

[54] **SLITTER/PERFORATOR APPARATUS**

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[56] **References Cited**

UNITED STATES PATENTS

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3,570,335 3/1971 Marin 83/482 X

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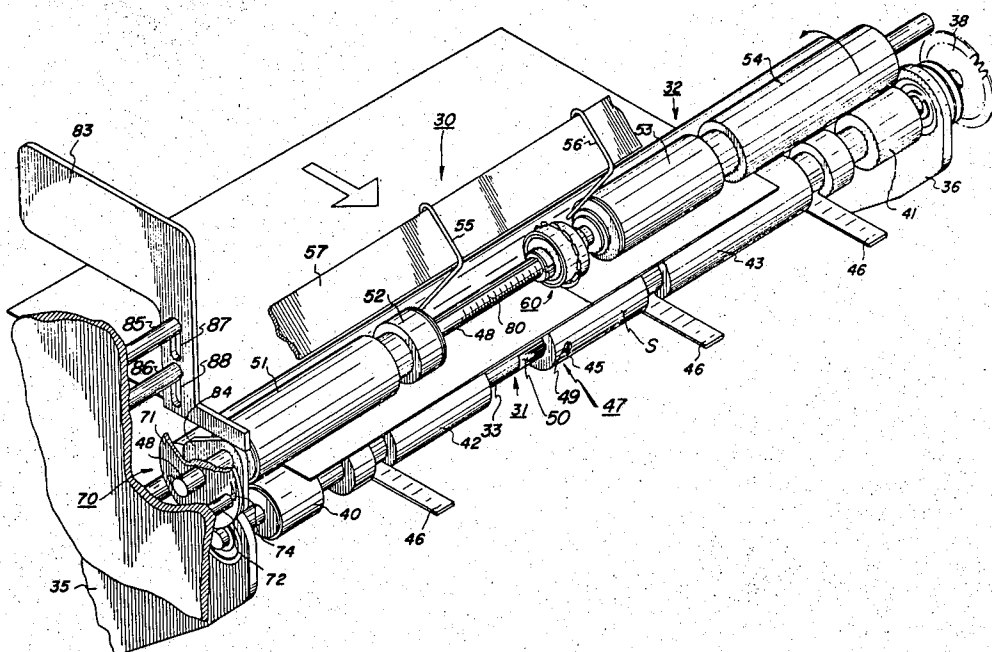
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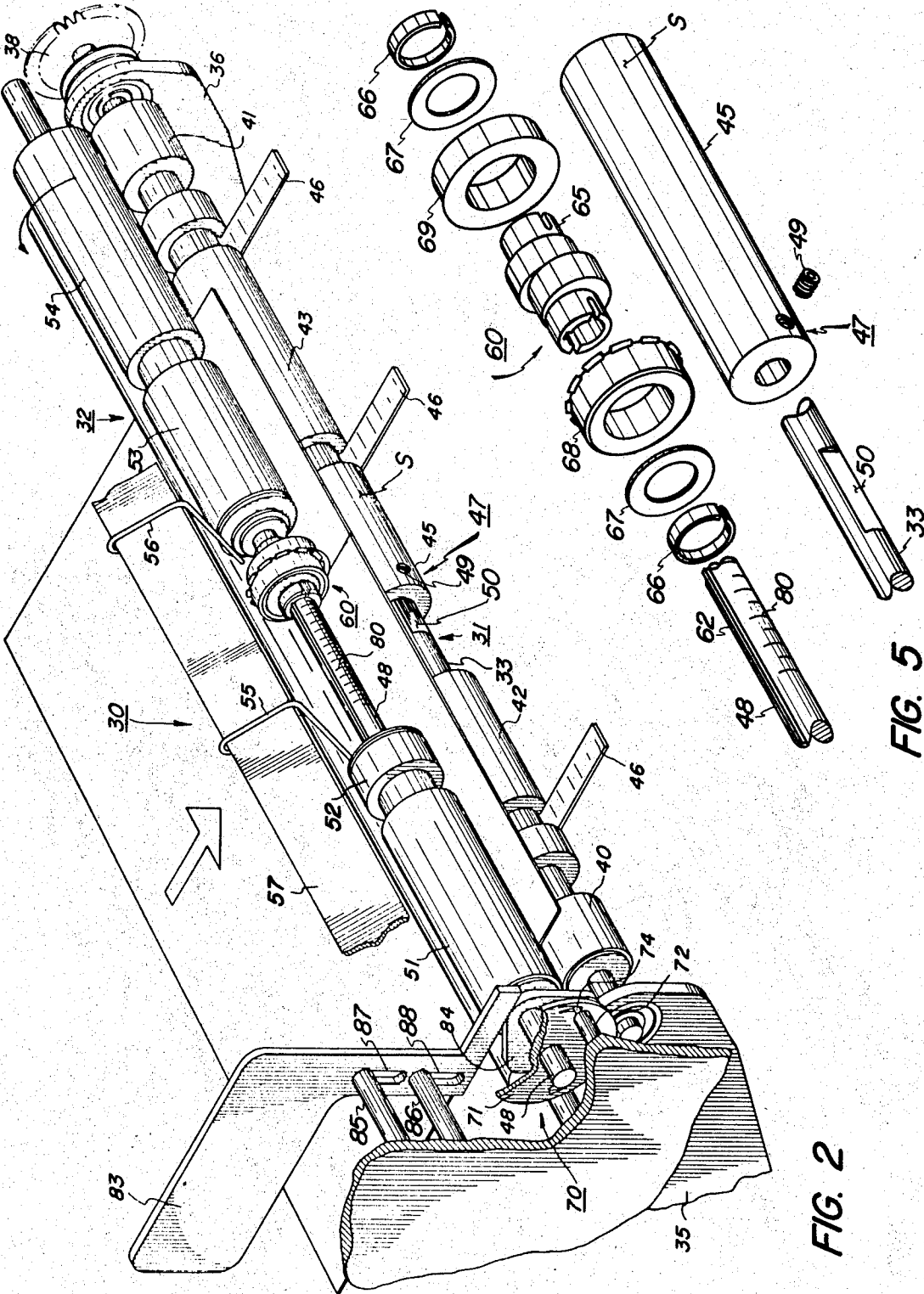
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ABSTRACT

