

Nov. 6, 1956

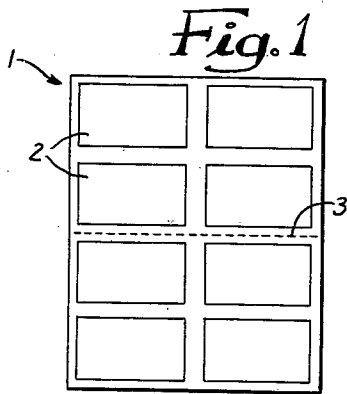
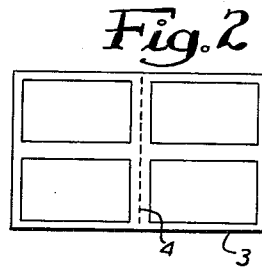
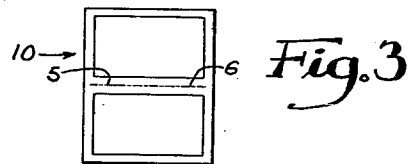
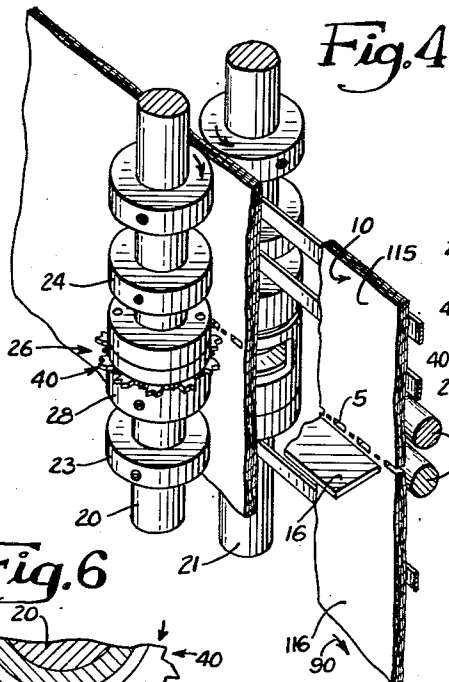
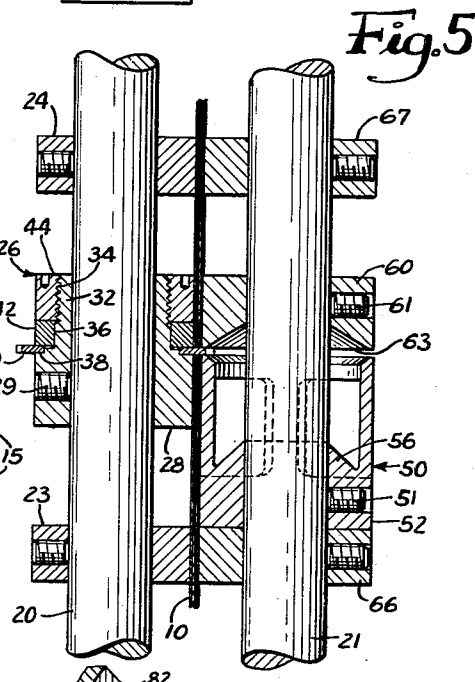
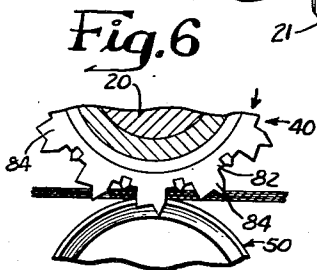
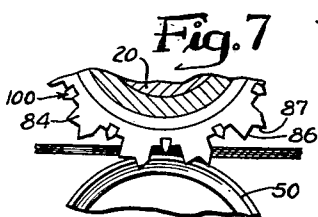
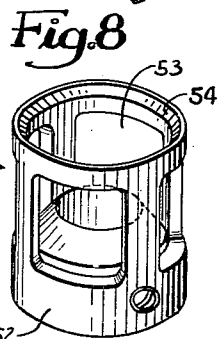
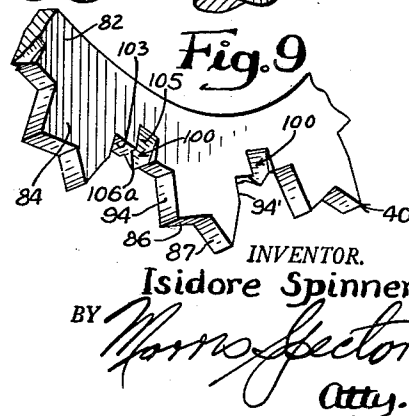
I. SPINNER

