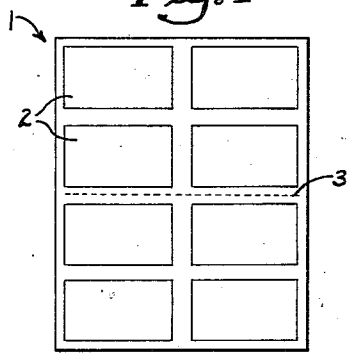
Feb. 12, 1957 I. SPINNER 2,781,095

ROLLER PERFORATING DEVICE

Filed Aug. 18, 1951 2 Sheets-Sheet 1

Fig. 1



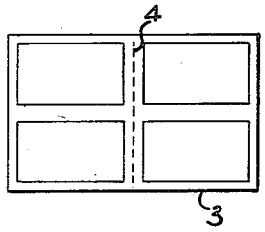


Fig. 2

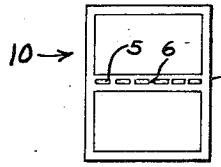


Fig. 3

Fig. 4

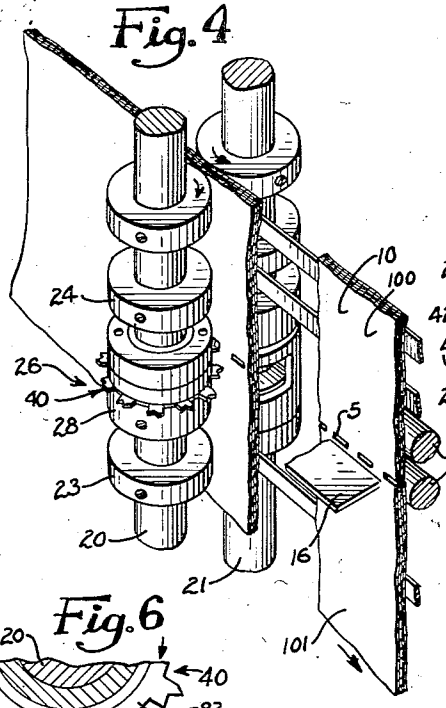


Fig. 5

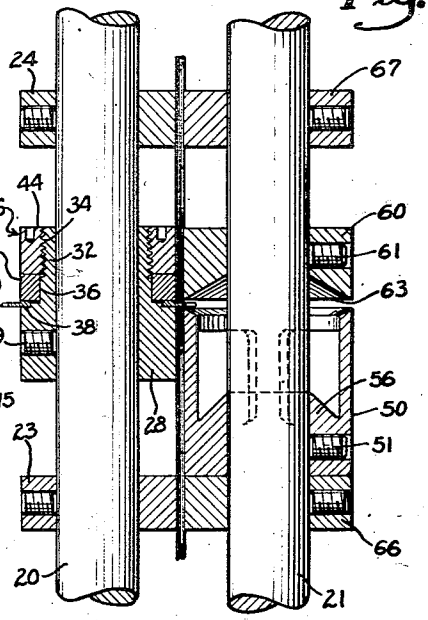


Fig. 6

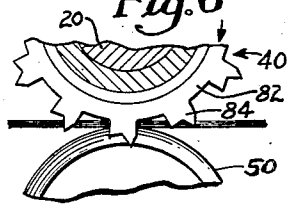
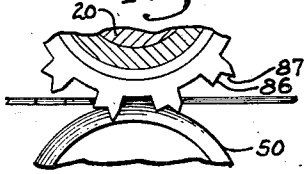


Fig. 7



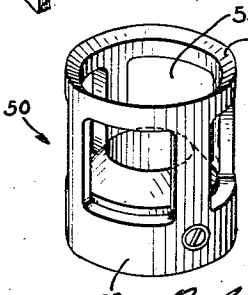


Fig. 8

Inventor
Isidore Spinner

by: Morris Spector Atty.