Apparatus for cutting or perforating a sheet of material that is moving through a pair of cooperating sheet advancing rolls along a predetermined path of travel. A cutting blade and a perforating blade are eccentrically mounted upon one of the advancing roll support shafts. The blades are arranged so as to be positionable whereby one of the blades can be extended into the sheet path of travel to act upon a sheet moving therealong or, alternatively, both blades can be retracted out of the path of travel to allow a sheet in process to pass untreated through the advancing roll assembly. Preferably the blade backing roller is adjustable to compensate for wear.

18 Claims, 5 Drawing Figures





SLITTER/PERFORATOR APPARATUS

This application is a continuation-in-part of our prior U.S. application, Ser. No. 317,029 filed Dec. 20, 1972, now abandoned.

This invention relates to a sheet cutting apparatus and, in particular, to a sheet cutting device suitable for use in an automatic copying machine.

With the advent of xerography, the copier field has expanded greatly bringing with it a demand for more sophisticated equipment, particularly equipment capable of performing many widely diverse sheet handling and cutting tasks. In particular there exists a need for a relatively simple and compact sheet cutting mechanism which, upon demand, can either slit or perforate a copy sheet to a predetermined size or, alternatively, permit the copy sheet to pass through the machine in an untreated manner.

Most existing cutting devices involve rotary slitter blades that are mounted in abutting relation with a cooperating blade backing member, as exemplified by the cutting device disclosed in U.S. Pat. No. 3,182,541. Conventionally, this type of cutting device is present with the blade accurately positioned in relation to the backing member. In this arrangement, the allowable working tolerance between the two coacting elements is extremely small. A dulling of the blade, due to excessive pressure, will result if the blade is placed too closely to the backing member. On the other hand, frequent misses are experienced when the blade is positioned too far out of contact with the backing member.

A new approach to sheet cutting, which alleviates some of these difficulties, has been devised and is more fully disclosed in U.S. Pat. No. 3,402,628. Here, a rotatable cutting blade is mounted in the machine with the blade extending perpendicular into the prescribed path of movement of a copy sheet to be acted upon. The blade is spring biased into contact with a continuously rotating backing roller constructed of an elastomeric material in a manner wherein the blade is caused to turn with the roller. In operation, the backing roller is rotated in the direction of sheet travel and the sheet passed between the blade and the backing roller thus producing a clean, even and more uniform cut. Because of the arrangement of the blade and the backing roller, the wear upon the cutting element is also considerably reduced.

