Dec. 30, 1969 O. SMILTENS 3,486,748

FOLDING MECHANISM PLANETARY GEARING INCLUDING ELLIPTICAL PAIR FOR COLLECT RUN

Filed Feb. 23, 1968 4 Sheets-Sheet 1

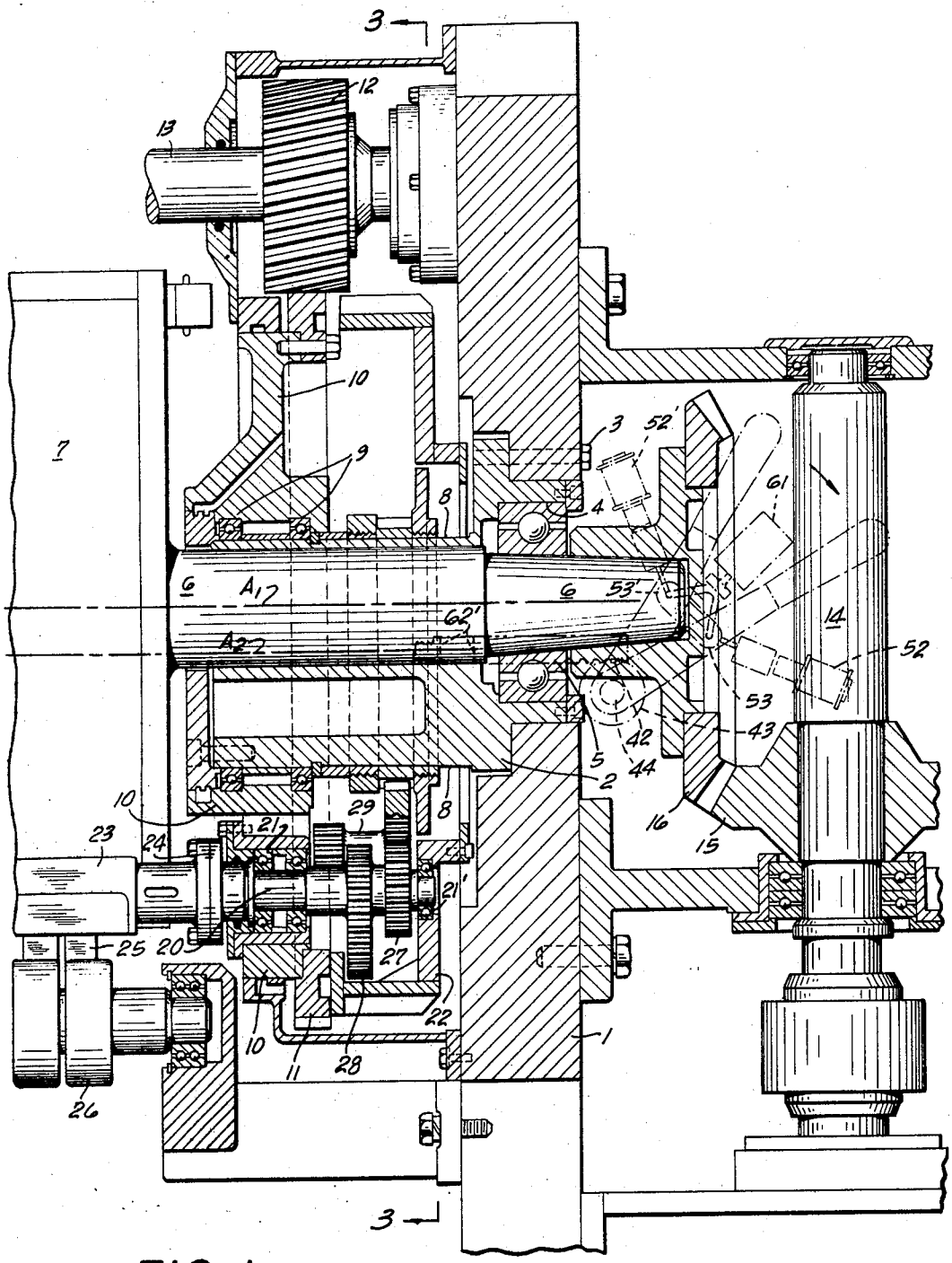


FIG. 1

INVENTOR
OSKAR SMILTENS

Dec. 30, 1969 O. SMILTENS 3,486,748
FOLDING MECHANISM PLANETARY GEARING INCLUDING
ELLIPTICAL PAIR FOR COLLECT RUN
Filed Feb. 23, 1968 4 Sheets-Sheet 2

