

[54] **HIGH-SPEED PRINTER HAVING
IMPROVED RIBBON DRIVING, REVERSING
AND TENSIONING MECHANISM**

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[52] U.S. Cl. 197/164, 197/151, 197/160
[51] Int. Cl. B41j 33/22
[58] Field of Search 197/16, 160-165,
197/151, 154, 18

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

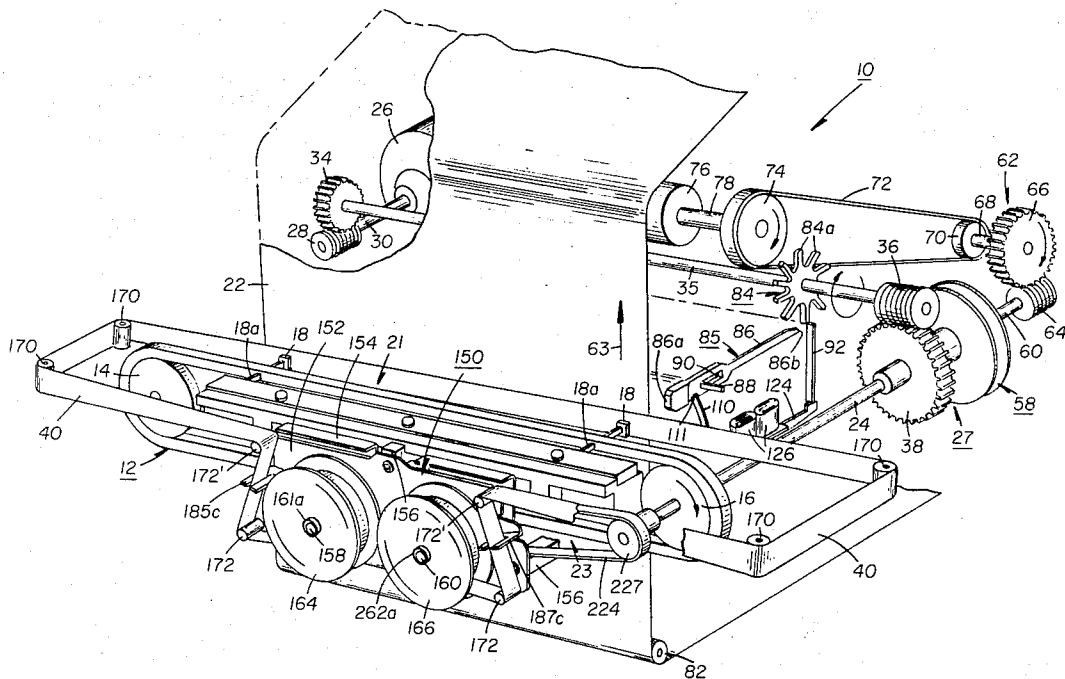
2,858,928	11/1958	Bristoll.....	197/165
3,011,434	12/1961	Schenk	197/162 X
3,340,989	9/1967	Bush	197/165
3,554,349	1/1971	Herbert.....	197/154
3,670,981	6/1972	Cavella	197/162 X
3,675,753	7/1972	Perucca	197/18

Primary Examiner—Robert E. Pulfrey
Assistant Examiner—R. T. Rader
Attorney, Agent, or Firm—Kenneth R. Bergum

[57] **ABSTRACT**

A high-speed impact printer has an improved ribbon driving, reversing, and tensioning mechanism that is jam-proof, of compact-simplified construction, reliable and substantially maintenance free in operation. By being compact, the drive mechanism may be centrally located at the front of an impact printer so as to facilitate spool and/or ribbon replacement. The drive mechanism, through the use of two sets of pivotally mounted, two-stage biased planetary coupling gears, effects gradual rotational engagement and disengagement of the selectively coupled driving and driven gears of the drive mechanism. This results in minimal gear wear, and produces smooth, automated reversal of ribbon travel, while the latter is continuously maintained under uniform tension.