Notwithstanding the advances that have been made in the paper cutting art, all the prior art devices exhibit similar shortcomings in that they fail to provide a rapid and efficient means by which the operator can change from a sheet cutting function to a sheet perforating function or, alternatively negating both the cutting or perforating functions entirely. Furthermore, these prior art devices are found to be space consuming because of the relatively bulky structure required to carry out the cutting operation and, because of the structural complexity involved, cannot be readily adapted for use in a normal machine environment.

It is therefore an object of this invention to improve sheet cutting and perforating apparatus for use in automatic copying machines.

A further object of this invention is to provide a sheet cutting and perforating device for use in an automatic copying machine which can conveniently perform a multiplicity of functions upon demand.

A still further object of this invention is to provide an interchangeability of sheet cutting function within a copying machine without having to replace the blade element involved.

Yet another object of this invention is to provide a sheet cutting apparatus which can be conveniently incorporated into existing copying devices.

Another object of this invention is to minimize the amount of space required of a sheet cutting and perforating apparatus.

Another object of this invention is to provide an apparatus as above preferably including an adjustable blade backing roller.

These and other objects of the present invention are attained by a sheet cutting mechanism including a cutting blade and a perforating blade eccentrically mounted upon one support shaft of a sheet advancing roll assembly, a backing roller preferably axially adjustable, mounted upon the opposite shaft of the assembly, and means to selectively position the cutting mechanism upon its support shaft whereby a sheet passing through the advancing roll assembly is cut when this device is in a first position, perforated when in a second position and remains untreated when in a third position.

For a better understanding of the invention as well as other objects and further features thereof, reference is had to the following detailed description of the invention to be read in connection with the accompanying drawings, wherein:

FIG. 1 is a schematic representation of an automatic xerographic reproducing machine incorporating the apparatus of the present invention;

FIG. 2 is a partial perspective view of the sheet cutting mechanism of the present invention as employed in the machine illustrated in FIG. 1;

FIG. 3 is a perspective view of the blade supporting implement used in the sheet cutting mechanism of the present invention.

FIG. 4 is an end view of the blade supporting implement of FIG. 3.

FIG. 5 is an exploded perspective view of the apparatus of the present invention.

Referring now to FIG. 1 there is shown an automatic xerographic reproducing machine incorporating the sheet slitting and perforating mechanism of the present invention. The copying machine illustrated employs an image recording drum member 10 having an outer surface thereon coated with a suitable photoconductive material 11 thereon capable of supporting a latent electrostatic image. Materials such as selenium or the like, which are well known and used in the art, can be conveniently used herein. The drum, which is journaled for rotation in the machine frame by means of a shaft 12, is rotated in the direction indicated thereby transporting the photoconductive recording surface through a plurality of xerographic processing stations. Although not shown, it is understood that suitable means are also provided for driving and coordinating the movement of the various machine components whereby a faithful rendition of the original input scene information is recorded on the drum surface and later transferred to a sheet of final support material.

Since the practice of xerography is well known in the art, the various processing stations for producing a copy of the original are herein represented in FIG. 1 as a series of blocks delineated A through E. At station A,

an electrostatic charge is uniformly placed upon the photoconductive drum surface preparatory to the surface receiving a light image of the original to be reproduced. The charged drum surface is then moved through an exposure station B containing a scanning apparatus for recording a flowing light image of an original 13 upon the moving drum surface. As a result of this imaging operation, the charge supported on the drum surface is selectively dissipated in the light exposed regions thereby recording the original input scene information on the photoreceptor surface in the form of a latent electrostatic image.

Next, in the direction of drum rotation, the image bearing plate surface is transported through a developing station C wherein toner material is applied to the charged drum surface thereby rendering the latent electrostatic image visible. The now developed image is brought into contact with a sheet of final support material, such as paper or the like, within a transfer station D wherein the toner image is electrically transferred from the photoconductive surface to the contacting side of the final support sheet. Finally, any residual toner material remaining on the drum surface after the completion of the transfer operation is cleaned from the photoreceptor within a cleaning station E thus placing the plate in a condition to be once again reused in the xerographic process.

