

[54] **INCREMENTAL FEED DEVICE FOR ADVANCING PAPER TAPE, RECORD CARDS AND AN INKED RIBBON IN A PRINTER**

[75] Inventors: **Ronald H. Mack; John Bortins,**
Plymouth, Mich.

[73] Assignee: **Burroughs Corporation,** Detroit,
Mich.

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197/82, 74/84, 74/436, 197/48

[51] Int. Cl. **B41j 13/00**

[58] Field of Search **197/2, 82, 127 R, 133 R,**
197/138 R, 133 T, 151, 1, 44, 48; 74/84, 436

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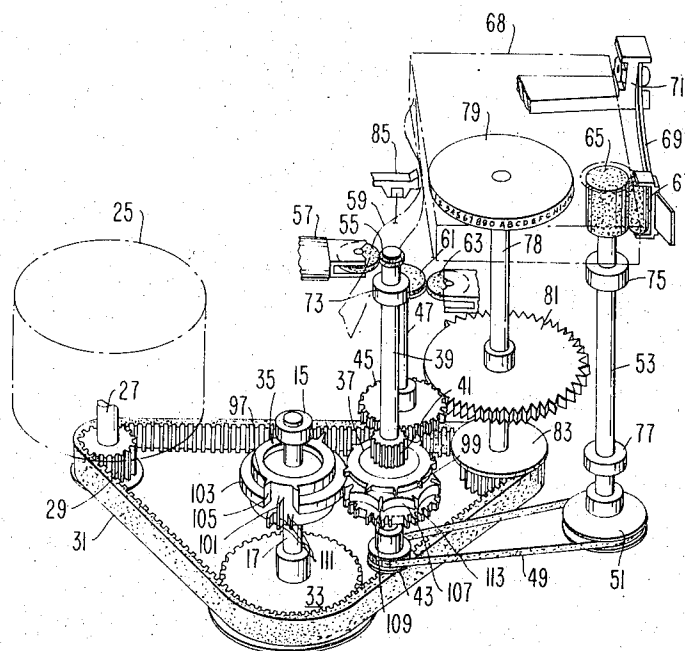
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Primary Examiner—Ernest T. Wright, Jr.
Attorney, Agent, or Firm—Edwin W. Uren; Paul W. Fish

[57] **ABSTRACT**

A plurality of feed shafts associated respectively with paper tape, record card and ribbon feed means are co-operably coupled with a tri-planed driven gear of a Geneva-type gear system, the driven gear being mountably and cooperably engaged with a tri-planed driving gear which is belt connected to an electric motor for continuous rotation therewith, the various planes of the driving and driven gears being so configured as to produce a predetermined number of positively controlled increments of anti-backup rotation of the driven gear for each complete revolution of the driving gear and to thereby incrementally feed an inked ribbon, a paper tape, and/or a record card in a printing device such as may be utilized in a business machine or in a terminal unit for a computer system, the tri-planed arrangement of the two gears providing a smooth meshing and unmeshing of the teeth thereof and serving to distribute the driving and driven loads of the two gears as between the teeth arranged on the three planes thereof.

