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Riley

[11] **3,917,048**

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[54] **SYNCHRONIZED LINE FEED TENSIONING AND GRIPPING APPARATUS FOR PRINTER**

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[73] Assignee: **Teletype Corporation,** Skokie, Ill.

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[52] **U.S. Cl.** ..... **197/133 P;** 197/133 R; 226/83; 226/153; 226/187; 226/195

[51] **Int. Cl.²** **B41J 15/04;** B41J 15/16

[58] **Field of Search** 197/133, 126, 132, 134; 226/82–85, 153, 195

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Attorney, Agent, or Firm—K. R. Bergum; W. K. Serp; J. L. Landis

[57] **ABSTRACT**

A line feed tensioning and gripping apparatus, particularly adapted for use in conjunction with conventional tractor or sprocket line feed mechanisms, comprises a pair of specially contoured pinch cams, mounted on and driven by a drive shaft for the line feed mechanism, and a pair of associated pinch rollers which together cooperate to grip and firmly hold a perforated web after each successive line feed advancement thereof, in a precisely synchronized manner. The pinch rollers may also be pre-loaded so as to control the desired tension exerted on the paper during each successive line feed advancement thereof in a manner that ensures continuous and reliable feed pin-paper hole registration. The apparatus, with or without pre-loaded pinch rollers, also acts as a buffer and a momentary positive web drive between the line feed mechanism and the web supply so as to eliminate any tendency of the feed pins (or sprocket teeth) to tear the web at the start of each successive line feed.