It is herein contemplated that the sheets of final support material processed in this automatic machine will be stored within the machine frame by means of a removable paper cassette 15. It is further contemplated that the automatic reproducing machine will also have a capability of accepting and processing copy sheets of various lengths, the length of the sheet processed primarily being dictated by the size of the original input scene information to be reproduced. In operation, the individual sheets of support material are placed in a stack configuration within the cassette from which the sheets are advanced into and through the transfer station D in synchronous moving relationship with a visible xerographic toner image on the plate surface. Sheet feeding is accomplished by means of a feed roller 16 and a sheet registering device 17. The sheet roller acts to separate the uppermost sheet from the stack and advance the separated sheet into the registering mechanism 17. Here, the motion of the leading edge of the sheet is momentarily interrupted while the sheet is properly aligned and registered with the image recorded on the drum surface prior to advancing the sheet through the transfer station D wherein the image is placed upon the copy sheet in the manner described above.

Upon the completion of the transfer operation, the image bearing sheet of support material is forwarded to a xerographic fusing station F via a conventional vacuum transport means 18 or any suitable transport means which is known and used in the art. Within the fusing station, the xerographic toner image is heated to a temperature sufficient to fix the toner to the support material thereby forming a permanent record of the input scene information. Although any number of well known fusing techniques can be employed to produce the desired image fixing, a radiant heat fuser 19 is herein shown for explanatory purposes.

Upon leaving the fuser, the fixed copy sheet is engaged by a first pair of cooperating advancing rollers, generally referenced 20, which forward the sheet along

a predetermined path of travel, described by guide plate 21, into a second advancing roll assembly 30 embodying the sheet cutting and perforating mechanism of the present invention, the operation of which will be explained in further detail below. Upon leaving the second advancing roll assembly 30, the copy sheets are directed into a collecting tray 22 where the sheets are stored subject to their removal from the machine.

The cutting and perforating apparatus of the present invention will now be described in greater detail by reference to FIGS. 2 through 5. FIG. 2 represents a perspective view of the cutting mechanism of the present invention with the cutting mechanism placed in a condition to produce a continuous slit in a sheet of paper passing through the feed roll advancing assembly 30.

As shown, the lower advancing roll sub-assembly 31 is mounted upon a support shaft 33 which is journaled for rotation at both ends in support brackets 35, 36. The left hand end of the shaft 33, as seen in FIG. 2, extends beyond the support bracket 36 and has a drive sprocket 38 affixed thereto. The drive sprocket is operatively connected, via a chain which is not shown, to the main machine drive system and is arranged to turn the lower shaft at a predetermined rate in the direction indicated. Mounted upon the lower shaft, so as to turn therewith, are two outer pinch rolls 40, 41, two elongated and slotted inner pinch rolls 42, 43 and the blade backing roller 45. All of the rollers supported upon the lower shaft 32 are of approximately the same diameter and are affixed to the shaft so as to turn therewith at a peripheral speed which is identical to the sheet processing speed, that is, the speed at which a copy sheet is moving through the automatic xerographic machine. A series of three flapper elements 46 are also affixed to the lower shaft and serve to drive a sheet moving through the advancing roll assembly into the collecting tray.

The blade backing roller 45 has a resilient surface S and preferably is adjustably supported upon shaft 33 so that it can slide axially along the shaft. This adjustment feature is desirable so that a fresh backing surface can be provided under the blades 68 or 69 after the previous surface has worn excessively. Since the blades 68 or 69 are biased against the surface of the roll 45 they tend to cut a circumferential groove in the surface S which eventually becomes large enough to interfere with the proper operation of the cutting or perforating apparatus.

The adjustment is made possibly by allowing the roll 45 to slide on the shaft 33 and by providing a backing means 47 to fix the roll in its desired position. As shown in FIGS. 2 and 5 the backing means 47 comprises a set screw 49 in combination with the flat portion 50 of the shaft 33. Tightening the set screw 49 against the flat 50 prevents axial and rotational movement of the rollers with respect to the shaft 33.