18 Claims, 8 Drawing Figures



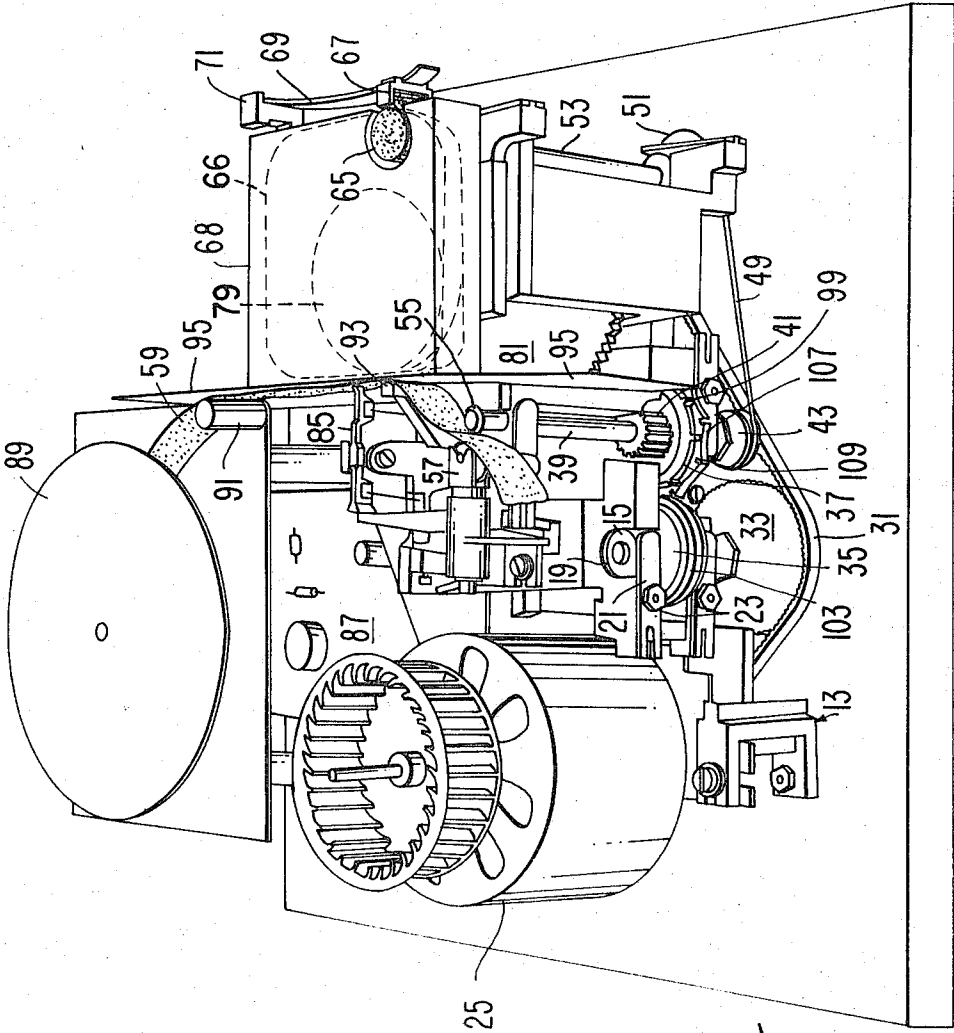


FIG. 1

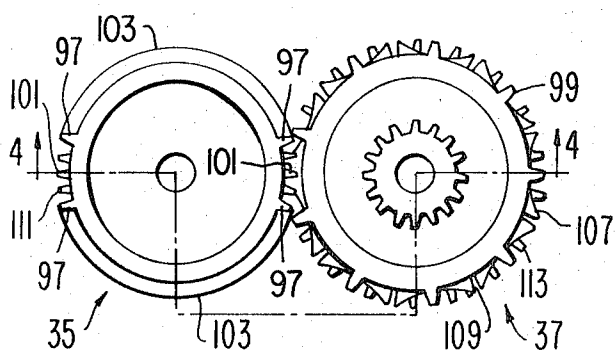


FIG. 3

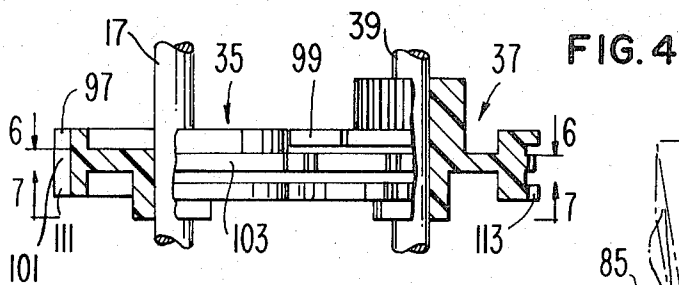


FIG. 4

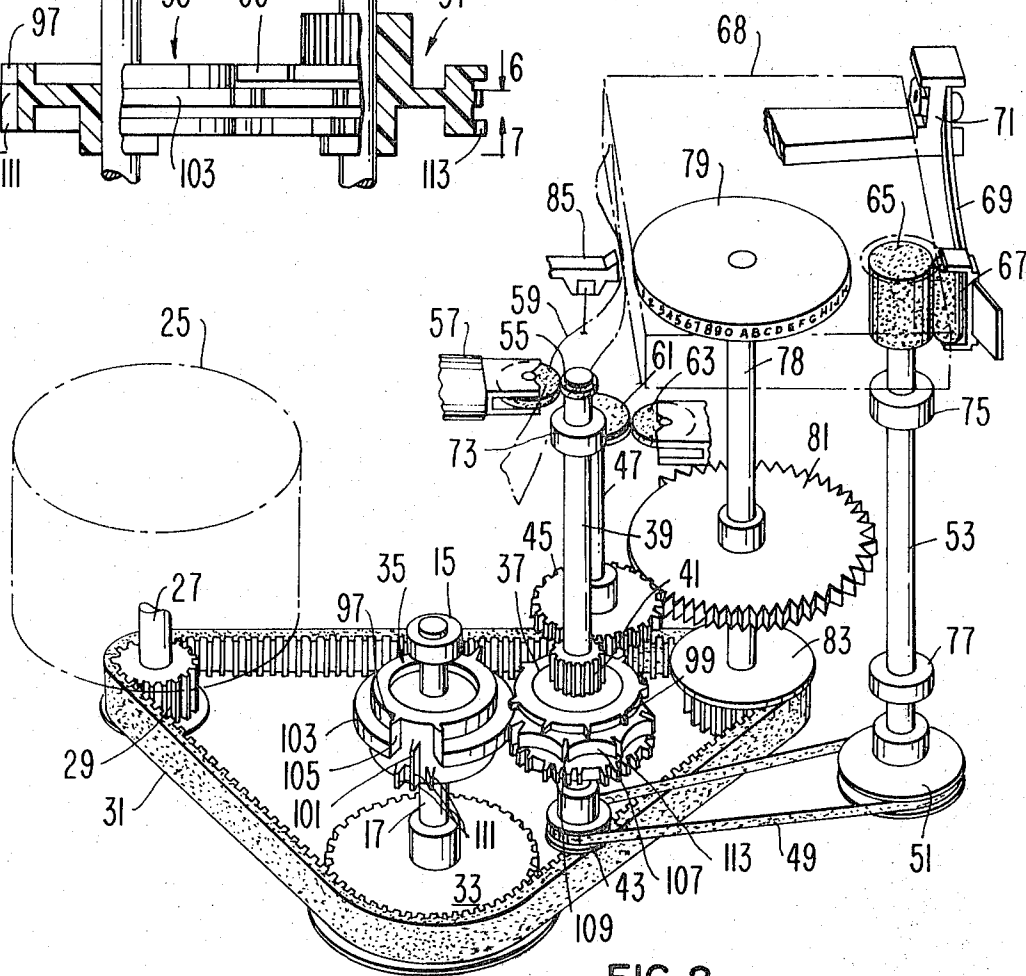


FIG. 2

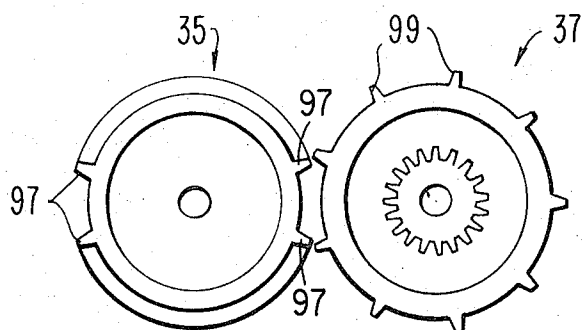


FIG. 5

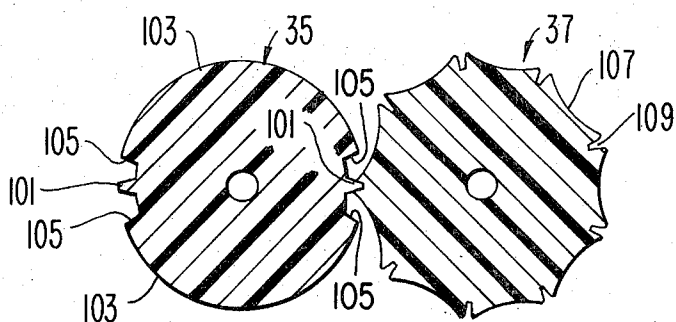


FIG. 6

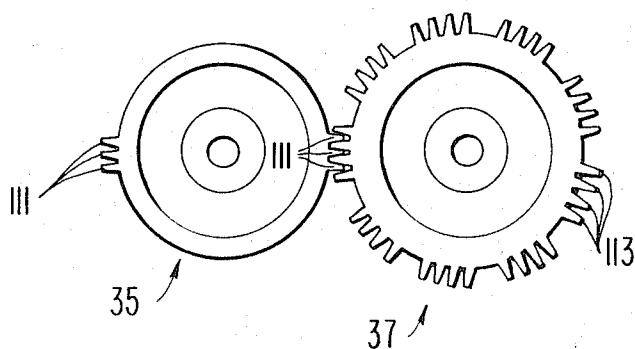


FIG. 7A

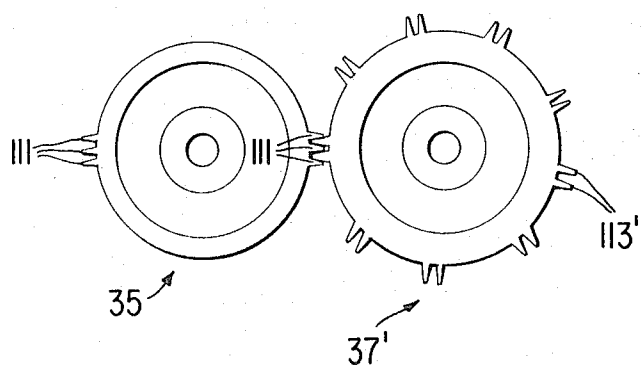


FIG. 7B

INCREMENTAL FEED DEVICE FOR ADVANCING PAPER TAPE, RECORD CARDS AND AN INKED RIBBON IN A PRINTER

CROSS REFERENCE TO RELATED APPLICATIONS

The present invention is related to a patent application by Ronald H. Mack and John Bortins titled Self Tensioning and Reinking Ribbon Cartridge which was filed on Oct. 27, 1972 and assigned Ser. No. 301,641, such application having been assigned to the assignee of the present invention. The relationship of the present invention to this patent application stems from their joint utilization in a printing device particularly adapted for use in a terminal unit of a computer system wherein the incremental feed device of the present invention, in addition to incrementally feeding paper tape and record cards, also incrementally feeds an inked ribbon which is disposed in a self tensioning and reinking ribbon cartridge.

BACKGROUND OF THE INVENTION

Known printing devices utilized in business machines and in terminal units for computer systems have generally provided separate feed means for incrementally advancing the paper tape and the inked ribbon, and still a third feed means for incrementally advancing record cards in those instances where printing is to take place on both record cards and on paper tape. The utilization of separate feed means for each of a plurality of feed functions in business machines and terminal units has tended to render them expensive to manufacture and to maintain, and to present a formidable obstacle to the much-desired objective of maximized compactness.

