

[54] **SHEAR CUT PERFORATOR**  
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[73] Assignee: **FMC Corporation**, San Jose, Calif.  
[22] Filed: **Oct. 6, 1970**  
[21] Appl. No.: **78,533**  
[52] U.S. Cl. .... **83/348, 83/674**  
[51] Int. Cl. .... **B27d 25/12**  
[58] Field of Search..... 83/346, 347, 348, 83/426, 508, 542, 592, 673, 674, 698, 349, 658, 583

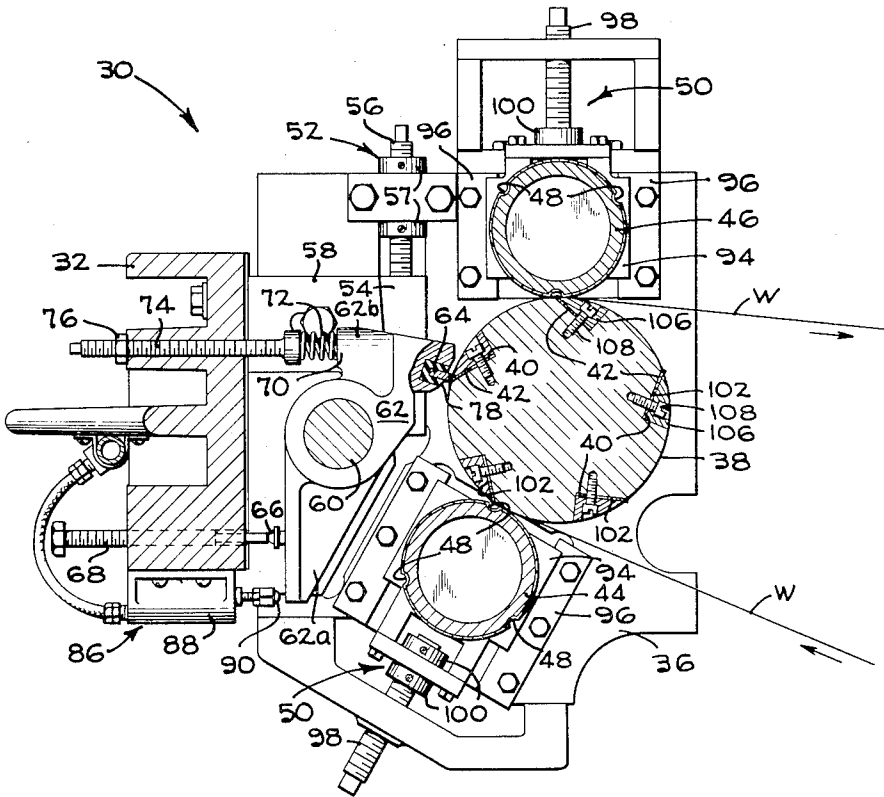
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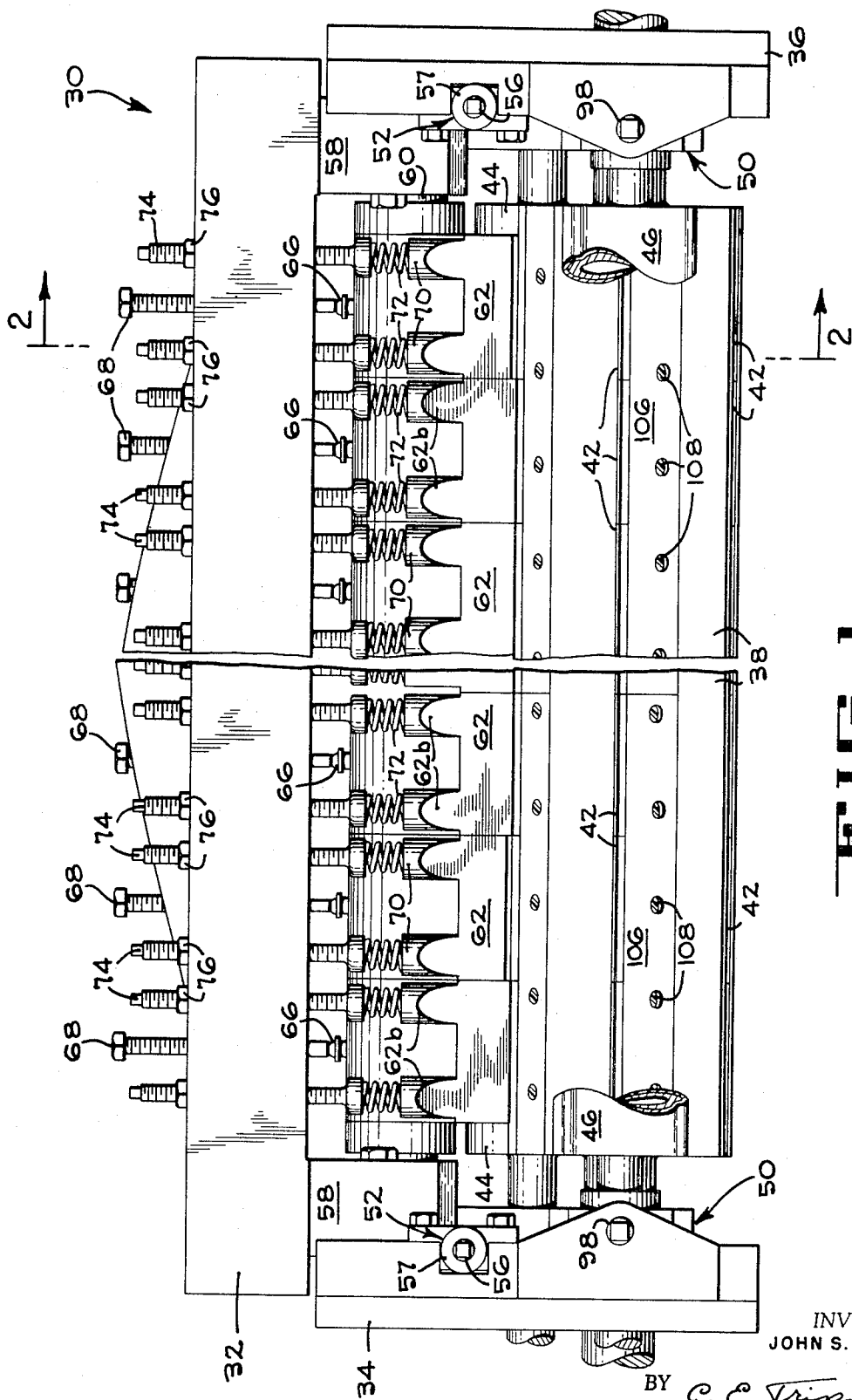
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*Primary Examiner*—Andrew R. Juhasz  
*Assistant Examiner*—Leon Gilden  
*Attorney*—F. W. Anderson, C. E. Tripp and L. J. Pizzanelli

[57] **ABSTRACT**  
This disclosure relates to a web perforating apparatus. Essentially the apparatus includes an unwind stand for supporting and unwinding a web of material, whether it be paper, foil or plastic, which is fed over a large rotating roll carrying circumferentially spaced rows of knives or blades which extend beyond the surface of the roll. A stationary rigid beam, coextensive with and adjacent the roll, support blocks mounting anvil blades or knives embedded in or surrounded by elastomeric material. The anvil knives make contact with the roll knives to effect perforation of the web.