The upper advancing roller sub-assembly 32 is supported upon a shaft 48 which is pivotally supported at both ends in the main machine frame (not shown). Four advancing pinch rolls 51, 52, 53 and 54 are rotatably supported upon the upper shaft and the entire sub-assembly is biased downwardly whereby the upper pinch rolls are held in friction contact with the lower pinch rolls by means of a pair of biasing springs 55, 56 mounted upon a stationary bracket 57. The free ends of the spring elements are arranged to exert a downward pressure upon two hardened steel receiving sur-

faces 58 carried upon shaft 48 which urges the entire upper sub-assembly downwardly into operative contact with the lower roll sub-assembly. Sufficient biasing pressure is provided by the spring elements so that a sheet of paper introduced into the nip formed between the contacting pinch rolls will be advanced at a predetermined rate into the collecting tray.

A cutting implement 60 is slidably mounted along the central portion of the upper shaft 48 as illustrated in FIGS. 2 through 5. The central portion of the shaft is provided with a raised key 62 which rides within a complementary slot machine in the bearing 65 of the cutting implement. As shown in the Figures the cutting implement 60 is provided with a double eccentric bearing upon which are mounted two freely rotating blades. As illustrated the perforating blade 68 and the cutting blade 69 are retained on bearing 65 by means of washers 67 and compression ring clips 66 which also serve to compress the slotted ends of the double eccentric bearing thus creating sufficient friction force to retain the cutting implement 60 in the selected location. In assembly, the two blades are mounted in face to face moving relationship with the cutting surfaces of the blades lying in the same plane, the plane being perpendicular to the sheet path of travel. As shown in FIG. 4, the centers 90 and 91 of the eccentric bearing surfaces 92 and 93 for the perforator blade 68 and the cutter blade 69 are located on radial lines 94 and 95 120° apart projecting from the center line 96 of the support shaft 48.

As seen in FIG. 2, the upper shaft 48 is provided with a shaft positioning mechanism 70 including an indexing plate 71 and a holding element 72. The holding element 72 is affixed at one end in the machine side wall 73 and contains an extendable pin 74 that is spring biased outwardly so the pin can engage a series of three positioning slots machine in the face of the indexing plate. When the pin is seated in engagement with one of the slots, the upper roll support shaft, and thus the cutting implement 60 keyed thereto, are locked in a predetermined position in regards to the lower roll sub-assembly.

Each of the pin receiving slots are accurately located upon the face of the indexing plate and provide a means for locating the blade implement in three discrete positions in relation to the backing roller 45. First, the shaft can be locked in a position as shown in FIG. 2 wherein the eccentrically mounting cutting blade is extended downwardly into contact against the backing roller. When so positioned, the blade 69 serves to cut a continuous slit in a sheet of material passing through the advancing roller assembly, the slit being parallel to the direction of sheet travel. It should be noted that at this time the perforated blade is raised upwardly out of the sheet path of travel and is thus incapable of acting upon a sheet in process.

Secondly, the shaft 48 can be rotated 120° to reverse the respective blade position. Rotation of the shaft is accomplished by the machine operator pulling back the spring biased pins 72, turning the indexing plate 120° and allowing the pin to seat itself within the perforating indexing slot. When so positioned, the perforating blade is extended into contact with the backing roller and the apparatus is now in a condition to perforate a sheet forwarded through the advancing roll assembly.

The backing roll 45 is constructed of a strong resilient elastomeric material such as polyurethane or the like. As noted above, the backing roll is arranged to turn with the lower support shaft. Under the biasing force of the spring elements, the selected blade element is caused to "bite" into the elastomeric backing material and, as a consequence, the blade turns in synchronous relation therewith. As a sheet to be perforated passes through the advancing roll nip, the rotating perforating blade element 68 produces a series of interrupted cuts in the sheet that are separated by a tie element made up of the base material. The perforations are such to permit the sheet to be easily separated along the perforated line. Preferably, the tie to cut relation is 1 to 5 with four cuts being produced per inch of copy material.

Lastly, a third slot is provided on the indexing plate face midway between the perforating blade locating slot and the cutting blade locating slot. Positioning the holding pin in this particular slot, in the manner described above, causes the center line of each cutting orbit to occur above the center line of support shaft 48. Both blades are thus raised out of contact with the backing roller and are incapable of acting upon a sheet forwarded by the advancing roll assembly. This third position, in effect, negates the cutting implement and allows the machine to operate in a normal or conventional manner.