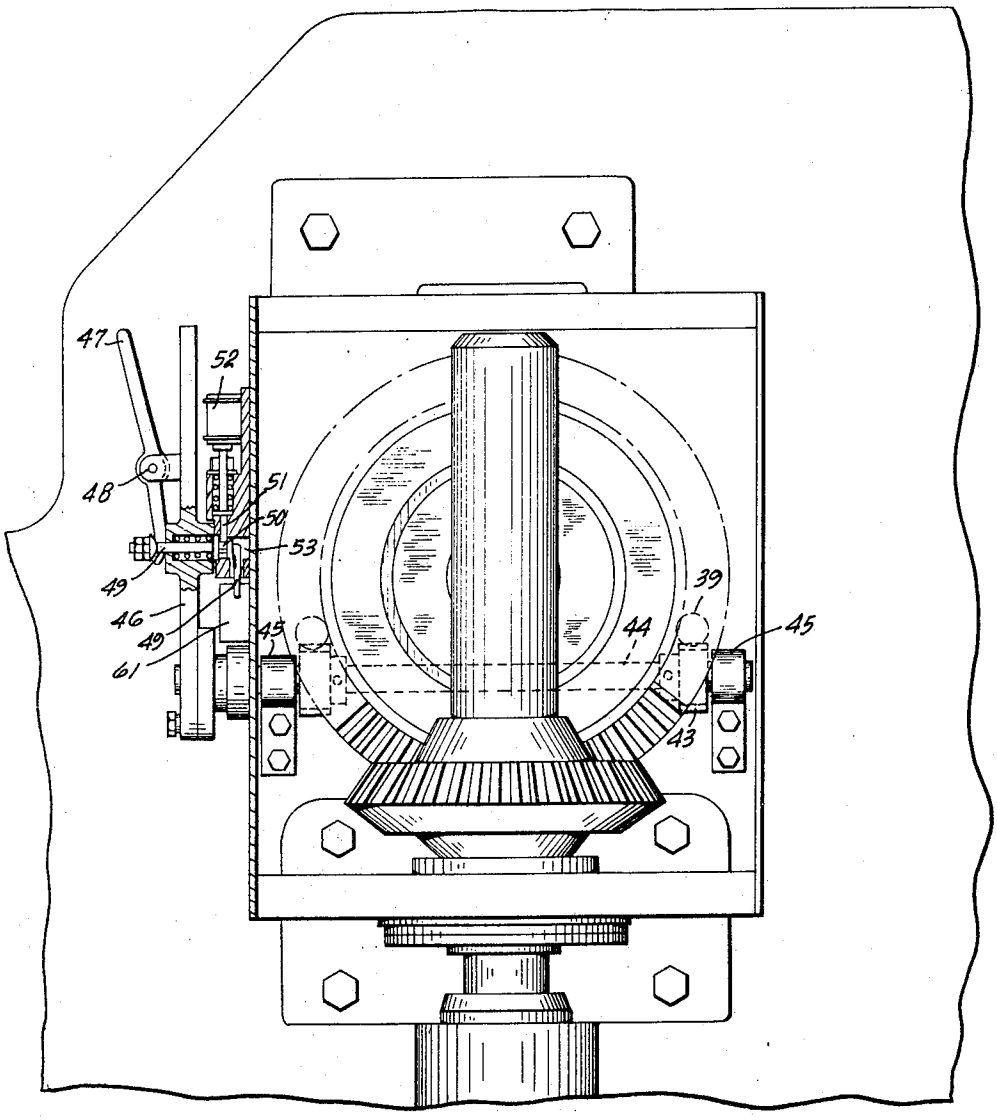


FIG. 2

INVENTOR
OSKAR SMILTENS

Dec. 30, 1969 O. SMILTENS 3,486,748
FOLDING MECHANISM PLANETARY GEARING INCLUDING
ELLIPTICAL PAIR FOR COLLECT RUN
Filed Feb. 23, 1968 4 Sheets-Sheet 3