4 Claims, 22 Drawing Figures





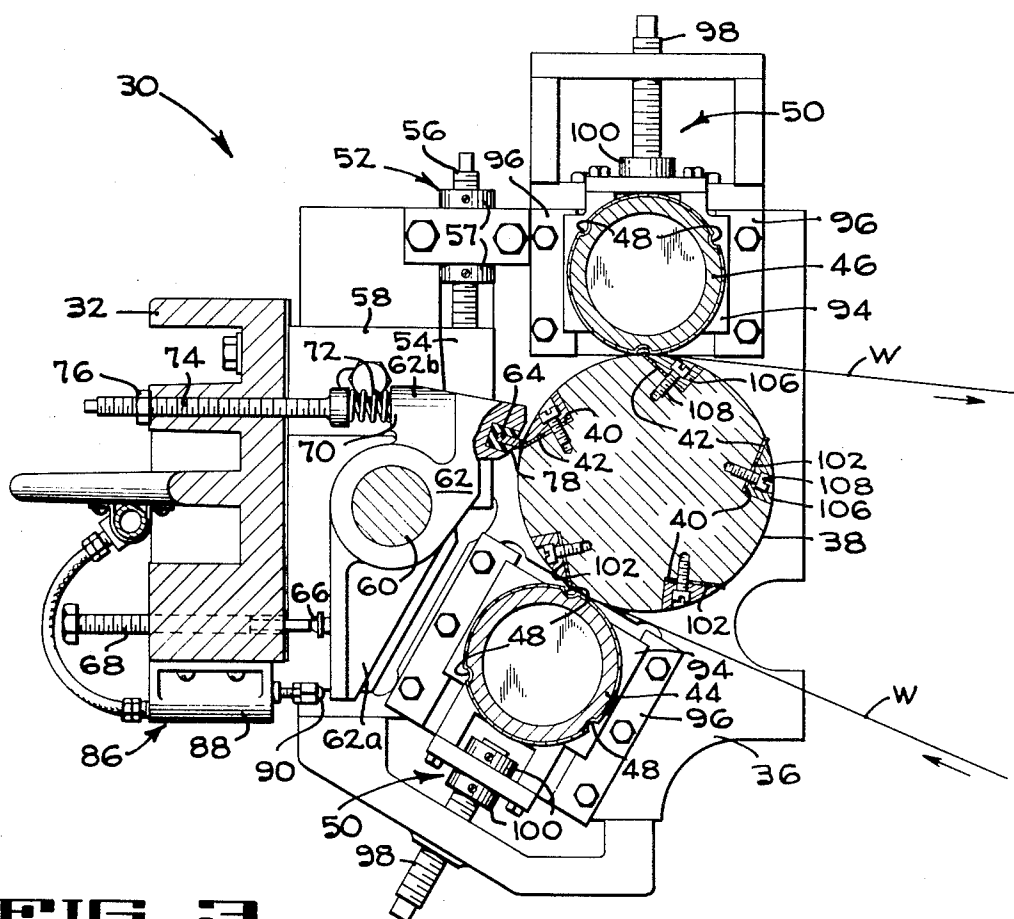
**FIG. 1**

INVENTOR.  
JOHN S. ATERIANUS

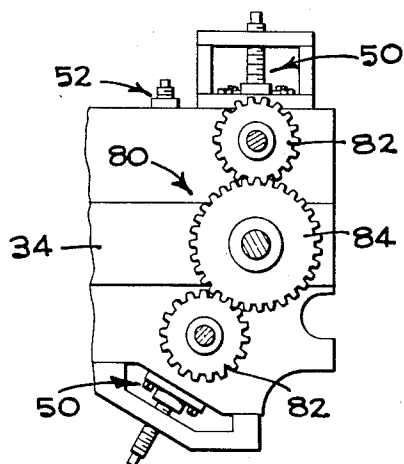
BY *C. C. Tripp*

ATTORNEY

**FIG. 2**



**FIG. 3**



**FIG. 3A**

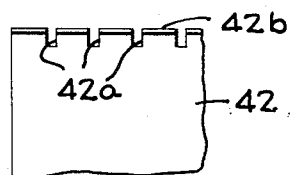


FIG. 4

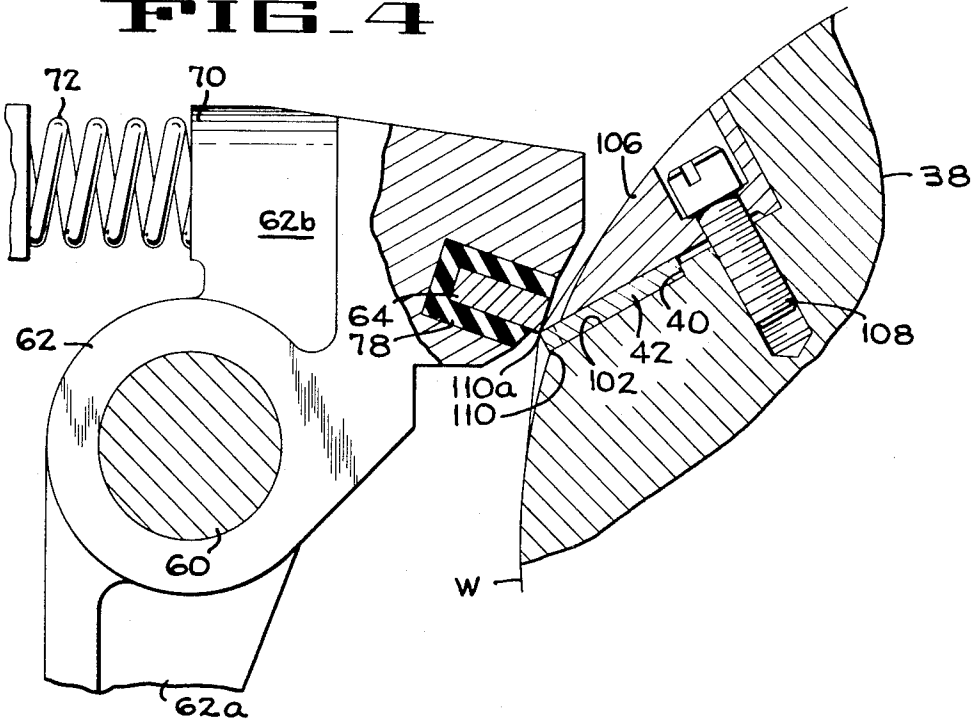


FIG. 5

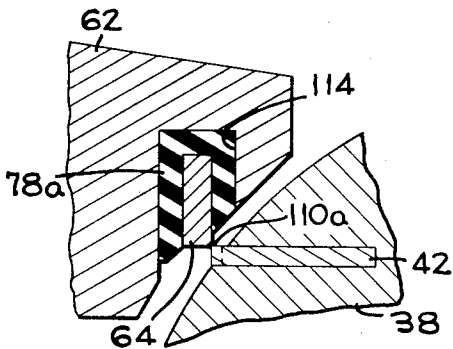


FIG. 6

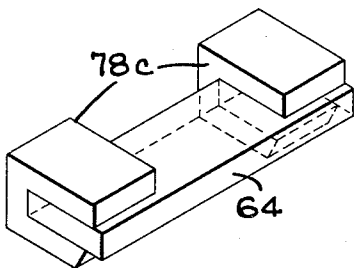
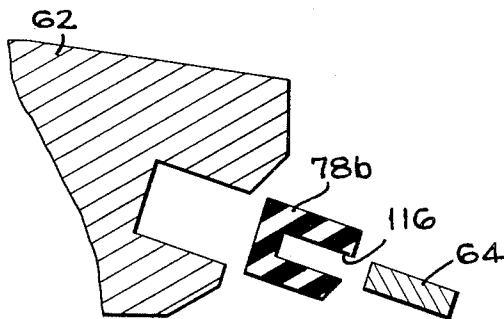
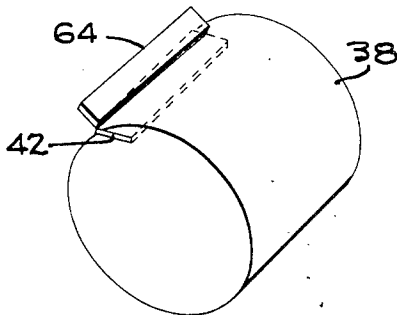
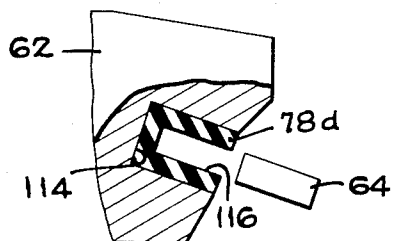