13 Claims, 8 Drawing Figures

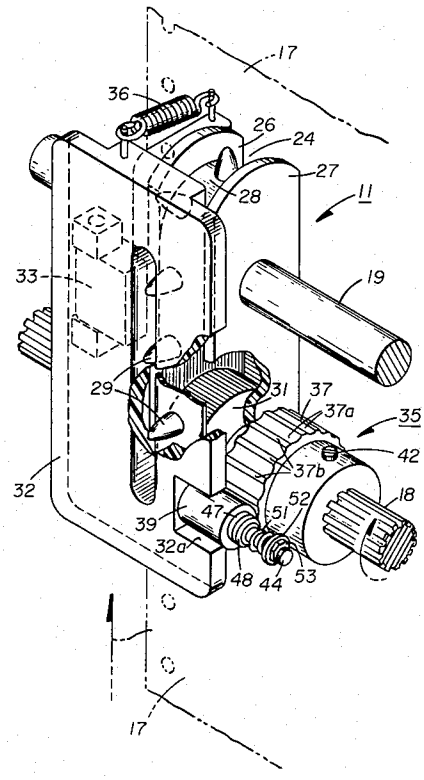


FIG. 1

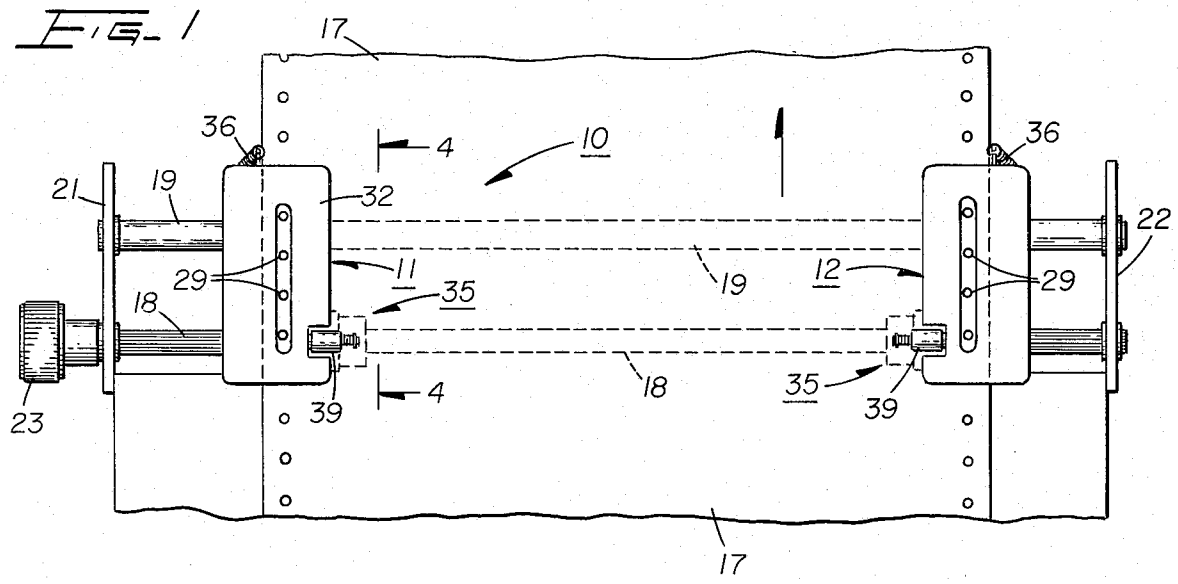


FIG. 2

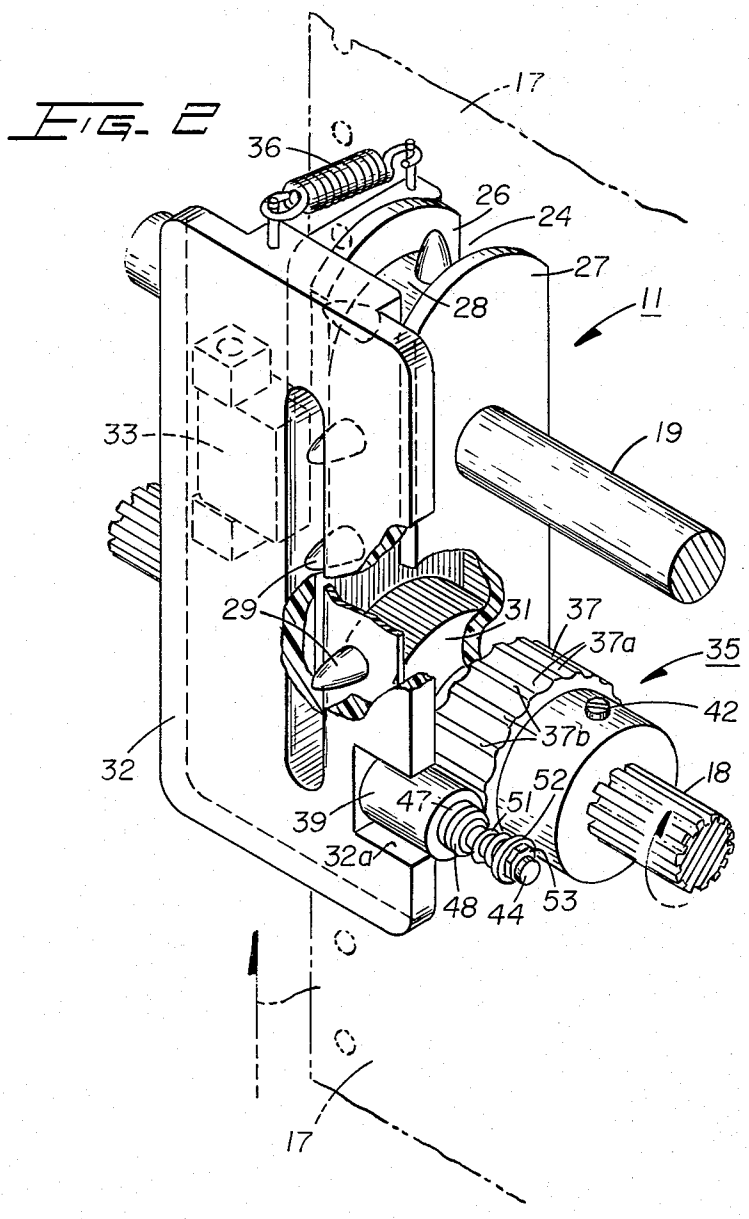


FIG. 3

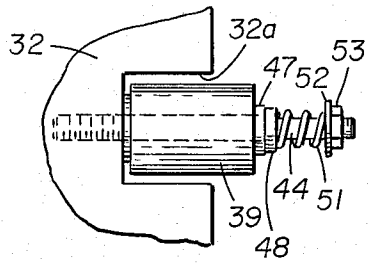


FIG. 5

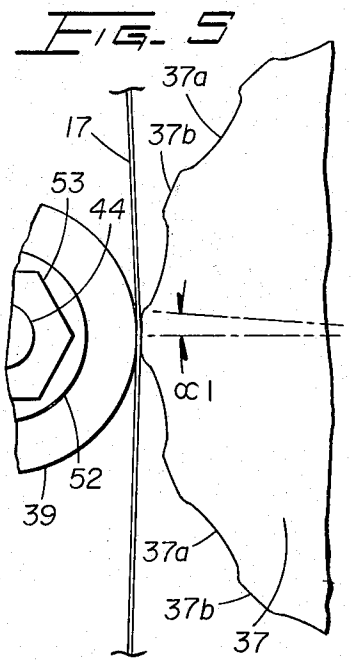


FIG. 4

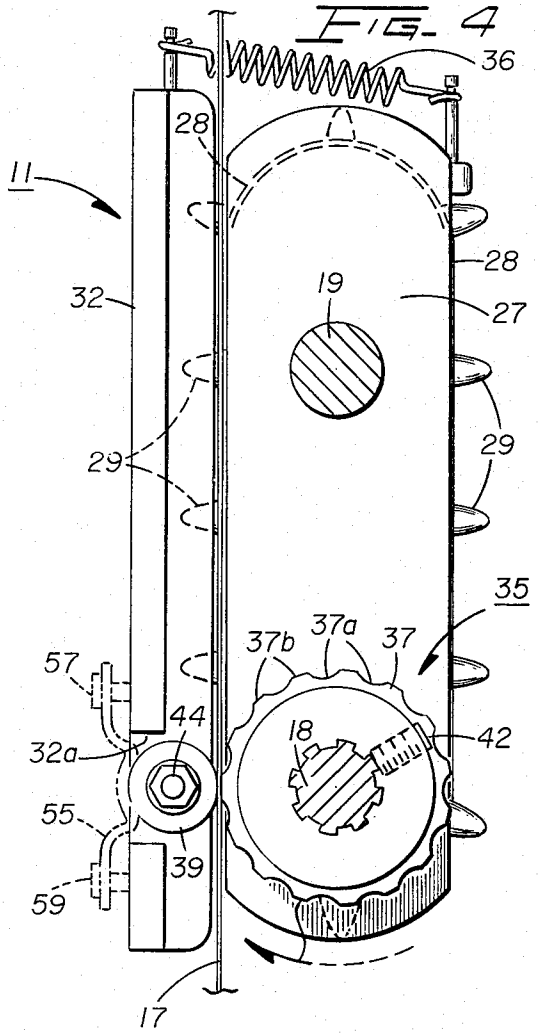


FIG. 6

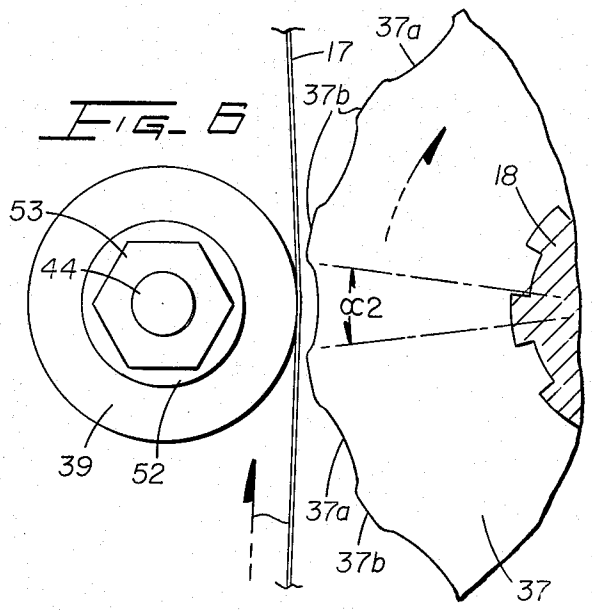


FIG. 7

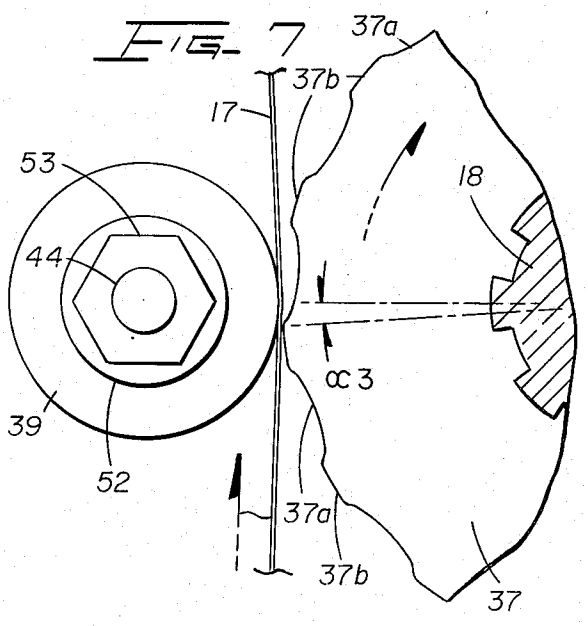
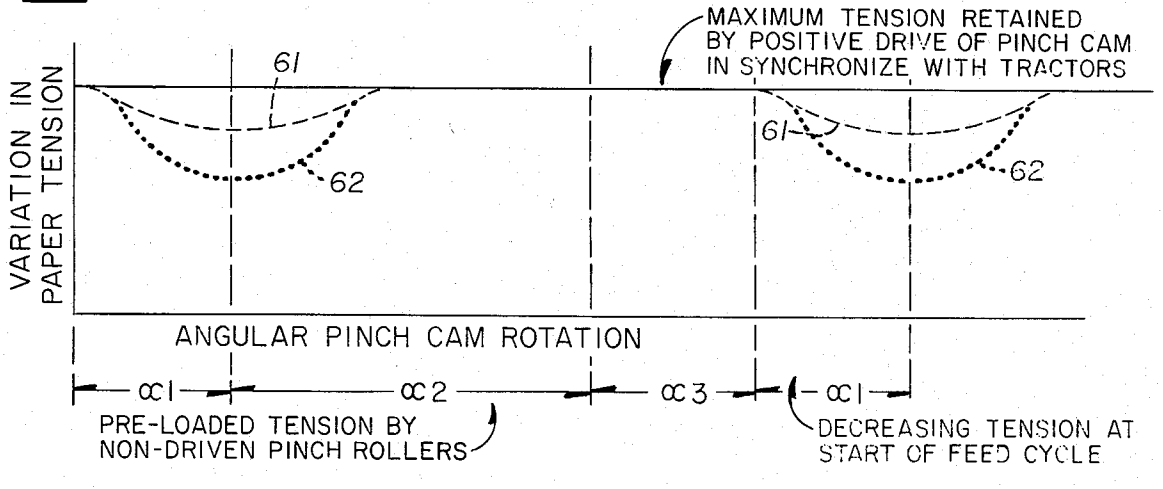


FIG. 8



SYNCHRONIZED LINE FEED TENSIONING AND GRIPPING APPARATUS FOR PRINTER

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a perforated web advancing apparatus and, more particularly, to a synchronized line feed tensioning and gripping apparatus particularly adapted for use with sprocket or tractor feed mechanisms employed in printers and the like.

2. Description of the Prior Art

The ever-increasing use of both on-site and remote data processing systems has resulted, through competitive design efforts, in improvements being made in not only the thru-put rates of the computers associated therewith, but in the transmission rates at which data may be transmitted therebetween. Such improvements have placed correspondingly increased demands on the associated peripheral equipment, such as high speed printers. It, of course, is readily apparent that in on-line date processing systems, and in the absence of temporary memory storage, the output rate of the computer is necessarily limited by the rate at which processed digital data can be recorded.

High speed printers employed in such data processing systems typically effect printing "on-the-fly." More specifically, in one class of such printers, the type characters or font dies are mounted on a continuously moving endless carrier driven past an aligned array of print hammers. Interposed between the print hammers and type characters, of course, is the periodically advanced medium on which the characters are to be printed, such as paper in roll stock or fold-back form, 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 print hammers which define the width of a printing line.

In still another form of impact printer, generally referred to as the dot matrix type, a print head is normally mounted on a suitable chain or lead screw driven carriage, which is driven reciprocally across the width dimension of the periodically advanced web or paper.

With recent significant advances having been made in the high speed integrated logic control circuitry for such printers, and with the use of very low mass, high velocity print hammers (or wires), very stringent performance demands have necessarily been imposed on the other associated ancillary mechanical mechanisms of the printer, such as the line feed mechanisms thereof.