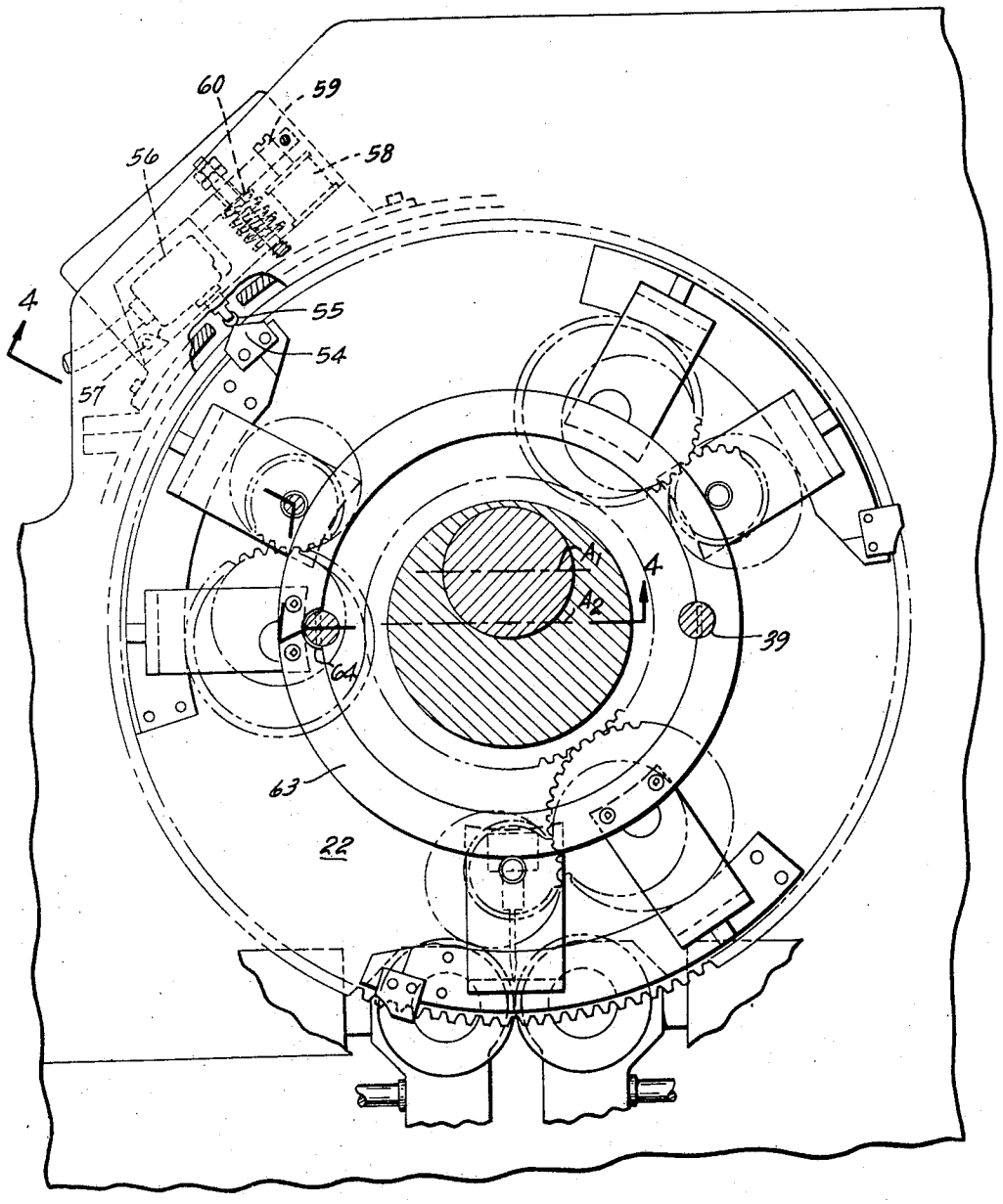


FIG. 3

INVENTOR
OSKAR SMILTENS

Dec. 30, 1969 O. SMILTENS 3,486,748
FOLDING MECHANISM PLANETARY GEARING INCLUDING
ELLIPTICAL PAIR FOR COLLECT RUN
Filed Feb. 23, 1968 4 Sheets-Sheet 4