Feb. 12, 1957 I. SPINNER 2,781,095

ROLLER PERFORATING DEVICE

Filed Aug. 18, 1951 2 Sheets-Sheet 2

Fig. 9

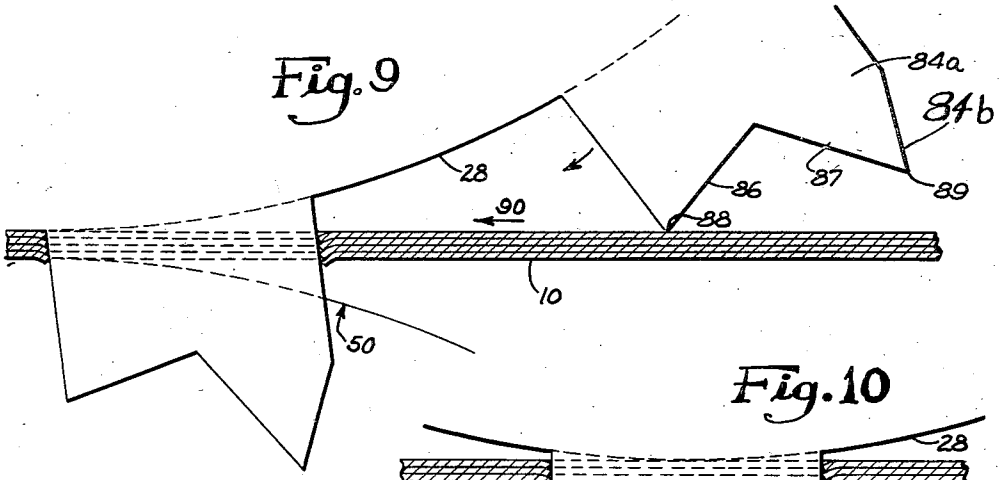


Fig. 10

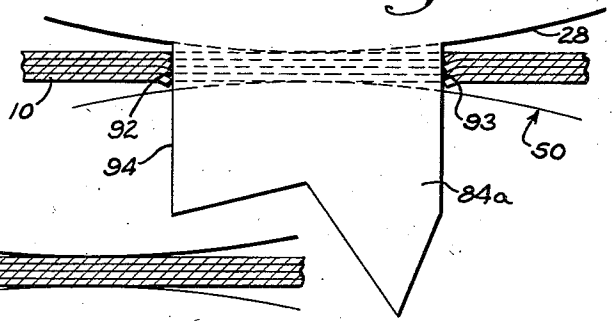


Fig. 11

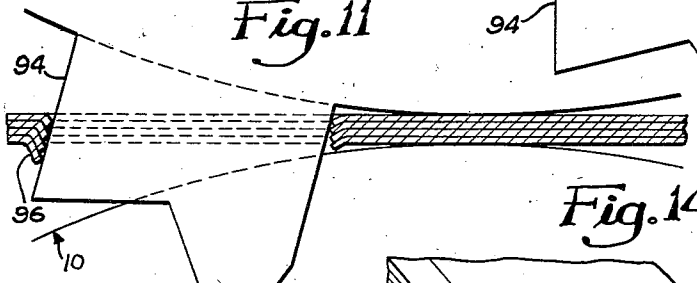


Fig. 14

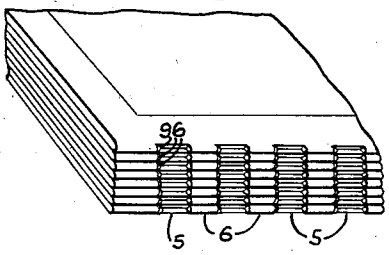


Fig. 15

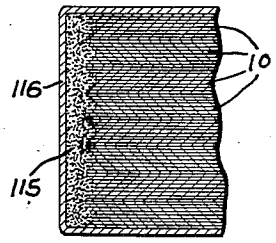


Fig. 12

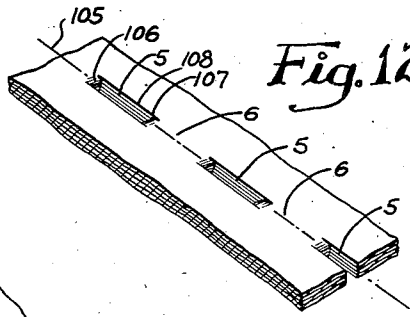
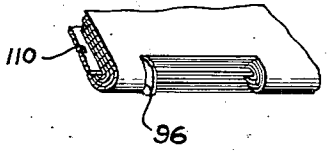


Fig. 13



Inventor
Isidore Spinner
by: Morris Spector
Atty.