The importance of the line feed mechanism in high speed printers is appreciated when it is realized that the paper is often incrementally line feed advanced (one or more line spaces) at rates that typically may be in the range of 200 to 1,000 single line spaces per minute. Such rapid starting and stoppong of the paper quite obviously presents a number of problems with respect to achieving reliable and accurate incremental advancement of the paper.

One of the most serious problems confronted in the design of line feed mechanisms is to overcome the tendency of the paper, whether in perforated form or not, to tear, or not advance a full line space, each time the line feed mechanism attempts to overcome the inertia effects of the mass of the paper roll. The importance of properly controlling the tension exerted on the paper, of course, increases directly with the line printing rate

of the printer, and with the mass of the paper supply, as the more rapid are the advancements of the paper, the more severe is the jerking effect if not compensated for in some way.

In both of the above types of impact printers, the web or paper has typically been line feed advanced by either frictional engagement with a rotatable platen, or by such a platen in combination with a pinch roller, or by engagement with an associated pair of spaced sprocket wheels or tractors, each of the latter having an orbital endless belt with an array of feed pins mounted therealong. The last two mentioned types of positive line feed mechanisms, of course, have often been preferred over friction feeds in an attempt to ensure consistent, positive, incremental advancements of the paper at very high speeds and/or when multiple plies of paper are used. While a pair of spaced drive sprockets are obviously considerably less expensive and require less space than a pair of tractors, the latter are nevertheless often preferred in order that a plurality of the belt carried pins may engage a corresponding number of perforations formed along the associated margin of the paper at any one time. This substantially minimizes the tendency of the paper to tear between perforations during each line feed advancement thereof.

In order to improve registration of the pins and paper, the pins are generally constructed with tapered profiles, and with the paper perforations ideally being slightly undersized. In this manner, and in conjunction with suitable paper hold-down members, it has been intended heretofore that the paper perforations would at all times be in substantially force-fit engagement with the respectively aligned pins so as to prevent any shift of the paper relative to the pins. Unfortunately, in practice, it has been found to be impractical, if not impossible, to manufacture both the tractor mounted pins (or sprocket teeth) and paper perforations with the requisite dimensions and spacings that will ensure no relative displacement therebetween.