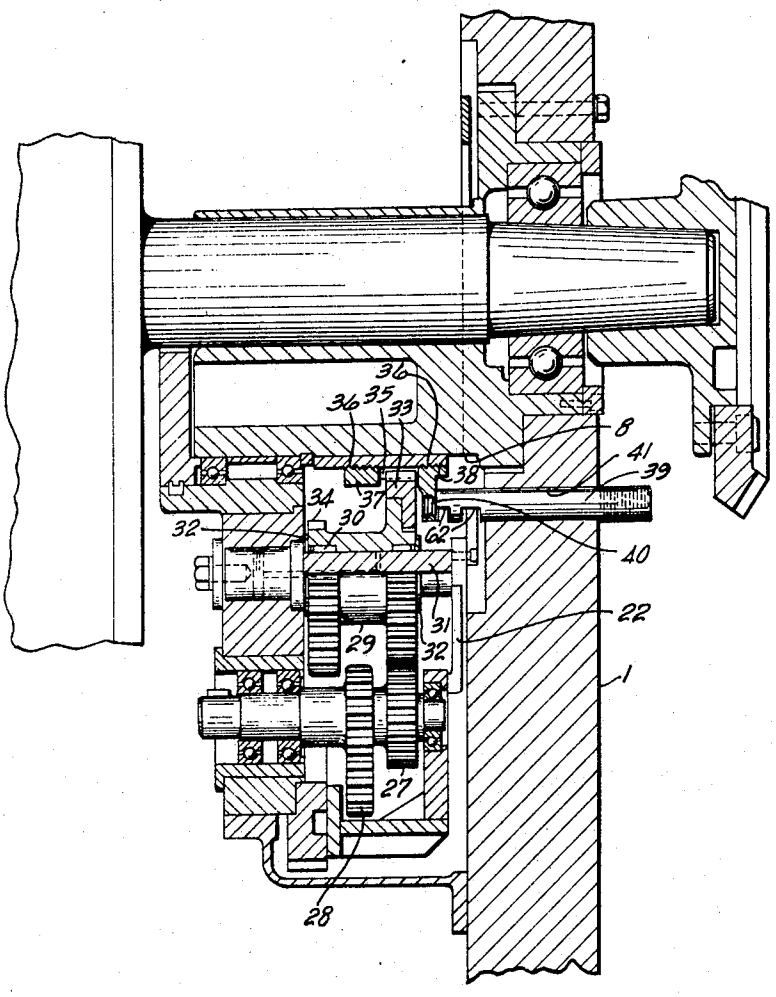


FIG. 4

INVENTOR
OSKAR SMILTENS

United States Patent Office 3,486,748 Patented Dec. 30, 1969

3,486,748

FOLDING MECHANISM PLANETARY GEARING INCLUDING ELLIPTICAL PAIR FOR COLLECT RUN

Oskar Smiltens, Bronx, N.Y., assignor, by mesne assignments, to James Talcott, Inc., New York, N.Y., a corporation of New York

Filed Feb. 23, 1968, Ser. No. 707,894
Int. Cl. B65h 45/16
U.S. Cl. 270—77 6 Claims

ABSTRACT OF THE DISCLOSURE

A folding blade mechanism of a 3:2 folder providing improved collect run drive mechanism. A sun gear, intermediate satellite gear and a driven gear for the folding blade shaft, suitably related for straight run operation. Non-circular gears integrally incorporated with the satellite and driven gear suitable for collect run operation, and a means for shifting from one drive to the other in changing from straight run to collect run drive.

BACKGROUND OF THE INVENTION

This invention relates to folding cylinder mechanisms, such as used with rotary printing machines, and more particularly, to so-called 3:2 folders.

In a 3:2 folder, the folding cylinder body has a circumference which is one and a half times that of a printing cylinder and it runs at two-thirds the angular speed of a printing cylinder. Three products are carried at 120° intervals around the cylinder, the cylinder product holding mechanism being arranged so that a product is relinquished for folding into the folding off rolls from each position during each rotation of the cylinder, for a straight run, and during alternate rotations of the cylinder for a collect run.

An obvious solution to the problem of providing suitable folding blade movements is as shown, for example, in Schmidt Patent 1,118,060, and involves the use of only two folding blades in a carrier rotating at one and one-half times the angular speed of the folding cylinder body. With such an arrangement, all that is required for a collect run is to silence one of the blades. This arrangement, however, possesses a serious drawback, in that the accommodation of the folding blade carrier and associated parts reduces the cylinder body itself to a comparatively flimsy structure.

Accordingly, 3:2 folder mechanisms have been designed in which there is a folding blade for each product carrying position of the cylinder body and the folding blade carrier rotates at the same angular speed as the cylinder body. This permits the use of adequately strong and massive cylinders with adequate product supporting surfaces, but creates a serious problem in providing for a collect run.

As brought out in more detail at appropriate points in the following specification, the requirements of the straight run operation are such as to determine the geometry of the mechanism within quite narrow limits and the provision for collect run operation must be worked out within those limits. This has proved increasingly hard to do, as speeds of operation have progressively increased and a point has been reached where the capability of the folding blade mechanism has become a definite limitation on the speed of the collect run.

