

[54] **AUTOSET AND TORSIONAL BEARING FOLDER**[75] Inventor: **Harold E. Boyer**, Anna, Ohio[73] Assignee: **Bell & Howell Company**, Sidney, Ohio[22] Filed: **May 10, 1974**[21] Appl. No.: **468,683****Related U.S. Application Data**

[63] Continuation of Ser. No. 299,704, Oct. 24, 1972, abandoned.

[52] U.S. Cl. **270/68**[51] Int. Cl. **B65h 45/14**

[58] Field of Search..... 270/68 R, 68 A; 64/14; 267/21; 287/85

[56] **References Cited****UNITED STATES PATENTS**

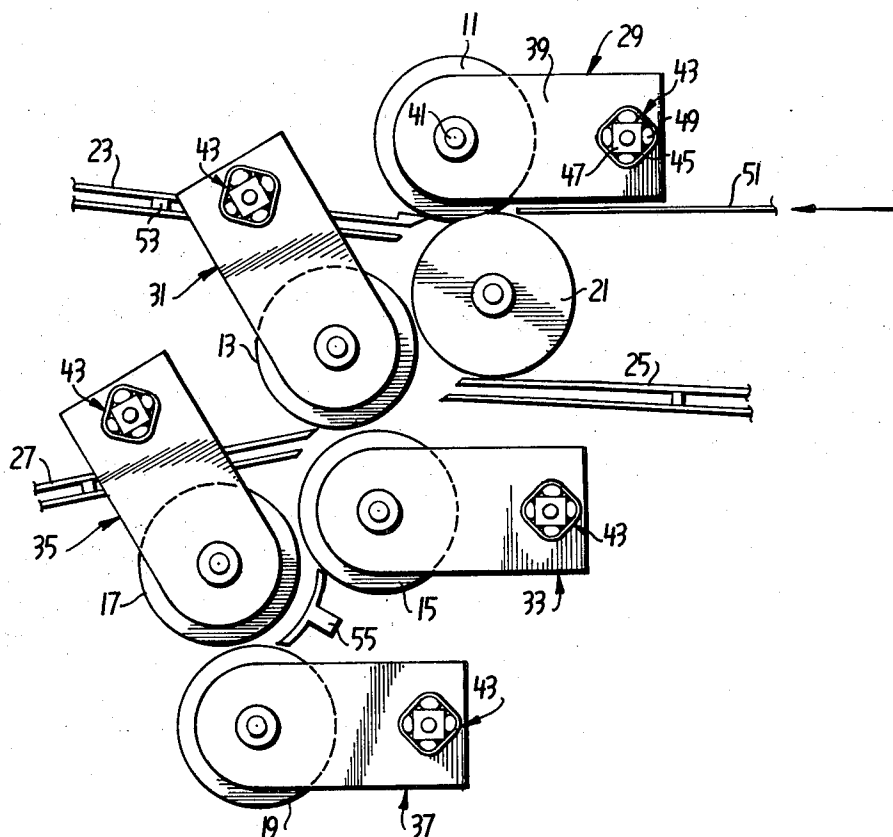
2,712,742	7/1955	Neidhart	64/14
2,729,442	1/1956	Neidhart	64/14 X
3,021,134	2/1962	Appell	270/68 A
3,089,695	5/1963	Brooks	270/68 A
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Primary Examiner—Joseph S. Reich*Assistant Examiner*—V. Millin*Attorney, Agent, or Firm*—Griffin, Branigan and Butler[57] **ABSTRACT**

A folding machine has folding rollers mounted to a frame by means of torsional bearings. The torsional bearings provide a force for biasing movable rollers toward complementary rollers.

In some embodiments the torsional bearings are also used as a means for adjusting and measuring the movable-roller biasing force. In these embodiments, torque arms are connected to the torsional bearings to be used for both adjusting and indicating this biasing force.

In another embodiment, a lifter arm is provided for separating a movable roller mounted on a torsional bearing from a stationary roller. A special linkage is provided for ensuring that the movable roller, when adjusted, moves in an arc about a central axis of the torsional bearing. A fixed lifter arm bracket is described for use in conjunction with the lifter arm. By inserting a sheet of paper between the lifter bracket and the lifter arm the movable roller is moved in an arc about the central axis the proper fixed distance from the stationary roller.