Known business machines and terminal units, in addition to providing separate feed means for the various printable web-like objects to be fed, have generally provided ribbon feed means that are characterized by the employment of biased pawls in association with a pair of ratchet wheels supporting the ribbon. Such commonly used ribbon and paper feed means have generally proven to be unreliable in their long-range performance, and the quality of the printed result produced by printing devices having separate and distinct feed means for the various web-like objects to be fed has commonly suffered through failure to synchronize the feeding of such objects.

SUMMARY OF THE INVENTION

It is accordingly an object of the present invention to provide an improved printer wherein a multi-function feed means of unitary design is employed for advancing all of the web-like objects that are involved in the printing process, and wherein printing may be performed on both a paper tape and on record cards, the improved printer being particularly adapted for use in a business machine or in a terminal unit of a computer system.

It is yet another object of the present invention to provide a multi-function printing device that is economical to manufacture and to maintain, such economy obtaining by reason of the reduced number of feed-related parts that are required.

It is still another object of the present invention to provide a highly reliable multi-function incremental feeder in a printing device, such reliability stemming in particular from the positive nature of the ribbon drive,

and to provide a printer wherein the quality of the printed result is significantly superior by reason of the fully synchronized feeding of the ribbon and the various printable media.

A further object of the present invention is to provide a unitary incremental feeder that utilizes a single driven gear for feeding all of the web-like objects that are involved in the particular printing process, such objects including the inked-ribbon as well as the various types of printable media that are employed, the utilization of but a single driven gear contributing significantly to the objective of optimized compactness in the printing device in which such feeder is incorporated.