Modern proposals are of a complicated character. One workable solution is shown in Harless Patent 2,981,540. In this construction, each folding blade has a drive mechanism including a differential gear and an oscillating gear sector with slider crank drive. The parts

involved are numerous and small, being accommodated in an annular space between the sun gear supporting structure and the peripheral ring gear by which the folding blade carrier is driven, which annular space may have a radial dimension of only about six inches. The moment of inertia of the parts driven at fluctuating speed is comparatively small, but the driving elements are also small. While, as stated, this structure is a workable one, it has been found preferable in the interest of simplicity and massiveness of elements to restore to a single variable speed drive mechanism for the sun gear itself, as shown in Neal Patent 3,055,657. In this structure, which involved the use of a bodily oscillated differential, together with a cam drive for it, it was found that, in view of the comparatively high moment of inertia of parts driven at fluctuating speed, and the comparatively great accelerations involved, the loads on the cam elements reached practically possible upper limits even with attention paid to the selection of the most suitable metals, great precision and the use of the best possible finishes.

Accordingly, a construction eleminating massive elements which were oscillated about axes at some distance from a principal axis was evolved (Bryer Patent No. 3,144,249). In this construction, a stationary sun gear was used for straight run and the sun gear was driven by an indexing drive for the collect run. This drive had several advantages, including a blade tip path in folding position which could be conformed to the straight run tip path about as closely as desired, and the rotation of fluctuating speed elements about principal axes of inertia, thus minimizing the torque corresponding to the required acceleration of parts.

A number of constructions of this last type are in commercial use and performing satisfactorily. It is, however, apparent that the maximum speeds obtainable with such contructions have just about been reached, and it has been necessary, again to utilize the best materials and finishes available and to reduce clearances to a minimum. Disadvantages of the collect run drive include the need for complex cam track shapes in the indexing drive mechanism, the presence of a number of backlash points and the presence of power loops feeding back vibration to the press drive itself. The further development of 3:2 folder collect run drive mechanisms appear to be at a standstill, as the possibilities had about been exhausted.

Since before the time of the Harless patent above mentioned, it seemed rather obvious that no train of epicyclic gearing, involving simple rotary gears could be used. However, this possibility was made the subject of an exhaustive theoretical investigation which is believed to confirm the impracticality of any such procedure. The possibility of utilizing complex cam-gear driving elements, as, for example, specially developed gear forms in which the pitch circles took the form of high and low circular dwells joined by suitable rise and fall sections and pairs of such elements were locked together by gear tooth or other elements to provide a drive were investigated.

In the course of this work, the whole problem was approached de novo, resulting in an extremely simple solution eliminating the defects of prior folding blade drives, above mentioned, and involving stresses of a moderate character, so that it has not only become possible to meet present speed requirements, but to do so with an adequate margin of safety, even when the effects of wear are taken into consideration so that it appears that the folding blade drive mechanism is no longer the bottle-neck in obtaining increased speed of press runs under collect run conditions, nor does it appear likely to be such a bottle-neck in the predictable future as speeds are increased.

It is an object of the invention to provide an improved folding blade mechanism including means for shaping the blade tip path in an appropriate manner for cooperation with the folding off rolls.

Another object of the invention is to provide an improved collect run drive mechanism for the folding blades of a 3:2 folder.

Another object of the invention is to provide a drive mechanism combining the straight run and collect run driving elements in a simple manner.

Still another object of the invention is to provide a folding blade drive mechanism which eliminates objectionable power loops and the feeding of vibration back into the press drive.

The drive mechanism of the present invention comprises a sun gear, intermediate satellite gear and a driven gear for the folding blade shaft, suitably related for straight run operation, together with elliptical gear elements, which may be incorporated integrally with gear members including also the satellite and driven gear for a straight run, together with means for shifting from the one drive to the other in changing from straight run to collect run drive.

A mechanism embodying the invention in a preferred form will now be described with reference to the accompanying drawings, and the features forming the invention will then be more particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a vertical axial section of a folding cylinder mechanism embodying the invention in a preferred form;

FIG. 2 is an end elevation view;

FIG. 3 is a section on the line **3**—**3** of FIG. 1;

FIG. 4 is a section on the line **4**—**4** of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT OF THIS INVENTION

The elements involved in the straight run drive may be, and are shown as, substantially identical to these involved in the above mentioned Bryer patent (apart from some changes in gear ratios which do not affect the straight run operation to any appreciable degree, but which are critical for the collect run operation, when integrated with the straight run operation as hereafter described).