The apparatus of the present invention also permits the blade implement 60 to be laterally repositioned upon the upper support shaft 48 to vary the size to which the support sheet is shaped. As explained in greater detail in copending U.S. application Ser. No. 205,911 filed Dec. 8, 1971, each sheet of support material that is fed through the automatic xerographic reproducing machine has one of its side margins, e.g. the left hand margin as shown in FIG. 2, in registration as it travels along the prescribed paper path through the various processing and handling stations. As can be seen, lateral shifting of the cutting implement will in effect reposition the blade element at some known distance from the registered margin of the sheet. To this end, an indicating scale 80 is etched along the central portion of the shaft 48 by which the operator can conveniently preset the blade to produce any desired width of cut within the working range of the blade. To reposition the blade, the operator simply lifts the upper roll sub-assembly back against the biasing force of the spring element sufficiently to free the blade from the backing roll and then slides the blade laterally along the shaft to the desired position. Releasing the upper roll assembly, causes the blade to once again seat itself in a holding position against the backing roller and prevents further laterally shifting of the blade implement.

Because the exact positioning of the blade element is generally difficult to observe when the apparatus is mounted within a machine environment, the apparatus of the present invention is herein provided with an indicator 83 capable of being viewed by the machine operator. The indicator is operatively associated with the upper support shaft 48 via a camming element 84. The indicator is supported upon a pair of dowels 85, 86, which pass through slotted holes 87, 88, respectively. As shaft 48 is moved from one position to another, the indicator is correspondingly repositioned within a viewing window (not shown) capable of being observed by

the machine operator thus giving a visible presentation which is indicative of the exact blade position.

It should be apparent from a consideration of FIG. 2 that there is a correlation between the diameters of rolls 51-54 and the diameters of the blades 68 and 69 and the amount of eccentricity of the blades relative to the centerline of the shaft 48 so that the blade or blades in their inoperative positions do not engage the backing roller 45. The diameters of the blades 68 and 69 and the locations of the centers 90 and 91 of the eccentrics may be selected as desired to insure that only a blade in its operative position will be able to engage the backing roller 45.

While the invention has been described with reference to an apparatus including a transport means 51-54 and 40-43 and the apparatus of this invention 60 and 45 in coaxial alignment it is not necessary for the cutting and perforating apparatus of this invention to be positioned in a transport means. The transport means 51-54 and 40-43 serves to transport the sheet through the slitting and perforating apparatus 60 and 45 and could if desired be located upstream or downstream spaced from the apparatus 60 and 45. Cooperation between the blades 68 and 69 and the roll 45 or with some other type of operative element is necessary for effective cutting or perforating action.

It is desirable but not essential to hold the sheet against the backing roll 45 during slitting or perforating. If the sheet were not held against the backing roll at all or only by the engagement of the roll with an operative blade 68 or 69 it is unlikely that the inoperative blade or blades would be able to act upon the sheet to slit or perforate it due to the absence of any coaction by the backing means 45.

The terms "cutting" or "slitting" are used interchangeably in accordance with this application.

In summary then, the apparatus for cutting or perforating a sheet of material in accordance with this invention includes a support means arranged adjacent to the path of travel of the sheet and first and second blades mounted upon the support means for operating upon the sheet. The blades are movable from an operative position in the path of travel of the sheet to an inoperative position out of the path of travel of the sheet. The blades are eccentric with respect to one another with the eccentricity of the blades being such that when one of the blades is positioned in the path of travel of the sheet the other of the blades is positioned out of the path of travel of the sheet. Means are also provided for cooperating with the blades in their operative position for providing effective cutting or perforating action such as the backing roller 45 as well as means for positioning the blades into and out of the path of travel of the sheet.

It should be clear from the present disclosure that the slitting and perforating device herein described is not only compact and easily installed in most copying devices but it is also capable of being adjusted to carry out a number of working functions without the need of dismantling the mechanism involved. While this invention has been described with reference to this structure disclosed herein, it is not confined to the details as set forth and this application is intended to cover any modifications or changes as may come within the scope of the following claims.