Yet another object of the present invention is to provide a unitary incremental feeder wherein a single driven gear thereof effective for feeding the inked ribbon and the web-like objects is provided with positive incremental driving control and wherein the driving load thereof is distributed as between a plurality of teeth thereon.

An important aspect of the invention, as above noted, is the use of a Geneva-type gear system in a printing device, such gear system consisting of a tri-planed driving gear and a tri-planed driven gear effective for converting the continuous rotational movement of the power source of the printer into a series of incremental rotational movements of the driven gear such that a plurality of web-like objects utilized by the printer may be incrementally advanced a predetermined plurality of uniform distances for each revolution of the driving gear.

Still another important aspect of the invention is the coupling of a plurality of feed shafts to the driven gear, each shaft being provided with a friction roller disposed in cooperating relationship with the web-like object that is to be fed thereby.

Another important aspect of the invention is the particular toothed configurations that are employed on the various planes of the driving and driven gears, such configurations providing separate sets of teeth on the various planes of the gears capable of producing a plurality of positively controlled and smoothly executed incremental movements of the driven gear as the driving gear is rotated continuously in either direction. The particular toothed configurations used additionally serve to distribute the driving load of the gears as between the toothed configurations on the various planes thereof, and to securely position the driven gear in an anti-backup fashion during the interval between the incremental movements thereof, such that the various associated web-like objects are positively and smoothly advanced during incrementing and securely positioned following each of their incremental movements. The arrangement of the particularly configured teeth on the various planes of the driving and driven gears is such that each incremental movement of the driven gear is produced by the sequential cooperation of the teeth on the various planes of the gears, the first-plane teeth producing a first phase motion, the second-plane teeth producing an intermediate motion, and the third-plane teeth producing a third phase motion, each phase motion being initially assisted by the teeth on a different plane of the gears, the second-plane configurations of the two gears additionally serving to secure the position of the driven gear and the plurality of feed shafts following each complete incremental movement of the driven gear.

BRIEF DESCRIPTION OF THE DRAWING

These and other objects, advantages and aspects of the invention will be more clearly understood from the following description when read in conjunction with the accompanying drawing, in which:

FIG. 1 is a partial side perspective view of a terminal unit for a computer system in which the improved incremental feed device of the present invention is employed;

FIG. 2 is an elevational view similar to FIG. 1 with various parts of the terminal unit removed to fully expose the driving and driven gears of the Geneva-type gear system and the various shafts of the improved incremental feed device;

FIG. 3 is a plan view of the driving and driven gears of the Geneva-type gear system;

FIG. 4 is a sectional elevation taken along the line 4—4 of FIG. 3 and showing one phase of cooperation between the driving and driven gears;

FIG. 5 is a plan view showing the first-plane tooth configuration of the gears;

FIG. 6 is a plan view of the second-plane tooth configuration of the gears as taken along the line 6—6 of FIG. 4;

FIG. 7A is a plan view of the third-plane configuration of the gears as taken along the line 7—7 of FIG. 4, the third plane of the driven gear 37 being provided with a plurality of sets of four teeth each; and

FIG. 7B is a modification of FIG. 7A and illustrates the third-plane configuration of the driving and driven gears wherein a modified driven gear is shown to include a plurality of sets of two teeth each.

DESCRIPTION OF A PREFERRED EMBODIMENT

The invention resides in the provision of a tri-planed Geneva-type gear system disposed in coupled relationship with a power source and a plurality of feed shafts in a printing device forming a part of a terminal unit for a computer system, the gear system and feed shafts being effective for incrementally advancing the inked ribbon of the printing device and also for incrementally advancing various web-like objects of a printable media type such as paper tape and record cards or ledgers, the arrangement of teeth on the various planes of a driving and a driven gear of the gear system serving to convert the continuous rotational movement produced by the power source of the printing device to incremental and anti-backup rotational movements of the driven gear and the plurality of feed shafts.

The printing mechanism forming the environment for the improved incremental feed device of the present invention may be generally described with reference to FIGS. 1 and 2 wherein a portion of the hardware of a terminal unit for a computer system is illustrated, such terminal unit, in addition to providing output printing capability as exemplified by the printing mechanism illustrated, may also provide keyboard and card reading input capabilities which form no part of the present invention. As illustrated in FIG. 1, the terminal unit and printing device thereof are supported by a base plate 11 and a unitary molded frame structure generally designated at 13, the frame structure 13 being so formed as to accommodate all of the hardware requirements of the particular input and output capabilities that are desired. Characteristic of the unitary molded frame struc-

ture 13 is the provision of a plurality of open-ended slots for attaching the various hardware elements, and grooved slots for retainably housing the various bearings that are required by the plurality of rotatable shafts that are employed, as for example the rotatable shafts that are utilized by the printing device illustrated in FIG. 2. An example of the manner in which shaft bearings may be supported in the grooved slots of the unitary molded frame structure 13 is shown in FIG. 1, wherein a bearing 15 of a driving gear shaft 17 (FIG. 2) is shown in retained relationship relative to a grooved slot 19, the bearing 15 being retained in the slot 19 by means of a retainer strip 21 which is secured to the frame structure 13 by means of a bolt and nut 23.

The various elements of the printing mechanism in which the improved incremental feed device of the present invention is shown may also be generally identified by reference to FIGS. 1 and 2, such elements including an electric motor 25, a motor shaft 27 (FIG. 2), a motor shaft gear 29, an endless belt 31, a feed gear 33 fixed to the lowermost extremity of the driving gear shaft 17, a driving Geneva-type gear 35 disposed in co-operating relationship with a driven Geneva-type gear 37, and a paper tape drive shaft 39 to which the driven gear 37 is fixed. The paper tape drive shaft 39 is also provided with a fixed pinion gear 41 disposed upwardly of the driven gear 37, and a fixed pulley 43 disposed below the driven gear 37. The pinion gear 41 is cooperably engaged with a gear 45 fixed to a record card feed shaft 47, and the pulley 43 is connected by means of a belt 49 to a pulley 51 fixed to the lowermost extremity of a ribbon feed shaft 53.