The frame structure **1** is bored and countersunk to hold a bushing element **2**, which is secured in place in the frame as by bolts **3**. Element **2** has a concentric inner bore **4** supporting the bearing **5** for the shaft **6** of the cylinder body **7**, the cylinder body rotating about the axis indicated at A_1. The bushing **2** has an eccentric outer surface **8** which supports the bearings **9** for the folding blade carrier disc or spider **10**, so that this element rotates about an axis indicated at A_2. The eccentricity or spacing between axes A_1 and A_2 provides for the necessary protrusion of the folding blades beyond the profile of the cylinder body when tucking products into the bight of the folding off rolls, while keeping the blade tips within the cylinder body profile at other times.

The folding blade carrier disc or spider **10** is equipped with a peripheral gear ring **11**, meshing with a drive pinion **12** carried on the offset shaft **13** (as will be understood, the folding blade carrier disc **10** at the opposite end of the machine (not shown) is similarly driven and shaft **13** is driven off the folding cylinder body, also at the opposite end of the machine, in the usual way).

The drive shaft **14** is connected to the printing machine drive, and through bevel gears **15**, **16**, drives the cylinder body shaft **6**. As usual, the folding blade carrier is driven about its eccentric axis A_2 at the same angular speed as the folding cylinder body **7**. The folding blade shaft element **20** is journaled in the disc **10** by means of bearings **21** and also supported at its outer end in a bearing **21'** mounted in the housing structure **22**. In the

construction shown, the shaft element **20** is secured to and supports the folding blade element **23** by means of a flanged connection **24**. In the lowermost position of a blade, as shown in the figures, blades **25** protrude beyond the profile of the blade carrier dsic and into the bight of the folding off rolls **26** for tucking products therein. Element **20** comprises a circular driven gear element **27** which is rotatably fixed to the blade by the member **20** and is operable during the straight run and also carries an elliptical driven gear element **28** which is rotatably fixed to the folding blade through the shaft element **20** and is operable during the collect run.

An intermediate gear **29** is rotatably supported (FIG. 4) by bearings **30** on a shaft element **31**, which in turn, is secured at one end to the carrier disc **10** and at the other to the casing structure **22**. The bearings **30** are held in place axially by washer plates **32** and this entire assembly is free to rotate upon the shaft **31** or slide axially therealong. Member **29** has a circular gear **33** rigidly secured to it and adapted to mesh with the gear **27**, previously referred to, as shown in the figures, and an elliptical gear element **34**, adapted to mesh with the elliptical gear **28**, previously referred to, in another position of the member **29**. The gear **33** meshes with a sun gear **35** slidably mounted on the eccentric outer surface **8** of the bushing **2**. The sun gear has threading **36** to each side of its teeth and collar elements **37** and **38** screwed onto it. These collar elements serve to locate the gear **33** axially and, hence, to hold it in mesh with gear **27**, previously referred to. The entire sun gear **35** together with its collars is held against rotation by a pair of rods **39** screwed into the collar **38** and **40** and accommodated in bores **41** in the frame structure **1**. The rods **39** also serve for shifting the sun gear axially along the bushing surface **8**, for shifting from straight run to collect run. As will be apparent, if the rods **39** are pulled outwardly of the frame, should **37** engaging against gear **33** will move the gear **33** along with the sun gear **35**, maintaining it in mesh therewith, and simultaneously moving the entire structure **29**, so that elliptical gear **34** comes into mesh with elliptical gear **28** while the gear pair **33**, **27** are brought out of mesh.

These very simple parts just described, when suitably interrelated as brought out in the following description, are all that are required to provide for both the straight run and collect run operations of the following blades.

Each of the bars **39** is formed with rack teeth **42** adjacent its outer end, and these teeth mesh with pinions **43** carried on a cross shaft **44** which is rotatably mounted in brackets **45** secured to the frame **1** and provided with gear shift lever **46**. Swinging this lever into one extreme position (solid lines in FIG. 1) pushes the bars **39** in, providing for the straight run, while swinging it to its other extreme position (broken lines of FIG. 1) pulls the bars outwardly and elements **35**, **29** with them, so as to provide for the collect run operation.

It is essential that the elements should be properly aligned at the time that the shift is made and also operation of the gear shift lever **46** should be prevented when they are not so aligned, and the mechanisms utilized for this purpose will now be described.

The gear shift lever has, first of all, the usual catch handle **47** pivotally mounted to it at **48**. The lower end of this handle engages a spring pressed plunger element **49**, the other end of which has a groove **50** receiving a solenoid actuated pin **51** operated by solenoid **52**. Unless the solenoid **52** is energized to withdraw pin **51**, the spring pressed plunger **49** cannot be withdrawn from a bore **53** in member **44** secured to the frame, so that it is impossible to operate the gear shift lever **46** unless the solenoid is energized.