16 Claims, 6 Drawing Figures

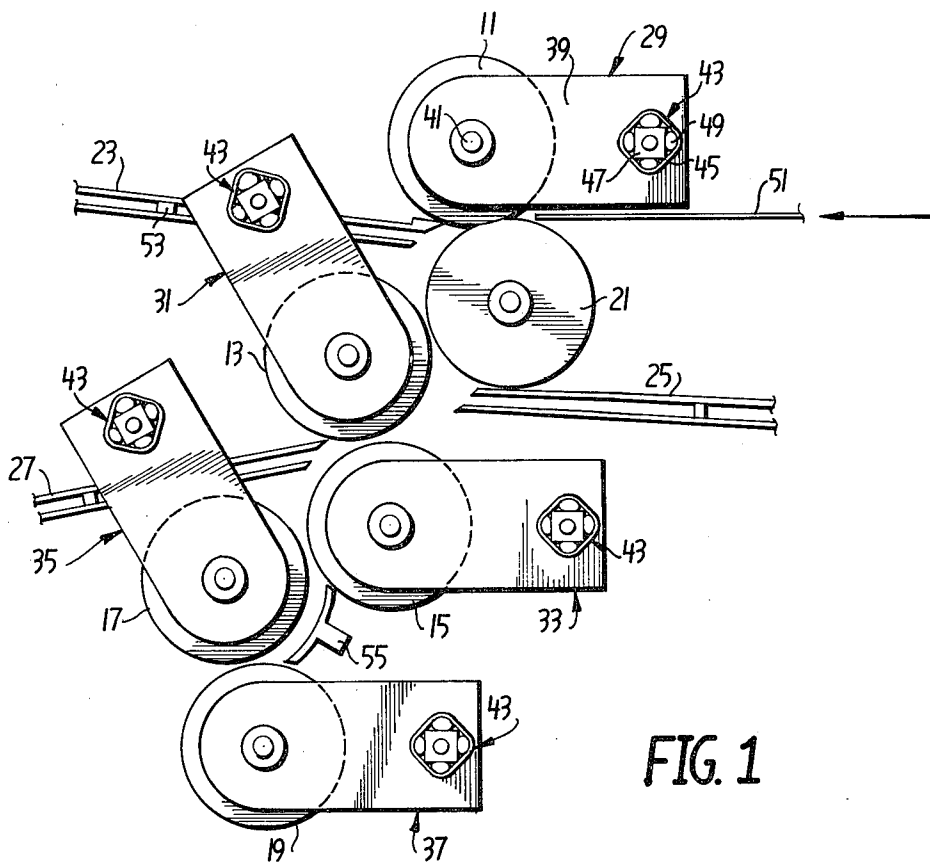
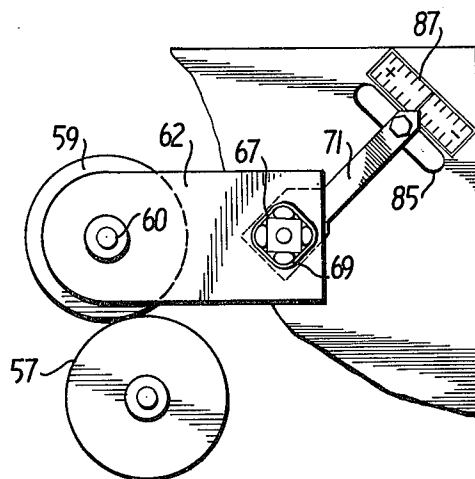