The paper tape drive shaft 39 is provided with a friction roller 55 disposed on the uppermost extremity thereof, such friction roller 55 cooperating with a resiliently mounted idler roller 57 for frictionally feeding a paper tape 59. The record card feed shaft 47 is provided with a friction roller 61 disposed at the uppermost extremity thereof, said friction roller 61 cooperating with a resiliently mounted idler roller 63 for feeding a record card 95 during the printable recording of data thereon. The ribbon feed shaft 53 is provided with an elongated friction roller 65 disposed at the uppermost extremity thereof, said friction roller 65 cooperating with a resiliently mounted idler roller 67 for feedably advancing an inked ribbon 66 contained within a ribbon cartridge 68, the idler roller 67 being resiliently supported by means of a biased arm 69 fixed to an upright arm 71 of the molded frame structure 13.

In addition to the bearing 15, which as previously indicated is retained in a grooved slot 19 of the frame structure 13 by a retainer strip 21, each of the feed shafts 39, 47 and 53 is provided with a pair of bearings which are retained in respective grooved slots of the frame structure 13 by means of retainer strips of the kind designated at 21 in FIG. 1. Some of these bearings for the feed shafts 39, 47 and 53 are shown in FIG. 2, as at 73 (associated with the paper tape drive shaft 39) and at 75 and 77 (associated with the ribbon feed shaft 53). Also shown in FIG. 2, in addition to the Geneva-type gear system 35-37 and the feed shafts 39, 47 and 53 of the inventive incremental feed device, is a print shaft 78, a print wheel 79, a sensing gear 81, a print gear 83 which is also belt connected to the feed gear 33 and the motor shaft gear 29, and a print hammer 85. Also illustrated in FIG. 1 at 87 is print control circuitry

effective for actuating the hammer 85 when the selected character of the print wheel 79 is adjacently disposed thereto as sensed by a photoelectric cell (not shown) in cooperation with the sensing gear 81 (FIG. 2), the operation of the print wheel 79 and print hammer 85, however, not forming a part of the present invention. It is to be noted in connection with the print wheel 79, however, that the ribbon cartridge 68, shown in FIG. 1 and disclosed in detail in the above referenced patent application Ser. No. 301,641 titled Self Tensioning and Reinking Ribbon Cartridge, is attachable to the frame structure 13 such that the print wheel 79 is disposed within the cartridge 68, the attachment of the cartridge 68 thereby linearly presenting a section of the ribbon 66 to the print wheel 79 at a point adjacent the selected type character and the print hammer 85.

The paper tape 59, which as previously suggested is incrementally advanced in a feed direction (to the front as viewed in FIG. 2) by the paper tape drive shaft 39 and in particular by the cooperation of the friction roller 55 and the resiliently mounted idler roller 57, is supplied to the terminal unit and to the printing mechanism thereof by means of a supply reel 89 shown in FIG. 1, and is guided to a print position intermediate the print hammer 85 and the ribbon cartridge 68 by means of a pair of guide members 91 and 93. A record card, which as previously suggested is feedably advanced by the incremental feed device of the present invention by means of the feed shaft 47 and in particular by the cooperation of the friction roller 61 (FIG. 2) and the resiliently mounted idler roller 63, is illustrated in FIG. 1 at 95. Such record cards 95 are inserted horizontally into a document chute of the terminal unit (rearwardly as viewed from the front in FIG. 1), such document chute being partially defined by the distance between the paper tape 59 and the ribbon cartridge 68. The printing mechanism forming the environment of the improved incremental feed device of the present invention is accordingly designed to serially print output data on a single line on the paper tape 59 or on a plurality of lines on a record card 95. An additional feature of the printing mechanism fragmentarily illustrated in FIGS. 1 and 2 is the use of a document elevating device which is also driven by the motor 25, such elevating device being neither shown nor described in connection with the present application. In the event output data is to be printed both on the paper tape 59 and on a record card 95, it would of course be necessary to utilize a carbonized paper tape of the kind that are well known in the art, whereupon printing on the record card 95 would be effectuated by the inked ribbon 66 of the ribbon cartridge 68 and printing on the paper tape 59 would be effectuated by the carbon in the carbonized paper tape.

The improvement characterizing the incremental feed device of the present invention derives substantially from the construction of the driving gear 35 and the driven gear 37 of the Geneva-type gear system, such gear system, as previously mentioned, serving to convert the continuous rotational movement of the motor shaft gear 29 and the feed gear 33 to a plurality of incremental rotational motions of the driven gear 37 and the feed shafts 39, 47 and 53 coupled thereto. As shown in FIGS. 3, 4, 5, 6 and 7A, each of the gears 35 and 37 is comprised of a tri-planed design, each plane of each gear 35 and 37 having a distinctive toothed