FIG. 7

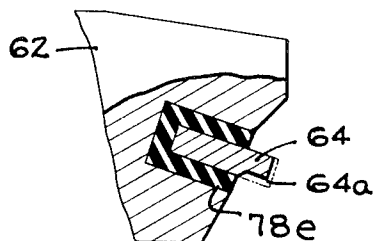
FIG. 7A



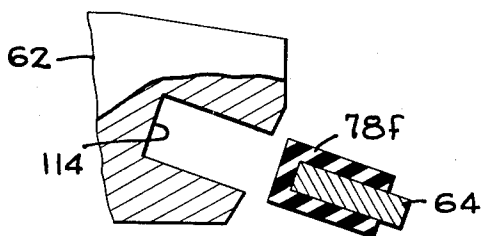
**FIG. 8**



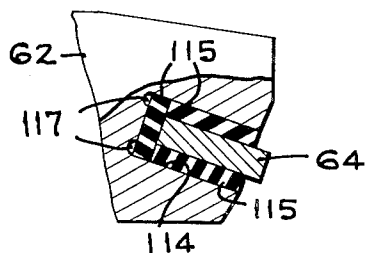
**FIG. 9**



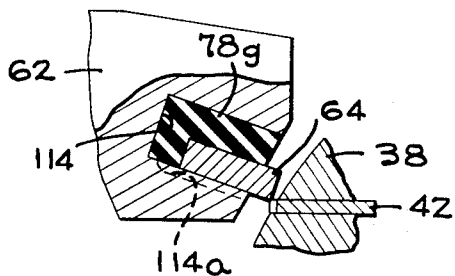
**FIG. 10**



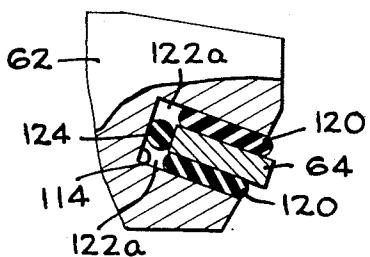
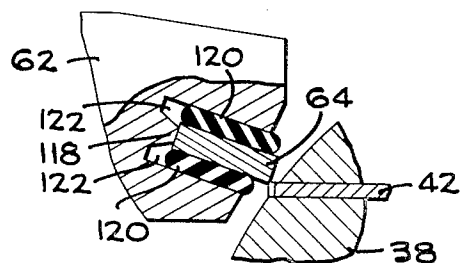
**FIG. 11**



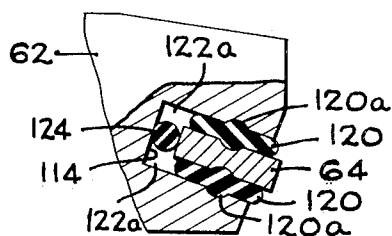
**FIG. 12**



**FIG. 13**

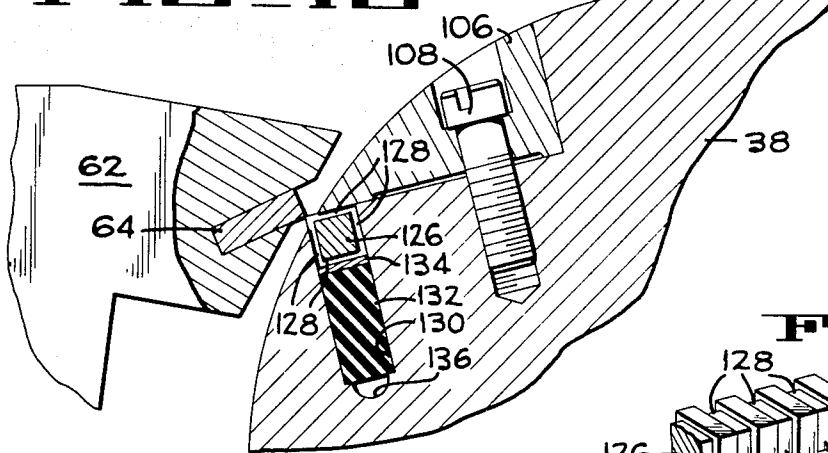


**FIG. 14**

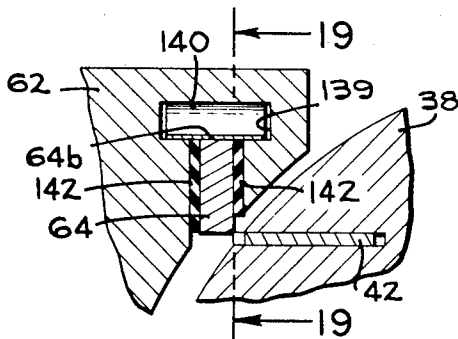
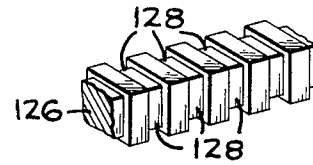