FIG. 2



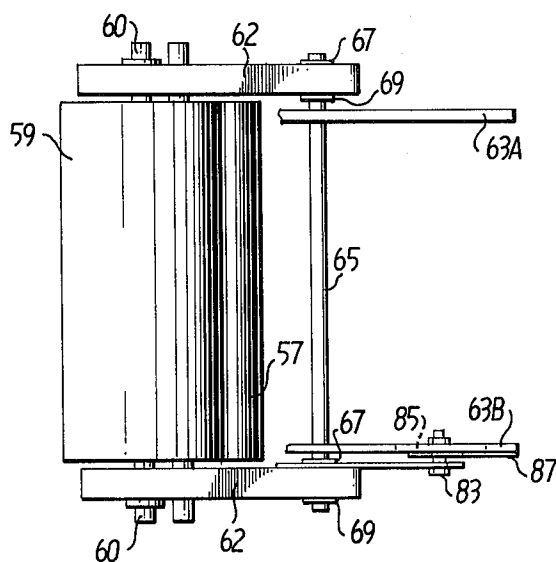


FIG. 3

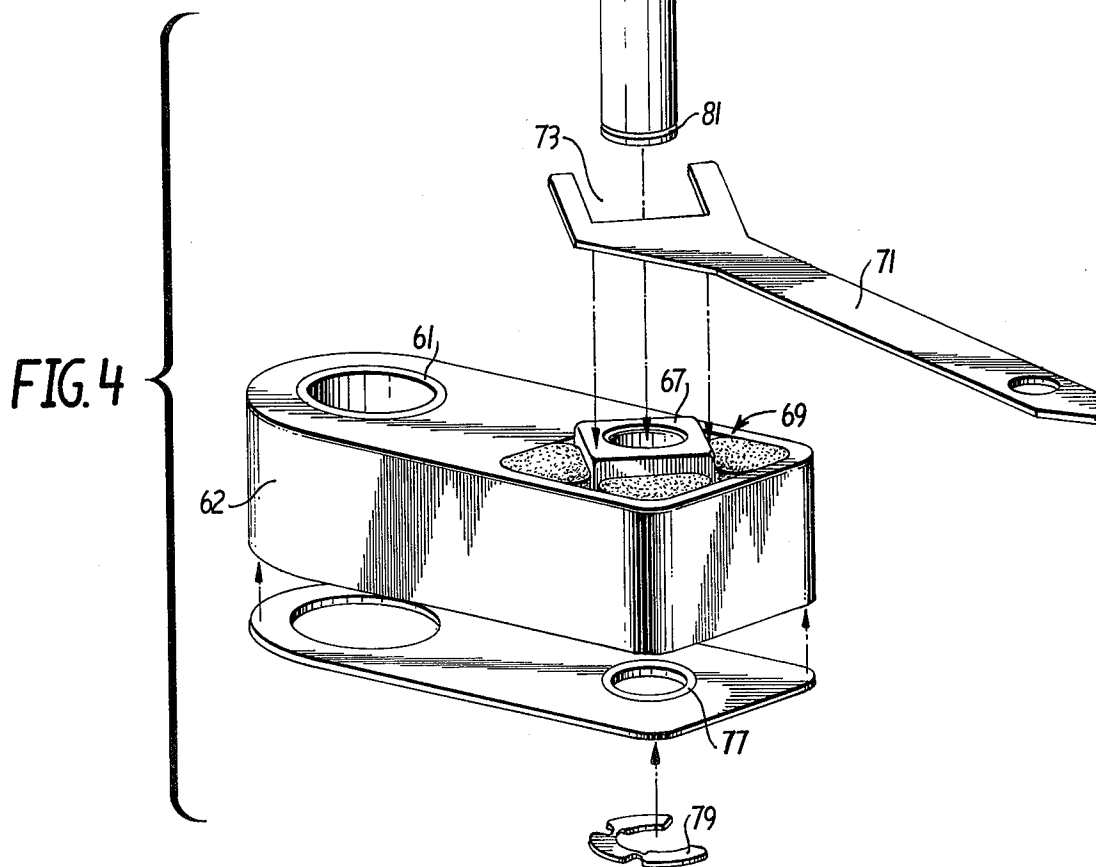


FIG. 5

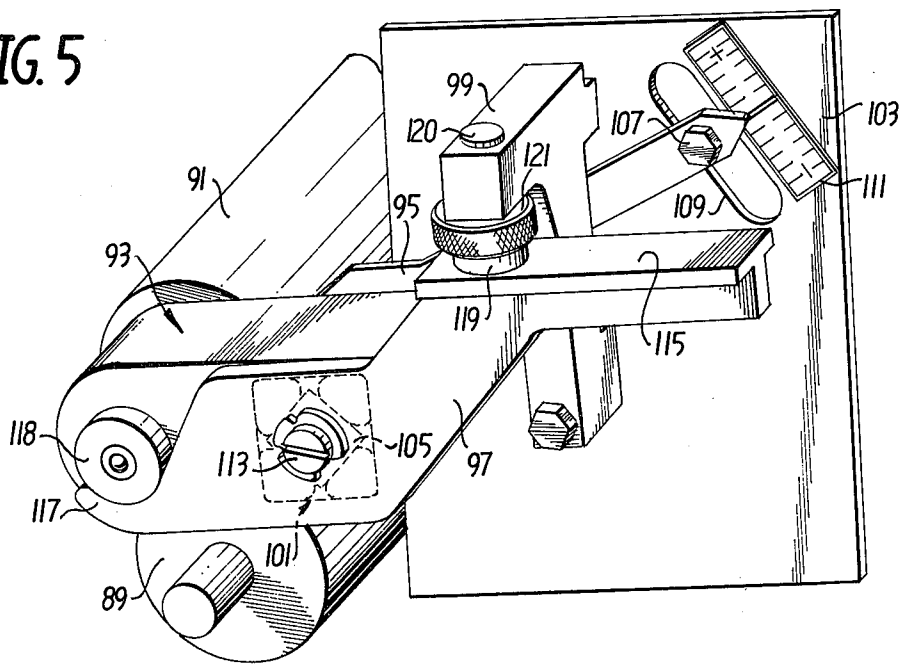
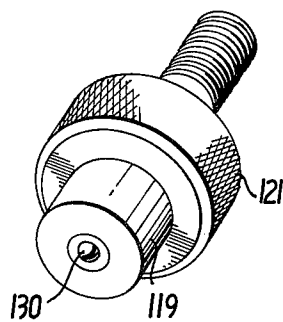


FIG. 6



AUTOSET AND TORSIONAL BEARING FOLDER

This is a continuation of application Ser. No. 299,704, filed Oct. 24, 1972, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates broadly to the art of folding machines and more particularly to buckling-type folding machines.

Stated briefly, a buckling-type folding machine normally comprises a series of rollers and stop assemblies. A sheet of paper to be folded is inserted between two rotating rollers of a first roller set and is driven by these two rollers into the mouth of a stop assembly. A forward edge of the sheet eventually strikes a stop in the stop assembly; however, the two rollers continue to feed the sheet forward. Thus, the sheet buckles and the bulge of this buckle eventually extends between two rollers of a second roller set. These rollers fold the sheet at the bulge and feed this folded edge into a second stop assembly. Upon striking a second stop there is a new buckle in the sheet and this buckle is in turn inserted between two rollers of a third roller set. This process continues until the sheet is folded the desired number of times.

In most buckling-type folding machines at least one roller of each roller set is adjustable so that the folding machine can be made to accommodate different sizes and weights of paper sheets. In this regard, prior-art folding machines normally must have their rollers adapted for separate adjustment on each job.

Basically, there are two types of adjustments that are made to the rollers.