18 Claims, 12 Drawing Figures



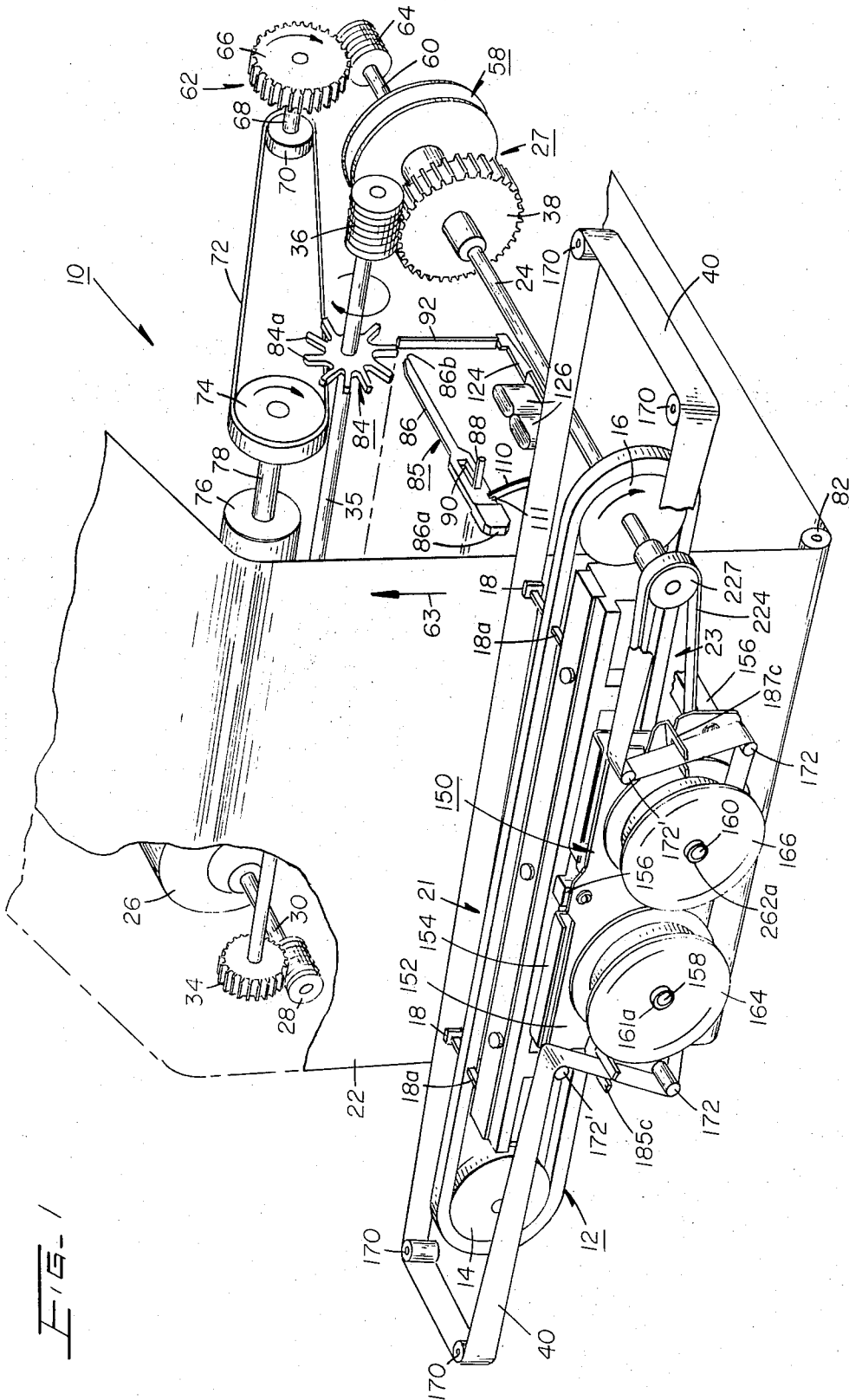


FIG. 2

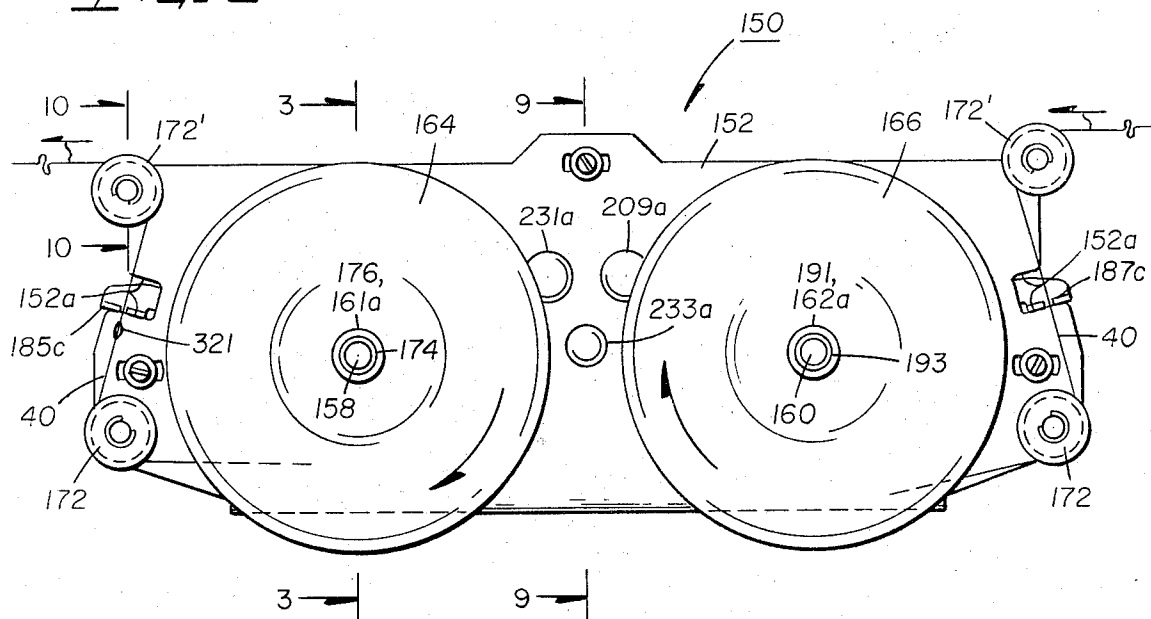


FIG. 3

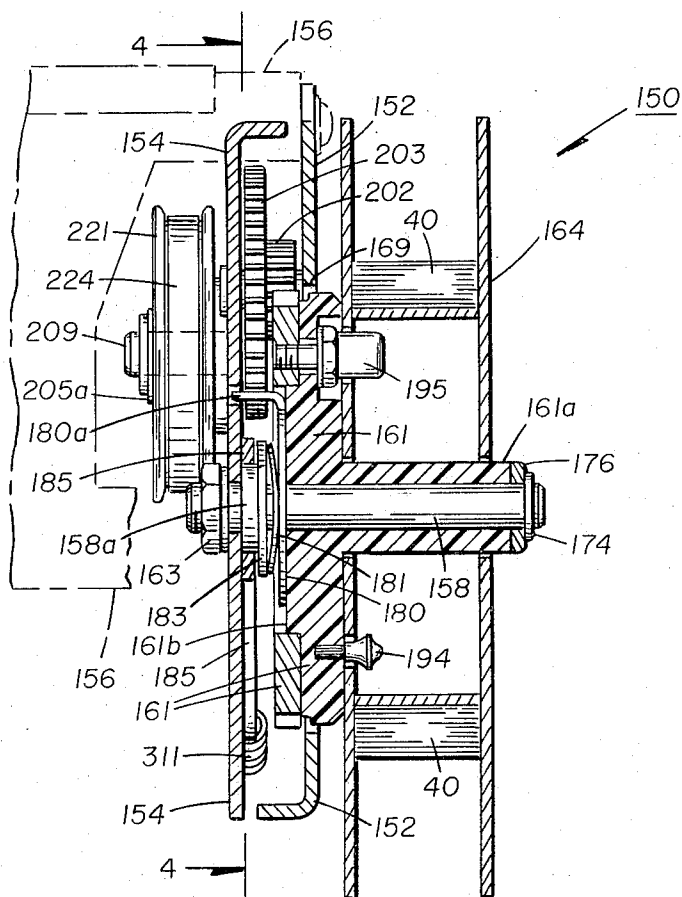


FIG. 4

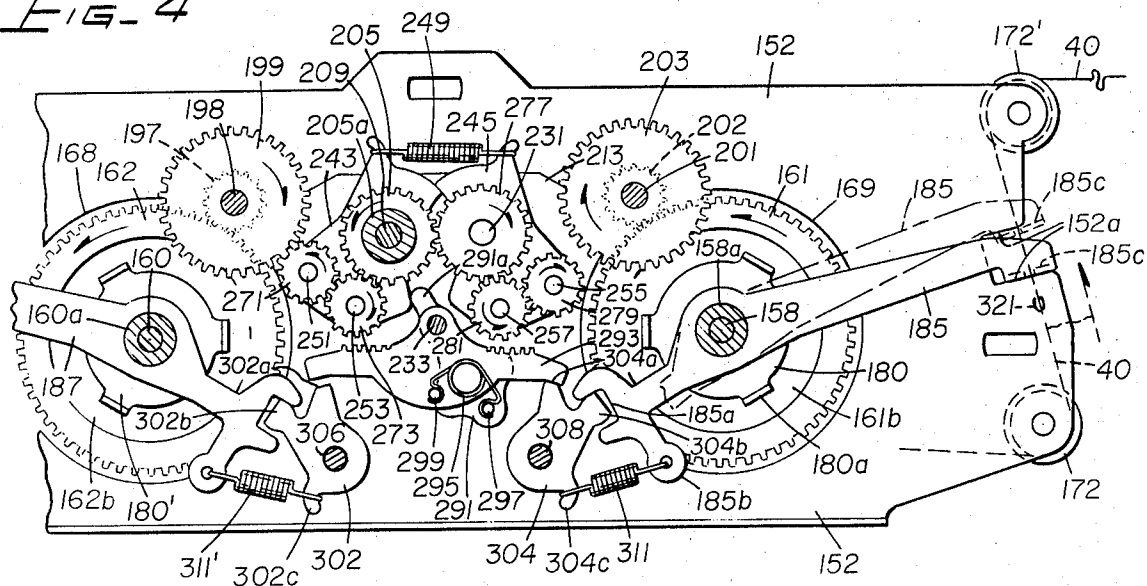


FIG. 5

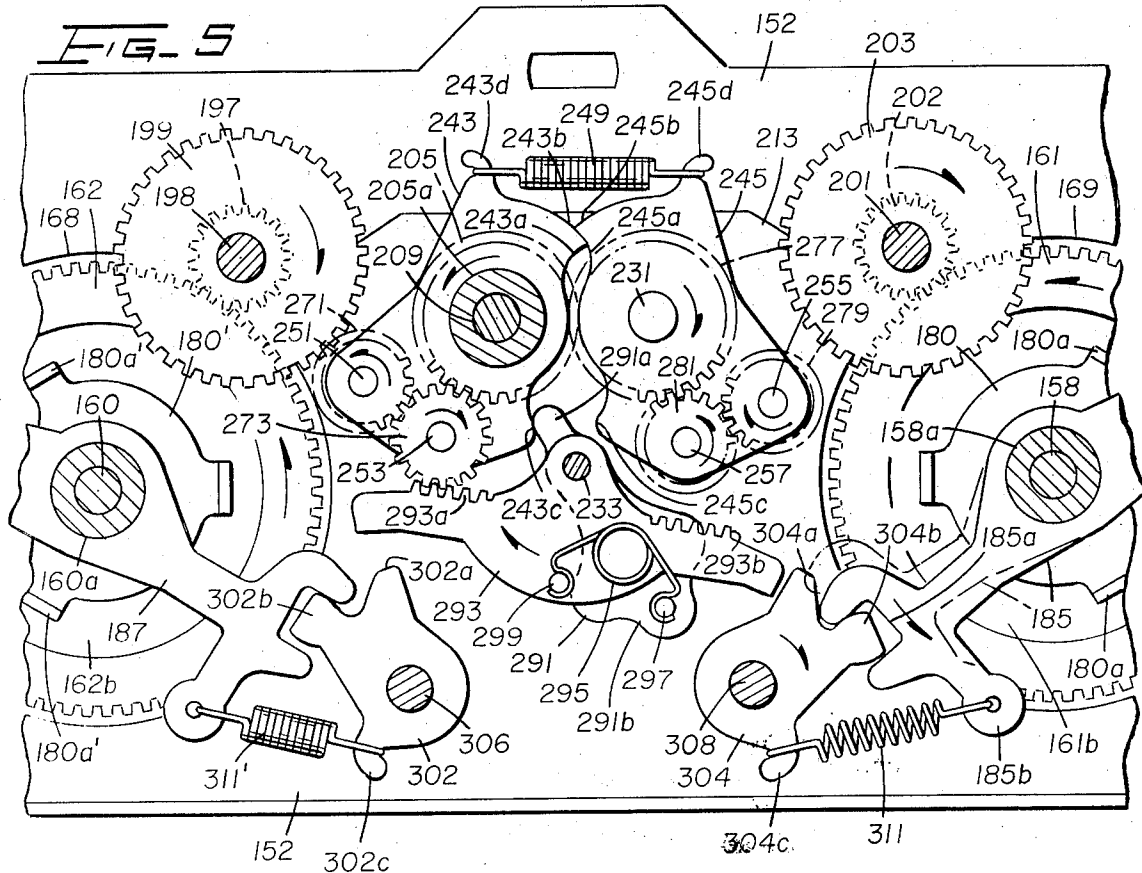


FIG. 6

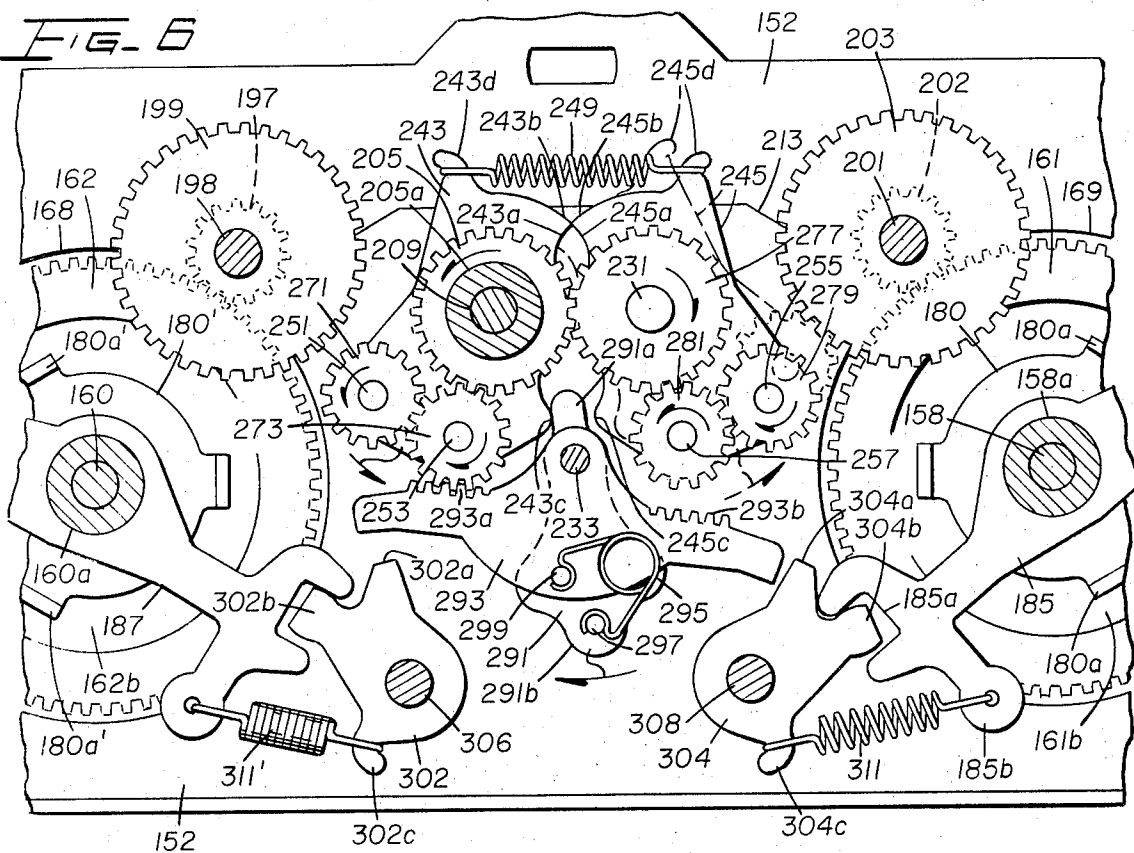
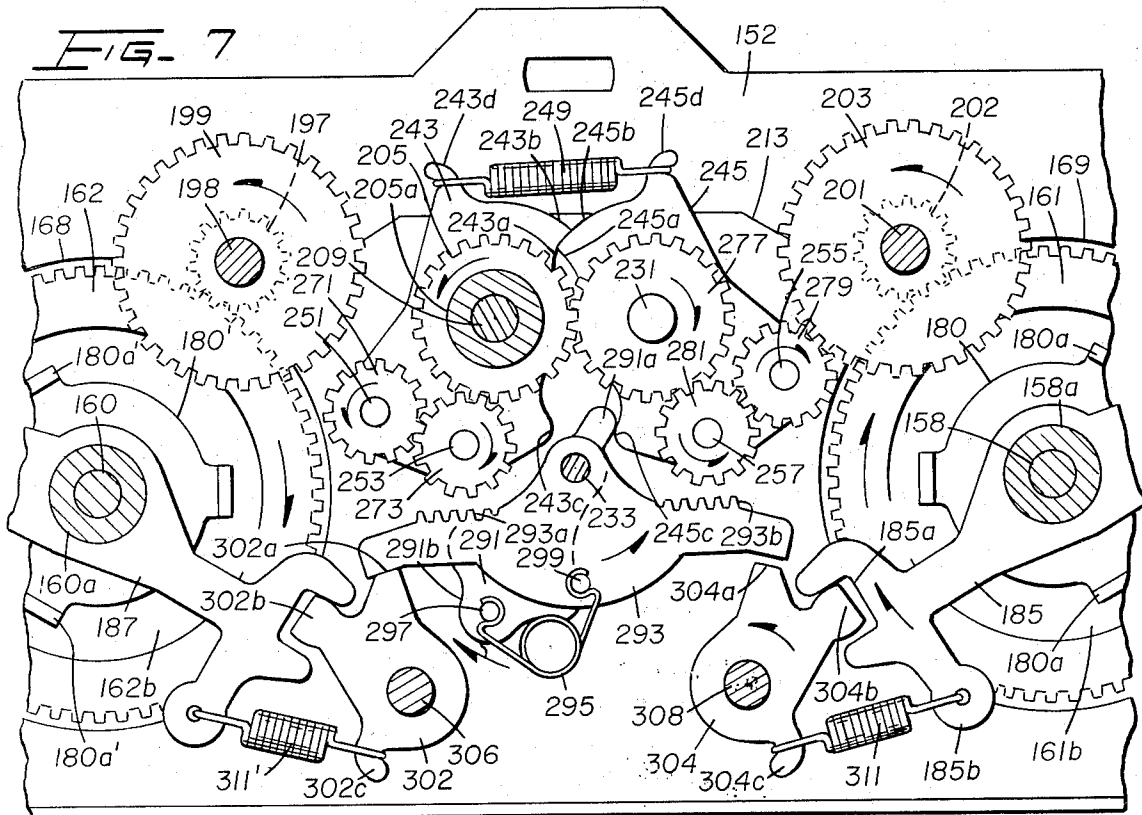
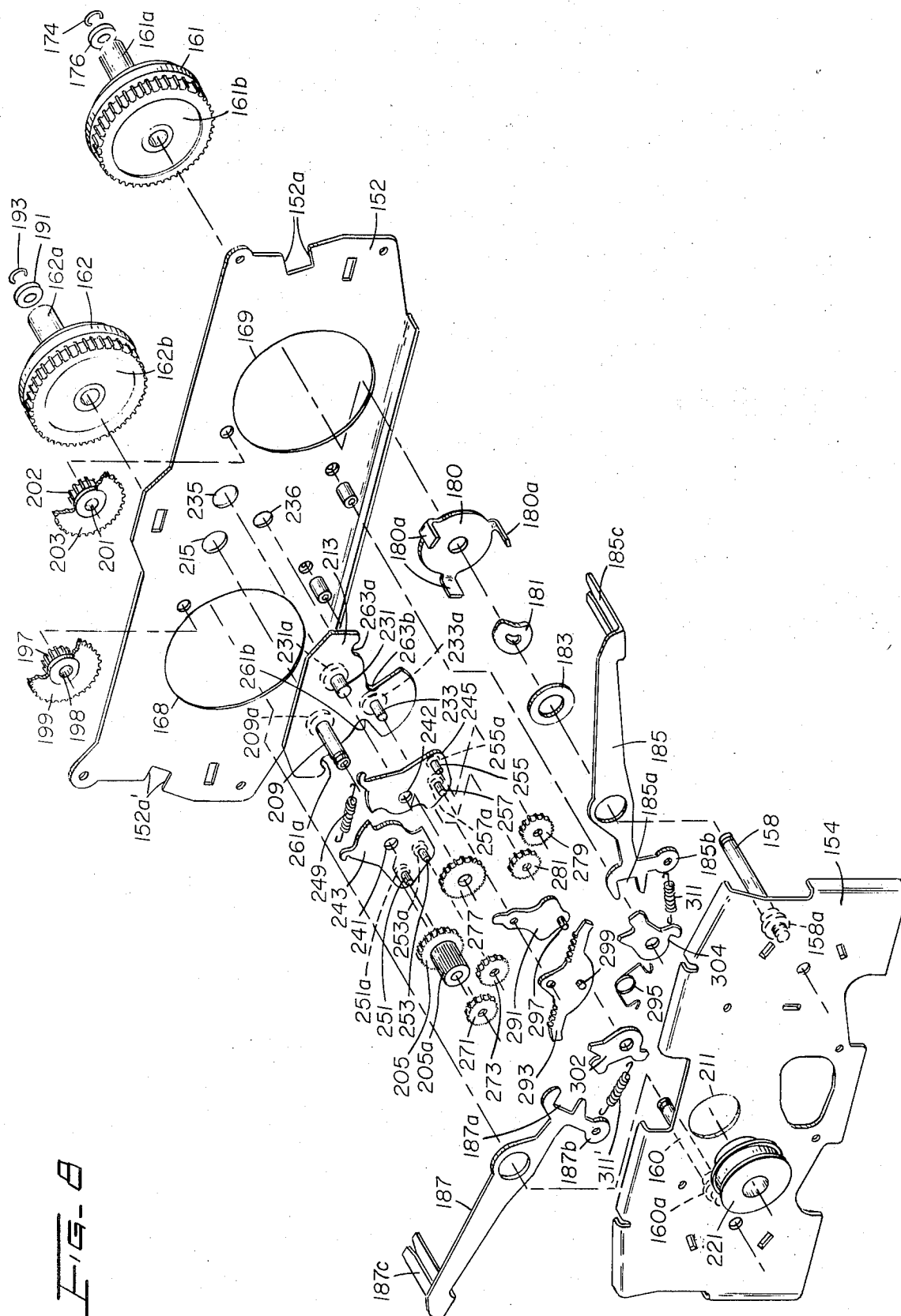