configuration which in the cooperation of the two gears 35 and 37 serve to sequentially produce an incremental rotational motion of the driven gear 37 which is comprised of three separate phases of rotational movement. The tri-planed toothed configuration of the driving gear 35 and the driven gear 37 can best be described with reference to FIGS. 5, 6 and 7A, wherein each of the three planes of the gears 35 and 37 is illustrated. As best shown in FIG. 5, the first or uppermost plane of the driving gear 35 is comprised of two diametrically opposed sets or pairs of teeth 97, and the first or uppermost plane of the driven gear 37 is comprised on a plurality of nine equally spaced apart teeth 99, the spaced apart distance of the teeth 99 being sufficient to receiveably span both teeth of one of the pairs of teeth 97 on the first plane of the driving gear 35, to thereby produce a first phase rotational movement of the driven gear 37 as the gear 35 is rotated in either direction. As shown in FIG. 6, the second or intermediate plane of the driving gear 35 is provided with a pair of diametrically opposed teeth 101 disposed vertically intermediate the pairs of diametrically opposed teeth 97 on the first plane thereof, and a pair of convex segments 103 defined by two pairs of walls 105 coplanarly disposed relative to the two pairs of teeth 97 on the first plane, and the second or intermediate plane of the driven gear 37 is provided with a plurality of nine concave segments 107 defined by a plurality of nine tooth recesses 109, the tooth recesses 109 being drivenly advanced by the pair of diametrically opposed teeth 101 on the second plane of the driving gear 35, to thereby produce a second phase rotational movement of the driven gear 37. One of the convex segments 103 on the second plane of the driving gear 35 engageably cooperates with one of the concave segments 107 on the second plane of the driven gear 37 upon the completion of each incremental advancement of the driven gear 37, to thereby secure the position of the driven gear 37 in an anti-backup manner.

As shown in FIG. 7A, the third or lowermost plane of the driving gear 35 is comprised of two diametrically opposed sets of three teeth 111, the central tooth of each set being coplanarly disposed and integrally formed relative to a corresponding one of the pair of diametrically opposed teeth 101 on the second plane thereof, and the third or lowermost plane of the driven gear 37 is comprised of a plurality of nine equally spaced apart sets of four teeth each as at 113, one of the two sets of three teeth 111 on the lowermost plane of the driving gear 35 cooperating with one of the sets of four teeth 113 on the lowermost plane of the driven gear 37 to thereby produce a third phase rotational movement of the driven gear 37. It will be observed that in the embodiment illustrated in FIG. 7B, the third or lowermost plane of the driven gear 37' is comprised of a plurality of nine equally spaced apart sets of two teeth each, as at 113'. Upon the completion of each incremental rotational motion, which is to say upon the completion of the third phase rotational movement thereof, one of the convex segments 103 on the second plane of the driving gear 35 cooperates with one of the concave segments 107 on the second plane of the driven gear 37 to thereby secure the position of the driven gear 37 and to prevent any back-up movement thereof.

Operation

To briefly describe the operation of the improved incremental feed device of the present invention, reference is made to FIGS. 1 and 2 of the drawing for the purpose of describing the incremental feeding of the paper tape 59 and a record card 95 in a leftward direction (as viewed from the right in FIG. 1), and the counterclockwise feeding of the inked ribbon 66 in the cartridge 68, it being understood, however, that the construction of the driving gear 35 and the driven gear 37 of the Geneva-type gear system would also enable feeding of the printable media 59 and 95 of the ribbon 66 in the opposite directions. The motor shaft 27 and motor shaft gear 29 in the printing mechanism described would be rotated in a continuous clockwise direction, to thereby rotate the feed gear 33 in a continuous clockwise direction. The driving gear shaft 17 would accordingly also be rotated continuously in a clockwise direction to thereby produce a plurality of incremental counterclockwise rotational movements of the driven gear 37, such incremental movements of the driven gear 37 being effectuated by means of the sequential cooperation of the respective toothed configurations on the three planes of the driving gear 35 and the driven gear 37. Each incremental counterclockwise movement of the driven gear 37 would be equal to the sum of the movements produced sequentially by the cooperation of the teeth 97, 101 and 111 on the three planes of the driving gear 35 with the teeth 99, 109 and 113 on the corresponding planes of the driven gear 37, the leading tooth 97 of a pair thereof on the first plane of the driving gear 35 cooperating with the trailing surface of one of the teeth 99 of the driven gear 37 to produce a first phase movement of the driven gear 37, the second plane tooth 101 corresponding to said pair of first plane teeth 97 cooperating with a tooth recess 109 on the second plane of the driven gear 37 to produce a second phase movement of the driven gear 37, and the third plane set of three teeth 111 corresponding to said pair of first plane teeth 97 cooperating with one of the sets of four (or two) teeth 113 on the third plane of the driven gear 37 to produce a third phase movement of the driven gear 37, following which third phase movement the trailing one of the convex segments 103 on the second plane of the driving gear 35 cooperates with the trailing one of the concave segments 107 on the second plane of the driven gear 37 to thereby secure the position of the driven gear 37. For each three-phase incremental movement of the driven gear 37 in a counterclockwise direction, the paper tape drive shaft 39 fixed thereto is rotated an equivalent distance in a counterclockwise direction, the record card feed shaft 47 is rotated an equivalent distance in a clockwise direction through the cooperation of the pinion gear 41 fixed to the shaft 39 and the gear 45 fixed to the shaft 47, and the ribbon feed shaft 53 is rotated an equivalent distance in a counterclockwise direction through the cooperation of the fixed pulley 43, the belt 49 and the pulley 51.

Each incremental counterclockwise rotation of the paper tape drive shaft 39 results in an incremental leftward feeding movement of the paper tape 59, as produced by the friction roller 55 and the idler roller 57, and each incremental clockwise rotation of the record feed shaft 47 results in an incremental outward movement of the record card 95 as produced by the friction roller 61 and idler roller 63, the record card 95 having been initially inserted inwardly to a positioning stop

(not shown) where the record card 95 is positioned to receive a first printed character at a predetermined distance from the left edge thereof. Each incremental counterclockwise movement of the ribbon feed shaft 53 results in an equivalent counterclockwise movement of the ribbon 66 in the ribbon cartridge 68 as produced by the elongated friction roller 65 and idler roller 67. It is to be noted that the distance of each incremental leftward movement of the paper tape 59 and the record card 95, as produced by the incremental movements of the shafts 39 and 47, respectively, should be sufficient to produce the desired linear space between the printed characters on the paper tape 59 and/or record card 95, such spacing between characters being alterable by changing the size and number of the teeth and tooth recesses disposed on the various planes of the driving gear 35 and driven gear 37.

