection 32 is moved further from the shaft axis towards the end of the arms 31, its action in the slot 33 is such as to increase the amplitude of swing of the sector gear 35 so that a greater length of paper is fed out of slot 12 by the feed roller.

Many modifications falling within the scope and spirit of the present invention will occur to those skilled in the art. For example, there are many different types of mechanical arrangements for causing intermittent movement of the feed rollers different from that illustrated. The embodiment illustrated, however, is deemed simple and is of a preferred type. Similarly, there are many different mechanical mechanisms for causing the drive shaft 16 to oscillate continuously for moving the rollers 19 and 20 in a back and forth motion on either side of the slot 12. However, the provision of the simple cam members 21 and 22 and driving gears 23 and 24 are the preferred construction for this purpose and in co-operation with the actuating means for the feed roller serves to provide a simple and reliable mechanical mechanism. The present invention, however, is not to be thought of as limited to the precise construction shown for illustrative purposes.

What is claimed is:

1. A paper folding machine comprising, in combination: a member having a smooth surface; side plates secured to said member; a pair of parallel elongated rollers engaging said surface; holding means securing said rollers at a fixed distance apart; a shaft mounted for rotation between said side plates and provided at its ends with arms extending laterally therefrom to engage said holding means; means for oscillating said shaft for moving said rollers back and forth over said surface, said means including a first bifurcated cam member and a second axially spaced bifurcated cam member, both cam members being rigidly secured to said shaft; a first driving gear adjacent said first cam member; a second driving gear adjacent said second cam member; a first

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cam pin eccentrically mounted on said first driving gear positioned to be received by the bifurcated portion of said first cam member; a second cam pin eccentrically mounted on said driving gear positioned to be received by the bifurcated portion of said second cam member; means for continuously rotating said first driving gear and said second driving gear in opposite directions at the same speed whereby said first cam member and said second cam member are respectively and sequentially engaged by said first cam pin and said second cam pin to oscillate said shaft; said surface having an elongated slot intermediate the outside limits of movement of said rollers and extending in a direction parallel to the axes of said rollers; and actuating means for feeding a given length of paper through said slot from the other side of said member when said rollers are positioned to one side of said slot.

2. A paper folding machine, comprising, in combination: a member having a smooth surface; side plates secured to said member; a pair of parallel elongated rollers engaging said surface; holding means securing said rollers at a fixed distance apart; a shaft mounted for rotation between said side plates and provided at its ends with arms extending laterally therefrom to engage said holding means; means for oscillating said shaft for moving said rollers back and forth over said surface, said surface having an elongated slot intermediate the outside limits of movement of said rollers and extending in a direction parallel to the axis of said rollers; and actuating means for feeding a given length of paper through said slot from the other side of said member when said rollers are positioned to one side of said slot, said actuating means including a sector gear; and means for arcuately swinging said sector gear back and forth in a predetermined relationship with said driving means.

3. A machine according to claim 2, in which said means for arcuately swinging said sector gear includes a shaft rotatably mounted between said side plates; an arm laterally extending from said shaft; a cam projection on said arm engageable within an elongated slot provided in said sector gear; and means for rotating said shaft whereby said cam projection reciprocates in said slot to drive said sector gear in an arcuate motion.

4. A machine according to claim 3, in which the distance of said cam projection from the axis of said shaft is adjustable whereby the amplitude of arcuate motion of said sector gear may be varied.

5. A paper folding machine comprising, in combination: a frame; a sheet member having a surface of semi-cylindrical shape supported with its convex side facing downwardly; side plates secured to the ends of said sheet member normal to the axis of said semi-cylindrical shape; a mandrel associated with said frame for holding a roll of paper above said sheet member so that the paper may unroll down between said side plates towards the concave side of said sheet member; said sheet member having an elongated slot in its lower portion for receiving the end of said paper; a feed roller mounted between said side plates adjacent said slot; actuating means for intermittently rotating said feed roller for feeding said paper down through said slot; roller means in pressing engagement with the under convex surface of said sheet member; driving means for moving said roller means along said convex surface back and forth from one side of said slot to the other; and coupling means associated with said actuating means for rotating said feed roller when said roller means are on one side of said slot.

6. A machine according to claim 5, in which said actuating means includes adjusting means for feeding a given length of paper through said slot, and in which said roller means comprises a pair of parallel elongated rollers; and holding means for securing said rollers at a fixed distance apart.

7. A machine according to claim 6, in which said

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driving means comprises a shaft mounted for rotation between said side plates and provided at its ends with arms extending laterally therefrom to engage said holding means; and cam means for oscillating said shaft.

8. A machine according to claim 7, in which said cam means include a first bifurcated cam member and a second axially spaced bifurcated cam member, both cam members being rigidly secured to said shaft; a first driving gear adjacent said first cam member; a second driving gear adjacent said second cam member; a first cam pin eccentrically mounted on said first driving gear positioned to be received by the bifurcated portion of said first cam member; a second cam pin eccentrically mounted on said driving gear positioned to be received by the bifurcated portion of said second cam member; and means for continuously rotating said first driving gear and said second driving gear in opposite directions whereby said first cam member and said second cam member are respectively and sequentially engaged by said first cam pin and said second cam pin to oscillate said shaft.

9. A machine according to claim 7, in which said coupling means comprises an overrunning clutch coupled to said feed roller, said clutch being designed to transmit unidirectional rotation to said feed roller; actuating means including a sector gear for effecting rotation of said clutch; and means for arcuately swinging said sector gear back and forth in a predetermined relationship with said driving means whereby said roller means are on one side of said slot.

10. A machine according to claim 9, in which said means for arcuately swinging said sector gear includes a shaft rotatably mounted between said side plates; an arm laterally extending from said shaft; a cam projection on said arm engageable within an elongated slot provided in said sector gear; and means for rotating said shaft whereby said cam projection reciprocates in said slot to drive said sector gear in an arcuate motion.

11. A machine according to claim 10, in which the distance of said cam projection from the axis of said shaft is adjustable whereby the amplitude of arcuate motion of said sector gear may be varied.

12. A machine according to claim 11, including an idler roller biased into pressing engagement with said feed roller; first and second arms extending laterally from opposite ends of idler roller and centrally pivoted to said side plates respectively; and a pair of cam wheels associated with the free ends of each of said arms whereby rotation of said cam wheels rotates said arms about their pivot points to disengage said idler roller from said feed roller.

13. A paper folding machine, comprising, in combination: a member having a smooth surface; a pair of rollers; holding means securing said rollers in parallel relationship at a given distance apart and in continuous engagement with said surface, said surface having an elongated slot extending in a direction parallel to the axes of said rollers; driving means connected to said holding means for moving said rollers back and forth on said surface between positions in which both said rollers are on one side of said slot and both of said rollers are on the other side of said slot; and actuating means for intermittently feeding a given length of paper through said slot from the other side of said member when said rollers are in one of said positions.

14. A paper folding machine according to claim 13, in which said given distance between said rollers is greater than one-half said given length of paper fed through said slot.

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