FIG. 7





15-1 B

FIG. 9

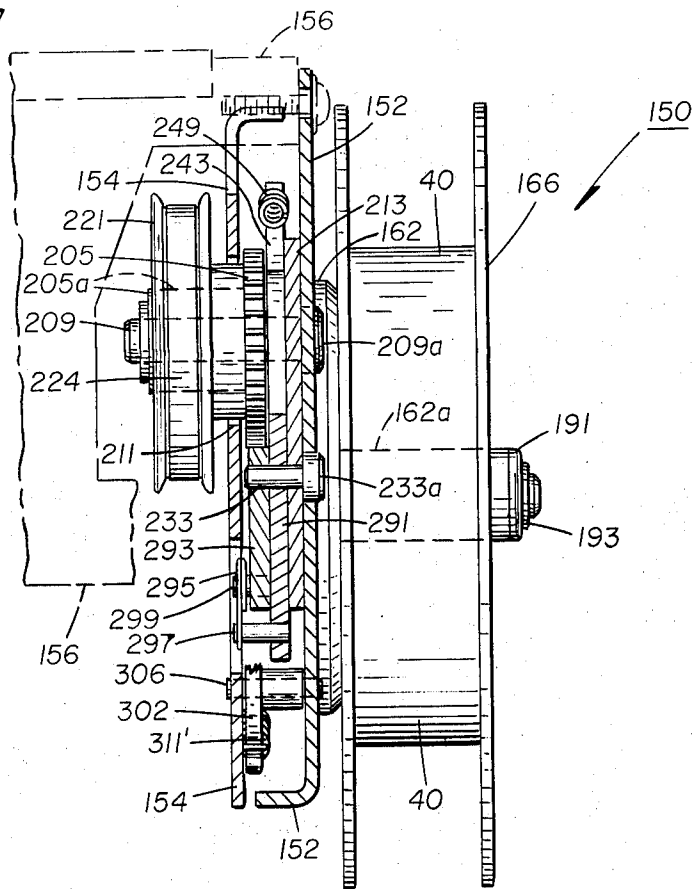
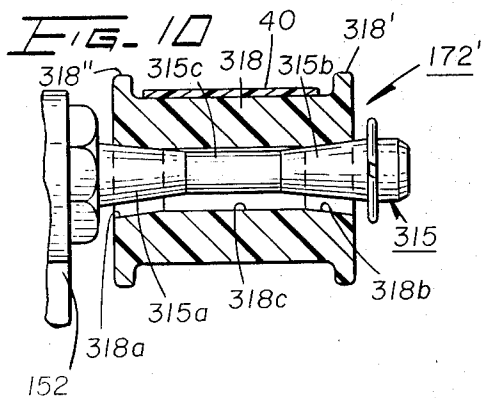
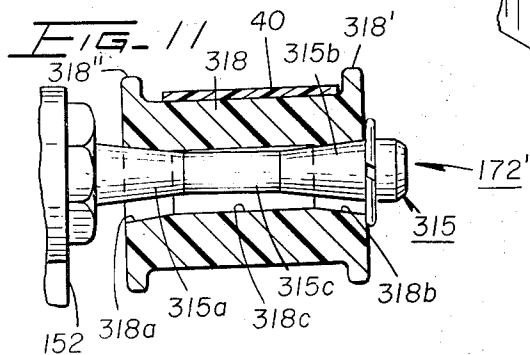
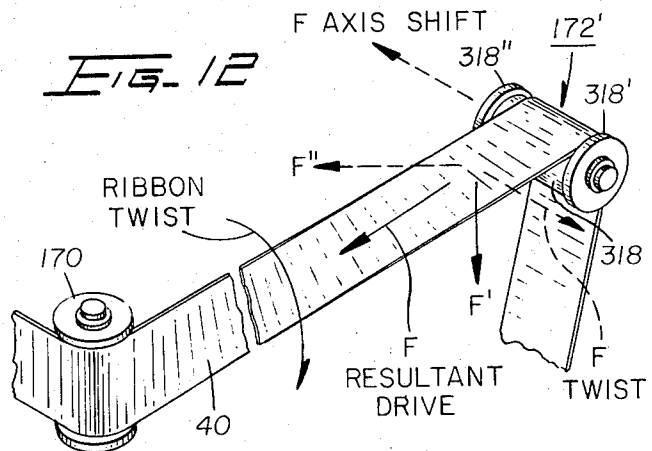


FIG. 12



HIGH-SPEED PRINTER HAVING IMPROVED RIBBON DRIVING, REVERSING AND TENSIONING MECHANISM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to high-speed impact printers and, more particularly, to a ribbon spool drive mechanism therefor.

2. Description of the Prior Art

High-speed printers of the type with which the present invention is primarily concerned effect printing "on the fly" at relatively high speeds. More specifically, in one class of such printers, the character or font dies are mounted on a continuously moving endless carrier drawn past an aligned array of print hammers. Interposed therebetween, of course, is the medium (paper) on which the characters are to be printed, and an inked (or carbon impregnated) ribbon that is continuously moved in reversible directions, under tension, in front of and along the aligned array of character dies which define the width of a printing line.

Ideally suited for use in printers of the type in question are hammer mechanisms of the type disclosed in U.S. Pat. No. 2,927,960, issued to W. P. Byrnes, Mar. 8, 1960, but preferably with the improvements disclosed in a copending application Ser. No. 268,238, of E. S. Babler, filed July 3, 1972, and assigned to the present assignee.

Because of the high-speed nature of most impact printers, incremental movement of the inked ribbon is precluded, as there would normally be insufficient ink (or carbon) on the ribbon to allow repetitive impacting of the character dies against common discrete areas during each index dwell period. Accordingly, ribbon advancement in high-speed printers cannot be accomplished simply as a by-product of type-bar mechanical motion, for example, as in the case with conventional typewriters. Rather, the ribbon spool drive mechanism must be of the type that slowly, but continuously, advances the inked ribbon along and between the aligned arrays of character dies and print hammers, and under constant tension so as to maintain the ribbon in alignment therewith. Ribbon reversal, of course, must also be effected automatically in any high volume printing application. In order to efficiently utilize all of the ink (or carbon) on the ribbon, it is also very advantageous that the entire width, as well as length, of the ribbon be exposed to indirect hammer impacting at some point in time during travel of the ribbon therepast in both directions.

Concomitantly, it is also of paramount importance that the ribbon spool drive mechanism be of simple, inexpensive construction, reliable in operation, essentially jam-proof, require only one common input power coupling connection, and allow ready access for inspection and periodic replacement of the ribbon spools by an operator.

One prior ribbon driving, tensioning and reversing mechanism for use in high-speed impact printers is disclosed in U.S. Pat. No. 3,554,349, issued to D. G. Herbert. As disclosed therein, two separate and spaced apart ribbon spool drive mechanisms are employed, one supported on each side of the printer frame, i.e., separated by the width of the printing area, and inter-

coupled through two laterally disposed coupling shafts, one used as a drive coupling and the other for effecting automatic ribbon reversal. The need for separate, duplicated, multi-shaft-coupled drive mechanisms add considerably both to the parts and assembly costs of an impact printer. In addition, the widely separated drive mechanisms are not always conducive to the packaging of an impact printer, or to ribbon-spool accessibility.

Another disadvantage of many prior spool drive mechanisms is that they require an internal spring-biased sensing mechanism, and ribbon spools having peculiar (e.g. arcuate) slots formed in at least one flange thereof which is mounted adjacent to the drive mechanism, in order to effect automatic ribbon reversal at the proper times. Such internal sensing mechanisms, of course, are not compatible with all conventional spools, and also are not readily accessible for inspection, repair or replacement. They also are not adapted to sense unintended obstructions impairing ribbon travel.

SUMMARY OF THE INVENTION

It, therefore, is an object of the present invention to provide a high-speed impact printer with a new and improved ribbon spool drive mechanism of novel design, and having universal application.

It is another object of the present invention to provide a ribbon spool drive mechanism that is of simple and inexpensive construction, is jam-proof, is compact and common to both spools, provides automatic ribbon reversal utilizing standard spools, maintains the ribbon under continuous tension, and exposes the entire width of the ribbon to the impacting print means at some point in time during travel therepast.

In accordance with the principles of the present invention, these and other objects are accomplished through the utilization of two continuously driven gear trains and two respectively associated driven gear trains, with each of the latter being alternately coupled to the associated drive gear train, so as to effect smooth, reliable, automated ribbon reversal in response to a sensed ribbon obstruction (such as an eyelet).

Alternate drive gear train-driven gear train coupling is effected by, and in response to, the rotational displacements imparted to both a common rotatable reversing rack and a common over-centering lever. Selective gear coupling engagement and disengagement is also effected at gradually increasing and decreasing rotational speeds, respectively, so as to insure that the ribbon is maintained continuously taut during each reversal in direction thereof, and to facilitate initial alignment of the periodically enmeshed gear teeth. Minimized gear wear is further insured in the present drive mechanism by utilizing a unique two-stage type of spring-bias for effecting the required periodic, alternate gear coupling.