United States Patent Office 2,781,095 Patented Feb. 12, 1957

2,781,095

ROLLER PERFORATING DEVICE

Isidore Spinner, Chicago, Ill.

Application August 18, 1951, Serial No. 242,534

6 Claims. (Cl. 164—99)

This invention relates to the book making art and, more particularly, to the means for preparing a signature for book binding. In its more particular aspects the present invention is concerned with the construction of a cutter to be applied to a folding machine for cutting the necessary slots in a signature after the signature has received all but the last fold.

In the formation of signatures it has heretofore been proposed to perforate the signature (without removal of paper) immediately preceding the last fold, the perforation being located at the place where the last fold is to be made. The perforation provides space for the entrance of glue into the back of the folded signature for holding the pages together and securing the back of the book cover to the signature or signatures. I have found that a great improvement is effected by forming punched holes in lieu of the perforations. However, where a series of holes are to be formed by the actual removal of paper the problem is complicated in that it is necessary to make sure that the paper is cut or tears in such a way that when the slot has been partially formed the partially cut-away paper will not interfere with the removal of the paper.

It is one of the objects of the present invention to provide a rotary cutter past which the partially folded sheets travel in moving to the last fold-forming portion of the machine, which cutter is so arranged to cut each slot substantially simultaneously from both ends of the slot towards the center. By this arrangement the portions of the paper that are being cut away at each slot are being forced towards one another by the cutter so that any tendency on the part of the paper to move away from its cutter is overcome by the action of the opposite portion of the cutter on the opposite side of the slot.

It is a further object of the present invention to provide a rotary cutter with means for supporting the cutting teeth as they rotate in engagement with the paper, particularly at the part of the paper where the cutter is subjected to the maximum stress. This arrangement reduces the tendency of the cutter teeth to bend or flex out of their normal positions. It is a still further object of the present invention to provide a rotary cutting die assembly and a rotary backing die assembly which acts as a guide and which is so constructed and arranged that the cutting die assembly and the backing die assembly can be readily assembled and disassembled as may be necessary for the replacement of the cutting die proper.

A further object of the invention is to provide a method of forming a folded signature blank wherein an increased gluing area is provided in the region of the final fold for purposes of assembling a stack of signatures in book form.

The attainment of the above and further objects of the present invention will be apparent from the following specification taken in conjunction with the accompanying drawings forming a part thereof.

In the drawings:

Figures 1, 2 and 3 are views of a sheet of printed pages in successive stages in the process of folding to form a signature;

Figure 4 is a perspective view of a portion of a folding machine where the slots are formed immediately before the last fold is formed in the signature;

Figure 5 is a longitudinal sectional view through the cutter and the cutter guide assembly;

Figures 6 and 7 are fragmentary views showing the movement of the cutter teeth through the signature in making the row of slots in the signature;

Figure 8 is a perspective view of a portion of the cutter guide cage that guides the cutter and through which the cut-away paper moves;

Figures 9, 10 and 11 are enlarged views illustrating the progressive action of the cutter teeth on the paper in forming of the slots;

Figure 12 is an enlarged perspective view illustrating slots formed in the signature;

Figure 13 is an enlarged fragmentary perspective view, through a portion of the signature, illustrating the insertion of an auxiliary page or sheet;

Figure 14 is a fragmentary perspective view of a stack of signatures preparatory to the application of a cover thereto; and

Figure 15 is an enlarged transverse sectional view through a book bound in accordance with the present invention, the section being taken through a slitted portion of the book.

Reference may now be had more particularly to the drawings wherein like reference numerals designate like parts throughout.

In Figures 1, 2 and 3 there is shown at 1 a sheet of paper having printed matter 2 thereon on both sides thereof and in such relationship that when the sheet is properly folded to form the signatures the printed pages will appear in the correct sequences. The sheet illustrated in Figure 1, for instance, contains sixteen pages of printed matter, eight on each side. The sheet 1 is folded along a dotted line 3 to produce the sheet of Figure 2. The folded sheet of Figure 2 is then perforated to produce a series of discontinuous perforations 4 spaced apart and in alignment centrally of the sheet. The perforations 4 are in the line of the next fold to be made and are for the purpose of facilitating the escape of air from between the layers of the sheet in the next folding operation, as is known in the art. These perforations do not involve the removal of paper from the partially folded signature and, per se, form no part of the present invention. The sheet of Figure 2 is then folded along the line 4 to produce the signature of Figure 3, which signature has yet to receive one additional fold. The next operation consists in forming aligned slots 5—5, of rectangular shape, each slot being formed by the actual removal of paper from the signature. The slots 5 are in alignment and are spaced apart by unslotted portions 6 of the signature, which unslotted portions then form hinges for the next to last folding operation of the signature. The slots 5 are of any desired size for the purpose intended, which will be more fully set forth as this description proceeds, it being sufficient for the present to state that the slots are in one construction approximately $\frac{3}{16}$ of an inch long, about $\frac{1}{32}$ of an inch wide, and about $\frac{1}{4}$ of an inch apart. The last fold of the signature is formed on a line passing lengthwise through the aligned slots 5, as is illustrated in Figure 4.