The first type of adjustment varies the amount of force or load that the movable rollers continuously exert toward the other rollers of their respective sets. In this regard, springs are normally adjusted to constantly urge the movable rollers toward the other rollers of their sets thereby applying requisite pressures between the rollers for obtaining appropriate folds.

The second adjustment relates to varying the positions of the movable rollers relative to the other rollers of their respective sets so that various thicknesses of paper stock may be folded by the machine. This adjustment is hereinafter referred to as the "roller gap" adjustment. In this regard, movable rollers are normally mounted on levers so that rotation of the levers varies the positions of the rollers. An example of such devices is found in U.S. Pat. No. 3,021,134 to Appell.

In some systems the roller gaps are set by placing pieces of paper stock between ends of the roller-mounting levers and stationary brackets so that the movable rollers mounted on these levers are moved the thicknesses of the sheets. An example of such systems is described in West German Pat. No. 1,436,558.

One difficulty with many of the prior art folding devices is that their "load" adjusting mechanisms employ large numbers of coil springs. In this respect, coil springs are somewhat cumbersome in that they require undue amounts of space to operate properly and require frequent adjustment.

Also, such springs tend to wear out relatively quickly. Not only does this feature require frequent replacement of springs, but also the resiliency of the springs, when being used, tends to change rather dramatically over relatively short periods of use. Thus it is difficult for operators to predict the proper settings of springs for a certain job, even though the same jobs may have

been performed previously on the same folding machines.