As such, it is very important that continuous and controllable tension (or drag) be exerted on both perforated plain line fed paper, if not only jerking and tearing of the paper is to be prevented, but if positive and consistent line feed advancement of the paper is to be ensured at all times, regardless of the rate of advancement or the type of paper employed. Concomitantly, as there is also a tendency for a slight shifting or displacement of even perforated paper relative to the tractor drive pins or sprocket teeth because of tolerance variations, or a phase difference between the line feed and tensioning mechanisms, there is also a definite need for a simplified and reliable means for periodically firmly locking or gripping the paper during each line printing period of an operating cycle.

One approach taken heretofore to compensate for the inertia effect on the paper upon each line feed advancement thereof has been to utilize a specially constructed paper roll holder with a yieldable spring-biased pressure bar. One preferred type of such a tensioning assembly is disclosed in a commonly assigned copending application of R. S. Denley, Ser. No. 480,785, filed June 19, 1974. While such a tensioning mechanism substantially minimizes the jerking effect during each line feed advancement of the paper, it does not maintain a continuous tension or drag on the paper, and in no way grips or locks the paper in a fixed position during each line printing period of a print cycle.

In order to maintain a continuous tension on line fed paper, a spaced pair of sprockets or tractors have been employed heretofore as braking mechanisms, as distinguished from positive drive mechanisms. Such auxiliary mechanisms not only substantially increase the costs of the composite line feed mechanism, but substantially increase the required space therefor. Difficulties also arise in the adjusting of the braking sprockets or tractors so that they will track the positive line feed drive mechanism with a degree of tension that will not result in the paper jerking or tearing, particularly between perforations.

Still another technique employed heretofore to provide controllable paper tensioning without the need for auxiliary braking sprockets or tractors, has involved the use of a laterally disposed vacuum manifold, preferably with adjustable orifices, which can exert a controllable drag on the incrementally advanced paper whether perforated or not. Such apparatus, of course, also requires a vacuum pump or fan with a controllable auxiliary motor and necessary tubing to interconnect the pump and manifold. While such paper tensioning apparatus may be readily adjusted, such apparatus requires considerable space, and by being operated independently of the line feed mechanism, is quite expensive.

One further approach taken heretofore to provide tension in line fed perforated paper has been to utilize a pair of spaced rotatably driven members, each having a plurality of flexible fingers formed about the periphery thereof. The spring-like action of the flexible fingers is employed to control the amount of frictional force-established tension exerted on the paper as it passes by the fingers, which are rotated in the same direction, but at a faster rate than the paper on the forward side of the print station. While such a tensioning mechanism is of simplified construction, the tension exerted on the paper is not readily adjusted or variably controlled in any simplified manner. Such fingers also in no way facilitate the gripping or locking of the paper during each line printing period.

All of the above described mechanisms, with variable degrees of success have reduced the tendency of line fed paper to tear or excessively jerk or jitter as a result of rapid successive line feed advancements thereof. However, such prior mechanisms have in no way incorporated apparatus, preferably synchronized with the line feed mechanism, to prevent the aforementioned problem of the paper shifting relative to the print head (or hammers) during line printing. Such displacement of the paper can readily result in misalignment of the imprinted characters along a given print line.

One mechanism employed heretofore to hold the paper from shifting during printing has involved a pair of normally floating tractors, with a ratchet type star wheel and linkage mechanism associated therewith. The star wheel and linkage mechanism is employed to periodically lock the floating tractors during each line printing period. Such an apparatus, however, by being necessarily spaced an appreciable distance away from the sprocket feed, can very readily place detrimental stress on the pin coupled perforations in the paper, resulting in tearing of the paper, should there develop any phase difference in the time at which the floating tractors and drive sprockets start and stop, such as caused by mechanical tolerance variations or inertia effects. Such phase differences, of course, can also lead to a slight shifting or displacement of the paper at the print station during printing.

SUMMARY OF THE INVENTION

It, therefore, is an object of the present invention to provide a new and improved line feed tensioning and gripping apparatus for use in high speed printers which is of simplified, compact, rugged and inexpensive construction, synchronized with and controlled by the line feed mechanism of the printer, and which apparatus is readily amenable to spacing adjustments which the line feed mechanism so as to accommodate different widths of paper.

In accordance with the principles of the present invention, the above and other objects are realized in one preferred illustrative embodiment wherein a pair of spaced pinch cams with specially contoured peripheries are rotatably mounted on a drive spline which is also coupled to a spaced pair of line feed tractors. The pinch cams are preferably mounted near the rearward ends of and adjacent to the inner sides of the respectively associated tractors.

Each of a pair of pinch rollers is mounted adjacent to a different pinch cam so that the peripheries thereof are mutually disposed. The pinch rollers are preferably formed with at least their outer surfaces being made of a resilient material, such as hard rubber, and are preferably rotatably mounted in such a manner as to establish a pre-adjusted degree of frictional force opposing their rotation.

In accordance with the principles of the present invention, the periphery of each pinch cam is formed with a plurality of uniformly spaced and alternately disposed ridges and recesses. The dimensions of the ridges and recesses of each pinch cam are chosen relative to the diameter and spacing of the associated pinch roller, such that a web or paper fed therebetween is only periodically gripped, namely, just prior to and during the quiescent period after the completion of each successive line feed advancement of the paper and momentarily at the start of the following line feed. With the pinch rollers preferably being pre-loaded, whenever the pinch cams, in response to the rotation of the common drive spline, release the respectively associated pinch rollers, the latter establish a predetermined drag or tension on the line feed advancing paper.

Advantageously, however, just before such tension is established, the initial positive advancement of the paper by the pinch cams and pinch rollers, by reason of having no mechanical interplay therebetween, can never present an undesired or detrimental drag on the paper as a result of advancing the paper at a slower rate than the tractors. If anything, the engaging pinch cams and pinch rollers ensure an initial positive advancement of the paper at the beginning of each line feed which momentarily reduces the tension on the paper until any slight displacement between the tractor feed pins and the perforations in the paper are taken up.