**FIG. 15**

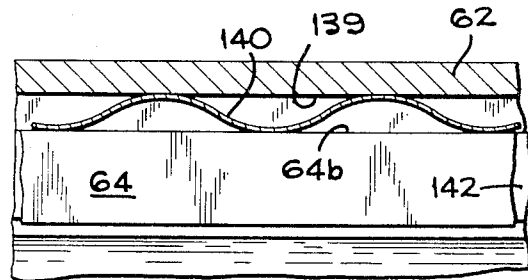
**FIG 16**



**FIG 17**

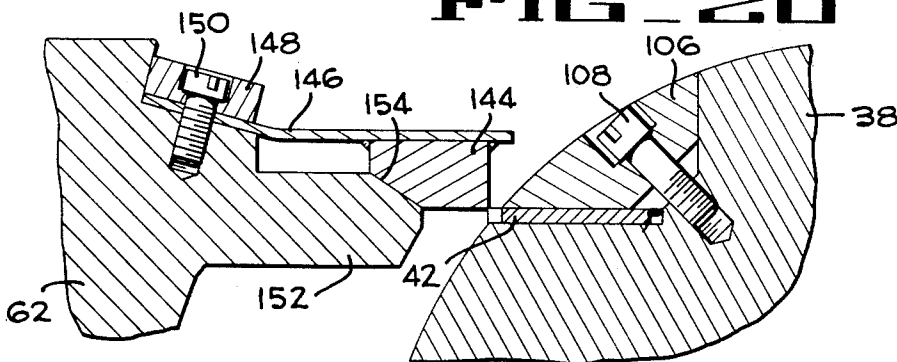


**FIG 18**



**FIG 19**

**FIG 20**



## SHEAR CUT PERFORATOR

## BACKGROUND OF THE INVENTION

New developments for perforating webs of paper, film or foil are shown and described in many patents, both foreign and domestic. More recent patented developments are shown and described in U.S. Pat. Nos. 2,970,940 and 2,986,058. These disclosures show apparatus for making transverse equally longitudinally spaced perforations in a paper web derived from a large mill roll. The perforations of the character made may be described as a series of linear shear cuts and uncut web portions, sometimes referred to as tabs, extending transversely entirely across the web.

Web perforating apparatus can be associated with other apparatus such as wrappers, sheeters, bag machines, interfolders and towel or toilet tissue rewinders. For convenience the present disclosure shows and describes the invention in connection with a rewinder which is sometimes referred to as a winder. Winders comprise an unwind stand for rotatably supporting a large parent or mill roll, controls for unwinding the web with a desired tension, dictated by the character of the web and the tightness of the wind required, a perforating unit, core shaft handling apparatus, mechanisms for feeding and mounting tubular paper cores on the core shafts, and mechanisms for removing a consumer size roll, for example toilet tissue or towelling, from the core shaft which is then ready for reception of another core. Accordingly, the perforating mechanism of the character disclosed by the present invention is combined with various other mechanisms to automatically produce consumer size rolls of toilet tissue or towelling.

The perforations performed by the apparatus of the present invention are known by those skilled in the art as clean cut perforations. Such perforations are achieved by providing stationary blades and rotating blades which are mounted on a relatively large diameter roll, usually referred to as a bed roll. The paper web is fed over the bed roll making an arc of contact in the order of 140-170 degrees. As the bed roll rotates feeding the paper web through the winder the bed roll blades make point contact with the stationary blades which are slightly skewed from the roll axis to produce a progressive shear action extending from one end of the blades to the other.

Perforating mechanisms operating on the shear cut principle provide the bed roll with generally rectangularly shaped blades or knives which are relatively thin. The bed roll blades have one edge clamped to the bed roll and the opposite edge extending a short distance beyond the surface of the bed roll. The bed roll blade mounting may be best characterized as a cantilevered beam which is subject to flexure or deflection when it makes engagement with the stationary anvil blade. The bed roll is provided with recesses or openings below the blade to allow for such deflection. It is usual practice to set the anvil blades and bed roll blades so that an interference of from three to six thousandths is created. With this interference flexure or deflection of the bed roll blades occurs during its engagement with the anvil blade.

Other perforating apparatus utilized with winders operate on the principle known as crush cut or pinch cut. Apparatus performing this method of perforation usually comprises two rotating rolls mounted adjacent each other. One roll has a smooth hardened surface

and the other is provided with rows of circumferentially spaced chisel point cutters which come in forceable contact with the surface of the smooth roll. The paper web is fed over the smooth roll, sometimes referred to as an anvil roll, bringing it in contact with cutters which make transverse longitudinally spaced perforations in the web. For example, in the case of toilet tissue the perforations are usually made every 4½ inches. The decided disadvantage of the crush or pinch cut perforation is that the anvil roll must assume massive proportions to resist the force of the perforating cutters which impose substantial shock forces which are necessary to perforate the web. This type of perforation can be best characterized as piercing of a web supported on a solid foundation by a sharpened element acting generally normal to the web supporting surface.

Machines performing the crush or pinch type of perforations have severe limitations the most prominent of which are the speed of operation and the width that can be adequately handled by the machine. These limitations are a direct result of the general concept of forcing a chisel tooth cutter through a web supported on a solid foundation. To achieve the penetration forces required an interference setting must be established between the anvil roll and the blade roll. Accordingly, these forces, which ideally may be thought of as an evenly distributed force applied to a beam of circular cross-section, cause deflection in the beam and generate noise levels which are intolerable to operating personnel and are destructive of the machine elements. Use of machinery performing a crush or pinch cut is accordingly limited to approximately 1,100 feet per minute and a maximum web width of 40 inches.

During the paper making process paper fibers accumulate on parts of the paper-making machinery which overlie the paper web. These fibers accumulate much like snow drifts which fall in clusters on the paper web. The clusters of fibers are eventually wound between wraps of the mill roll. In the industry such accumulations of paper fibers are called wads which are a normal condition encountered in all paper making processes, particularly paper used for making toilet tissue and towelling. When a mill roll of paper passes through a rewinder or winder the wads obviously encounter the perforating unit and in doing so impose a burden on the perforating blades which oftentimes causes the perforator blades to break requiring shut-down of the machine.