Reference may now be had more particularly to Figure 4 that shows a fragmentary portion of one conventional type of folding machine, namely, the Cleveland folder, to which the present invention is applied. In this well know type of machine the sheet of paper of Figure 1 advances to a first set of folding rollers that fold it

along the line 3 to produce the structure of Figure 2, and then advance to a second set of folding rollers that fold it along the line 4 of Figure 2 to produce the almost completely folded signature of Figure 3, and then the paper advances to a final set of folding rollers where it is folded along the line of slits 5. In Figure 4 the partially formed signature 10 of Figure 3 is indicated in position ready to be forced between a pair of motor driven folding rollers 15, as by a pusher 16, to form the last fold, along the line of slits 5 of Figure 3. Immediately preceding the last folding rollers 15—15 the machine is provided with two parallel driven rotary shafts 20—21. On the shaft 20 there is keyed a pair of friction driving pulleys 23—24 and a rotary cutting punch or die assembly 26 between them. The rotary cutting punch assembly includes a collar 28 that is keyed to the shaft 20 as by a set screw 29. The collar includes a neck 32 externally threaded as at 34 and having a circular portion 36 that terminates at a shoulder 38 for receiving a rotary cutting die 40. The cutting die is in the form of a circular or ring-like disc which will be more fully described as this specification proceeds. The disc rests on the shoulder 38 of the collar 28 and is clamped in place by a ring 42 that rests on the rotary cutting die 40 and is clamped thereagainst by a nut 44 threaded on the external threads 34 of the neck 32. The nut 44 is of a cylindrical external shape and of the same external diameter as are the rollers 23 and 24.

On the shaft 21 there is mounted a cage 50 as by a set screw 51. The cage 50 constitutes a backing die for the cutting die or punch assembly 26. The cage 50 is of cylindrical shape and includes a bottom roller portion 52, intermediate openings 53 and an upper guiding edge 54. At the inside of the cage 50 the collar portion 52 has an upwardly extending frusto conical projection 56 which flares outwardly, so that paper cuttings within the cage will be guided downwardly and outwardly through the openings 53. The upper inclined edge 54 is tapered almost to a knife edge and constitutes a support for the teeth of the rotary cutter 40 during operation of the machine to minimize any tendency for the respective teeth to be bent.

Above the cage 50 there is mounted a cylindrical collar 60 as by a set screw 61. The under side of this collar has a frusto conical bore 63 that terminates substantially in a knife edge and of the same diameter as that of the cage 50 and located above the knife edge 54 an amount slightly in excess of the thickness of the teeth of the rotary cutter.

Upper and lower rollers 66—67 are secured to the shaft 21 as by set screws in positions opposite the rollers 23—24 for guiding the signature as it moves between the two shafts into a position where it is perforated.

All the rollers thus far described, on the shaft 20, are of the same diameters and all the rollers thus far described, on the shaft 21, are of the same diameters. One of the two shafts, preferably the shaft 20, is motor driven, and the shaft 21 is driven by frictional engagement with the rollers on the motor driven shaft. The shafts 20 and 21 may be of considerable length and it is desired that there shall be no variation in the separation of the shafts. They may therefore be braced with respect to one another. The direction of rotation of the shaft 21 is such as to tend to tighten the nut 44 on its threaded collar 32.