The folding blade carrier disc **10** carries a cam point **54** adapted to engage the operating roller **55** of a microswitch **56** for energizing the solenoid **52**. Microswitch **56** is carried on a swinging frame pivotally mounted at **57**

and is normally held out of position for engagement of its roller **55** by the cam point **54**. When, however, the press is stopped, a solenoid **58** connected to the pivotal member supporting the microswitch at **59**, is energized bringing the microswitch down to operating position against the action of the spring **60**. Microswitch **61** having its operating element engaging an end of plunger **49**, prevents starting of the press when the handle **47** is in use. Pin and solenoid elements **51'** and **52'** are provided (FIG. 1) for the other extreme position of the shift lever **46**.

The folder may be coordinated with the control circuits of the printing machine in a very simple manner, as by connecting solenoid **58** so as to operate only when the press drive is stopped and utilizing microswitch **56** to energize the solenoids **52**. Under such conditions, the shift lever **56** can be operated only when the press is stopped and the folding blade carrier is in proper angular position for shifting the gear member **29**. Microswitch **61** may similarly be connected so as to prevent starting the press unless the handle **46** is in one of its two operating positions.

One of the bars **39** has a pair of notches **62** for accommodating annular plate **63** fixed to the housing **22** when the handle **46** is in either of its two extreme positions. During the shifting, the bar is in register with a semicircular recess **64** in plate **63**, permitting the required axial movement of rod **39**. The other of the rods **39** (to the right in FIG. 3) has a single notch **62'** so as to accommodate the member **63** in any position. Bar **39** with notches **62** and the plate **63** with cut outs **64** serve as an additional insurance against attempting to change from straight to collect run with the elements in improper angular positions and also against the starting up of the equipment with the elements in partly shifted position.

OPERATION

Assuming the bars **39** to be forced inwardly (to the left of FIG. 1), so that the parts are arranged for a straight run, the intermediate satellite gear **33** rolls on the sun gear **35** and drives the folding blade gear **27**. The straight run conditions require that the distance from the carrier rotation axis A_2 to the axis of the folding blade shaft element **20** be twice the distance from the latter axis to the tip of the folding blade **25**. This is a necessary condition for a true hypotrochoidal folding blade tip path. A small variation in this particular can be tolerated, the effect being to produce a somewhat prolate (blunt-cusped) tip path, or curate (looped) tip path.

The radial location of the axis of the folding blade shaft **20** is, however, substantially fixed by the straight run requirements. It is also necessary that the gear tooth ratio between the sun gear **35** and folding blade gear **27** be accurately 3:1. Under these conditions, a three cusped hypotrochoidal straight run folding blade tip path will be produced as in Patent 3,144,249, and other prior patents mentioned.

While, in prior mechanisms, the sun gear and folding blade shaft gear sizes may be varied over a considerable range, so long as the 3:2 tooth ratio is maintained, and the intermediate gear (being idle) may be of any convenient size, the collect run arrangements of the present invention require that the straight run gear train have teeth in the ratios 3:2:1. Still further requirements exist, as a matter of convenience, so that for given diametral pitch, the numbers of teeth in the gears are substantially determined as, in the particular folder selected as illustrative, 69:46:23.

With respect to the collect run, the first requirement is clearly that the folding blade shaft should rotate at an *average* retrograde speed (with reference to carrier **10**), which is one-half its speed for the straight run, or one and one-half retrograde rotations for every rotation of the carrier. Such rotation at a uniform speed would be useless as the blade tip path in this case is a lobed, rather than a cuspidal one. It is therefore, necessary to accelerate and decelerate the folding blade rotation so that when it is in the folding position, the tip path may approximate to the cuspidal form of the straight run path.

The elliptical gear pair **34–28** comprises elliptical gears having the same number of teeth, so that the folding blade shaft **20** runs at the same average speed as member **29** and, hence, one and one-half times the average speed of the carrier, as required. The eccentricity of the gear ellipses is selected so as to provide a proper hypotrochiodal path for the folding blade tip in folding position. This is achieved, theoretically, by utilizing an elliptical gear pair in which the essentricity of the pitch ellipse is one-third, thus providing in one position of the elliptical gears (bottom of FIG. 3) a 2:1 drive ratio and in another a 1:2 drive ratio, so that the elliptical gear pair has an average drive ratio of 1:1.