The perforating unit shown in U.S. Pat. No. 2,986,058, assigned to the assignees of the present invention, mounts the stationary anvil blades on anvil blocks which are mounted for a limited degree of rotation on a transverse shaft. The anvil blocks are held in their operative positions by a spring force. In the event a wad or other condition interfering with the perforating function of the blades occurs the anvil blocks moves against the bias of the springs allowing passage of the wad without causing damage to the bed roll mounted perforating blades. The present invention makes use of this advantageous feature since it mounts the anvil blade in an anvil block of substantially the same construction.

## SUMMARY OF THE INVENTION

In accordance with a primary feature of the present invention the rotating blades are mounted in the bed roll so that deflection or flexure thereof does not occur

when contact with a stationary anvil blade takes place. Preferably all blade movement is accommodated by the anvil blade which is associated with elastomeric material mounting the anvil blade in the anvil block.

Several distinct benefits result from such an arrangement. Since the rotating blades carried by the bed roll are supported so that no flexure or deflection occurs, they can be heat treated to a higher degree of hardness which therefore extends blade life and consequently the frequency of adjustment is greatly reduced. Another advantage resulting in providing rigid blades in the bed roll is that the interference setting between the rotating and stationary blades made under static conditions, or during low speed operation of the machine, will be maintained during normal operating speeds which is in the order of from 1,500 to 2,000 feet per minute. Perforators utilizing deflectible or flexible bed roll blades are bent outwardly relative to the radius of the bed roll blade due to the centrifugal forces. These forces obviously increase proportionately with increases in the speed of the bed roll.

This condition greatly increases the difficulty and the time required to adjust the interference between the bed roll blades and the stationary anvil blades. Most experienced operators perform the adjustment under running conditions by listening to the sound made when the bed roll blades make contact with the anvil blades. Therefore a fair degree of experience is necessary to properly adjust perforators using flexing or deflectible bed roll blades.

The stationary anvil-mounted blades, sometimes referred to as anvil blades, of the present invention are mounted in the anvil so that they can be controllably displaced when contact is made with the rotating bed roll blades. The present invention discloses various ways in which the anvil blade can be mounted to exhibit the limited amount of displacement necessary to perform a good perforation and yet give blade life comparable to or better than that which is presently experienced with commercial perforators.

By mounting the anvil blade in an elastomeric material it will respond in more than one plane, therefore allowing the blade to exhibit degrees of freedom, in at least two planes, which greatly reduces the criticality of setting-up and adjusting the rotating bed roll blade with the stationary anvil blade. Moreover, such freedom of movement will in most instances obviate the need of hollow ground blades which are expensive to produce and maintain.

Another benefit derived for mounting the anvil blade with two or more degrees of freedom is that more uniform blade wear and a more lengthy blade life is achieved.

A further advantage provided by mounting the anvil block with elastomeric material is that quieter operation is achieved as the metal-to-metal contact of the perforating blades is effectively dissipated.

The fundamental concept of this invention now makes it possible to provide an elastic foundation for the cutting element mounted in the bed roll while the stationary cutting element can be mounted so that no displacement or deflection thereof occurs during normal operation. Moreover it is also possible to provide a resilient foundation for each cutting element.

Another important feature of the present invention is the latitude achieved in providing any desired response characteristics of the perforating blades. Known com-

mercial perforators, for example the type shown and described in the above mentioned United States patents, are highly restricted in the options available for changing or varying the response time of the perforating blades. It can be accomplished in one of two ways. The rotating bed roll blade can be lengthened to increase the amount of flexure produced when it contacts the stationary anvil blade or the rotating bed roll blade can be made thicker to thereby reduce the deflection or flexure of the blade. The present invention can be readily tuned to produce any response characteristics required by the speed or the type of web being perforated. All that is necessary is to either change the geometrical configuration of the elastomeric support or to change the durometer hardness of the rubber. It should be realized therefore that changes in response time can be accomplished with a minimum of time and cost since the inventory of elastomeric material is immeasurably more economical than providing an inventory of blades having different lengths or thicknesses.

In accordance with the present invention the rotating bed roll blades can be made much narrower, in the order of one half an inch, instead of the seven eighths or one inch that is presently used in commercial perforators. This is made possible by the present invention since the rotating bed roll blade is firmly clamped and does not deflect with respect to the bed roll. As a result of the perforating concept of the present invention, that is, providing a non-flexing bed roll blade, the bed roll does not require the rather complex surfaces and more sophisticated clamping arrangements of a flexing blade. Further the rigidity of the bed roll is greatly improved because for a given bed roll diameter the cross sectional area and accordingly the moment of inertia is increased permitting higher speed operation.

Other features and advantages of the present invention will be pointed out as the description of the preferred embodiment and some of its modifications are described hereinafter.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view, with a central section partly broken away, of a perforating apparatus incorporating the features of the present invention,

FIG. 2 is a transverse section of FIG. 1 taken substantially along the line 2—2 of FIG. 1,

FIG. 3 is an end view of the perforating structure shown in FIG. 1, illustrating in reduced scale, the gear train provided for driving the bed roll and the feed rolls,

FIG. 3A is an enlarged fragmentary portion of a perforating bed roll blade,

FIG. 4 is a greatly enlarged fragmentary portion of the anvil block, carrying the stationary blade, and the bed roll supporting the rotating blade,

FIG. 5 is a fragmentary of FIG. 4 showing an alternative method of mounting the anvil blade,

FIG. 6 is a similarly enlarged fragmentary portion of the anvil block showing the molded or extruded rubber insert and the anvil blade disassembled,

FIG. 7 is a perspective of the anvil blade showing generally U-shaped rubber members mounted at each end of the anvil blade,

FIG. 7A is a diagrammatic perspective showing the orientation of the anvil and bed roll blades to produce point contact for progressive shearing of the web,

FIG. 8 is another modified form of the anvil block in which rubber, or other elastomeric material, may be molded and ground to provide a slot for receiving the anvil blade,

FIG. 9 is yet another modified form of the anvil block wherein the elastomeric insert and the anvil blade are assembled and bonded to the anvil block,

FIG. 10 is yet another modified form of assembling the anvil blade in the anvil block in which the elastomer is molded and bonded to the anvil blade and then pressed into the anvil block slot,

FIG. 11 is another modified form of mounting the anvil blade in the anvil block by utilizing precision strips of elastomer having one side supplied with adhesive backing firmly holding the strips to the anvil block while the anvil blade is pressed in between the rubber strips,