What is claimed is:

1. An apparatus for perforating a sheet of material that is moving along a predetermined path of travel including:

a support means being arranged adjacent to the path of travel;

a first blade for operating upon said sheet mounted upon said support means, said blade being movable between an operative position in the path of travel of the sheet and an inoperative position out of the path of travel of the sheet;

a second blade for operating upon said sheet mounted upon said support means, said second blade being movable between an operative position in the path of travel of the sheet and an inoperative position out of the path of travel of the sheet, said second blade being eccentric with respect to said first blade, with the eccentricity of said blades being such that when one of said blades is positioned in the path of travel of the sheet the other of said blades is positioned out of the path of travel of the sheet;

means cooperating with said blades in their operative position for providing effective cutting or perforating action;

and means for positioning said blades into and out of the path of travel of the sheet.

2. An apparatus as in claim 1 wherein said first blade comprises a cutting blade and wherein said second blade comprises a perforating blade.

3. An apparatus as in claim 2 wherein said blades are slidably positional transverse to the path of travel of the sheet to vary the width of cut taken by the operative blade element.

4. An apparatus as in claim 3 wherein said support means includes a shaft having a center and wherein said first blade has a first eccentric center with respect to the center line and wherein said second blade has a second eccentric center with respect to the center line and wherein said first and second eccentric centers are spaced from one another.

5. An apparatus as in claim 4 wherein the cutting blade and the perforating blade are each mounted to freely rotate upon a double eccentric bearing and wherein said blades are in face-to-face contact with each other.

6. An apparatus as in claim 1 wherein said blade cooperating means includes blade backing surface arranged to rotate against the operative blade and wherein said blade cooperating means is adjustable with respect to said operative blade to provide a fresh blade backing surface if desired.

7. An apparatus as in claim 6 wherein said blade cooperating means comprises a backing roller and wherein said backing roller is slidably adjustable with respect to said operative blade.

8. An apparatus as in claim 7 further including means to bias said operative blade into contact with said backing roller.

9. An apparatus as in claim 8 further including means for advancing said sheet along said path of travel.

10. Apparatus for cutting and perforating a sheet of material that is moving along a predetermined path of travel including:

a support shaft being arranged adjacent to said path of travel,

blade holding means affixed to said support shaft comprising a first sheet cutting blade and a second

sheet perforating blade being eccentrically mounted upon said shaft whereby rotation of said shaft positions said first cutting blade into the sheet path of travel to act upon a sheet passing therealong and further rotation of said shaft removes said first blade from the path of travel and positions said second perforating blade in the path of travel to act upon a sheet passing therealong, and actuating means operatively associated with said support shaft for prepositioning said blade holding means, in a first condition wherein the cutting blade is positioned in the path of travel or in a second condition wherein the perforated blade is positioned in the path of travel or in a third position wherein both blades are retracted from said path of travel.

11. The apparatus of claim 10 further including a backing roller in parallel alignment with said support shaft on the opposite side of said path of travel to contact a preselected blade positioned in said path of travel.

12. The apparatus of claim 11 wherein said backing roller is arranged to rotate against a blade brought in contact therewith.

13. The apparatus of claim 11 wherein the support shaft and the backing roller are coaxially aligned with upper and lower pinch rolls, respectively, of a sheet advancing means that is arranged to engage a sheet moving along said path of travel and further advance said sheet.

14. The apparatus of claim 13 wherein said lower pinch rolls and said backing roll are operatively associated with a drive means for rotating said pinch rolls and

the backing roller in the direction of sheet movement.

15. The apparatus of claim 10 wherein the blade element is slidably positionable transverse to the path of sheet travel to vary the width of cut taken by a selected blade element.

16. The apparatus of claim 10 wherein the cutting blade and the perforated blade are each mounted to freely rotate upon a double eccentric bearing with their axis eccentric to each other and affixed in eccentric relationship upon a support shaft with the blades in face-to-face contact with each other.

17. The apparatus of claim 16 having further means to bias the blades into friction driving contact with the backing roller.

18. In a feed roll assembly of the type wherein a co-operating pair of pinch rolls comprising a set of driven rolls supported in friction contact with a set of idler rollers to advance a sheet of material introduced therebetween, the improvement comprising;

an elongated backing roller coaxially aligned with the driven rolls and arranged to move in relation therewith,

a blade holding element coaxially aligned with the idler rolls, said blade holding element having a cutting blade and a perforating blade eccentrically mounted within said element, and

means to rotate the holding element to place one of said blades into contact with said backing roller whereby a sheet of material advanced through said rolls is acted upon by said one blade.

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