Compactness and simplicity of the drive mechanism is advantageously made possible by positioning the gear trains in juxtaposed clusters, and primarily in a common plane. This arrangement not only facilitates structural simplicity, but substantially minimizes the number of moving parts required and, thereby, contributes to the essentially jam-proof nature of the drive mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partially broken away perspective view of a high-speed impact printer, with some parts being omitted for the purpose of illustration, and incorporating a unique ribbon spool driving, reversing, and tensioning mechanism in accordance with the principles of the present invention;

FIG. 2 is an enlarged, partial front elevational view of a ribbon spool drive mechanism depicted only generally in FIG. 1;

FIG. 3 is an enlarged, detail sectional side view of the spool drive mechanism taken along the line 3—3 of FIG. 2;

FIGS. 4 and 5 are enlarged, partial, detail rear elevational views, with the back cover plate removed, of the ribbon spool drive mechanism taken along the line 4—4 of FIG. 3, and disclosing, in sequence, in FIG. 4 the relationship of the left side gear cluster, in particular, relative to the oscillatory reversing rack and over-centering lever, required to effect rotational driving of the left spool driven gear, and in FIG. 5 the relationship of the same parts required to disengage the left spool driven gear;

FIGS. 6 and 7 are enlarged, partial, detail rear elevational views, with the back cover removed, of the ribbon spool drive mechanism, also taken along the line 4—4 of FIG. 3, but disclosing, in sequence, in FIG. 6 the relationship of both ribbon spool associated gear clusters, relative to the oscillatory reversing rack and over-centering lever, at a momentary time of ribbon reversal, when neither spool driven gear is coupled for rotational movement, and in FIG. 7 the relationship of the right gear cluster, in particular, relative to the reversing rack and over-centering lever, required to effect driving of the right spool driven gear.

FIG. 8 is an exploded, perspective view disclosing in detail at least one of all of the major parts comprising the ribbon spool drive mechanism, with some duplicated parts being omitted in the interest of clarity;

FIG. 9 is an enlarged, detail sectional side view of the ribbon spool drive mechanism taken along the line 9—9 of FIG. 2;

FIGS. 10 and 11 are enlarged, detail cross-sectional views, taken along the line 10—10 of FIG. 2, of one of several twist compensating ribbon guide rollers embodying features in accordance with the present invention, and respectively illustrating the relative positions of the guide roller elements in response to ribbon non-twist and twist conditions;

FIG. 12 is an enlarged, partial, perspective view of portion of the continuously moving impact printer ribbon, with a 90° twist formed therein, and further illustrates by force vectors the compensating effects produced by the specially constructed guide rollers.

DETAILED DESCRIPTION OF THE INVENTION

Background Description Of Printing Mechanism

Referring now in greater detail to one preferred embodiment of the invention, as depicted in FIG. 1, a high-speed impact printer, indicated generally by the reference numeral 10, is disclosed which is of the class that utilizes an endless carrier 12, entrained about a pair of normally disposed pulleys 14 and 16, which are oriented for rotation in a common vertical plane. The pulleys are suitably journaled on the frame (only partially shown in FIGS. 1 and 3) of the impact printer.

The carrier 12 is adapted to transport a plurality of type pallets 18 (only two being shown in FIG. 1) in an essentially orbital path which is oriented in a vertical plane so as to define an upper line printing course in the area generally defined by the numeral 21 and a lower return course in the area defined by the numeral 23.

Each of the pallets 18 has a front face portion having a character die (not shown) secured thereto or otherwise formed as an integral part thereof. The pallets 18 are secured to the carrier 12 and uniformly spaced therealong by means of integral shank portions 18a that extend through suitable apertures formed in the carrier, and are oriented in a direction transverse to the longitudinal axis thereof. Whatever form the carrier 12 and pallets 18 take, it is apparent, of course, that more than one set of pallets, forming a particular font, for example, may be disposed longitudinally along the endless carrier so as to provide a longer line, i.e., a greater number of possible characters per printed line. For further details as to one preferred embodiment of the carrier 12 and pallets 18, and associated mounting structure therefor, reference is made to the copending application of F. E. Huntoon and J. F. Kearney, Ser. No. 208,198, filed Dec. 15, 1971, and assigned to the assignee of the present invention.

In the illustrative embodiment, carrier pulleys 14 and 16 constitute idler and drive pulleys, respectively. Driving torque is continuously transmitted to the pulley 16 through a shaft 24, which is coupled to a prime mover, herein shown as a motor 26, through a drive train designated generally by the reference numeral 27 in FIG. 1. The drive train includes a worm gear 28, secured to a shaft 30 of the motor 26, a gear 34, operably enmeshed with worm gear 28, and secured to one end of an elongated drive shaft 35, a worm gear 36, secured to the other end of the drive shaft 35, and a gear 38, operably enmeshed with the worm gear 36. Gear 38 is secured to the same shaft 24 as the pulley 16.

A clutch 58, which may be of conventional design, is mounted in juxtaposition with gear 38 so as to releasably couple a split shaft 60 to the coextensively aligned shaft 24. Selective actuation of the clutch 58 may be effected through control logic means (not shown) which may be of conventional design, and the structural details of which form no part of the present invention.

Whenever the clutch 58 is operated so as to couple the shaft 24 to the shaft 60, a drive train designated generally by the reference numeral 62 incrementally advances the web 22 in the direction shown by arrow 63, one line-at-a-time. Considered more specifically, such incremental advancement of the web 22 is effected, in part, by the clutch 58 incrementally rotating the shaft 60, a worm gear 64 secured thereto, a gear 66 coupled to the worm gear, and through a subshaft 68, a drive pulley 70. A suitable drive belt 72 is operably entrained about the pulley 70 and a driven pulley 74 for intermittently rotating a cylindrical roller 76, which is concentrically mounted on a shaft 78 in common with the pulley 74. The cylindrical roller 76 is disposed transversely of and adjacent to the path of web movement so as to frictionally engage the web and, in cooperation with other web guide means (not shown) intermittently feed the web from a supply source (not shown) about a lower guide cylinder 82, as the web is advanced in the direction of the arrow 63.

In the illustrative impact printer embodiment, the character printing impact mechanism further comprises both an array of spoke-line impellers **84** (only one shown in FIG. 1) which are spaced apart along and concentrically secured to the longitudinally extending drive shaft **35**, and a plurality of respectively associated impactors designated generally by the reference numeral **85** (only one shown in FIG. 1). Each impeller **84** has a plurality of radially extending, uniformly spaced spoke-like impeller elements **84a**, all of which are oriented in a common plane perpendicular to the axis of the shaft **35**. In a preferred embodiment of the printer, the impellers **84** are arranged in a manner disclosed in a copending application of E. S. Babler, Ser. No. 268,236, filed July 3, 1972, and assigned to the assignee of the present invention.

Each impactor **85** includes a hammer **86** mounted in a channel (not shown) forming part of the printer frame so as to be selectively driven along a rectilinear path, perpendicular to the web **22**, between a normal, untensioned, or non-printing position, and a printing position whereat an enlarged forward head portion **86a** of each hammer is biased against the backside of the web **22**. In order to facilitate printing, it is apparent that each hammer must be axially aligned with a different pallet **18**, the latter being mounted in an array on the carrier **12**, as described hereinabove. As such, the continuous movement of the pallet-character die assemblies along a path extending across the width of, and closely adjacent to, the front side of the web **22**, makes it possible for each pallet **18** (with a character die on the front face thereof), or groups thereof, to be successfully brought into momentary axial alignment with the hammers **86**.

To effect the selective driving of the hammers **86** against the web **22** with sufficient force to print character images thereon, a horizontal bumper, in the form of a rod **88** is disposed through a longitudinally extending slot **90** formed in each of the hammers **86**, for limiting rectilinear movement of the hammer. Opposite ends of the rods **88** are secured to the printer chassis (not shown herein), but shown in detail in the aforementioned Babler application, Ser. No. 236,238. The magnitude of the impact forces of the hammers are preferably controlled by means of the type disclosed in another copending application of E. S. Babler, Ser. No. 268,237, filed July 3, 1972, and also assigned to the assignee of the present invention.

The agency through which each impeller **84** drives an aligned hammer **86** against the backside of the web **22** comprises an interponent **92** (only one shown in FIG. 1). Each of the interponents essentially comprises an elongated upright finger-like member, and is aligned and operably associated with one particular impeller **84** and hammer **86**. The interponents **92** are disposed in a lateral array, parallel to and respectively adjacent the free rearward ends **86b** of the hammers **86**. Briefly described herein, each interponent can be positioned in: (1) a first or vertically raised upper position, with its upper free end portion disposed in the path of movement of a then immediately adjacent impeller spoke-like element **84a** (for transmitting force from the aligned impeller **84** to an aligned hammer **85**), in consequence of which printing occurs; or (2) a second or vertically lowered, non-printing position, in which the upper free end portion of the interponent **92** is displaced from the path of an impeller spoke **84a**.

A plurality of leaf springs **110** (only one shown in FIG. 1) are respectively associated with the hammers **86**, with the upper end portion of each spring being engaged in a slot **111** formed in the underside of an enlarged forward portion of each hammer **86**. The lower end of each leaf spring **110** is secured to a front chassis plate (not shown herein). Each leaf spring **110** is in a relatively unbiased condition when the associated hammer **86** is in its rearward non-printing position, and is in a spring-biased condition during printing, when it urges its associated hammer backward, or away from the web **22** to a nonprinting position. This cannot occur, however, until after the rearward free end **86** of the hammer has been released by its associated interponent **92**. For further details with respect to the mounting and function of the springs **110**, reference is made to the aforementioned copending Babler application Ser. No. 268,238.

Considering the interponents **92** now in greater detail, they are not physically connected to any other structural elements of the printer, even though each interponent is periodically and selectively driven upwardly into contact with an aligned impeller **84**, under the control of a separate electromagnetic assembly comprising a magnetically latchable armature **124** and a pair of electromagnets **126** (only one such assembly being shown in FIG. 1). Structural details of the electromagnets and associated armatures, and the manner in which they are supported and actuated, and cooperate with the impactors **85**, form no part of the present invention. Accordingly, for such further details, reference is made to the aforementioned copending Babler applications, Ser. Nos. 268,238 and 268,237, and to another copending Babler application, Ser. No. 292,003, filed Sept. 18, 1972, and also assigned to the assignee of the present invention.

For the purposes of understanding the present invention, it will suffice to simply state at this point that the impact printer **10**, as thus far described, constitutes a line-at-a-time printer, i.e., a plurality of characters may be simultaneously printed across the width dimension of the web **22** during each dwell period thereof (i.e., between successive index advancements). The printing of actual images on the front side of the web **22** is accomplished, of course, by the impellers **84** generating, and transferring through the respectively associated and selectively aligned interponents **92**, sufficient force against the respectively associated hammers **86** to cause the latter to be driven against the backside of the web **22**. The hammer biased areas of the web **22** are then, in turn, urged against correspondingly aligned areas of the aligned inked ribbon **40**, with those areas of the latter then being urged against the particular character dies, supported on the front faces of the pallets **18**, aligned therewith with sufficient force to effect controlled impact printing of character images on the front side of the web. This requires facilities, of course, for selectively energizing simultaneously a plurality of selective ones of the electromagnets **124**. Any suitable control logic circuitry (not shown and forming no part of the present invention) which may be of conventional design, may be employed for selectively energizing the electromagnets **126**.

RIBBON MECHANISM

Attention will now be directed to a new and improved ribbon driving, reversing and tensioning mecha-

nism, designated generally by the reference numeral **150**, with which the present invention is primarily concerned. While the ribbon spool drive mechanism is disclosed and described herein as having particular application in an impact printer, it should be appreciated that the mechanism could also be advantageously utilized with other types of printing apparatus.

With particular reference first to FIGS. 1-3 and 9, the ribbon spool drive mechanism **150** comprises a single compact unit housed within a front cover plate **152** and a rear cover plate **154** (best seen in FIG. 8). The front cover plate **152** is secured to a front panel (not shown) of the printer by means of a support bracket **156** (only partially shown in FIGS. 1 and 3.) Two shafts **158**, **160**, which alternately function as drive and idler shafts, are each secured at one end to the rear cover plate **154**, and respectively support at their opposite free ends ribbon spool driven gears **161**, **162**, having spindle portions **161a**, **162a**, upon which spools **164**, **166** are mounted.

Considering for the moment the previously identified inked ribbon **40** in greater detail, it is payed-out from one of the spools **164**, **166** and taken-up by the other after having been drawn along a circuitous path defined by two sets of guide rollers **170** and **172**. The rollers **170** have their axes oriented in a vertical direction, whereas the rollers **172** have their axes oriented in a horizontal direction, as viewed in FIG. 1. The upper two guide rollers of the set **172**, which are further identified by primed numerals, incorporate automatic ribbon twist alignment features which will be described in greater detail herein below. With the two sets of guide rollers arranged in the manner just described, it is seen that the ribbon **40** in travelling from spool **164**, for example, to spool **166**, passes closely adjacent the web **22**, and is oriented in a vertical plane parallel therewith.