FIG. 12 is still another modified form of mounting the anvil blade in the anvil block by providing a rubber insert or elastomeric insert adjacent two surfaces of the anvil blade,

FIG. 13 shows a modification wherein the anvil block is provided with a locating shoulder engaging the rear surface of the anvil blade,

FIG. 14 shows yet another modified form in which rubber strips are mounted on opposed surfaces of the anvil blade and a circular rubber insert makes engagement with the rear surface of the anvil blade,

FIG. 15 shows a modified form wherein the anvil blade and the anvil block are provided with longitudinal semicircular grooves for receiving complementary shaped circular projections of the rubber inserts,

FIG. 16 is a modified form of the perforating apparatus of the present invention utilizing a square shaped bed roll blade, supported on an elastomeric insert,

FIG. 17 is an enlarged perspective of the bed roll blade of FIG. 16,

FIG. 18 shows yet another manner of mounting the anvil blade in the anvil block which includes a sinusoidal or wave shaped spring engaged by the rear surface of the anvil blade and rubber inserts on either side of the anvil blade,

FIG. 19 is a section taken substantially along line 19-19 of FIG. 18, and

FIG. 20 illustrates a modification wherein the anvil blade is mounted on a leaf spring.

#### DESCRIPTION OF THE PREFERRED EMBODIMENT

The perforating apparatus of the present invention is generally identified by the numeral 30 and its major components include a transverse beam 32 carried by side plates 34 and 36 that are in turn mounted on the frame of the rewinding or winding machine (not shown). Rotatably supported between the side plates 34 and 36 is a bed roll 38 provided, as shown in FIG. 2, with a plurality of equally circumferentially spaced slots 40 in which perforating blades 42 are mounted. The web W is wrapped around the bed roll 38 and fed thereover by felt covered feed rolls 44 and 46 that are in pressure engagement with the bed roll 38 to insure that the web speed and the surface speed of the bed roll 38 is substantially the same. The feed rolls 44 and 46 are provided with longitudinal indentations 48 for receiving the projecting portion of the bed roll blades 42 to insure smooth vibration free operation of the perforator. Adjusting means 50 are associated with each end

of the feed rolls 44 and 46 for regulating the nip pressure that the feed rolls 44 and 46 establish with the bed roll 38.

The anvil beam 32, which is mounted between the side plates 34 and 36, is adjustable transversely relative to the bed roll 38 by a mechanism 52 which includes a wedge block 54 translatable by an adjusting stud 56 having collars 57 that hold stud 56 against axial movement. Rotation of the stud 56 moves the wedge blocks 54, which, depending upon the direction of rotation of the stud 56, adjusts the anvil beam 32 toward or away from the bed roll 38. Each end of the beam 32 is rigidly connected to end plates 58 which are fitted in guideways formed in the end plates 34 and 36 to insure linear transverse movement of the beam structure 32 relative to the bed roll 38.

A shaft 60 has its ends rigidly connected to the end plate 58 and is disposed parallel to the axis of the bed roll 38. On the shaft 60 a plurality of anvil blocks 62, taking the form of a bell crank having a depending lever arm 62a and an upwardly extending lever arm 62b, are rotatably mounted. The anvils 62 carry anvil blades 64 being located to cooperate with the bed roll blades 42 to effect transverse perforation of the web as it is moved past the anvil blades. Each of the depending lever arms 62a has a stop button 66, taking the general form of a spherical projection, rigidly secured thereto which is engaged by a screw 68 received in a threaded bore provided in the anvil beam 32. The lever arm 62b is formed to provide a bored boss 70 in which is disposed a spring 72 whose degree of compression is determined by adjustable studs 74 threaded in the beam 32 and provided with lock nuts 76. Since the anvil block 62 is mounted for freedom of rotation on a shaft 60, the position assumed by the anvil blade 64 is determined by the adjustment of the screws 68, the end of which is in abutting engagement with the buttons 66 on each anvil. The force supplied by the spring 72 determines the contact force between the buttons 66 and its associated screw 68. As a consequence of this arrangement the forces resulting from the engagement of the rotating bed roll blades 42 with the anvil blade 64 are in part resisted by the spring 72. Ruling out the presence of wads or other obstructions the rubber insert 78 permits the anvil blade to be slightly displaced both sidewise and endwise when it is contacted by the rotating bed roll blade, since these blades are adjusted with a predetermined amount of interference which is necessary to subject the paper web to the shearing action necessary to produce the clean cut perforations. When a wad is carried by the web to the bed roll the amount of displacement to which the anvil blade 64 is subjected is greater than can be accommodated by the rubber insert 78. Accordingly, under the circumstances the springs 72 are compressed due to the resulting counterclockwise rotation (as viewed in FIG. 2) of the anvil block 62 permitting the obstruction or wad to pass without causing undue stress to the coacting blades 42 and 64.

As shown in FIG. 3, a gear train 80 including gears 82, keyed to the ends of rolls 44 and 46 and a gear 84, keyed to the end of the bed roll 38, is provided for establishing the speed relationship between the rolls 44 and 46 and the bed roll 38 thereby insuring that the indentations 48 are in time with the bed roll blades 42.

The disclosed perforating apparatus also provides a mechanism for positioning the anvil block 62 to a non-

operative position and such means are generally indicated by the numeral 86. On the lower surface of the anvil beam 32 a plurality of air cylinders 88, corresponding in number to the anvils 62, are mounted. On the end of each cylinder rod a spherical button 90 is mounted and is engageable with the lower portion of the dependent lever arm 62a. Actuation of a conventional control valve (not shown) supplies pressure fluid to each of these cylinders 88 extending the rods thereby engaging the buttons 90 with the depending lever arms 62a. The anvil blocks 62 are accordingly rotated in a counterclockwise direction against the bias of the spring 72. The anvil blades 64 are thus drawn away from the bed roll 38. With the anvil block 62 located in this position threading of the web or removing obstructions occasioned by wrap ups or jams of any nature is facilitated. In returning the machine to its operative position the cylinders 88 are vented to the atmosphere rendering the spring 72 operative to retract the plungers of each cylinder.

According to the above described arrangement it can be seen that a web W is supported on the bed roll 38 and it is provided with longitudinally spaced transverse perforations when each bed roll blade 42 makes contact with the stationary anvil blade 64.

To adjust the nip pressure that the rolls 44 and 46 establish with the bed roll 38 the adjusting means 50 are provided. Since the adjusting means 50 are identical in structure and function description of one will suffice for all. It should also be understood that each end of the rolls 44 and 46 are provided with a journal received within bearings carried by the adjusting means 50. Referring now to FIG. 2, it will be observed that a bearing block 94 is provided for supporting the journals of rolls 44 and 46. The bearing blocks are slidable along guides 96 rigidly attached to the side plate 36. By means of an adjusting screw 98, fixed against axial movement relative to the bearing blocks 94 by collars 100, the bearing blocks and accordingly the rolls 44 and 46 can be translated toward and away from the surface of the bed roll 38. In this manner, the nip pressure exerted by the feed rolls 44 and 46 on the bed roll 38 can be regulated.