2,769,496

ROTARY CUTTING DIE FOR PERFORATING OF SIGNATURES

Filed Nov. 23, 1951

2 Sheets-Sheet 1



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2,769,496

ROTARY CUTTING DIE FOR PERFORATING OF SIGNATURES

Filed Nov. 23, 1951

2 Sheets-Sheet 2

Fig. 10

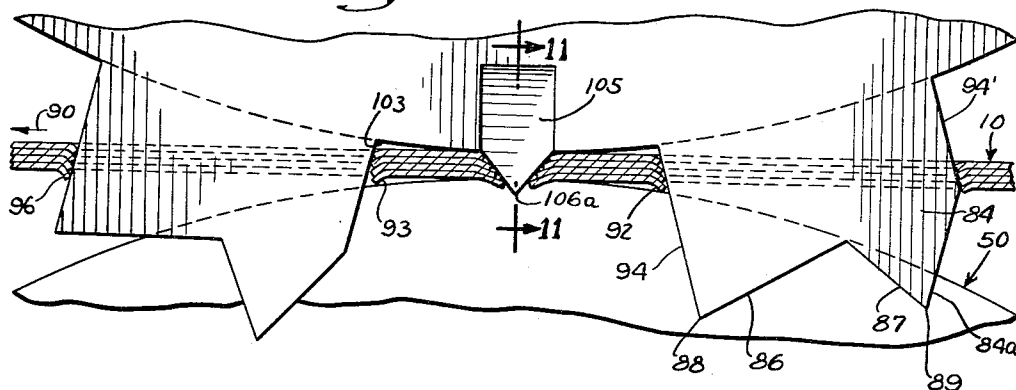


Fig. 11

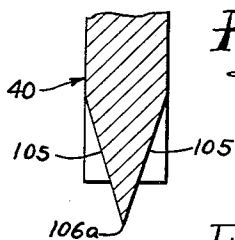


Fig. 12

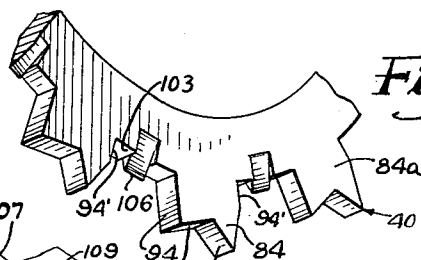


Fig. 15

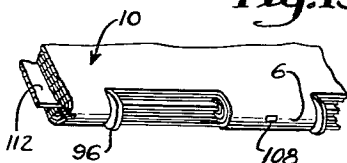


Fig. 13

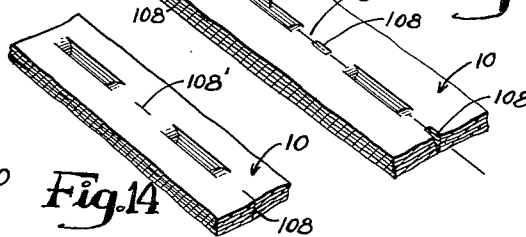


Fig. 17

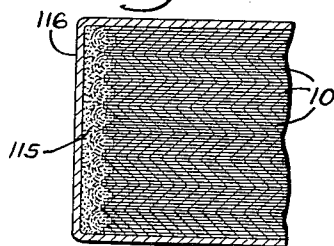


Fig. 14

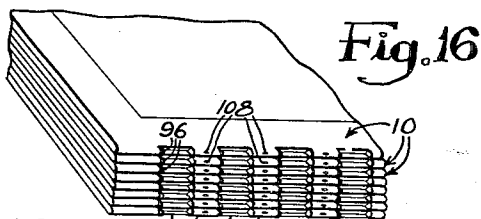
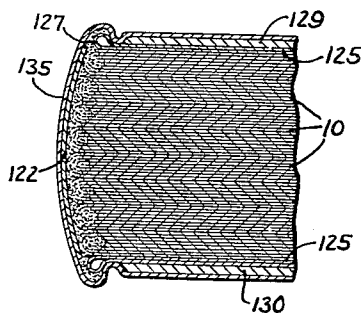


Fig. 16

Fig. 18



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2,769,496

ROTARY CUTTING DIE FOR PERFORATING SIGNATURES

Isidore Spinner, Chicago, Ill.