In order to better utilize the entire width of the ribbon **40**, the two guide rollers **170** on the left side of the printer, as viewed in FIG. 1, are positioned at a lower horizontal elevation than the two corresponding guide rollers **170** on the right side of the printer. This results in the ribbon passing adjacent the linear array of character dies (carried by the pallets **18**) at an angle sufficient to cause character die impacting across the entire width thereof.

Considering the mechanical features of drive mechanism **150** now in greater detail, and with particular reference first to FIGS. 3 and 8, it is seen that the ribbon spool support shaft **158**, for example, has one threaded end which extends through a close fitting aperture in the rear cover plate **154**. A locking nut **163** (FIG. 3) is threaded onto the shaft **158** with sufficient torque so as to bias an integral flange **158a** firmly against the inside surface of the rear cover **154** and, thereby rigidly support the shaft perpendicularly relative to the cover plate. The opposite free end of the shaft **158** extends through an oversized circular opening **169** in the front cover plate **152**, and has a C-ring **174** (FIG. 3) secured within a groove therein, so as to confine a thrust washer **176** on the shaft.

As best seen in FIG. 8, the following piece parts are supported on the shaft **158**, and sandwiched between the rear cover plate **154** and the C-ring **174**: the keyed thrust washer **176**, the ribbon spool driven gear **161**, a friction disc **180**, a spring washer **181**, a flat washer **183**, and a ribbon sensing arm **185**. The mounting aper-

ture in the pivotal sensing arm **185** is dimensioned so as to loosely fit coaxially on the raised shoulder of largest diameter of the integral shaft flange **158a**, and is confined thereon without pressure contact by the adjacent washer **183**. With the stacked array of parts arranged as described, frictional movement between mating parts only occurs between the inner annular surface **161b** of the ribbon spool driven gear **161** (see FIG. 8) and the adjacent annular face of the disc **180**, and between the annular exterior end face of the driven gear spindle portion **161a** and the adjacent annular surface of the thrust washer **176**. The disc **180** is prevented from rotating by having leg portions **180a** that extend through respectively aligned slots in the rear cover plate **154**. An identical sandwiched array of piece parts (only the ribbon spool driven gear **162** and sensing arm **187** being shown in FIG. 8, in the interest of clarity), are mounted on the shaft **160**, between the rear cover plate **154** and a thrust washer **191**, confined by a C-ring **193** (FIG. 9).

As best seen in FIG. 3, the ribbon spool driven gears **161** and **162**, which are preferably molded out of a plastic material that is somewhat resilient, such as acetal or "DELRIN" resins, each has a resilient spool locking detent **194**, preferably of plastic, either force fit within a bore thereof (as shown) or molded therein or as a part thereof. Such a contoured, resilient detent advantageously provides a simple means for effecting a snap-on type of interlock between each spool driven gear and the particular ribbon spool mounted on the integral spindle portion thereof.

In order to effect positive rotation of the mounted ribbon spools with their respectively associated driven gears, a protruding drive pin **195** (only one seen in FIG. 3) is secured to and extends outwardly from the outer annular face of each of the driven gears **161** and **162**. These drive pins **195** are dimensioned so as to extend through an accommodating aperture formed in at least one adjacently positioned flange of each associated mounted ribbon spool. The spool-locking detents **194** are dimensioned and oriented such that only the drive pins **195** apply driving torque to the spools.

Referring now particularly to FIG. 4, it is seen that the teeth in the left side ribbon spool driven gear **162** (supporting the ribbon spool **166** shown on the right side in FIGS. 1 and 2) continuously enmesh the teeth in a rotatable pinion **197**, mounted on a stationary shaft **198** which, in turn, is suitably secured at opposite ends to the front and rear cover plates **152** and **154**, respectively. An intermediate gear **199** is also rotatably supported on the shaft **198**, and is secured to, or preferably formed to be integral with, the pinion **197**. A similar combination is mounted on a shaft **201**, namely, a pinion **202**, coupled to the spool driven gear **161**, and an intermediate gear **203**.

An input drive gear **205** (best seen in FIGS. 4-8) is rotatably mounted on a stationary shaft **209** which extends through an aperture in, and is secured to, a spacer plate **213** (FIG. 8). The spacer plate is rigidly secured by any suitable means, such as rivets (not shown) to the inner surface of the front cover plate **152**. One end of the shaft **209** has a head portion **209a** which is confined (but not secured) within an aperture **215** formed in the front cover plate **152**, while the other end extends through an oversized aperture **211** formed in the rear cover plate **154**. As best seen in FIGS. 3, 8, and 9, a driven pulley **221** is secured to a

shank portion 205a of, and preferably formed to be integral with, the input drive gear 205. Driving torque is supplied to the pulley 211 by a drive belt 224 (FIG. 1) which is entrained around pulley 221 and a driving pulley 227, the latter being secured to the end of the previously described drive shaft 24.

The spacer bracket 213, as best seen in FIGS. 8 and 9, has two additional stationary shafts 231 and 233 secured within apertures thereof, with these shafts also having integral head portions 231a and 233a (FIG. 8) that are confined within respectively aligned apertures 235 and 236 formed in the front cover plate 152. The other end of the shafts 231 and 233, in cantilever fashion, preferably abut against, but are not secured to the rear cover plate 154. The structure rotatably supported on shaft 233 will be described in detail hereinafter.

With particular reference still to FIG. 8, it is seen that the shafts 209 and 231 respectively extend through oversize apertures 241 and 242 formed in a pair of oscillatory gear support plates 243 and 245. These gear support plates are positioned in a common plane and, as identified in only FIGS. 5-7, are formed with selectively overlapping contoured edges 243a, b and 245a, b, as well as cam edges 243c and 245c. The gear support plates are dimensioned such that the front portion of one edge of one plate, such as 243b, may abut against the upper portion of the edge 245a of the other plate (as depicted in FIGS. 4 and 5), or vice versa (as depicted in FIG. 6). A spring 249, connected at opposite ends to upwardly extending ears 243d and 245d of the gear support plates 243 and 245, normally maintain the selective overlapping contoured edges in continuous spring-biased contact.

Gear support plate 243 also has a pair of stub shafts 251 and 253 secured within apertures thereof, with the shafts respectively having head portions 251a and 253a protruding outwardly from the back side of the support plate, as viewed in FIG. 8. Gear support plate 245 similarly is constructed with two identical stub shafts 255 and 257, having head portions 255a and 257a, respectively.

With particular reference still to FIG. 8, it is seen that the spacer plate 213 has a recessed portion formed in the left side thereof wherein a pair of semi-circular grooves 261a and 261b are formed. A similar recessed portion is formed in the right side of the spacer plate 213, wherein a pair of semi-circular grooves 263a and b are formed. The semi-circular groove 261a is dimensioned and positioned in the spacer plate 213 so as to provide a positive stop for the head portions 251a of the shaft 251 secured to the oscillatory gear support plate 243. Similarly, the semi-circular groove 263a provides a positive stop for the head portion of the shaft 255, secured to the oscillatory gear support plate 245. The semi-circular grooves 261b and 263b simply provide clearance for the respective head portions 253a and 257a of the shafts 253 and 255 when periodically moved into close proximity therewith.

Such stops advantageously limit the degree of oscillatory spring-bias movement imparted to the gear support plates 243 and 245. This, in turn, as will be described in detail hereinafter, limits the depth of gear teeth engagement between certain of the gears mounted thereon and other associated gears periodically coupled thereto.

With particular reference again to FIG. 4, it is seen that the stationary shafts 251 and 253 secured to the

oscillatory gear support plate 243 respectively and rotatably support continuously mating planetary gears 271 and 273. Gear 273 is also positioned so as to be continuously coupled to the input drive gear 205. Thus, as the oscillatory gear support plate 243 is rotated about its support shaft 209, which also supports the drive gear 203, the planetary gears 271 and 273 move in arcs of constant radii about the shaft 209. As such, the planetary gear 273 continuously remains intercoupled to both the input drive gear 205 and the planetary gear 271.

The planetary gear 271, however, is not always positioned to be in engagement with the previously described intermediate gear 199, as readily seen from a comparison of FIGS. 4-7. The point in time at which both the planetary gear 271 and the intermediate gear 199 become enmeshed, and the cause and effect of such coupling, will be described hereinbelow in connection with a description of a typical mode of operation of the ribbon spool drive mechanism.

The oscillatory gear support plate 245 (best seen in FIG. 8), an input drive gear 277 (the previously described shaft 231), and planetary gears 279 and 281 (rotatably mounted on the above described and respective shafts 255 and 257), all respectively correspond essentially identically to the gear support plate 243, and gears 205, 271, and 273 described hereinabove. The only structural difference between input drive gear 205 and drive gear 277 is that the latter is actually driven by the former and, thus, does not require a pulley-mounting shank portion (such as 205a depicted in FIGS. 8 and 9).

Positioned below the oscillatory gear support plates 243 and 245, as best seen in FIGS. 4-8, is an over-centering lever 291 and a reversing rack 293, both of which are rotatably mounted on the shaft 233, which extends through the spacer plate 213 as previously identified. The over-centering lever 291 has an upper lobe 291a which, as will become more apparent hereinafter, is alternately rotated in opposite directions by the periodic, alternate arcuate movements of the cam edges 243c and 245c of the oscillatory gear support plates 243 and 245, respectively.

As will also be discussed in greater detail hereinbelow, after the over-centering lever 291 passes through a vertically oriented position (not shown), the lever is spring-biased rapidly in the same direction as the movement previously imparted thereto by (gear support plate) cam-action. Such independent spring-biased movement of the lever is produced by an over-centering spring 295. This spring is frictionally anchored at one end to a stub shaft 297 secured to, or formed as an integral part of, the over-centering lever 291. The other end of the spring 295 is frictionally anchored to a centrally located stub shaft 299 secured to, or formed as an integral part of, the reversing rack 293.

The reversing rack 293, as previously mentioned, is rotatably supported on the shaft 233, and has two rack sections 293a and 293b (identified only in FIGS. 5-7) formed along upper edges thereof. As best seen by the sequence of views depicted in FIGS. 4-7, the rack sections 293a and b are alternately brought into engagement with the respectively associated planetary gears 273 and 281. And because these gears may move in arcs about the respective pivot points of their associated gear support plates 243 and 245, it is seen that

they not only can be selectively brought into engagement with, but roll along each associated rack section toward the interior end thereof. During the periods between ribbon reversals, the reversing rack 293 is positioned in an essentially horizontal position (such as in FIGS. 4 and 7), out of engagement with both planetary gears 273 and 281.

In order to maintain the reversing rack 293 in an essentially horizontal or disengaged position, two rotatable stops 302 and 304 (best seen in FIGS. 4-8), are respectively supported on stationary shafts 306 and 308. These shafts are each secured at opposite ends within aligned apertures in the front and rear cover plates 152 and 154. Considering in greater detail only stop 304 (as stop 302 is identical thereto), it is formed with three outwardly extending lobes designated 304a, b, and c, and is restricted to only the two angular positions depicted in FIGS. 4 and 7, or 5 and 6. As such, it is seen that the rotatable stop 304 may be selectively rotated to provide either a positive abutment (lobe 304a, FIG. 4) for an overlying lower edge extremity of the reversing rack 293, or no abutment therefor, as depicted in FIGS. 5 and 6.

Still referring to FIGS. 4-7, rotational movement of the stops 302 and 304 are controlled by the aforementioned ribbon sensing arms 185 and 187. As previously mentioned, these sensing arms are pivotally supported near their lower ends on the shafts 158 and 160, respectively. With particular reference now to only sensing arm 185 (as arm 187 is identical thereto), there is formed at the lower extremity thereof a substantially rectangular cut-out 185a which is dimensioned to accommodate the lobe 304b of the stop 304, and allow angular movement therebetween. A spring 311, connected between the lobe 304c of the rotatable stop and an extended arm portion 185c of the sensing arm 185, maintains the arm and stop continuously spring-biased in clockwise and counter-clockwise directions, respectively.

Again with reference only to sensing arm 185, and as best seen in FIGS. 4 and 8, a slot guide portion 185c extends in a direction perpendicular to the major axis of the sensing arm, and is formed as an integral part thereof. This slot guide portion 185c has a narrow slit formed therein (best seen in FIGS. 1 and 8) of sufficient width to allow the ribbon 40 to pass therethrough with minimal frictional contact, but still narrow enough to block an eyelet 321 (or some other protuberance) purposely secured to the ribbon near both ends thereof. As such, any obstruction moving toward the slot guide portion 185c of the sensing arm 185 from the underside will cause the sensing arm, as viewed in FIG. 4, to rotate slightly in the counter-clockwise direction (in opposition to the spring force applied thereagainst), to the position shown in phantom. The limits of such rotational displacement is determined by the spacing between the mutually disposed edges of a rectangular cut-out 152a formed in the front cover plate 152 (best seen in FIG. 8), through which the sensing arm slot guide portion 185c outwardly extends.