Therefore, it is an object of this invention to provide a folding machine having an adjusting mechanism which employs resilient elements which are generally more durable than metallic springs; operate more uniformly; and do not require a large amount of adjustment.

Still another difficulty with prior art folding devices is that the roller gaps must be adjusted for most jobs even though the paper thicknesses of several job varies very little. Thus, it is yet another object of this invention to provide a folding machine wherein a single roller-gap setting accommodates relatively large variations of paper thicknesses.

A difficulty encountered in adapting torsional bearings to be used with buckle-type folding machines is that there is a certain amount of "play" in torsional bearings (that is, a small amount of lateral motion as well as rotational motion); thus making it difficult to obtain an accurate gap setting for torsional-bearing-mounted rollers. Therefore, it is another object of this invention to provide a folding machine having a torsional-bearing-mounted roller wherein the gap setting can be accurately adjusted.

SUMMARY OF THE INVENTION

According to the principles of this invention, movable rollers of a buckling-type folding machine are mounted on arms which, in turn, are mounted on a folding machine frame by means of torsional bearings.

In some embodiments, the amount of "loading" applied by the movable rollers to stationary rollers is controlled by controlling the positions of central square shafts of the torsional bearings. Torque arms are provided for both rotating the central square shafts and for indicating the positions of the central shafts. Thus, the torque arms provide indications of loading pressures between rollers.

In other embodiments of the invention a lifter arm is provided for causing a torsional-bearing-mounted roller to move in an arc about a central axis of the torsional bearing in response to movement of the lifter arm. Thus, the lifter arm can be used for adjusting roller gap. In addition, a system is disclosed wherein proper gap adjustment is obtained by inserting a sheet of paper between the lifter arm and a stationary bracket.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of preferred embodiments of the invention, as illustrated in the accompanying drawings, in which reference characters refer to the same parts throughout different views. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating principles of the invention in a clear manner.

FIG. 1 is a side elevation of a series of bucklefolder rollers, some of which are mounted to a frame by means of torsional bearings;

FIG. 2 is a side elevation of a buckle-type folding machine roller set which is mounted according to principles of this invention;

FIG. 3 is a top view of the roller set shown in FIG. 2;

FIG. 4 is an exploded view of a torsional bearing assembly and its mounting means; and

FIG. 5 is an isometric view of a buckle-type roller mounted according to principles of this invention with a mounting means including a lifter arm and a torque arm assembly.

FIG. 6 is a pictorial view illustrating a spring loaded ball protruding from a fine adjusting knob broken out of FIG. 5.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to FIG. 1, the folding system depicted therein comprises five movable, or adjustable, rollers 11-19, a stationary fixed roller 21 and three stop assemblies 23-27.

Each of the five movable rollers 11-19 are respectively mounted on one of five torsional bearing assemblies 29-37.

Each of the torsional bearing assemblies 29-37 comprises a roller mounting arm 39, a roller mounting bushing 41 and a torsional bearing 43. One such torsional bearing which can be used in preferred embodiments of this invention is described in U.S. Pat. No. 2,712,742 to Neidhart.

The torsional bearing 43 includes a tubular housing 45, having a somewhat square cross-section, a square shaft 47, and cushioning elements 49. The tubular housing 45 is fixedly attached to the roller mounting arm 39. Normally, the position of the square shaft 47 can be fixed relative to a folding machine frame (not shown). Thus, with respect to a neutral position when there is relative rotation between the roller mounting arm 39 and the square shaft 47, the cushioning elements 49 are compressed. This compression produces a torque tending to rotate the roller mounting arm 39 to the neutral position where the cushioning elements 49 are compressed to a lesser extent.

Normal torsional bearings employ cushioning members which have a hardness measuring 70 durometers or so. In preferred embodiments of this invention, however, the cushioned members have a hardness of 50 durometers to obtain a torsional bearing of the preferred stiffness, but other hardness ratings can be satisfactorily employed.

When the movable rollers 11-19 are moved from their neutral positions, they are biased by their respective torsional bearings 42-46 toward the neutral positions. It follows that the amounts of biasing forces exerted by the movable rollers 11-19 on rollers they contact, depends on the attitudes of the square shafts 47 relative to the roller mounting arms 39.