An explanation will now be given of the construction and operation of the cutter 40. The cutter 40 comprises an annular disc of die steel having a ring portion 82 from which project a number of identical, uniformly spaced teeth 84. Each tooth 84 is in effect a punch having two cutting edges 86 and 87 at an angle to one another forming a leading cutting edge 88 and a trailing cutting edge 89. The edges 88 and 89 are so located with respect to one another that in the rotation of the cutter both edges 88 and 89 strike the outer surface 90 of the stack of paper at almost the same time, or with the edge 86 engaging the paper slightly before the edge 89 of the pages of the paper. In Figure 9 this is illustrated at a very much enlarged scale wherein the right hand tooth 84*a* is in a position such that the leading edge 88 is just about to engage the paper and the trailing edge 89 will engage the paper shortly thereafter. The paper is being advanced in the direction indicated by the arrow 90 due to the rolling action of the rollers 24, 44, 28 and 23 (Fig. 5) all of which are of the same diameter. As the cutter and the paper continue to advance after the edge 88 has engaged the paper, the edge 88 of the cutter tooth 84*a* (Fig. 9) first flexes and then tears or cuts the paper and the cutting edge 86 follows and produces some cutting or punching action before the edge 89 engages the top sheet of the partially formed signature 10. Thereafter, as the paper and the cutter tooth 84*a* continue to move, there is a continuation of the advance of the cutting edge 86 and the cutting edge 87 into the stack of the paper 10, with the uncut paper portion between the cutting edges 86 and 87 becoming progressively smaller in length by an action wherein the cutting edge 87 is cutting towards the cutting edge 86. When the cutter tooth 84*a* reaches its innermost position in the signature it is in the position illustrated in Figure 10. At this time the slot 5 has been formed in the paper and the edges of the individual sheets at the slot are flexed slightly in a direction downwardly as seen in Figure 10, the flexure at the leading edge being indicated at 92 and at the trailing edge being indicated at 93. As the movement of the cutter and the paper continues, the edge 94 of the cutter tooth forces the flexed edge of the slot at 92 downwardly as seen at 96 in Figure 11, so that the paper at 96 at the edge of each slot is flexed outwardly to form a short projection. In Figure 11 this is shown in somewhat exaggerated scale. The projection 96 is utilized in the binding of a book of which the signature is one of the component parts, as will be more fully explained as this description proceeds.

It is to be noted that the trailing side of each cutter tooth 84*a* has a surface 84*b* which is inclined with respect to the radial axis of the tooth. It is this inclined surface 84*b* which causes a slight spreading action of the trailing edge of each slot. Because of the fact that the teeth completely penetrate all the thicknesses of paper of the signature and because of the fact that the radial extent of the teeth is greater than the radial extent of the periphery of the driving rolls, the rate of the tangential component of motion or sweep of the teeth passing through the slot is greater than the rate of travel of the paper signature and this in a large measure accounts for the spreading action wherein the leading end of the slots are deformed outwardly.

From the description thus far given it is apparent that during the cutting action of the cutter the paper is removed by the action of the two cutting edges 86 and 87 moving towards one another. As the paper is being cut at each slot the cut edges of the paper are being pushed progressively through the slot so that when all of the paper of the slot is severed the cut-away paper or chips enter the cage 50, there being a definite and certain expulsion of all of the removed paper. The paper cuttings or chips fall to the bottom of the cage 50 where they are guided by the rotating frusto conical portion 56 to the outside of the cage, by the action of centrifugal force, through the openings 53. The chips may be drawn off by any vacuum or suction system. During the cutting action the paper is held between the collars on the shaft 20 and the collars on the shaft 21, the cage 50 also acting as paper holding means. The teeth of the cutter enter between the top of the cage 50 and the bottom of the collar 60 and are thus held against bending.

After the paper leaves the cutter of Figure 4 an additional fold is formed therein along the center line of the

cut or punched row of holes **5**, as previously stated. This fold is formed in a conventional manner, illustrated diagrammatically in Figure 4. When this fold is formed the page surfaces **100** and **101** (Fig. 4) are brought into facing contact position by a fold that folds the paper towards rather than from the surface where the rotary cutter enters the paper.

The signature formed in the manner described above may then be stacked with similarly formed signatures to form a book, in the manner described in my pending application Serial No. 185,897.