While an embodiment of the improved incremental feed device has been shown and described in considerable detail, it will be understood that various modifications and alterations therein may be made without departing from the true spirit and scope of the invention.

What is claimed is:

1. In a printing device having an inked ribbon and effective for producing printed characters comprising printed data output for a computer system, improved unitary feed apparatus for incrementally and concomitantly feeding a plurality of printable media along with said inked ribbon in said device, said unitary feed apparatus comprising:

- a. a motor driven feed gear,
- b. a rotatably mounted driving member coupled to said motor driven feed gear for continuous rotation therewith, said driving member having a first predetermined circumferential toothed configuration arranged on three separate planes thereof including a plurality of spaced apart pairs of teeth disposed on a first plane thereof, a plurality of spaced apart single teeth and a plurality of convex segments disposed on a second plane thereof, said spaced apart single teeth being disposed vertically intermediate each of said pairs of spaced apart teeth on said first plane and each of said convex segments being adjacently and outwardly defined by one of said pair of spaced apart teeth of said first plane such that the beginning and ending walls of each segment coincide with the inboard surfaces of said pair of spaced apart teeth, and a plurality of sets of three teeth disposed on a third plane thereof, the center tooth of each set forming an extension of one of said single teeth on said second plane and the first and third teeth of each set being disposed a one tooth distance inwardly of each tooth comprising one of said pairs of spaced apart teeth on said first plane and of said beginning and ending segment walls on said second plane,
- c. a rotatably mounted driven member cooperably disposed relative to said driving member, said driven member having a second predetermined circumferential toothed configuration arranged on three separate planes thereof in cooperating relationship with said three planes of said first predetermined circumferential toothed configuration of said driving member to thereby convert said continuous rotation of said driving member to a smooth and positively controlled incremental rota-

tion of said driven member, the arrangement of the predetermined first and second toothed configurations on three separate planes of said driving member and said driven member serving to distribute the driving load therebetween and to thereby prolong the life of the members, and

- d. a plurality of feed means coupled to said driven member and effective for incrementally advancing said inked ribbon and said plurality of printable media, said incremental advancement of each of said plurality of printable media being effective for establishing the desired spaced apart distance of said printed characters comprising said printed data output.

2. The improved unitary feed apparatus defined in claim 1 wherein said second predetermined circumferential toothed configuration of said driven member comprises:

- a. a plurality of equally spaced apart teeth disposed on a first plane thereof, the distance between said equally spaced apart teeth being sufficient for receivably spanning one pair of said plurality of pairs of spaced apart teeth on said first plane of said driving member,
- b. a plurality of concave segments defined by a plurality of tooth recesses disposed on a second plane thereof, said concave segments being cooperably engageable by said convex segments on said second plane of said driving member and said tooth recesses being cooperably engageable by said plurality of single teeth on said second plane of said driving member, and
- c. a plurality of sets of teeth disposed on a third plane thereof, each set of teeth on said third plane of said driven member being effective for cooperating with one of the sets of three teeth on said third plane of said driving member, a central tooth recess of each set of teeth on said third plane of said driven member being effective for receiving said center tooth of one of said sets of three teeth on said third plane of said driving member.

3. The improved unitary feed apparatus defined in claim 2 wherein said pluralities characterizing said first plane pairs of spaced apart teeth, said second plane single teeth and convex segments, and said third plane sets of three teeth of said driving member in each instance comprises a diametrically opposed set of two.

4. The improved unitary feed apparatus defined in claim 3 wherein said pluralities characterizing said first plane equally spaced apart teeth, said second plane concave segments and tooth recesses, and said third plane sets of teeth of said driven member in each instance is nine.

5. The improved unitary feed apparatus defined in claim 2 wherein each set comprising said plurality of sets of teeth on said third plane of said driven member consists of four teeth.

6. The improved unitary feed apparatus defined in claim 2 wherein each set comprising said plurality of sets of teeth on said third plane of said driven member consists of two teeth.

7. A Geneva-type gear system for use in an incremental feeding device wherein it is desired to utilize the continuous rotation of a driving gear to incrementally advance a plurality of web-like objects as by friction rollers fixed to a plurality of feed shafts, said gear system comprising:

- a. a rotatably mounted driving member coupled to said driving gear for continuous rotation therewith, said driving member having a first predetermined circumferential toothed configuration arranged on three separate planes thereof including a plurality of spaced apart pairs of teeth disposed on a first plane thereof, a plurality of spaced apart single teeth and a plurality of convex segments disposed on a second plane thereof, said spaced apart single teeth being disposed vertically intermediate each of said pairs of spaced apart teeth on said first plane and each of said convex segments being adjacently and outwardly defined by one of said pair of spaced apart teeth of said first plane such that the beginning and ending walls of each segment coincide with the inboard surfaces of said pair of spaced apart teeth, and a plurality of sets of three teeth disposed on a third plane thereof, the center tooth of each set forming an extension of one of said single teeth on said second plane and the first and third teeth of each set being disposed a one tooth distance inwardly of each tooth comprising one of said pairs of spaced apart teeth on said first plane and of said beginning and ending segment walls on said second plane, and

- b. a rotatably mounted driven member coupled to said plurality of feed shafts and cooperably disposed relative to said driving member, said driven member having a second predetermined circumferential toothed configuration arranged on three separate planes thereof in cooperating relationship with said three planes of said first toothed configuration of said driving member to thereby convert said continuous rotation of said driving gear and said driving member into a smooth and positively controlled incremental rotation of said driven member and said plurality of feed shafts such that said plurality of web-like objects may be incrementally and concomitantly advanced, the arrangement of the predetermined first and second toothed configurations on three separate planes of said driving member and said driven member serving to distribute the driving load therebetween and to thereby prolong the life of the members.