Turning now to the operation of the system shown in FIG. 1, a sheet of paper 51 is inserted between the first movable roller 11 and the stationary roller 21. These rollers are adapted by a means (not shown) to drive the sheet of paper 51 into a first stop assembly 23. Eventually a forward edge of the sheet of paper 51 contacts a stop member 53. At this point, the sheet of paper 51 buckles and a buckle bulge moves between the stationary roller 21 and the second movable roller 13. The sheet of paper is folded as the bulge area moves between these latter two rollers and the folded edge is driven into the second stop assembly 25, whereupon the same buckling procedure described above is repeated. That is, another fold occurs between rollers 13 and 15; and another between rollers 15 and 17. Eventually, the folded sheet of paper is guided by a guide 55

between the fourth and fifth movable rollers 17 and 19 and fed to a suitable receiver.

The square shafts 47 of the torsional bearings 43 are preset to cause a desired biasing of torques on the movable rollers 11-19. Hence, as a sheet of paper passes between two given rollers they are allowed to spread apart by respective ones of the five torsional bearings 42-46 so that the bearings exert a correspondingly desired torque.

Not only does the system described above eliminate the use of prior types of space consuming springs, but experiments have shown that, without readjustment, this system accommodates a much wider range of paper-sheet weights and thicknesses than the former types of spring-biased systems. The reason that this system can accept a wider variety of sheets without readjustment is not fully understood but the results have been outstanding. Moreover, when used in the above described manner the torsional bearings have been found to have a much longer useful life than most coil springs. Hence, not only do they require less frequent replacement but their performance characteristics do not change as rapidly or drastically as those of coil spring types of folder adjustments.

FIGS. 2, 3, and 4 depict a portion of a modified embodiment of the system shown in FIG. 1 which illustrates another advantage of torsion-bearing-mounted rollers over conventional spring biased rollers. With reference to FIGS. 2 and 3, a stationary roller 57 and a movable roller 59 form a roller pair. The movable roller 59 is mounted by means of its shaft 60 and bushings 61 on torsional bearing assemblies 62 which, in turn, are mounted on frame members 63 A and B by means of a shaft 65 having a round-cross-section. Shaft 65 is rigidly attached to square-cross-sectional shafts 67 of torsional bearings 69 which are similar to the torsional bearings 43 shown in FIG. 1. These bearings are shown in more detail in the exploded view of FIG. 4.

A torque arm 71 has a square aperture 73 (FIG. 4) for gripping the square shaft 67 of one of the torsional bearings 69. The shaft 65, torque arm 71, and torsional bearing assembly 62 are held together as shown by means of a flange 75, a washer 77, and a retaining ring 79 which mates with an indentation 81 in the shaft 65.

A nut and bolt assembly 83 (FIG. 3) is used to fix the torque arm 71 at various positions along an elongated slot 85 (FIG. 2) in the frame member 63B. A graduated scale 87 provides an indication of the position of the torque arm 71.

Overall operation of the FIGS. 2-4 embodiment is basically the same as operation of the system of FIG. 1. That is, the square shafts 67 of the torsional bearings 69 are set to cause a biasing torque on the torsional bearing assembly 62. This torque, in turn, biases the movable roller 59 against the stationary roller 57. The amount of biasing torque, however, can be easily modified by rotating the torque arm 71 in the slot 85, thus changing the attitude of the square shafts 67 which changes the neutral position of the torsional bearings 69.

The graduated scale 87 provides an indication of the angular position of the torque arm 71 which, in turn, provides an indication of the amount of pressure exerted by the movable roller 59 against the stationary roller 57. Referring to FIG. 2, for example, the torque arm is adjacent 0 on the graduated scale 87 at such time the movable roller 59 and the stationary roller 57

are in contact but no appreciable force is exerted by the movable roller 59 on the stationary roller 57. A different setting of the indicator results in a different force.

Turning lastly to FIG. 5 there is shown a roller-set assembly comprising essentially a stationary roller 89, a movable roller 91, a torsional bearing assembly 93, a torque arm 95, a lifter arm 97 and a fixed lifter-arm bracket 99.