Application November 23, 1951, Serial No. 257,700

5 Claims. (Cl. 164—99)

This invention relates to the book making art. More particularly, it relates to books of the type comprising one or more signatures the pages of which are secured together and to a cover by adhesive, without stitching, stapling or the like.

In my co-pending applications Serial Nos. 185,897, filed September 20, 1950, now abandoned, and 242,534, filed August 18, 1951, there is disclosed a method of making a book of the type with which the present invention is concerned, wherein each signature has a series of aligned slots formed at the fold thereof and into which glue or other adhesive enters for securing the sheets of the signature together. Consider a signature wherein the glue-receiving slots are of a generally rectangular shape. Those slots may have to be of an appreciable width to provide the required glue-holding areas, and for other reasons, in the case of books that have a comparatively long, useful life as distinguished from pamphlets, magazines or the like. Also, in books wherein the pages are of appreciable thickness and where it is desired that each signature constitute a large number of pages, it is necessary that the series of longitudinal slots at the fold be of appreciable width. In all books it is necessary that the fold line be centered with respect to the respective aligned adhesive-receiving slots. In the making of the signature the last fold is made after formation of the aligned slots that are to be centered on the fold. When the fold is made after the slots have been formed there is a tendency in many instances for the line of fold to form off center with respect to the aligned slots. This is objectionable not only because it results in relative misalignment of the printing matter on the respective pages, but also, it reduces the holding action of the adhesive insofar as concerns some of the pages.

It is one of the objects of the present invention to provide a means for producing the last fold in the perforated or slotted signature wherein the fold will naturally form centrally of the series of slots. In the preferred embodiment of the present invention this result is obtained by forming in each hinge portion between adjacent slots one or more centrally located weakened portions that may comprise pin hole perforations or may comprise a short longitudinally extending slit in the tab between adjacent slots, each slit being of a length appreciably less than the spacing between adjacent slots in the signature.

It is a further object of the present invention to provide a cutter for forming the glue-receiving slots in the signature, which cutter will also form the fold facilitating weakened portions so that in the formation of the signature it is assured that the weakened portions will be properly located with respect to the slots. This eliminates the need for extreme precision in alignment of the mechanisms such as would be necessary if the slot forming perforator and the weakening mechanism were different mechanical parts to perform their operations successively.

The attainment of the above and further objects of

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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 wherein 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;

Figure 9 is a perspective view of a fragmentary portion of the male cutter ring of the present invention;

Figure 10 is an enlarged view illustrating the action of the cutter teeth on the paper in forming the slots;

Figure 11 is a fragmentary sectional view taken along the line 11—11 of Figure 10 and looking in the direction of the arrows;

Figure 12 is a perspective view of a fragmentary portion of a modified form of the male cutter ring of the present invention;

Figures 13 and 14 are enlarged perspective views illustrating the slots and cuts formed in the signature by the cutters of Figures 9 and 12, respectively;

Figure 15 is an enlarged fragmentary perspective view through a portion of the signature at a fold, illustrating the insertion of an auxiliary page or sheet thereinto;

Figure 16 is a fragmentary perspective view of a stack of signatures preparatory to the application of a cover thereto; and

Figures 17 and 18 are enlarged fragmentary transverse sectional views through two different books bound in different ways and embodying the signatures of the present invention, the sections being taken through a slotted portion of the book in each case.

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 or 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 known 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 6. 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 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 inner surface of the cage 50 is tapered to a narrow thickness at 54 to constitute 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 in a narrow guiding edge and of the same diameter as that of the cage 50 and located above the guiding edge 54 an amount slightly in excess of the thickness of the teeth of the rotary cutter.