Each bed roll blade 42 has its cutting edges formed to make an interrupted cut which consists of aligned linear shear cuts separated by uncut portions. The portion of the blade 42 shown in FIG. 3A produces such cutting by providing substantially equally spaced slots 42a interrupting the cutting edge 42b. Each blade is designed to provide four cutting edges before resharpening is required.

In accordance with the preferred arrangement of the present invention the perforating apparatus mounts the rotating bed roll blade so that it is not subject to flexure or deflection. All movement resulting from the blades coming in contact is produced by the anvil blade. FIG. 4 illustrates, on greatly enlarged scale, one of the bed roll blades 42 in cutting engagement with an anvil blade 64. As shown in FIG. 4, the web W overlies the bed roll blades 42 which are carried in the slot 40 having a planar back up surface 102 formed in the bed roll for backing up the trailing side of the blade. As shown in FIG. 2, the bed roll includes a plurality of equally circumferentially spaced slots 40, each having a planar surface 102 for supporting the bed roll blades 42. The blades 42 are clamped in position on the surface 102 of the slot 40 by a clamping bar 106 mounted to the bed roll by bolts 108 which are received in tapped

holes. The bed roll blade 42 is positioned on the surface 102 so that the intersection of its lower surface and its outer edge, identified by the numeral 110, lies within the surface of the bed roll 38. Due to the fact that the bed roll blade 42 defines an angle less than 90 degrees with the radius of the bed roll, the blade provides a projecting edge 110a extending beyond the surface of the bed roll for cooperation with the anvil blade 64.

In order to achieve progressive shearing action from one edge of each blade 42 to the other, the anvil blades 64 are skewed slightly, as shown in FIG. 7A, so that the bed roll blades 42 make point contact with one edge of the anvil blade 64 and this point of contact travels progressively along the width of the anvil blades to produce the perforations.

As will be pointed out hereinafter, with reference to the various embodiments shown in FIGS. 5-15 and 18 and 19, the rubber insert 78 can comprise either a unitary molded piece provided with a slot for receiving the anvil blade, flat rubber strips or rubber inserts having a configuration keying the anvil blade to the anvil block. The rubber insert may be press fitted into the anvil block, and the anvil blade may be in turn press fitted into the rubber insert. The rubber insert may be bonded to the anvil block and have a slot dimensioned for press fitting the anvil blade therein or the rubber insert may be bonded to the anvil blade and the unitary structure press fitted into the anvil block. Moreover, the rubber insert may be bonded to the anvil block and the anvil blade bonded to the rubber insert. If this procedure is followed the anvil blade may be ground, while assembled in the anvil block, to define the cutting edge.

Referring now to FIG. 5, there is shown another way in which the anvil blade and the rubber insert may be carried by the anvil block. In this case the anvil block 62 is provided with a slot generally indicated by the numeral 114 in which is fitted, either by pressing or by bonding, a rubber insert 78a. The insert 78a is generally of a U-shaped configuration in cross section thereby providing a slot in which the anvil blade 64 is fitted again either by bonding or pressing. It will be noted that the anvil blade 64 assumes a general vertical orientation presenting one of its edges for engagement with the projecting edge 110a of the bed roll blade 42.

FIG. 6 shows an arrangement which is in substantial respects similar to that of FIG. 4. The rubber insert 78b may be molded or extruded, and, as in the case of the modification shown in FIG. 5, may be bonded to the anvil block 62. The anvil blade 64 can be press fitted into the slot 116.

The structure of FIG. 7 shows the anvil blade 64 carrying generally U-shaped rubber bands 78c on each end thereof. The bands 78c may be bonded to the anvil blade 64 which may then be press fitted into the slot of the anvil block 62. Alternatively the rubber inserts 78c may be press fitted into the anvil block slot 114 and the anvil blade 64 press fitted into the rubber inserts.

The modification of FIG. 8 is made by bonding a solid piece of elastomeric material 78d into the anvil block slot 114. The anvil blade receiving slot 116 is the ground to a size establishing a press fit for the anvil blade 64.

FIG. 9 is substantially similar to the arrangement as shown in FIG. 8 with the exception that the anvil blade 64 and the rubber insert 78e are bonded, respectively, to the insert and to the anvil block 62. The dotted line

indicates the original size of the anvil blade 64 before it is ground to define the cutting edge 64a.

FIG. 10 shows yet another modified form of assembling the anvil blade 64 into the anvil block 62. In this instance the rubber insert 78f is bonded to the anvil blade 64 and they are inserted as a unit into the slot 114.

In FIG. 11 the slot 114 of the anvil block 62 is lined with rubber strips collectively identified by the numeral 115. The strips may be provided with an adhesive backing and may be of selective durometer hardnesses in order to give the anvil blade 64 response characteristics which will assure that the anvil blade is in the proper position when the successive bed roll blades 42 come in contact therewith to effect perforation of the web. For example if the anvil blade 64 were to respond in such a way that it does not assume the proper position to engage a successive bed roll blade 42, the cause may be that the hardness of the rubber is not sufficient to damp the forces imparted to the anvil blade in the time available for the upcoming bed roll blade to cutting engagement with the full width of the anvil blade. The slot 114 is formed with cavities 117 which allow an expansion space for the rubber strips when they are under stress.

FIG. 12 shows an arrangement for mounting the anvil blade 64 so that an elastomeric insert 78g is in contact with the rear and the upper surface of the anvil blade 64. When the bed roll blade 42 makes contact with the anvil blade 64 it is moved rearwardly and slightly upwardly against the inherent pliability of the rubber insert 78g. Upward movement of the anvil blade 64 enables paper dust to gather thereunder causing progressive upward relocation of the blade 64 which may result in imperfect or lost perforations. To preclude such a condition a series of grooves 114a, preferably of sawtooth configuration are formed in the lower surface of the slot 114.

FIG. 13 shows another way in which the anvil blade 64 may be mounted in the anvil block 62. In this embodiment the anvil block 62 is provided with a locating shoulder 118 against which the rear surface of the anvil blade 64 is located. Rubber strips 120, which again may be of the same or different durometer hardnesses, are inserted in the anvil block on either side of the anvil blade 64. The locating shoulder 118 and the width of the rubber strips 120 define cavities 122 which accommodate displacement of the rubber strips during the time the anvil blades 64 encounters the shock loads produced by contact with the rotating bed roll blades 42. By providing the locating shoulder 118 the anvil blade 64 is held against rearward movement but rocking of the blade 64 occurs by virtue of the rubber strips 120.