The movable roller 91 is mounted on the torsional bearing assembly 93 in the same manner as the movable rollers of FIGS. 1-4. The torsional bearing assembly 93 also has a torsional bearing 101, similar to the torsional bearings previously described. In this case the assembly is mounted on a folding-machine frame 103. Again, a square shaft 105 of the torsional bearing 101 is rotatable relative to the frame 103, but is held in a fixed position by means of the torque arm 95; and the torque arm's angular position is adjustable by means of an adjusting screw 107 in a slot 109. A graduated scale 111 provides an indication of the angular position of the torque arm 95.

The lifter arm 97 is rotatably mounted on a circular shaft 113 which extends through the square shaft 105. A table 115 is formed at one end of the lifter arm 97 and a cradle 117 is formed at the other end of the lifter arm 97. The cradle 117 "cradles" a shaft 118 of the movable roller 91 such that lifting movement of the cradle 117 causes the movable roller 91 to lift up from the stationary roller 89.

The table 115 is adjacent an anvil 119 which is a part of the lifter arm bracket 99. The lifter arm bracket 99 is fixed to the frame 103, however, the anvil 119 can be lowered and raised relative to the bracket 99 by means of a threaded screw (20), by rotating a knob 121. The location of the anvil 119 is such that movement of the portion of the table 115 located adjacent the anvil 119 is in a 1:1 relationship with movement of the cradle 117.

In operation, the loading, or biasing, pressure exerted by the movable roller 91 toward the stationary roller 89 is controlled by rotating the torque arm 95, as in the FIGS. 2-4 embodiment. In this regard, rotation of the torque arm 95 rotates the square shaft 105 thereby changing the neutral position of the torsional bearing 101. Again, a setting of 0 indicates roller contact with virtually no loading force.

A gap can then be accurately set between the movable roller 91 and the stationary roller 89 by adjusting the position of the table 115. This can be accomplished by inserting a piece of the paper stock to be folded between the table 115 and the anvil 119, thereby causing the cradle 117 to lift the movable roller 91 a distance from the stationary roller 89 equal to the thickness of the paper sheet. At this point, the position of the tension lever 95 can be readjusted if it is desirable.

The knob 21 provides an additional fine adjusting feature. In the preferred embodiment, there is a spring loaded ball 130 in the anvil 119 pressing downwardly to help hold a paper sheet between the anvil 119 and the table 115.

It should be understood that the special shape of the lifter arm 97, which provides a cradle 117, produces an arcuate movement of the movable roller 91 about a central axis of the torsional bearing 101. If, for example, the table 115 were attached directly to the torsional bearing assembly 93, arcuate movement of the

table 115 may not produce a similar arcuate movement of the movable roller 91 due to play in the torsional bearing 101.

In summary, torsional-bearing mounted rollers on folding machines have the following advantages among others:

A more compact folding machine is produced because the torsional bearings generally take up less room than the levers and springs of prior art systems. In this regard, torsional bearings also combine the functions performed by both bearings and springs of prior-art folding-machines; thus torsional bearings also conserve space by eliminating parts.

As compared to most prior art systems torsional-bearing-mounted rollers can accommodate a wider range of paper weights and thicknesses without readjustments.

Torsional bearings are normally more durable than the metallic coil springs of prior art systems. In this regard, experiments have shown that torsional bearings last millions of cycles without reduction of spring force; and comparative tests presently appear to indicate that torsional bearings have life spans of as much as 20 times longer than those of coil springs.

There are generally fewer linkage problems with torsional bearing systems than with most prior art systems, thus, less lubrication and maintenance is required and joint freezing is reduced.

Torsional bearings are self damping and self aligning. Also because of lateral play in the torsional bearings a roller can be out of line or canted; yet the roller still functions properly even though a sheet is inserted on only one side of the roller. This feature is sometimes said to produce a floating roller effect.

A relatively uncomplicated system can be employed to adjust the constant pressure applied by a movable roller to a stationary roller. In this regard, it is also significant that the systems for adjusting roller pressure and roller gap are independent of one another and are in some respects less complicated than some similar prior art systems wherein the same linkage is used to provide both types of adjustment.

While the invention has been particularly shown and described with reference to preferred embodiments, it will be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention. For example, the torsional bearing described herein can take on various forms, some of which are described in the previously referred to U.S. Pat. No. 2,712,742 to Neidhart.