Lower and upper 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 20 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 of the stack of paper at almost the same time, or with the edge 88 engaging the paper slightly before the edge 89. 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 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 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 reaches its innermost position in the signature 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 10, so that the paper at 96 at the edge of each slot is flexed outwardly to form a short projection. In Figures 10 and 15 this is shown greatly exaggerated to facilitate illustration. 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 has a surface 84a which is inclined with respect to the radial axis of the tooth. It is this inclined surface 84 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 ends 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 be-

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tween the top of the cage 50 and the bottom of the collar 60 and are thus held against bending.

To make certain that the fold that is to be formed in the signature will extend longitudinally centrally through the row of cut or punched holes 5, the cutter 40 is provided with a series of pins or knife edge projecting blades 100 between adjacent teeth 84. These are of a depth merely sufficient to penetrate the stack of sheets and will form either a pin hole or a short knife cut in the stack of sheets extending lengthwise between adjacent slots 5. Each pin or knife edge blade is formed by cutting away the metal between adjacent teeth to a greater depth adjacent the leading and trailing edges 94—94' of each tooth than at the center between teeth, so that at the center between teeth there is left a small projection extending radially outwardly from the periphery 103. This projection can then be milled or machined either to form a pin point, as in Figure 9, or to form a knife edge as in Figure 12. In each case it is formed by removing metal at the edges of the projection to form the opposite converging surfaces 105—105'. This forms a knife edge at 106 (Fig. 12) which knife edge may, if desired, be reduced to a point 106a as in Figure 9. As a result, the paper leaving the cutter will have formed therein a series of aligned slots 5—5 where paper has been removed and leaving hinged portions 6—6 between adjacent slots. The slots are aligned along the longitudinal center line 107. Each of the hinge portions 6 has a narrow cut or pin hole therein located on the longitudinal center line 107. In the case of the cutter shown in Figure 9, this hole is in the nature of a pin hole or needle hole, indicated at 108 in Figure 13. This hole is centered on the center line 107 and is of a width substantially less than the width of the respective slots 5 and does not involve the removal of any paper. In the case of a cutter such as shown in Figure 12, the corresponding cut is shown at 108' and consists of a slit extending lengthwise on the center line 107 and of a very short length which is a fractional part of the distance between adjacent slots 5. It may be, for instance, of a total length of the order of one-third of the distance between adjacent slots 5. This also involves no removal of paper.

After the paper leaves the cutter of Figure 4 it passes to the last fold-forming apparatus on the folding machine. This fold is formed in a conventional manner, indicated diagrammatically in Figure 4. When this fold is formed the page surfaces 115 and 116 (Fig. 4) are brought into facing contact position by a fold wherein the paper is folded 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 13 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 107 which is the center line of the aligned rectangular slots 5. The slots 5 are more rough at their transverse sides 109—110 than at their longitudinal edges 111, 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 15, wherein the spaces 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 auxiliary sheet, such as indicated at 112, 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 16, is formed. The slots in each signature may be

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in line with or out of line with the slots of adjacent signatures. The back of the stack of signatures of Figure 16 is then coated with a suitable adhesive which penetrates the slots 5, the adhesive being indicated at 115 in Figure 17, 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.

Figure 18 shows a cross section through the end of a book in an edition binding embodying the signatures of the present invention. In making a hard covered or "edition" binding book the signatures of the present invention are assembled and put through the usual forwarding operations, the backs coated with glue and overlaid with a backing paper sheet 122. In the hard covered book two cover-receiving sheets of paper 125 are folded lengthwise as by a fold 127 and pasted one to the uppermost and one to the lowermost sheet of the stack of signatures 10 in the usual manner, as by a narrow line of paste or other adhesive that extends lengthwise along the top and bottom of the stack of signatures adjacent to the back thereof. Upper and lower cover sheets 129 and 130 are pasted to the respective sheets 125 which cover sheets are secured together by the usual stiff book backbone 135 that arches away from the folded edges of the signatures 10 that constitute the book, as is usual in edition bound books. The book of Figure 18 is one intended for more durable service than is the book of Figure 17. The signatures of the books of Figure 17 and Figure 18 are held together entirely by the glue or other adhesive that penetrates the slots or notches 5 of the respective signatures and also secures the pages of each signature together. The slots 5 are made of sufficient width so that when the signature is folded the notches formed at the respective slots are of a considerable depth thereby to allow enough glue to enter into each notch adequately to secure the pages together.