Figure 12 shows an enlarged view of a portion of a sheet of paper immediately after the slots **5** are formed and before folding. The fold is formed along the center line **105** which is the center line of the aligned rectangular slots **5**. The slots **5** are more rough at their transverse edges **106—107** than at their longitudinal edges **108**, which facilitates the adhesion of adhesive that is to be used for securely holding the signature and the individual sheets thereof in place. When a signature of this type is folded the fold at the slot appears somewhat as shown in Figure 13, wherein the voids which formerly were in the form of slots in the unfolded signature result in a series of spaced notches at the folded edge of the signature and wherein the outwardly extending tab **96** is shown in rather exaggerated form. It is to be noted that in this type of signature an insert sheet, such as indicated at **110**, may be inserted at any place in the signature, and a portion of the edge thereof will be exposed at the slots, so that glue which is later to be applied will secure such inserted sheet in place. A stack of similar signatures, as illustrated in Figure 14, is formed. The slots in each signature may be in line with or out of line with the slots of adjacent signatures. The back of the stack of signatures of Figure 14 is then coated with a suitable adhesive which penetrates the slots **5**, the adhesive being indicated at **115** in Figure 15, and then a book cover **116** is wrapped around the backbone to extend over the outer signatures to constitute the cover of the book thus formed, the cover being adhered to the stack of signatures by the adhesive **115**, as set forth in my application Serial No. 185,897.

In compliance with the requirements of the patent statutes I have here shown and described a preferred embodiment of my invention. It is, however, to be understood that the invention is not limited to the precise construction here shown, the same being merely illustrative of the principles of the invention. What I consider new and desire to secure by Letters Patent is:

1. Cutting instrumentalities for forming a linear series of perforations in a blank of material comprising a rotary cutting die having a series of radially projecting cutting teeth extending outwardly from the periphery thereof and of a width substantially equal to the width of the perforations to be formed in the blank, a rotary backing die designed for cooperation with said cutting teeth, said rotary dies being mounted for rotation about respective vertical axes, means for feeding the blank between said dies for successive perforating operation thereupon by said teeth, said backing die being of hollow cage-like construction and having circumferential openings and being provided with an upwardly facing circular knife edge over which said cutting teeth are adapted to successively pass upon rotation of the cutting die, said cage-like backing die being provided with a conical mound-like bottom having walls tapering outwardly toward the lower portion thereof to direct chips entering the die through said circular shearing edge outwardly through the said circumferential openings thereof, and means for rotating one of said dies, the other die being adapted to rotate due to tractional engagement with the blank undergoing feeding.

2. In a device for forming a linear row of perforations having material width and length in a blank, a pair of feeding rolls including a power roll adapted to receive the blank therebetween, a rotary cutter positioned on one side of the blank and having a series of radially projecting cutting teeth extending outwardly from the periphery thereof, the radial extent of said teeth being substantially greater than the combined radius of said power roll and the thickness of the blank, means for rotating said power roll and cutter in unison and at the same rate of rotation, a backing roll positioned on the other side of the blank, means operatively connecting said backing roll and one of said feeding rolls for rotation in unison, said backing roll being hollow and formed with a circular knife edge rim circumferentially extending about the backing roll and defining a circular opening to the hollow therein, said knife edge being located opposite said cutter and being normal to the plane of the blank undergoing perforation and designed for shearing cooperation with the cutting edges of successive cutting teeth in passing, said backing roll being adapted to receive chips through said opening therein which enter the hollow portion of the die, the leading and trailing sides of said teeth diverging inwardly of the cutter from each other an amount sufficient to effect lateral deformation of the leading and trailing ends of the perforations upon sweeping of the teeth across said circular knife edge and a consequent elongation of the formed perforations.

3. In a device for forming a linear row of perforations having material width and length in a composite signature blank, a pair of feeding rolls including a power roll adapted to receive the blank therebetween, a rotary cutter positioned on one side of the blank and having a series of radially projecting cutting teeth extending outwardly from the periphery thereof, the radial extent of said teeth being substantially greater than the combined radius of said power roll and the thickness of the signature blank, means for rotating said power roll and cutter in unison and at the same rate of rotation, a backing roll positioned on the other side of the blank, means operatively connecting said backing roll and one of said feeding rolls for rotation in unison, said backing roll being hollow and formed with a circular knife edge rim extending circumferentially about the backing roll and defining an opening to the hollow therein, said knife edge being located opposite said cutter and being normal to the plane of the blank undergoing perforation and designed for shearing cooperation with the cutting edges of successive cutting teeth in passing, said backing roll being adapted to receive chips through said opening therein, each of said cutting teeth being formed with a transversely extending leading knife edge and a transversely extending trailing knife edge spaced therefrom, said edges being adapted to initially penetrate the moving blank thicknesses at spaced points therealong, the intervening regions of each tooth between said edges being formed with receding shearing edges for severing the material of the blank between the initial points of penetration inwardly of the perforation to be formed in opposite directions, the leading and trailing faces of said teeth diverging inwardly from each other so as to effect longitudinal spreading of the perforations with a consequent lateral deformation of the material at the ends thereof.