As will be described in greater detail hereinbelow, such counter-clockwise rotational movement of the sensing arm 185 is sufficient to, in turn, rotate the associated stop 304 clockwise, as viewed from the position depicted in FIG. 4, for example, to the position depicted in FIG. 5. The sensing arm 185 will stay in the latter position until such time that the reversing rack

293 is rotated counter-clockwise to the position depicted in FIG. 7. With the reversing rack 293 at this time no longer being in a position to prevent counter-clockwise rotation of the stop 304, the spring 311 will subsequently cause the stop to rotate counter-clockwise, and the sensing arm to rotate clockwise, so that they again acquire the former positions depicted in FIG. 4. This will happen, of course, only after the ribbon starts to travel in the opposite direction so as to displace the eyelet 321 from the underside of the slot guide portion 185c of the sensing arm 185.

It is such rotational movements of the stops 302 and 304, in opposite directions, that allows the lever 291, and the associated reversing rack 293, to periodically rotate about shaft 233, in opposite directions, so as to initiate the necessary gear coupling changes to effect alternate ribbon reversal. As the structure associated with sensing arm 187 is identical to that described above in connection with sensing arm 185, a correspondingly numbered, but primed, biasing spring 311' and a front cover plate cut-out 152a' are identified with arm 187.

Considering now in greater detail the two upper ribbon guide rollers 172' depicted generally in FIGS. 1 and 2, they each comprise, as depicted in detail in FIGS. 10 and 11, a uniquely shaped supporting arbor 315, which has mutually disposed and inwardly tapered shank portions 315a and b, which merge into a uniform, cylindrical central portion 315c. An outer sleeve 318 is concentrically mounted on and rotatable relative to the arbor 315. The sleeve has an oversized axial bore extending therethrough, formed with mutually disposed and outwardly extending tapered end portions 318a and b which merge at their innermost adjacent ends into a uniform, cylindrical central portion 318c.

The primary advantage of guide rollers 172', particularly at the locations identified in FIG. 1, is that they have been found to facilitate maintaining the ribbon 40 in continuous tracking alignment, particularly around each adjacent pair of guide rollers disposed on either side of a 90° twist in the ribbon. More specifically, such a ribbon twist has a tendency to cause the ribbon to shift toward the raised shoulder of a conventional guide roller preceding the twist, on the side thereof defined by the angular direction of the twist, as viewed in the direction of ribbon travel. This tendency of the ribbon to continuously shift laterally on a conventional guide roller can cause the edge of the ribbon to become frayed with use, and sometimes even result in the ribbon riding over the shoulder of the drive roller in question.

FIGS. 10 and 11 respectively illustrate how a typical ribbon 40 passes over a guide roller 172' under conditions when there is no twist imparted to the ribbon thereafter, and when there is, and the compensating effect produced by the specially constructed guide rollers embodying features of the present invention. As depicted first in FIG. 10, it is seen that when the ribbon 40 has no subsequent twist imparted thereto, and with it being assumed that each adjacent pair of guide rollers are accurately aligned, the ribbon will tend to travel along the central region of the guide roller 172' (as well as all other guide rollers) equidistant with respect to the shoulders of the sleeve 318.

However, consider now a twist, such as 90° counter-clockwise, formed in the ribbon 40, such as is involved in the ribbon passing over the upper left guide

roller 172' and around the aligned forward left roller 170, as depicted in FIG. 1. This would normally, with a conventional guide roller, cause the ribbon to be firmly biased against, and possibly ride over, the left shoulder of the guide roller, as viewed in the direction of ribbon travel in FIG. 12, as a result of a twist force F_{TWIST} .

In accordance with the compensating nature of the rollers 172', however, any transverse twist force (designated F_{TWIST} in FIG. 12), causes the sleeve 318 to be shifted, or to effectively "float" to the right side, as viewed in FIG. 11, or in the direction designated F_{TWIST} in FIG. 12. This results in the axis of the sleeve becoming slightly canted relative to the arbor. The degree of relative lateral displacement between the arbor 315 and the sleeve 318 (within the limits defined primarily by the length of the arbor) is dependent essentially on the magnitude of the ribbon twist force F_{TWIST} . With such guide roller produced twist-force-compensation in the illustrative example, the ribbon 40 does not have a tendency to ride up and over the shoulder 318', for the direction of ribbon travel depicted in FIG. 12, or to be firmly biased against the inner wall of that shoulder so as to cause wear and possible fraying of the left edge of the ribbon with extended use. The possible, undesired resultant forces designated F' and F'' in FIG. 12 are representative of those forces that could exist with a twisted ribbon and no guide roller compensation, and unintended guide roller compensation (i.e., non-ribbon forced sleeve displacement) with no ribbon twist, respectively, for the direction of ribbon travel noted. The net result of having a ribbon twist and guide roller compensation of the type realized with rollers 172' is an effective, desired, driving ribbon force designated $F_{RESULTANT DRIVE}$. It should be appreciated that a compensating guide roller 172' could be employed on either side of each ribbon twist with equal effectiveness, or employed on both sides if desired. Such compensating guide rollers are also advantageous in insuring accurate ribbon alignment (or tracking) along any circuitous path, even when there are no ribbon twists.

OPERATION OF THE RIBBON DRIVE MECHANISM

As previously mentioned, the impact printer 10 is adapted to function as a line-at-a-time printer, i.e., a plurality of characters simultaneously may be printed transversely of the path of web movement during each dwell period thereof. A detailed description will not be given herein with respect to the mode of operation of the character printing mechanism itself, which includes the electromagnets 126, associated armatures 124, impellers 84, interponents 92, hammers 86 and the character die carrying pallets 18 (all briefly described hereinabove), as such details form no part of the present invention, nor aid in understanding the features and mode of operation of the ribbon spool drive mechanism 150, which is of particular concern as embodied herein. For details of the character generating printer apparatus per se, reference is again made to the aforementioned copending Babler and Huntoon-Kearney applications, the disclosures of which are all incorporated by reference herein.

With respect then to the operation of the ribbon spool drive mechanism 150 in particular, and with reference first to FIGS. 1, 3, and 4, it is seen that the input drive gear 205 is continuously driven in a counter-

clockwise direction (FIG. 4), by means of the belt 224 and pulleys 221 and 227 (FIGS. 1 and 3). Such continuous rotational movement of the input drive gear 205, in turn, continuously drives the associated and permanently enmeshed planetary gears 271 and 273, mounted on the oscillatory gear support plate 243, as well as the associated drive gear 277. The latter drive gear, of course, is similarly continuously coupled to the two associated planetary gears 279 and 281.

With all of the piece parts and gears of the drive mechanisms initially being in the position depicted in FIG. 4, it is further seen that the planetary gear 271 is then also urged into engagement with the intermediate gear 199, by means of both the coil spring 249 and the over-centering spring 295. With it being assumed initially, as represented in FIG. 4, that torque is applied to the spool driven gear 162 in a counter-clockwise direction, then ribbon 40 will move from the left (pay-out) ribbon supply spool 164 to the right (take-up) ribbon spool 166, as viewed in FIGS. 1 and 2, with the latter spool being driven clockwise by the drive pin 193 (FIG. 3). Under such initial operating conditions, the sensing arms 185 and 187 will be in the positions shown in solid line form in FIG. 4. Upon the slot guide portion 185c of the sensing arm 185 sensing an obstruction, such as an eyelet 321 (FIG. 4, typically secured to conventional ribbons near the ends thereof), the sensing arm 185 is rotated slightly counter-clockwise to the position shown in phantom. As previously mentioned, the extent of angular rotation of the sensing arm 185 is determined by the dimensions of an accommodating slot 152a (see FIG. 8) formed in the side edge of the front cover plate 152. A similar slot identified by the numeral 152a' is associated with the sensing arm 187.

Upon the sensing arm 185 being rotated to the position shown in phantom in FIG. 4 (e.g., by an eyelet 321), this, in turn, causes the coupled stop 304 to rotate clockwise to the position depicted in FIG. 5. Such movement of the stop 304 allows the reversing rack 293 to rotate slightly clockwise about its support shaft 233, in response to the rotational force then exerted thereagainst by the over-centering spring 295. As a result, the reversing rack section 293a is brought into engagement with the planetary gear 273, as depicted in FIG. 5.

As the planetary gear 273 rolls inwardly along the rack portion 293a, from the position shown in FIG. 5 to that shown in FIG. 6, the oscillatory gear support plate 243, on which the planetary gear 273 is rotatably supported, is caused to rotate counter-clockwise about its support shaft 233, in opposition to the clockwise rotational force then exerted thereagainst by the coil spring 249. This, of course, disengages the planetary gear 271 from the intermediate gear 199, thus, removing driving power from the ribbon spool driven gear 162 (FIGS. 1 and 2). Also, as a result of the counter-clockwise rotational movement of the gear support plate 243 (as viewed in FIGS. 4 and 5), a point is finally reached whereat the upper forward portion of the edge 245b (identified only in FIGS. 5-7) of the oscillatory gear support plate 245 is rapidly rotated (by spring 249) counter-clockwise into the mating arcuate edge 243a of the gear support plate 243 (as best seen from a comparison of FIGS. 5 and 6). This results in the planetary gear 279, supported on the gear support plate 245, being brought into engagement with the associated intermediate gear 203. As such, drive power is

coupled to the spool driven gear 161, through the intermediate pinion 203 and, hence, effects ribbon reversal, with the ribbon spool 164 (as viewed in FIGS. 1 and 2) now being the take-up spool.

It should also be appreciated that as the planetary gear 273 advances along the reversing rack section 293a toward the inner end thereof (from the position in FIG. 5 to that of FIG. 6), the cam surface 243c of the oscillatory gear support plate 243 moves the lobe portion 291a of the over-centering lever 291 in a clockwise direction until the two stub shafts 297 (on the over-centering lever 291) and 299 (on the reversing rack 293) are essentially vertically aligned. At that point, the over-centering spring 295 performs two important functions:

First, spring 295 rapidly rotationally displaces the reversing rack 293 counter-clockwise by an amount sufficient to cause the left extremity thereof to abut against the lobe 302a of the stop 302 (as seen from a comparison of FIGS. 6 and 7). Such movement of the reversing rack 293 disengages the latter from the planetary gear 273.

A second function of the over-centering spring 295, upon passing through a vertically oriented position (such as in the direction of the arrow depicted in FIG. 6), is to rapidly effect rotation of the over-centering lever 291 to the inclined position depicted in FIG. 7. This latter increment of lever displacement, it should be appreciated, is effected independently of the previous camming action produced by the rotational movement of the oscillatory gear support plate 243.

With the lobe 291a of the over-centering lever 291 spring-biased against the cam edge 245c of the cam support plate 243, as depicted in FIG. 7, it is seen that the over-centering spring 295 actually augments the spring-biased force exerted on the gear support plate 245 by the coil spring 249, but after the planetary gear 279 has been brought into engagement with the associated intermediate gear 203. Springs 249 and 295 thus effectively provide a two-stage type of spring-biased engagement of the planetary gears 271 and 279 with their respectively associated intermediate gears 199 and 203.

After the ribbon spool 164 approaches a fully wound ribbon condition, with all parts and gears of the drive mechanism in the relative positions depicted in FIG. 7, the sensing arm 187 will encounter an eyelet 321 (or some other obstruction) that will cause it to rotate slightly clockwise. This, in turn, effects the counter-clockwise rotation of the associated stop 302 so as to release the reversing rack 293 for spring-biased rotation in a counter-clockwise direction. Such rotation of the reversing rack 293 results in the planetary gear 281 being brought into the same coupled relationship with the rack section 293b, as was the planetary gear 273 with respect to the rack section 293a, as depicted in FIG. 5. This constitutes the initial operating state of the drive mechanism immediately preceding another ribbon reversal, at which time the spool 166 again becomes the take-up spool.