In this manner, the tendency of the paper to often tear heretofore, due to the otherwise sudden jerking thereof by the engaging tractor feed pins, at the start of each successive line feed is substantially minimized, if not completely eliminated. Significantly, however, after the pinch rollers have been released from positive rotation by the respectively associated pinch cams, they gradually re-establish a maximum predetermined tension on the paper, which causes the pins, if not then

in proper registration with the aligned perforations, to again acquire such registration, i.e., with the forward peripheral edge portions of the perforations being firmly biased against the forward sides of the drive pins. Such desired registration will then remain not only until a given line feed advancement of the paper has been completed, but during the entire subsequent line printing period, as the then engaging pinch cams and pinch rollers allow no displacement of the paper relative to the tractors.

It is apparent, of course, that if other apparatus is employed in a given printer to effect line tensioning, or if the speed of printing or the type of paper does not require precise control oveer paper tensioning, the pinch rollers may simply be allowed to freely rotate when not engaged by the associated pinch cams so as to still provide reliable, synchronized, periodic gripping of the paper during the printing.

It is thus seen that the unique tensioning and gripping functions described above are accomplished with the same structural elements, namely, two pairs of pinch cams and pinch rollers, the operation of which is advantageously controlled by, and synchronized with, the operation of the line feed mechanism. Such apparatus advantageously is not only of simplified, rugged and inexpensive construction, but by being very compact, the apparatus may be readily mounted in the printer and driven in a manner so as to in no way interfere with the operation of the tractors (or sprocket feed), or the spacing thereof for variable width papers.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an enlarged, partial front elevational view of an illustrative impact printer line feed mechanism, with a number of parts being omitted for the purpose of illustrating a unique, variable paper tensioning and gripping apparatus incorporated therein and embodying the principles of the present invention;

FIG. **2** is an enlarged, partial perspective view, partly broken away, showing in greater detail the relationship between the variable paper tensioning and gripping apparatus associated with one of the illustrative line feed tractors depicted in FIG. **1**;

FIG. **3** is a fragmentary side elevational view of one pinch cam roller, and the manner in which it is mounted so as to establish an adjustable degree of rotational friction to tension a paper advanced thereover;

FIG. **4** is an enlarged, side elevational view, taken along the line **4—4** of FIG. **1**, showing in greater detail the positional relationship between the pinch cam and pinch roller of the variable paper tensioning and gripping apparatus embodied herein, relative to the common drive spline, associated line feed tractor, including the endless pin carrying belt, and a perforated paper advanced thereby;

FIGS. **5–7** are enlarged, fragmentary detail views of different angular positions of one of the two pairs of pinch cams and pinch rollers of the paper tensioning and gripping apparatus, relative to the perforated paper advanced therebetween, at different periods of time in order to effect different work functions on the paper, and

FIG. **8** is a graph illustrating the variable tension exerted on the paper during a given line feed advancement thereof in accordance with one preferred embodiment of the tensioning and gripping apparatus.

DETAILED DESCRIPTION OF THE INVENTION

Background of the Associated Line Feed Mechanism

As previously mentioned, the variable paper tensioning and periodic gripping apparatus as embodied herein has universal application, but for purposes of illustration, it is disclosed herein in connection with the previously identified line feed mechanism **10**, particularly adapted for use with printers and the like, and comprising a pair of tractors **11, 12** for line feeding a perforated web **17**, such as paper in roll stock or pleated form. As the tensioning and gripping apparatus embodied herein is only associated directly with the line feed mechanism **10**, no details of the associated printer mechanism per se are required in order to appreciate and fully understand the unique features and significance of the present invention.

With attention particularly directed first to FIGS. **1** and **2**, it is seen that the previously identified tractors **11** and **12** of the line feed mechanism **10** are spaced apart and mounted on a drive spline **18** and a support shaft **19**. The drive spline is suitably journaled for rotation near the opposite ends thereof in side plates **21, 22** (only partially shown) comprising part of the printer frame. As the support shaft **19** need not rotate, it is preferably fixedly secured in any suitable manner to the side plates **21, 22**. An outer extension of the drive spline **18** has a pulley **23** mounted thereon, so as to allow the spline to be rotated and, thereby, drive the tractors through a belt or chain, for example, coupled to an appropriate drive source, such as a motor (not shown).

The tractors, of course, are designed to incrementally advance the perforated paper one or more line spaces at a time past a print head or an array of hammers (neither shown) of a printer. In this connection, it should be appreciated that the tractors **11, 12** are merely illustrative of one of a number of conventional and commercially available types applicable for use in conjunction with the tensioning and gripping apparatus embodied herein.

With particular reference now to FIGS. **2** and **4**, it is seen that each of the illustrative tractors, such as **11**, for example, is formed with a recessed orbital channel **24**, defined at least in part by juxtaposed undercut shoulders (not shown) formed in two mutually disposed side members **26, 27**. An endless belt **28**, with a plurality of uniformly spaced and tapered feed pins **29** secured thereto, is driven along the channel **24** by engagement with a spline receiving drive wheel **31**, suitably journaled within aligned spertures formed in the side members **26, 27** of the tractor. It is obvious, of course, that the drive wheel could be coaxially mounted on a spline bushing, or formed as an integral part thereof, with either a plane, frictional periphery (as shown), or a sprocket toothformed periphery, for engaging the belt **28**.

A pivotal spring-biased cover **32** is hinged to a bracket **33** (FIG. **2**), secured to the side member **26**, so as to allow the drive pins **29** of the laterally spaced endless belt **28** to be brought into alignment with the perforations **17***a* (FIG. **1**) formed in and extending along each marginal edge of the paper. Thereafter, upon the spring-biased cover **32** being closed, to the position depicted in FIGS. **2** and **4**, under the spring bias of a coil spring **36**, the underside of the cover urges the interposed paper downwardly against the base of the ta-

pered pins. This ideally establishes a force-fit relationship between the peripheral edges of the perforations and the peripheral base regions of the aligned pins. Because of tolerance variations, however, such force-fit registration is not always possible, and for that reason a paper tensioning mechanism is normally required to minimize displacement between the paper and the belt supported pins of the tractors.

It is to be understood, of course, that in addition to the spline-receiving drive wheel **31** employed in each tractor, the belt **28** may either be entrained at the opposite end of its orbital path about an idler wheel or sprocket (neither shown), or simply be driven about a stationary, semi-circular end portion of the channel **24,** formed by the mutually disposed side members **26, 27.** As for the cover **32,** it may take any one of a number of other suitably contoured forms, and may be mounted in any one of a number of ways well known in the art for the purpose intended.

One particular tractor of the type generally depicted herein, and which is readily applicable for use with the tensioning and gripping apparatus of the present invention now to be described is disclosed in U.S. Pat. No. 3,825,162, issued to Leo J. Hubbard on July 23, 1974.