The modification of FIG. 14 is functionally similar to that shown and described in FIG. 13 with the exception that the slot 114 in the anvil block 62 carries a solid circular elastomeric element 124 which is engaged by the rearward surface of the anvil blade 64. Also, as in the case of the arrangement shown in FIG. 13, cavities 122a are provided to allow displacement of the elastomeric material when the anvil blade comes under the influence of the bed roll blades 42. The rubber strips 120 can be made of the same or of different durometer hardnesses depending upon the response characteristics desired. Further the embodiment of FIG. 14 permits the anvil blade 64 to move inwardly toward the

circular rubber insert 124 when the bed roll blades 42 make contact with the anvil blade 64. In the case of FIG. 13, such action is not possible since the locating shoulder 118 prevents any inward movement of the anvil blade 64.

The embodiment of FIG. 15 generally follows the constructional arrangement of FIG. 14 with the exception that the rubber strips 120 are formed with semi-circular, longitudinally extending, ribs 120a which are received in grooves formed in the anvil blade 64 and in the anvil block 62. The ribs 120a fulfill a function of keying the anvil blade 64 to the anvil block and therefore absorb a portion of shear forces the anvil blade 64 is subjected to when it comes in contact with the bed roll blades 42. This of course increases the stiffness of the system by reducing the displacement of the anvil blade by the bed roll blades 42 and resists any permanent dislocation of the anvil blade 64.

The concept of the present invention providing perforating blades which do not flex or deflect makes it possible to provide a rigid non-displaceable anvil blade coacting with a displaceable bed roll blade. The concept of the present invention is also applicable to a perforating system wherein the stationary anvil blade and the rotating bed roll blade are each supported in elastomeric material. Referring now to FIG. 16 there will be seen a perforating apparatus in which the bed roll blade is mounted for displacement while the anvil blade is rigid with respect to the anvil block. The anvil block 62 has rigidly mounted therein the anvil blade 64. The bed roll 38, rotatable in the direction of the arrow, is provided with a perforating bar 126 being generally a rectangular bar. The bar 126 is shown in large perspective in FIG. 17 and it will be observed that it is of substantially rectangular cross section having undercut bands 128 extending on all four sides. By making the bar in this manner all four edges may be used before regrinding is necessary. The bed roll is formed with the cavity 130 in which is fitted a mass of elastomeric material 132. Overlying the elastomeric material is a thin metal plate 134 upon which is seated the perforating bar 126. The perforating bar is held in place by the clamping bar 106 which is attached to the bed roll by screws 108. The cavity 130 is provided with expansion chambers 136 for allowing extrusion of the elastomer 132 when it is subjected to compressive force generated when the perforating bar 126 makes contact with the anvil blade 64. This is necessary since the elastomer is volumetrically incompressible and requires freedom of displacement so that it may fulfill the function of a resilient foundation. When one set of edges of the perforating bar 126 is worn, the bar can be positioned to present a new sharpened edge to the anvil blade 64.

The modified form of the perforator shown in FIGS. 18 and 19 combines the benefits derived from utilizing elastomeric inserts on either side of the anvil blade 64 and a wave or sinusoidal spring backing up the anvil blade. Referring first to FIG. 18 it will be seen that the anvil block 62 is provided with a T slot 139 in one leg of which is mounted a wave spring 140 which provides a flexible foundation for the inner edge 64b of the anvil blade 64. The anvil blade is further resiliently restrained against transverse movement by rubber strips 142, which may be of the same or different durometer hardnesses, to achieve a desired dynamic response. By this construction the force that the anvil blade 64 is subjected to when it makes contact with the bed roll

blade 42 is in part absorbed by the wave spring 140 and the rubber strips 142. The rubber strips also permit the blade 64 to rock in response in contact with the bed roll blade 42.

The final embodiment of the present invention is shown in FIG. 20. The anvil blade identified by numeral 144 is rigidly attached, preferably by welding, to a leaf spring 146 which in turn is clamped to the anvil block 62 by a bar 148 held in place by fasteners 150. The anvil block 62 is formed with a projection 152 having an inclined surface 154 supporting a complementary inclined surface formed on the anvil blade 144. It should be noted that the spring 146 assumes a nonlinear configuration causing the spring to be preloaded thereby holding the anvil blade 144 in forceable contact with the surface 154. The degree of spring force can be regulated by selecting the thickness of the spring 146. Such preloading is necessary to insure that the anvil blade 144 will remain in contact with the bed roll blade 42 to produce acceptable perforations.

Although the best mode contemplated for carrying out the present invention has been herein shown and described, it will be apparent that modification and variation may be made without departing from what is regarded to be the subject matter of the invention.

What is claimed is:

1. An apparatus for perforating thin, flexible sheet material such as paper, plastic or foil, said apparatus being of the type comprising a normally stationary anvil, means for mounting an anvil blade on said anvil, a bed roll mounting a rotary blade disposed at an acute angle to a radius of the roll so that only the leading edge of said rotary blade makes contact with an edge of said anvil blade, means for adjusting one of said blades to establish a predetermined amount of interference between said contacting blade edges, said means for

mounting the anvil blade on said anvil comprising means forming an elongate slot in said anvil, and a body of elastomeric material in said slot for resiliently supporting two faces of said anvil blade, at least one face of said body of elastomeric material being unconfined along the extent of said blade in order to accommodate sidewise displacement of said anvil blade relative to said anvil when said rotary blade makes contact with said anvil blade; the improvement wherein there is no metal to metal contact between said anvil and said anvil blade on the side of the anvil blade that is urged sidewise toward the opposed wall of said anvil slot when said anvil blade is contacted by said rotary blade.

2. The apparatus of claim 1, wherein said body of elastomeric material comprises a rubber member formed to releasably retain said anvil blade.

3. An apparatus for performing thin flexible sheet material such as paper, plastic or foil of the type comprising a normally stationary anvil block having a slit therein, means mounting an anvil blade in said anvil block slot, a rotary blade having one of its edges located to make contact with an edge of said anvil blade, and means for adjusting one of said blades to establish a predetermined amount of interference between the edges thereof; the improvement comprising means supporting said anvil blade on an elastomeric foundation for causing biased multidirectional displacement of said anvil blade when its edge is contacted by the edge of the rotary blade to thereby maintain said edges in forceable engagement thereby effecting perforation of the sheet material, said anvil blade mounting means comprising a U-shaped rubber insert in said slot formed to receive and retain said anvil blade.

4. The apparatus of claim 3, wherein said rubber insert is bonded in said anvil block slot.

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