Considering the latest described impending ribbon reversal in greater detail, as the planetary gear 281 rolls along the reversing rack section 293b, toward the interior and thereof, this causes the associated oscillatory gear support plate 245 to rotate clockwise, in opposition to the spring-bias applied thereagainst by the coil spring 249. This produces the following results: First,

the planetary gear 279, by moving in an arc out of engagement with its associated intermediate gear 203, gradually removes driving power from the spool driven gear 161.

Secondly, the upper forward edge 245b of the gear support plate 245 is rotated clockwise out of spring-bias contact with the then mating edge 243a of the gear support plate 243. A point is finally reached whereat the shoulder portion 243c is free to abruptly recede into mating contact with the shoulder portion 245a of the gear support plate 245. This, of course, results in the gear support plate 243 being rapidly rotated clockwise, under the bias of the spring 249, so as to cause the planetary gear 271 to be brought into coupling engagement with the intermediate gear 199. Thus, driving power is again coupled to the ribbon spool 166 and, hence, effects a reversal in ribbon travel.

Thirdly, the clockwise rotation of the gear support plate 245 also results in the cam edge 245c thereof camming the lobe 291a of the over-centering lever 291 in a counter-clockwise direction until the lever acquires a vertical position. At that time, the over-centering spring 295 abruptly snaps the associated lever 291 against the cam edge 243c of the gear support plate 243, as depicted in FIG. 4. While in that position, the spring 295 not only augments the spring bias exerted on the gear support plate 243 by the coil spring 249, but also biases the reversing rack 293 clockwise to a position out of engagement with the planetary gear 281. From that point in time until the next ribbon reversal, not only the reversing rack 293, but the over-centering lever 291, oscillatory gear support plates 243 and 245, rotatable stops 302 and 304, and the sensing arms 185 and 187 all remain in the positions depicted in FIG. 4, with ribbon travel from spool 166 to spool 164.

During the time that each ribbon spool 164, 166 is not being directly driven to function as the take-up spool, frictional drag is applied thereto so as to continuously maintain the ribbon 40 under tension. This drag is produced by the spring washers 181 (only one seen on the shaft 158 in FIGS. 3 and 8), which exert frictional forces between not only the friction discs 180 and the inner annular surfaces of the respectively associated gears 161, 162, but between the exterior spindle ends of the latter and the respectively associated thrust washers 176, 191. As such, the ribbon 40 is readily maintained under tension at all times and, particularly, during the period of time required to effect ribbon reversal.

From the foregoing operating description of the unique ribbon spool drive mechanism 150 embodied herein, it can be readily appreciated that the planetary gears 271 and 279 are moved along arcuate paths into engagement with their respectively associated intermediate gears 199 and 203, and maintained in coupling engagement through the application of two sequentially applied spring-bias forces. More specifically, the first biasing force is established by the coil spring 249, followed by the augmenting biasing force established by the over-centering spring 295. This type of periodic gear engagement facilitates not only initial mating gear teeth alignment, but the positive coupling thereof with minimum wear of the periodically enmeshed gear teeth.

In addition, the arcuate path of travel of the planetary gears 271 and 279 results in their engagement and

disengagement from the respectively associated intermediate gears 199 and 203 in a manner that provides a smooth transitional reversal of ribbon travel. As previously briefly mentioned, the semi-circular openings 261a, and 263a, formed in the spacer plate 213 (see FIG. 8), are actually employed in the preferred embodiment as stops for the respective head portions 251a, and 255a of the correspondingly numbered shafts secured to the oscillatory gear support plates 243 and 245. In this manner, the springs 249 and 295 may rotationally spring-bias the planetary gears 271 and 279 selectively into engagement with their respectively associated intermediate gears 199 and 203, but in a manner that does not result in forced tip-to-root intermeshing of the gear teeth, which could otherwise increase the wear thereof.

In summary, a unique spool ribbon driving, reversing and tensioning mechanism 150 has been described and is claimed herein that is of simple, reliable, and compact construction, and which allows the mounting thereof on the front side of an impact printer so as to facilitate spool and/or ribbon replacement. Equally important, of course, is the fact that the ribbon spool drive mechanism embodied herein minimizes wear of the moving parts, particularly the selectively coupled gear train combinations, and is jam-proof.

With respect to the latter feature, it should be noted that the mechanism will reverse ribbon travel at any time the underside of either of the sensing arm guide slot portions 185a or 187a senses an obstruction on the ribbon 40, whether intended or not, and regardless of where it occurs along the ribbon. It should also be appreciated that a reversing cycle, once initiated by the unlatching of a lightly loaded sensing lever (185 or 187) in the present invention, is irreversible. More specifically, the reversing cycle is always completed, once initiated, without regard to continued ribbon motion. This is made possible, of course, by the uniquely intercoupled and spring-biased reversing rack 293 and over-centering lever 291, together with the spring-biased oscillatory gear support plates 243, 245.

A basic failing of certain prior reversing mechanisms is that they have been dependent upon ribbon travel itself to drivingly force the establishment of some type of spring-biased over-centering condition in the drive mechanism. Such a mode of operation not only greatly increases the possibility of a jamming condition (i.e., where both spools are driving or neither spool is driving), but it necessarily places an unnecessary, and often detrimental, load on the ribbon eyelet after having been initially sensed. This, of course, substantially increases the possibility, particularly with time, that the eyelet on occasion may be actually torn from the ribbon, which would then most certainly result in a serious "jam" condition in many prior art ribbon reversal mechanisms of the type in question.

With respect to the present mechanism, it should also be appreciated that if the ribbon 40 ever became snagged at some point intermediate the two ribbon spools, or should either ribbon spool at some time be prevented from rotating due to an obstruction, for example, the particular pair of planetary gears (271, 273, or 279, 281) then coupled to the associated spool driven gear (through the associated intermediate gear) would attempt to rotate about their associated input driving gear (205 or 277) so as to become disengaged from the associated intermediate gear. Such planetary

gear movement, of course, would be in opposition to the forces exerted by both springs 249 and 295.

Whether the intercoupled planetary gears in question would completely disengage from their associated intermediate gear or not would depend primarily on the particular spring forces exhibited by the springs chosen for use in the drive mechanism. In any event, however, the attempt of either pair of planetary gears to become disengaged from its associated intermediate gear, because of an unintended ribbon or ribbon spool obstruction, would cause a disengaging gear teeth-generated type of clattering sound that would provide an audible warning to an operator, without damaging the partially mating gears.

It should also be understood that while a preferred embodiment of the present invention has been described in detail herein, it will be obvious that various modifications may be made and alternatives provided without departing from the spirit and scope of the present invention. For example, the rollers 170 on the left side of the printer, as depicted in FIG. 1, as previously mentioned, are positioned at a lower horizontal elevation than the rollers 170 on the right side. This is done, of course, so that the ribbon will pass in front of the aligned array of pallets 18 at a slight angle, so as to insure character die impacting across the entire width of the ribbon. Such inclined ribbon travel has a further benefit in that it readily permits only the right side guide rollers 170, for example, to be mounted on vertically displaceable shafts (actuated by any suitable means, not shown) so as to allow the entire section of the ribbon adjacent the web to be sufficiently lowered periodically to allow visual observation of a printed line. Such ribbon displacement apparatus would be far more simple and inexpensive than previously employed mechanisms for that purpose, typically requiring intercoupled structure mounted on both sides of a printer so as to raise (or lower) the entire section of the ribbon adjacent the web.

What is claimed is:

1. A compact, reversible ribbon spool drive mechanism adapted for use with a high-speed impact printer, comprising:

first and second continuously driven input drive gear trains, each train being mounted for independent oscillatory movement about the axis of one of said gears thereof, while remaining in continuous gear-coupled relationship with the other drive gear train;

first and second selectively driven gear trains, each including a different gear-associated spindle for supporting and selectively rotatably driving a ribbon spool in a direction opposite to that of the other spindle;

operable reversing means adapted to sense an obstruction carried on a moving ribbon and, in response to each sensed obstruction, rotating said first and second oscillatory mounted drive gear trains in predetermined arcuate directions to couple the previously uncoupled one of said first and second input drive gear trains to a respectively associated one of said first and second driven gear trains, so as to provide positive driving torque alternately, and in opposite angular directions, to said ribbon spool driving spindles thereof, said reversing means including an oscillatory reversing rack mounted for rotation, said reversing rack being al-

ternately rotated in opposite directions into coupling engagement with said first and second continuously driven input drive gear trains respectively, each such coupled drive gear train thereafter moving along said rack in a direction so as to become disengaged from the associated one of said first and second driven gear trains; and

biasing means for alternately rotating said reversing rack in opposite directions.

2. A ribbon spool drive mechanism in accordance with claim 1 wherein said biasing means includes:

an over-centering lever, mounted on a shaft in common with said reversing rack, and

an over-centering spring connected at one end to said over-centering lever and at the other end to said reversing rack for establishing oppositely directed, and reversibly controlled, rotational forces thereagainst, said forces urging said reversing rack alternately into engagement with the respectively associated first and second drive gear trains, said engagement being in response to controlled pivotal movement of said over-centering lever alternately in opposite directions by an amount, relative to said reversing rack, so as to cause said over-centering spring to pass through a balanced center line condition, whereupon it abruptly reverses the opposed rotational spring-biased forces previously applied to said over-centering lever and reversing rack, and

biasing means for alternately pivoting said over-centering lever in opposite directions.

3. A ribbon spool drive mechanism in accordance with claim 1 wherein said reversing rack includes first and second mutually disposed teeth-forming rack sections formed therein, and wherein said first and second drive gear trains are respectively rotatably supported on first and second rotatably mounted oscillatory gear support plates positioned in a common plane and having contoured adjacent mating edges that allow selective overlapping thereof, one with the other, wherein each of said first and second drive gear trains include:

a separate pair of continuously coupled planetary gears rotatably mounted on each of said gear support plates, each pair of said planetary gears being positioned so as to move in an arc when brought into engagement with a particular one of said first and second rack sections respectively associated therewith, and to thereby rotate said associated support plate in a direction so as to reverse the overlapping relationship between said gear support plates and cause a change in the coupling of said first and second planetary gears with the respectively associated first and second driven gear trains; and

biasing means for continuously urging said first and second gear support plates against each other along the contoured mating and selectively overlapped edges thereof, and for maintaining each alternately coupled pair of planetary gears in engagement with the particular one of said first and second driven gear trains associated therewith until the next succeeding ribbon obstruction is sensed.

4. A ribbon spool drive mechanism in accordance with claim 2 wherein said reversing means further includes:

first and second rotatable stop means, and

first and second pivotal sensing arms operably coupled respectively to said first and second rotatable stop means, said stop means being positioned relative to said reversing rack so as to selectively and respectively prevent angular rotation of said reversing rack in opposite angular directions, each of said sensing arms having a ribbon guide slot formed therein and being operable, in response to an obstruction sensed on a ribbon while the latter is drawn through said guide slot in a given direction, to angularly displace both the sensing arm and the one of said first and second rotatable stop means associated therewith, the rotation of said stop means in a given direction being sufficient to allow the reversing rack to be rotated, at least in part by the force exerted thereagainst by said over-centering spring, in a direction and to a position whereby the rack section associated with the one of said first and second drive gear trains then providing torque to its associated driven gear train disengages the former from the latter train, while simultaneously allowing the previously disengaged one of said first and second drive gear trains to be brought into engagement with its associated driven gear train so as to provide positive driving torque to the ribbon spool driven spindle associated therewith in a direction opposite to that imparted to the previously driven spindle, whereafter said over-centering spring biases said reversing rack out of engagement with the particular drive gear train previously coupled thereto.

5. A ribbon spool drive mechanism in accordance with claim 3 wherein said operable reversing means further includes:

an over-centering lever, rotatably mounted with said reversing rack,

an over-centering spring connected at one end to said over-centering lever and at the other end to said reversing rack for establishing oppositely directed, and reversibly controlled, rotational forces thereagainst, said forces urging the rack sections of the latter alternately into engagement with the respectively associated first and second drive gear trains, said engagement being in response to controlled cam-initiated pivotal movement of said over-centering lever alternately in opposite directions by an amount, relative to said reversing rack, so as to cause said over-centering spring to pass through a centerline force-balanced condition whereupon it abruptly reverses the opposed rotational spring-biased forces previously applied to said over-centering lever and reversing rack, said cam-initiated movement of said lever selectively in opposite directions being produced by the contoured edges of said respective gear support plates when the latter are drivingly rotated alternately in opposite directions, and

first and second pivotal ribbon obstruction sensing means, each including a ribbon guide slot, for respectively and alternately sensing movement in opposite directions of at least one obstruction secured to a ribbon while said ribbon is drawn through said guide slots, each of said sensing means, in response to a sensed obstruction, releasing said reversing rack for rotational movement in the proper direction to effect a reversal in ribbon travel.