Variable Line Feed Tensioning and Periodic Gripping Apparatus

With particular attention directed first to FIGS. **1** and **2,** it is seen that the variable paper tensioning and gripping apparatus with which the present invention is primarily concerned is identified generally by the reference numeral **35,** and comprises a specially contoured pinch cam **37** and a periodically mating pinch roller **39** associated with each of the tractors **11, 12.** As the two sets of pinch cams and pinch rollers are of identical construction, reference will generally be made to only one set hereinafter. As best seen in FIG. **2,** the pinch cam **37,** preferably made of steel, is positioned closely adjacent the side member **27** of the associated tractor **11,** and is mounted on and fixedly secured to the drive spline **18** by any suitable means, such as a set screw **41** threaded in an undercut and integral pinch cam extension **42.** As thus mounted, the pinch cam **37** is positively rotated during each successive line feed in synchronism with the associated tractor wheel **31.**

The outer periphery of each pinch cam **37** is formed to have a scalloped contour which defines a plurality of uniformly spaced recesses **37***a* and raised ridges or crests **37***b*. The dimensions and spacings of these recesses and ridges are chosen so as to cooperate with the adjacent pinch roller **39** in a unique manner which will be described in further detail hereinbelow.

The pinch roller **39** may be made of steel, but in one preferred embodiment is constructed with at least a resilient outer annular surface, such as of hard rubber. The pinch roller is positioned adjacent to the associated pinch cam **37** so that the outer peripheral surfaces thereof are in mutually disposed relationship. To accomplish this, the pinch roller **39** is preferably positioned within a recessed or notched area **32***a* of the spring-biased pivotal cover **32** of the associated tractor **11.** The pinch roller is rotatably supported within the recessed area **32***a* by a stub shaft **44** that is suitably secured to the cover **32,** such as by being force-fit or threaded within a bore or tapped hole (see FIG. **3**) that communicates with the base of the recess **32***a*.

In accordance with the principles of the present invention, each pinch roller **39** in one preferred embodiment is preferably adjustably pre-loaded so as to produce a controlled amount of frictional force opposing the rotation thereof. As illustrated in FIGS. **2** and **3,** this force in one preferred embodiment is readily accomplished through the use of two mating washers **47,** 48, and a helical coil spring **51** interposed between the washer **48** and a washer **52** abutting a threaded nut **53** adjustably mounted on the threaded end of the stub shaft **44.** The washer **48** is preferably formed with a protruding key (not shown) that is received within an undercut keyway **44***a* (FIG. **3**) formed in the stub shaft **44.** As such, once the threaded nut **53** has been adjusted to exert the desired spring-biased force of the spring **51** against the washer **48,** the primary frictional force that must be overcome to rotate the pinch roller **39** is established by the relative movement between the freely rotatably washer **47** and the stationary washer **48.** It, of course, becomes readily apparent that the desired rotational frictional force exerted against each pinch roller **39** may be established between a single non-rotatable washer, such as **48,** and the mating end surface of the pinch roller **39.**

Another alternative means of adjustably spring loading each pinch roller **39** is disclosed in FIG. **4,** wherein a simple, resilient, flat springs **55,** shown in phantom, may be employed. Such a spring is preferably formed out of suitable sheet stock material, and bent into the configuration illustrated so that an arcuate intermediate portion thereof makes adjustable spring-biased contact with the outer periphery of the pinch roller **39.** With the flat spring **55** formed so that at least one, but perferably both ends thereof normally extend outwardly away from the adjacent surface of the cover **32,** two threaded fastening screws may be readily employed to adjust the rotational frictional force exerted by the spring against the associated pinch roller **39.** The purpose and function of such adjustable pre-loaded pinch rollers **39** will become more readily apparent in connection with the mode of operation of the paper tensioning and periodic gripping apparatus described hereinbelow.

A significant and important aspect of the present invention is that the tensioning and gripping apparatus, with or without pre-loading of the pinch cams, will never exert a detrimental tension on the paper, particularly at the beginning of a given line feed, which could otherwise cause tearing of the paper between the feed pin engaging perforations. Should this happen, of course, the paper could be displaced longitudinally relative to the feed pins so as to impair line space uniformity.

The present apparatus prevents any tearing of the paper by not only firmly gripping the paper and holding it stationary during each line printing period, but by producing a buffer effect at the beginning of each line feed. More specifically, the unique pinch cams **37** and pinch rollers **39,** at the start of each line feed, not only are firmly gripping the paper at that time, but for a momentary period thereafter, the then positively rotated pinch cams effect reliable positive feeding of the paper over a fractional part of one line space independently of the tractors. Accordingly, during that period of initial advancement of the paper, the pinch cams and pinch rollers by being interposed between the tractors and the supply roll of paper, prevent the engaging feed

pins of the tractors from ever abruptly jerking and, thereby possibly tearing the paper between the pin engaging perforations.

Moreover, the momentary positive driving force effected by the pinch cams **37** and pinch rollers **39** at the start of each line feed allows any tolerance variations that exist in the drive unit of the tractors, as well as any displacement of the feed pins due to the somewhat flexible manner in which they are normally mounted on the endless belt, to be taken up gradually as the pinch cams rotate out of engagement with the paper. It is because of such inherent play in the tractors, of course, that they could never initially advance the paper at a faster rate than the engaging pinch cams and pinch rollers, all of which are at least initially responsive to the rotation of the common drive spline **18.**

The significant functions of the pinch cams **37** and pinch rollers **39** can best be appreciated by reference to the graph of FIG. **8,** wherein it is seen that the tension exerted on the paper will normally decrease only slightly, if at all, from a predetermined maximum at the start of each successive line feed, to a minimum tension generally depicted by the dash-lined curved segments **61,** in the region defined by the angular rotation of the pinch cams **39** designated α_1 (also identified in FIG. **5**). Considering even a worst case situation, involving appreciable mechanical play in the tractors and/or appreciable tolerance variations in the feed pin-paper hole diameters, the tension on the paper would normally never decrease to zero, but rather, to some intermediate tension at the start of a given line feed, such as represented by the dotted line curve segments **62** in FIG. **8.** In any case, however, the tension exerted on the paper will always increase to the maximum desired value as depicted by the solid line curve in FIG. **8** before each line feed has been completed.