8. The gear system defined in claim 7 wherein said second predetermined circumferential toothed configuration of said driven member comprises:

- a. a plurality of equally spaced apart teeth disposed on a first plane thereof, the distance between said equally spaced apart teeth being sufficient for receivably spanning one pair of said plurality of pairs of spaced apart teeth on said first plane of said driving member,
- b. a plurality of concave segments defined by a plurality of tooth recesses disposed on a second plane thereof, said concave segments being cooperably engageable by said convex segments on said second plane of said driving member and said tooth recesses being cooperably engageable by said plurality of single teeth on said second plane of said driving member, and
- c. a plurality of sets of teeth disposed on a third plane thereof, each set of teeth on said third plane of said driven member being effective for cooperating with one of the sets of three teeth on said third plane of said driving member, a central tooth recess of each set of teeth on said third plane of said

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driven member being effective for receiving said center tooth of one of said sets of three teeth on said third plane of said driving member.

9. The gear system defined in claim 8 wherein said pluralities characterizing said first plane pairs of spaced apart teeth, said second plane single teeth and convex segments, and said third plane sets of three teeth of said driving member in each instance comprise a diametrically opposed set of two.

10. The gear system defined in claim 9 wherein said pluralities characterizing said first plane equally spaced apart teeth, said second plane concave segments and tooth recesses, and said third plane sets of teeth of said driven member in each instance is nine.

11. The gear system defined in claim 8 wherein each set comprising said plurality of sets of teeth on said third plane of said driven member consists of four teeth.

12. The gear system defined in claim 8 wherein each set comprising said plurality of sets of teeth on said third plane of said driven member consists of two teeth.

13. Improved apparatus for converting the continuous rotation of a driving member to an incremental rotation of at least one driven member, said apparatus comprising:

a. a first rotatable member coupled to said driving member and having a first predetermined circumferential toothed configuration arranged on three separate planes thereof including a plurality of spaced apart pairs of teeth disposed on a first plane thereof, a plurality of spaced apart single teeth and a plurality of convex segments disposed on a second plane thereof, said spaced apart single teeth being disposed vertically intermediate each of said pairs of spaced apart teeth on said first plane and each of said convex segments being adjacently and outwardly defined by one of said pair of spaced apart teeth of said first plane such that the beginning and ending walls of each segment coincide with the inboard surfaces of said pair of spaced apart teeth, and a plurality of sets of three teeth disposed on a third plane thereof, the center tooth of each set forming an extension of one of said single teeth on said second plane and the first and third teeth of each set being disposed a one tooth distance inwardly of each tooth comprising one of said pairs of spaced apart teeth on said first plane and of said beginning and ending segment walls on said second plane, and

b. a second rotatable member coupled to said driven member and cooperably disposed relative to said first rotatable member, said second rotatable member having a second predetermined circumferential toothed configuration arranged on three separate planes thereof in cooperating relationship with said three planes of said first toothed configuration of said first rotatable member, whereby by means of the cooperation of said first predetermined circumferential toothed configuration of said first rotatable member with said second predetermined cir-

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cumferential toothed configuration of said second rotatable member said second rotatable member and said driven member are provided with a predetermined number of smoothly executed and positively controlled incremental rotational advancements for each complete revolution of said driving member and said first rotatable member, the arrangement of the predetermined first and second toothed configurations on three separate planes of said first and said second rotatable members serving to distribute the driving load therebetween and to thereby prolong the life of said first and said second rotatable members.

14. The apparatus defined in claim 13 wherein said second predetermined circumferential toothed configuration of said second rotatable member comprises:

a. a plurality of equally spaced apart teeth disposed on the first plane thereof, the distance between said equally spaced apart teeth being sufficient for receiveably spanning one pair of said plurality of pairs of spaced apart teeth on said first plane of said first rotatable member,

b. a plurality of concave segments defined by a plurality of tooth recesses disposed on a second plane thereof, said concave segments being cooperably engageable by said convex segments on said second plane of said first rotatable member and said tooth recesses being cooperably engageable by said plurality of single teeth on said second plane of said first rotatable member, and

c. a plurality of sets of teeth disposed on a third plane thereof, each set of teeth on said third plane of said second rotatable member being effective for cooperating with one of the sets of three teeth on said third plane of said first rotatable member, a central tooth recess of each set of teeth on said third plane of said first rotatable member being effective for receiving said center tooth of one of said sets of three teeth on said third plane of said first rotatable member.

15. The apparatus defined in claim 14 wherein said pluralities characterizing said first plane pairs of spaced apart teeth, said second plane single teeth and convex segments, and said third plane sets of three teeth of said first rotatable member in each instance comprise a diametrically opposed set of two.

16. The apparatus defined in claim 15 wherein said pluralities characterizing said first plane equally spaced apart teeth, said second plane concave segments and tooth recesses, and said third plane sets of teeth of said second rotatable member in each instance is nine.

17. The apparatus defined in claim 14 wherein each set comprising said plurality of sets of teeth on said third plane of said second rotatable member consists of four teeth.

18. The apparatus defined in claim 14 wherein each set comprising said plurality of sets of teeth on said third plane of said second rotatable member consists of two teeth.

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