Considering now the lowermost folding blade shaft as indicated in FIG. 3 with the folding blade of folding position, and the elliptical gear pair driving at a 2:1 ratio, it will be apparent that at this point and for an infinitesimal distance to either side thereof, the blade tip path is identical with that for the straight run, for the reason that the drive ratio between the elliptical gear pair, at this point, is the same as the straight run gear pair **33–27**. As the carrier is rotated away from the position of FIG. 3, the drive ratio of the elliptical gear pair decreases in a sinusoidal manner, with the result that the gear tip path forms a somewhat more obtuse cusp that is the case for the straight run, being comparable to a blade tip path shown in prior Harless Patent 2,981,540. This path is as fully as satisfactory in the folding action obtained as that of Patent 3,144,249 and involves less shock.

While the invention has been described and illustrated with respect to a certain preferred embodiment which gives satisfactory results, it will be understood by those skilled in the art after understanding the principle of the invention that various other changes and modifications may be made without departing from the spirit and scope of the invention, and it is intended therefore in the appended claims to cove all such changes and modifications.

What is claimed is:

1. In a 3:2 printing machine folding mechanism, a rotatable folding blade carrier, folding blade shafts rotatably journaled in the carrier, a sun gear, means mounting the sun gear concentric with the carrier, and planet gearing mounted on the carrier for driving the folder blade shafts, the said planet gearing for each folding blade shaft comprising straight run gearing including a driven gear rotatably fixed to the folding blade shaft for driving the same, an intermediate gear rotatably mounted on the carrier and meshing with the said driven gear and with the sun gear, these gears having tooth numbers in 1:2:3 ratio; the said planet gearing also comprising the collect run operation, a non-circular gear pair having a 1:1 average drive ratio and 2:1 maximum drive ratio, means rotatably fixing the gears of the said pair, respectively, to the folding blade shaft and to the said intermediate gear, with the gear pair rotation timed to the carrier rotation so that driving at the said 2:1 maximum ratio occurs at the time of furthest protrusion of the folding blade in folding position.

2. Mechanism according to claim **1**, comprising means slidably mounting the sun gear for movement between two predetermined positions, and gear shifting means operable by the sun gear when so moved for shifting between straight run and collect run operation.

3. Mechanism according to claim **2**, comprising an adjusting member for moving the sun gear between collect run and straight run positions, an annular element fixed to the housing and rotatable therewith, the said adjusting member being positioned to interfere with the said annular element, but having notches for accommodating the said element when the adjusting member is in its collect run and straight run positions, the annular

element also having a notch for accommodating movement of the said adjusting member, whereby gear shifting is permitted only in a predetermined angular position of the planet gearing.

4. In a 3:2 printing machine folding mechanism, a rotatable folding blade carrier, folding blade shafts rotatably journaled in the carrier, a sun gear, means mounting the sun gear concentric with the carrier, and planet gearing mounted on the carrier for driving the folding blade shafts for a collect run, the said planet gearing comprising an elliptical gear pair, a satellite gear meshing with the sun gear and driving one gear of the said pair at a constant speed ratio to the carrier speed of rotation, the other gear of the said pair driving the folding blade shafts.

5. In a 3:2 printing machine folding mechanism, a rotatable folding blade carrier, folding blade shafts rotatably journaled in the carrier, a sun gear, means mounting the sun gear concentric with the carrier, and planet gearing mounted on the carrier for driving the folding blade shafts for a collect run, the said planet gearing comprising for each folding blade shaft an elliptical gear pair, the eccentricity of the pitch ellipses being substantially ⅓, one gear of the said pair driving the folding blade shaft, and a satellite gear meshing with the sun gear and driving the other gear of the said pair at a constant speed ratio to the carrier speed of rotation.

6. In a 3:2 printing machine folding mechanism, a rotatable folding blade carrier, folding blade shafts rotatably journaled in the carrier, a sun gear, means mounting the sun gear concentric with the carrier and planet gearing mounted on the carrier for driving the folding blade shafts for a collect run, the said planet gearing comprising for each folding blade shaft an elliptical gear pair, the eccentricity of the pitch ellipses being substantially ⅓, one gear of the said pair driving the folding blade shaft, and a satellite gear meshing with the sun gear and driving the other gear of the said pair at a constant 3:2 speed ratio to the carrier speed of rotation.

References Cited

UNITED STATES PATENTS

3,055,657 9/1962 Neal et al. ---------- 270—77

EUGENE R. CAPOZIO, Primary Examiner

PAUL V. WILLIAMS, Assistant Examiner