After the pinch cams **37** are rotated out of engagement with the paper **17,** only the pinch rollers **39** then engage the advancing paper **17,** as depicted in FIG. **6,** and, if they are pre-loaded, will independently control the maximum desired tension exerted on the paper during the major line feed portion of angular rotation of the pinch cams designated α_2 (also identified in FIG. **6**). Near the completion of the angular rotation α_2, a new raised ridge **37***b* of each pinch cam is rotated into engagement with the paper **17,** just after rotating beyond the position depicted in FIG. **7** in the direction of the arrow.

From that point in time until the completion of a given line feed, the mating pairs of pinch cams **37** and pinch rollers **39** firmly grip the respective marginal edges of the paper **17,** and with the paper then being maintained under the desired maximum tension, positively advance the paper in precisely phased relationship with the tractors until both are stopped by the common drive spline **18.** As such, the paper will always remain under the then established tension, whether attributable to the pinch rollers being pre-loaded, or to other means, during not only the last portion of angular pinch cam rotation, designated α_3 in FIGS. **7** and **8,** but during the quiescent line printing period.

With the advancement of the paper controlled in the unique manner described above, it is seen that precise registration of the paper relative to the feed pins is always assured during line printing, regardless of not only any tolerance variations that may exist in the drive elements of the tractors, but regardless of the thickness dimension of the perforated paper, or the number of plies thereof.

In order to accomplish the unique type of precisely synchronized variable line feed tensioning and periodic gripping of the paper described herein, the recesses **37***a* and ridges **37***b* must be specially formed in the outer periphery of each pinch cam. More specifically, these spacings and ridges must be dimensioned and spaced in each pinch cam not only relative to each other, but relative to the periphery of the adjacent pinch roller **39,** such that the pinch cams and pinch rollers positively engage the paper interposed therebetween for only a short predetermined period of time near the end of one line feed advancement of the paper, and for a short predetermined period of time at the beginning of the next advancement of the paper. This, of course, also requires that the diameter of each pinch roller **39,** as well as the distance between the axes of each pinch roller and the aligned pinch cam, also be properly chosen in relation to the dimensions of the recesses **37***a* and ridges **37***b* in each pinch cam. To a lesser extent, the degree of resiliency exhibited by the outer surface of the pinch rollers must also be taken into account.

These factors, of course, are readily determined by simply laying out the maximum diameter profiles desired for the pinch cams and pinch rollers, bearing in mind the requisite center line-to-center line distance between adjacent pinch cam ridges **37***b* dictated by the degree of angular rotation required by the drive spline to effect one line space advancement of the paper.

As previously mentioned, should a given printer utilize a separate paper tensioning mechanism, or if the line feed rate for the type of paper employed should not require any special paper tensioning in a given printer, or printing application, the pinch rollers **39** may simply be operated in a freely rotatable manner. In that event, the very important functions of the paper being periodically firmly gripped in a precisely synchronized manner during line printing, and momentarily positively advanced at the start of each line feed, would still be effected by the two pairs of pinch cams and pinch rollers embodied herein.

In summary, a paper tensioning and gripping apparatus has been described herein which is particularly adapted for use in conjunction with conventional sprocket or tractor line feed mechanisms. This apparatus also periodically firmly grips and fixedly holds the paper in the immediate region of the print station during each line printing period of the print cycle so as to always ensure uniform alignment of the print characters along each print line. The apparatus, with preloaded pinch rollers, advantageously may also be employed to control the desired tension exerted on the paper during each successive line feed advancement thereof in a manner that ensures continuous and reliable tractor pin-paper hole registration, even when appreciable tolerance variations may exist therebetween, as well as in the drive elements of the tractors. With or without pre-loaded pinch rollers, the tensioning and gripping apparatus further acts as a buffer and a momentary positive paper drive between the line feed tractors and the paper supply so as to eliminate any tendency of the feed pins to tear the paper at the start of each successive line feed. Finally, the tensioning and gripping functions are advantageously accomplished with the same simplified, rugged and compact structural elements, with the operation thereof being con-

trolled by and synchronized with the operation of the line feed mechanism.

In view of the foregoing, it is obvious that various modifications may be made to the present illustrative embodiments of the invention, and that a number of alternatives may be provided without departing from the spirit and scope of the invention.

What is claimed is:

1. In an apparatus including a mechanism for alternately advancing a web a predetermined distance, and for stopping the web for a predetermined period, with both normally occurring in a relatively rapid, repetitive manner, the combination further comprising:

an assembly for firmly gripping and holding a web in a fixed position during those periods when not positively advanced, said assembly including:

cam means coupled to and movable in response to actuation of said web advancing mechanism, said cam means having a plurality of alternately spaced protuberances and arcuate recesses formed along the periphery thereof, said cam means being positioned adjacent to the web so that at least one protuberance thereof is moved along an arcuate path into periodic contact with one side of said web:

means for causing the time of periodic contact to coincide with said predetermined period, and

web engaging means positioned on the side of the web opposite said cam means, and in alignment with the latter, the position and dimensions of said web engaging means being chosen relative to the path of movement of, and the dimensions of the recesses and protuberances in, said cam means such that when each successive protuberance of said cam means is brought at least into its closest proximity with said web engaging means, the web is firmly gripped therebetween.

2. In an apparatus including a mechanism for alternately advancing a web a predetermined distance, and for stopping the web for a predetermined period, with both normally occurring in a relatively rapid, repetitive manner, the combination further comprising:

an assembly for maintaining tension on a web while being advanced, and for firmly gripping and holding the web in a fixed position under tension during those periods when not positively advanced, said assembly including:

rotatable cam means coupled to and rotated in response to actuation of said web advancing mechanism, said cam means having a plurality of alternately spaced protuberances and arcuate recesses formed along the periphery thereof, said cam means being positioned so that at least one protuberance thereof is moved along an arcuate path into contact with one side of the web:

means for causing the time of periodic contact to coincide with said predetermined period, and

rotatable web engaging and tensioning means positioned in contact with the side of the web opposite said rotatable cam means, and in alignment with the latter, the axis and dimensions of said web engaging and tensioning means being chosen relative to both the axis of, and the dimensions of the recesses and proturberances in, said rotatable cam means such that when each successive protuberance of said cam means is moved at least into its closest proximity with said rotatable web engaging and tensioning means, the web is firmly gripped therebetween.