4. In a device for forming a linear row of perforations in a composite signature blank, a pair of feeding rolls including a power roll and a backing roll adapted to receive the blank therebetween, a rotary cutter positioned on one side of the blank and having a series of radially projecting cutting teeth extending outwardly from the periphery thereof, the radial extent of said teeth being substantially greater than the combined radius of said power roll and the thickness of the signature blank, means for rotating said power roll and cutter in unison and at the same rate of rotation, means operatively connecting said backing roll and one of said feeding rolls for rotation in unison, said backing roll being hollow and formed with a circular knife edge rim extending circumferentially about the backing roll and defining an opening to the hollow

therein, said knife edge being located opposite said cutter and being normal to the plane of the blank undergoing perforation and designed for shearing cooperation with the cutting edges of successive cutting teeth in passing, said backing roll being adapted to receive chips through said opening therein, each of said cutting teeth being formed with a transversely extending leading knife edge and a transversely extending trailing knife edge spaced therefrom, said edges being adapted to initially penetrate the moving composite blank thicknesses at spaced points therealong, the intervening regions of each tooth between said edges being formed with inwardly converging opposed shearing edges for progressively severing the material of the blank between the initial points of penetration inwardly of the ends of the perforations to be formed in opposite directions, the leading and trailing sides of said teeth diverging inwardly from each other so as to effect a lateral deformation of the leading and trailing ends of the perforations.

5. A perforating device comprising a cutter which is rotatable about a vertical axis, a series of cutting teeth extending outwardly from the periphery thereof, the radial extent of said teeth being sufficiently great to extend beyond the material which it is to perforate, a backing roll which is adapted to be rotated with said rotary cutter about an axis parallel to and displaced from the axis of rotation of said cutter, the backing roll being hollow and having a knife edge rim extending circumferentially about the top end of the backing roll and defining an opening to the hollow therein, said knife edge being parallel to the plane of the cutting teeth of the cutter and adapted for cooperation with said teeth of said cutter, the bottom of said hollow backing roll being provided with a conical mound-like bottom having walls tapering outwardly toward the lower portion thereof, and circumferential openings opposite the bottom of said hollow adapted to receive chips from said backing roll passing through said opening defined by said circular knife edge for removing the chips from the backing roll.

6. A perforating device comprising a rotary cutter having a series of projecting cutting teeth extending outwardly from the periphery thereof, the radial extent of said teeth being sufficiently great to extend beyond the material which it is to perforate, a backing roll which is adapted to be rotated with said rotary cutter about an axis parallel to the axis of rotation of said rotary cutter, the backing roll being hollow and having a central knife edge rim extending circumferentially about one end of the backing roll and defining an opening in the hollow therein, said knife edge being parallel to the plane of the cutting teeth of the rotary cutter and adapted for cooperation with said teeth of said rotary cutter, said backing roll being adapted to receive chips through said opening therein which are removed from the material being perforated by said rotary cutter.

References Cited in the file of this patent

UNITED STATES PATENTS

154,450	Braidwood	Aug. 25, 1874
371,736	Burton	Oct. 18, 1887
533,218	Gilson et al.	Jan. 29, 1895
742,299	Downing	Oct. 27, 1903
1,110,238	Spiegel	Sept. 8, 1914
1,542,097	Ripley	June 16, 1925
1,937,499	Adams	Dec. 5, 1933
2,107,462	Wood	Feb. 8, 1938
2,343,120	Zaslawsky	Feb. 29, 1944

FOREIGN PATENTS

4,351	Great Britain	Nov. 10, 1876
800,395	Germany	Nov. 2, 1950
807,622	Germany	July 2, 1951