While the present invention has here been shown as applied to signatures wherein the slots 5 are rectangular and involve substantial removal of paper, it is within the purview of the present invention to apply the principles that involve forming the fold centering perforations 108 or 108' in a signature wherein the glue enters an opening that is formed otherwise than rectangular, as in Figures 13 and 14. For instance, the perforations 108 or knife cuts 108' may be formed in corresponding locations in a signature such as is shown, by way of example, in Figures 4 and 12 of my co-pending application Serial No. 185,897, filed September 20, 1950, to which reference may be had. The center biasing perforations 108 or slots 108' may be formed in any signature wherein it is desired to make certain that the fold will form on a given line where it might not otherwise form.

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. A rotary cutting die for forming a linear series of perforations in a stack of sheets of paper that are to constitute a signature, said die having a series of radially projecting punching teeth extending outwardly from the periphery thereof, the overall radial extent of each tooth being of sufficient length to project well beyond the signature and to eject the severed chips of the various paper layers from the formed perforation, and said die having sheet perforating projections between certain teeth, each having a substantially smaller corresponding transverse cross-sectional dimension and radial extent relative to said teeth, the teeth and the projections being in a common plane which passes through the centers of the teeth and the centers of the projections so that said projections

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produce cuts in the sheet substantially smaller than the blanks cut by the teeth and centered along the central plane of said teeth.

2. A rotary cutting die for forming a linear series of perforations in a stack of sheets of paper that are to be folded along the series of perforations to constitute a signature, said die having a series of radially projecting punching teeth extending outwardly from the periphery thereof and having centers in a common plane, 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 penetrate a stack of sheets with which it is in rolling engagement at spaced points therealong, the intervening regions of each tooth between said edges being formed with radially inwardly converging opposed 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 overall radial extent of each tooth being of sufficient length as to eject the severed chips of the various paper layers from the formed perforation, and said die having sheet perforating projections between certain teeth and substantially narrower in a direction transverse of the fold line, and shorter in radial extent, than said teeth, the centers of the projections being in the same common plane as that of the centers of the teeth to produce cuts in the sheet substantially narrower than the widths of the blanks cut by the teeth, and centered along the central plane of said teeth.

3. A rotary cutting die for forming a linear series of perforations in a stack of sheets of paper that are to be folded along the series of perforations to constitute a signature, said die having a series of radially projecting punching teeth extending outwardly from the periphery thereof the overall radial extent of each tooth being of sufficient length as to forcibly eject the severed chips of the various paper layers from the formed perforations, and said die having slitting projections between adjacent teeth which slitting projections have a dimension along the fold line which is a fractional part of the distance between teeth and have a radial extent smaller than said teeth, and are in a plane coincident with the central plane through said teeth for cutting the signature between the perforations without substantial removal of paper.

4. A rotary cutting die for forming a linear series of perforations in a stack of sheets of paper that are to be

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folded along the series of perforations to constitute a signature, said die having a series of radially projecting punching teeth extending outwardly from the periphery thereof, the overall radial extent of each tooth in a direction transverse of the fold line being of sufficient length as to eject the severed chips of the various paper layers from the formed perforation, and said die having sheet-engaging projections between certain teeth and substantially shorter in radial extent and narrower than said teeth in a direction transverse of the fold line, and said sheet-engaging projections and said punching teeth having their centers in a common radial plane, the projections producing weakened lengths in the sheet substantially narrower than the widths of the perforations cut by the teeth and centered along the central plane of said teeth and extending lengthwise of and between perforations.

5. A rotatable cutting die for forming a linear series of perforations in a stack of sheets of paper that are to be folded along the series of perforations to constitute a signature, said die having a plurality of radially projecting teeth wherein at least one of the teeth has an appreciable dimension transversely of a radial and a circumferential line to form a perforation of appreciable size in a direction transversely of the fold line and at least one of the teeth being smaller in a radial direction and also smaller in a direction parallel to the axis of rotation of the die than the corresponding dimensions of said one tooth, the teeth having their centers in a common radial plane normal to the axis of rotation of the die whereby said smaller teeth form a narrow perforation transversely of the fold line.

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