3. In an apparatus in accordance with claim **2**, said rotatable cam means comprising at least two rotatable pinch cams adjustably mounted on a common drive shaft coupled to said web advancing means, said pinch cams being spaced apart so as to coincide with opposite marginal edge regions of the web, and said rotatable engaging and tensioning means comprising at least two rotatable pinch rollers respectively aligned with said pinch cams.

4. In an apparatus in accordance with claim **3**, said common shaft comprising a spline shaft which allows said pinch cams mounted thereon to be adjustably spaced for different web widths, and said web advancing mechanism comprising a spaced pair of tractors, with belt carried feed pins, coupled to and adjustably spaced along said spline shaft for advancing a web having a row of perforations formed along and near each marginal edge thereof, with the perforations being dimensioned and spaced for registration with said aligned drive pins.

5. In a printer including a line feed mechanism for alternately advancing a web at least one predetermined line space at a time, and for stopping the web for a predetermined line printing period, with both normally occurring in a relatively rapid, repetitive manner, the combination further comprising:

an assembly for maintaining tension on said web while being advanced, and for firmly gripping and holding said web in a fixed position under tension during each line printing period, said assembly including:

rotatable pinch cam means coupled to and rotated in response to an actuation of said line feed mechanism, said pinch cam means having a plurality of spaced protuberances with arcuate peripheral wall portions, each having a common maximum radius, with adjacent protuberances being separated by arcuate recesses so as to define a scalloped periphery, said pinch cam means being positioned adjacent to the web so that the arcuate peripheral wall portion of at least one protuberance thereof periodically contacts one side of said web, and moves in the same direction as said web when said web is moving:

means for causing the time of periodic contact of said at least one protuberance to coincide with said predetermined period, and

rotatable pinch roller tensioning means positioned in contact with the side of the web opposite said pinch cam means, and being in alignment with the latter, the axis and dimensions of said rotatable pinch roller tensioning means being chosen relative to both the axis of, and the dimensions of said recesses and protuberances in, said pinch cam means such that when each successive arcuate peripheral wall portion of said pinch cam means is rotated at least into its closest proximity with said pinch roller tensioning means, defined by a plane bisecting the axes thereof, said web is firmly gripped under tension therebetween.

6. In a printer in accordance with claim **5**, said rotatable pinch cam means comprising at least two rotatable pinch cam adjustably mounted on a common drive shaft coupled to said line feed mechanism, said pinch cams being spaced apart so as to coincide with opposite

marginal edge regions of the web, and said pinch roller means comprising at least two rotatable pinch rollers and tensioning respectively aligned with said pinch cams, and with each having at least a resilient peripheral surface.

7. In a printer in accordance with claim **6,** said assembly further including adjustable spring biasing means for loading each of said pinch rollers so as to control the amount of tension exerted on a web while the latter is being advanced and drawn over said pinch rollers without being positively engaged by said rotatable pinch cams.

8. In a printer in accordance with claim **7,** the width of the arcuate peripheral portion of each of said protuberances formed in each of said pinch cams, as measured along the circumference thereof, being sufficiently great to cause each successive protuberance to be brought into contact with, and pinch said web firmly against the aligned one of said pinch rollers for short predetermined periods of time at the end of and at the beginning of the line feed advancement periods respectively preceeding and following each predetermined line printing period, whereby said pinch cams and pinch rollers not only firmly grip the web, but positively advance the web independently of said line feed mechanisms.

9. In a printer in accordance with claim **8,** said common shaft comprising a spline shaft which allows said pinch cams mounted thereon to be adjustably spaced for different web widths, and said line feed mechanism comprising a spaced pair of tractors, with belt carried feed pins, coupled to and adjustably spaced along said spline shaft for advancing a web having a row of perforations formed along and near each marginal edge thereof, with the perforations being dimensioned and spaced for registration and with aligned drive pins.

10. In a printer including a type character print mechanism and a line feed mechanism for alternately advancing a web at least one predetermined line space at a time, and for stopping the web for a predetermined line printing period, with both normally occurring in a relatively rapid, repetitive manner, the combination further comprising:

an assembly for applying adjustable tension on said web while being advanced, and for firmly gripping and holding said web in a fixed position under tension during each line printing period, said assembly including:

a pair of rotatable pinch cams coupled to and rotated in response to the actuation of said line feed mechanism, said pinch cams being spaced apart so as to be respectively positioned near the opposite longitudinal edges of said web in the immediate area of said print mechanism, said pinch cams each having a plurality of spaced protuberances with arcuate peripheral wall portions, each having a common maximum radius, with adjacent protuberances being separated by arcuate recesses so as to define a scalloped periphery, each of said pinch cams being positioned adjacent to said web such that the arcuate peripheral wall portion of at least one protuberance thereof contacts one side of said web and moves in the same direction as said web when said web is moving:

means for causing the time of periodic contact of said at least one protuberance to coincide with said predetermined period, and

a pair of rotatable pinch and tensioning rollers, each having at least a resilient peripheral surface, respectively positioned in contact with the side of said web opposite a different one of said pinch cams, and being in alignment with the latter, the axis and dimensions of each rotatable pinch and tensioning roller being chosen relative to both the axis of, and the dimensions of said recesses and protuberances in, said associated pinch cam such that when each successive arcuate peripheral wall portion of said associated pinch cam is rotated at least into its closest proximity with said aligned pinch and tensioning roller, defined by a plane bisecting the axes thereof, said web is firmly gripped under tension therebetween.

11. In a printer in accordance with claim **10,** said rotatable pinch cams being mounted on and adjustably spaced along a common, laterally disposed drive spline, and said line feed mechanism comprising a spaced pair of tractors, with belt carried feed pins, coupled to and adjustably spaced along said spline shaft for advancing a web having a row of perforations formed along and near each marginal edge thereof, with the perforations being dimensioned and spaced for registration with said aligned drive pins.

12. In a printer in accordance with claim **11,** each of said rotatable pinch and tensioning rollers being mounted on a stub shaft secured to a pivotal housing member of a different one of said tractors.

13. In a printer in accordance with claim **12,** the pivotal housing member of each of said tractors comprising a spring biased hold-down plate for the web passing thereunder, said plate when in its normal position spring biasing the one of said pinch and tensioning rollers supported thereon to the desired position relative to said associated pinch cam, and with each of said pinch and tensioning rollers being adjustably spring loaded so as to control the tension exerted on said web at least during the major portion of the time when said web is advanced thereover.

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