6. A ribbon spool drive mechanism in accordance with claim 5 wherein said first and second drive gear trains further respectively include:

first and second input drive gears, each rotatably mounted on an axis in common with an associated one of said first and second gear support plates, and being spaced apart so as to be in continuous coupling engagement with each other, and each with one of the gears of said first and second pairs of planetary gears respectively associated therewith, and wherein each pair of said planetary gears are alternately maintained in spring-biased coupling engagement with the respectively associated first and second driven gear trains by the forces produced by both said over-centering spring, through said over-centering lever, and by said biasing means in rotatably urging said first and second gear support plates against each other along the contoured mating edges thereof, and wherein said drive mechanism further includes:

means for maintaining the ribbon spool driven gear-associated spindle of each of said first and second driven gear trains under continuous frictional drag so as to maintain a ribbon passing from one spool to the other under continuous tension.

7. In a high-speed impact printer wherein a ribbon is continuously drawn alternately in opposite directions along and between an aligned array of character printing dies and a web to be printed on, the improvement comprising:

a ribbon spool drive mechanism, said mechanism including:

first and second power driven drive gear trains, each train being mounted for independent oscillatory movement about the axis of one of said gears thereof, while remaining in continuous gear-coupled relationship with the other of said drive gear trains;

first and second driven gear trains, each including a gear associated spindle for mounting and rotatably driving a ribbon spool in a direction opposite to that of the other spindle;

operable reversing means adapted to sense an obstruction secured to a moving ribbon and, in response to each sensed obstruction, rotating said first and second oscillatory mounted drive gear trains in predetermined directions so as to alternate the coupling between said first and second drive gear trains and said associated first and second driven gear trains so as to provide positive driving torque alternately, and in opposite angular directions, to said respectively associated ribbon spool driving spindles, said reversing means including:

a rotatably mounted reversing rack positioned so as to be alternately rotated in opposite angular directions into engagement with the particular one of said first and second drive gear trains then coupled to an associated driven gear train, and to thereby disengage the former from the latter train;

operably controlled biasing means for alternately urging said reversing rack in opposite angular directions into engagement with said first and second drive gear trains, and for urging during that period of time the particular one of said drive gear trains not coupled to said reversing rack into engagement with its associated driven gear; and

ribbon obstruction sensing and control means, responsive to each obstruction sensed on a moving ribbon while the latter alternately travels in opposite directions, for releasing said reversing rack for rotation in the proper direction, under the control of said biasing means, then actuated, so as to initiate said reversal in ribbon travel.

8. In a high-speed impact printer in accordance with claim 7, said ribbon spool drive mechanism further comprising:

a plurality of guide rollers for directing a ribbon along a circuitous path, including one intermediate region of linear travel adjacent an array of character dies, in passing from one spool to the other, and wherein at least one of said guide rollers is a compensating roller comprising:

a spool supporting arbor having mutually disposed and inwardly tapered shank portions which merge into a uniform, cylindrical central portion, and an outer sleeve concentrically mounted on and rotatable relative to said arbor, said sleeve having raised end shoulders and an oversized axial bore extending therethrough, said bore being formed with mutually disposed and outwardly extending tapered end portions which merge at their innermost adjacent ends into a uniform, cylindrical central portion, said sleeve being dimensioned so as to be laterally displaceable on said arbor and, thereby, capable of acquiring a slightly canted position relative to the axis of said arbor in response to, and by an amount necessary to compensate for, any transverse ribbon twist forces that tend to displace said sleeve laterally relative to said arbor.

9. In a high-speed impact printer in accordance with claim 7, said operably controlled biasing means including:

a pivotal over-centering lever, and an over-centering spring, said spring being connected at one end to said reversing rack and at the other end to said over-centering lever, alternate pivotal movement of said lever, relative to said reversing rack, in opposite directions, causing said over-centering spring to pass through a balanced center-line condition after which it abruptly reverses the opposed rotational spring-biased forces previously exerted against said lever and reversing rack, each of said spring-biased reversals causing said reversing rack, after having been initially coupled to one of said first and second drive gear trains, to thereafter be rotated in a direction out of engagement therewith, and causing said over-centering lever, to thereafter, at least in part, bias the previously disengaged one of said first and second drive gear trains into coupling engagement with the driven gear train associated therewith so as to provide driving torque to the previously undriven ribbon spool supporting spindle.

10. In a high-speed impact printer in accordance with claim 9, said ribbon obstruction sensing means further including:

first and second rotatable stop means, and first and second pivotal sensing arms operably coupled to said first and second rotatable stop means, said stop means being positioned relative to said reversing rack so as to selectively and respectively prevent angular rotation of said reversing rack in opposite angular directions, each of said sensing

arms having a ribbon guide slot formed therein and being operable, in response to an obstruction sensed on a ribbon while the latter is drawn through said guide slot in a given direction, to angularly displace both the sensing arm and the one of said first and second rotatable stop means associated therewith, the rotation of said stop means in a given direction being sufficient to allow the reversing rack to be rotated under spring-bias in a direction and to a position whereby the rack engages the one of said first and second drive gear trains then providing torque to its associated driven gear train so as to disengage the former from the latter train, while simultaneously allowing the previously disengaged one of said first and second drive gear trains to be brought into engagement with its associated driven gear train so as to provide positive driving torque to the ribbon spool driving spindle associated therewith in a direction opposite to that imparted to the previously driven spindle, whereafter said over-centering spring biases said reversing rack out of engagement with the particular drive gear train previously coupled thereto.

11. In a high-speed impact printer in accordance with claim 9, said ribbon spool drive mechanism further including:

first and second rotatably mounted oscillatory gear support plates positioned in a common plane and having contoured adjacent mating edges that allow selective overlapping thereof, one with the other, and wherein each of said first and second drive gear trains includes:

a separate pair of continuously coupled planetary gears rotatably mounted on each of said gear support plates, each pair of said planetary gears being positioned so as to move in an arc when brought into engagement with said reversing rack, and to thereby rotate said associated support plate in a direction so as to reverse the overlapping relationship between said gear support plates and cause a change in the coupling of said first and second planetary gears with the respectively associated first and second driven gear trains, and

biasing means for continuously urging said first and second gear support plates against each other along the contoured mating and selectively overlapped edges thereof, and for maintaining each alternately coupled pair of planetary gears in engagement with the particular one of said first and second driven gear trains associated therewith until the next succeeding ribbon obstruction is sensed.

12. In a high-speed impact printer in accordance with claim 11, said alternate pivotal movement of said over-centering lever in opposite directions is produced by a camming region of the contoured edge of each of the gear support plates when drivingly rotated by the particular pair of planetary gears mounted thereon when brought into engagement with said reversing rack, and said spool ribbon drive mechanism further comprising:

means for maintaining the ribbon spool driven gear-associated spindle of each of said first and second drive gear trains under continuous spring-biased frictional drag so as to maintain a ribbon passing from one spool to the other under continuous tension.

13. In a high-speed impact printer in accordance with claim 12, said ribbon obstruction sensing and control means further including:

first and second rotatable stop means positioned relative to said reversing rack so as to selectively and respectively prevent rotation of said rack in opposite angular directions, and

first and second pivotal sensing arms, each including a ribbon guide slot, operably coupled respectively to said first and second rotatable stop means, each of said sensing arms, upon sensing a ribbon obstruction moving in a given direction, rotating the associated one of said stop means to release said reversing rack for rotation in the proper direction so as to initiate a reversal in ribbon travel.

14. In a high-speed impact printer in accordance with claim 9, said ribbon spool drive mechanism further comprising:

a plurality of guide rollers for imparting a predetermined twist to a ribbon on either side of one intermediate region of travel thereof in passing from one spool to the other, and wherein at least one of the guide rollers respectively positioned on either side of each ribbon twist is a compensating roller comprising:

a spool supporting arbor having mutually disposed and inwardly tapered shank portions which merge into a uniform cylindrical central portion, and

an outer sleeve concentrically mounted on and rotatable relative to said arbor, said sleeve having raised end shoulders and an oversized axial bore extending therethrough, said bore being formed with mutually disposed and outwardly extending tapered end portions which merge at their innermost adjacent ends into a uniform, cylindrical central portion, said sleeve being dimensioned so as to be laterally displaceable on said arbor and, thereby, capable of acquiring a slightly canted position relative to the axis of said arbor in response to, and by an amount necessary to compensate for, any transverse ribbon twist forces that tend to displace said sleeve laterally relative to said arbor.

15. In a high-speed impact printer in accordance with claim 14, said ribbon spool drive mechanism further comprising:

four ribbon guide rollers having their respective axes disposed essentially horizontally, and four guide rollers having their respective axes disposed essentially vertically so as to define a circuitous path of travel for the ribbon between two ribbon spools, with the ribbon having a twist, in opposite directions, imparted thereto on either side of said one region wherein the ribbon is oriented in a vertical plane so as to travel along one linear section of said one region parallel to and oriented broadside of an array of character printing dies and a web, and wherein at least one of said guide rollers respectively positioned on either side of each ribbon twist comprises a compensating guide roller.

16. In a high-speed impact printer wherein a ribbon is continuously drawn alternately in opposite directions along and between an aligned array of character printing dies and a web to be printed on, the improved combination comprising:

a ribbon spool drive mechanism including:

first and second mating input drive gears rotatably mounted on respective fixed axes shafts;

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first and second pairs of planetary gears respectively coupled continuously to and mounted both for rotation with and planetary movement about said first and second drive gears,
 first and second intermediate gears rotatably 5
 mounted on respective fixed axes shafts,
 first and second pinions secured to said first and second intermediate gears, respectively,
 first and second rotatably mounted ribbon spool driven gears continuously coupled to said first and second pinions, respectively, and each including a 10
 spindle associated therewith to support and selectively drive a ribbon spool when mounted thereon,

ribbon obstruction sensing means, and 15
 operable ribbon reversing means, responsive to a sensed ribbon obstruction, for alternating the coupling between said first and second pairs of planetary gears and said associated first and second intermediate gears so as to provide positive driving 20
 torque alternately, and in opposite angular directions, to said respectively associated spindles.

17. In a high-speed impact printer in accordance with claim 16, said operable reversing means further comprising: 25

a rotatable reversing rack having mutually disposed first and second teeth-forming rack sections,
 an over-centering lever rotatably mounted on a shaft in common with said reversing rack, and
 an over-centering spring connected at one end to said 30
 over-centering lever and at the other end to said reversing rack for establishing oppositely directed, and reversibly controlled, rotational forces thereagainst, said forces urging the rack sections of the latter alternately into engagement with a different 35
 associated one of said first and second pairs of planetary gears, said engagement being in response to controlled pivotal movement of said over-centering lever alternately in opposite directions by an amount, relative to said reversing rack, so as to 40
 cause said over-centering spring to pass through a balanced center-line condition, whereupon it

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abruptly reverses the opposed rotational spring-biased forces previously applied to said over-centering lever and reversing rack, and
 biasing means for alternately pivoting said over-centering lever in opposite directions.

18. In a high-speed impact printer in accordance with claim 17, said ribbon obstruction sensing means including:

first and second rotatable stop means, and
 first and second pivotal sensing arms operably coupled respectively to said first and second rotatable stop means, said stop means being positioned relative to said reversing rack so as to selectively and respectively prevent angular rotation of said reversing rack in opposite angular directions, each of said sensing arms having a ribbon guide slot formed therein and being operable, in response to an obstruction sensed on a ribbon while the latter is drawn through said guide slot in a given direction, to angularly displace both the sensing arm and the one of said first and second rotatable stop means associated therewith, the rotation of said stop means in a given direction being sufficient to allow the reversing rack to be rotated, at least in part by the force exerted thereagainst by said over-centering spring, in a direction and to a position whereby the rack section associated with the one of said first and second pairs of planetary gears then providing torque to its associated intermediate gear disengages the former from the latter, while simultaneously allowing the previously disengaged one of said first and second pairs of planetary gears to be brought into engagement with its associated intermediate gear so as to provide positive driving torque to the ribbon spool driven spindle associated therewith in a direction opposite to that imparted to the previously driven spindle, whereafter said over-centering spring biases said reversing rack out of engagement with the particular pair of planetary gears previously coupled thereto.

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