The embodiments of the invention in which an exclusive property or privilege are claimed are defined as follows:

1. A folding machine comprising a system of rotatable rollers mounted on a frame so that said rollers form bites therebetween for gripping and transporting sheets to be folded, said folding machine including guiding means for guiding said sheets between said bites so that some of said bites, upon gripping and transporting said sheets, cause folds in said sheets, said folding machine further including a roller mounting means comprising:

a roller mounting arm;

a torsional bearing including a resilient means for mounting said roller mounting arm on said frame at a first area along said roller mounting arm; and

a roller mounting means for mounting a first roller on said roller-mounting arm at a second area spaced from said first area along said roller mounting arm; wherein,

said torsional bearing is preset so that said resilient means causes a predetermined biasing torque on said roller mounting arm to thereby urge said first roller toward a second roller so that a bite formed by said first and second rollers produces appropriate folds in sheets of a given thickness range.

2. A folding machine as claimed in claim 1 wherein said torsional bearing comprises:

an inner shaft;

an outer housing; and

a cushioning member positioned between said inner shaft and said outer housing; and

wherein is further included a torque adjusting means for adjusting the angular position of said inner shaft to cause said proper biasing force.

3. A folding machine as claimed in claim 2 wherein said torque adjusting means includes a gauge means for indicating the angular position of said inner shaft.

4. A folding machine as claimed in claim 3 wherein said torque adjusting means includes an elongated arm attached to said inner shaft.

5. A folding machine as claimed in claim 1 wherein is further included a roller positioning means for adjusting the position of said roller.

6. A folding machine as claimed in claim 5 wherein said roller positioning means is for causing causes said roller to rotate in an arc about a central axis of said torsional bearing.

7. A folding machine as claimed in claim 6 wherein said roller positioning means comprises a lever which pivots about said central axis of said torsional bearing, said lever being linked to said roller mounting arm in such a manner as to cause said roller mounting arm to rotate about said central axis in an arc in the same manner that said lever rotates about said central axis.

8. A folding machine as claimed in claim 7 wherein said lever includes a table at one end thereof and a cradle at the opposite end thereof, and wherein is further included a fixed bracket adjacent to said table whereby a piece of material inserted between said table and said bracket causes said roller to have a predetermined position.

9. A folding machine as claimed in claim 8 wherein said torsional bearing comprises:

an inner shaft;

an outer housing; and

a cushioning member positioned between said inner shaft and outer housing;

and wherein is further included a torque adjusting means for adjusting the angular position of said

inner shaft to cause said proper biasing force.

10. A folding machine as claimed in claim 9 wherein said adjusting means includes a gauge means for indicating the angular position of said inner shaft.

11. A folding machine as claimed in claim 10 wherein said torque adjusting means includes an elongated arm attached to said inner shaft.

12. A folding machine as claimed in claim 1 wherein said folding machine includes a series of rollers;

and a plurality of elongated roller mounting arms and torsional bearings for respectively mounting said rollers on said frame.

13. A folding machine as claimed in claim 1 wherein said torsional bearing comprises:

an inner shaft;

an outer housing; and

a cushioning member positioned between said inner shaft and said outer housing, said cushioning member producing a measurement of approximately 50 on a durometer.

14. A folding machine as in claim 1 wherein the pivot point of said torsional bearing is located at a fixed distance from the axis of rotation of said roller.

15. The folding machine of claim 1 wherein said roller mounting means includes an axle for said first roller and said torsional biasing means comprises an inner shaft, an outer housing, and a cushioning member positioned between said inner shaft and said outer housing; and wherein said folding machine further includes:

means connecting said inner shaft of said torsional bearing to said axle for maintaining a fixed distance between the center of said torsional bearing and said roller axle.

16. A folding machine comprising a system or rotatable rollers mounted on a frame so that said rollers form bites therebetween for gripping and transporting sheets to be folded, said folding machine including guiding means for guiding said sheets between said bites so that some of said bites, upon gripping and transporting said sheets, cause folds in said sheets, said folding machine further including:

resilient mounting means for pivotally mounting a first roller on said frame so that said first roller is adapted to pivot about a point on said frame;

said resilient mounting means including a resilient torsional bearing located at said pivot point on said frame, said resilient torsional bearing causing a predetermined biasing torque on said means for pivotally mounting said first roller to thereby urge said first roller toward a second roller so that a bite formed by said first and second rollers produces appropriate folds in sheets of a given thickness range.

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