

[54] **PAPER TRIMMING KNIFE SYSTEM**

[75] Inventor: **Hans G. Faltin**, York, Pa.

[73] Assignee: **Advance Enterprises, Inc.**, York, Pa.

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[51] Int. Cl. **B26d 1/24**

[58] Field of Search **83/500, 501, 502, 503, 83/675, 676, 699, 700**

[56] **References Cited**

UNITED STATES PATENTS

478,023	6/1892	Rohan.....	83/500 X
823,797	6/1906	Lupton	83/501 X
1,181,354	5/1916	Stevens	83/500 X
3,172,326	3/1965	Hamilton	83/676 X

Primary Examiner—Frank T. Yost

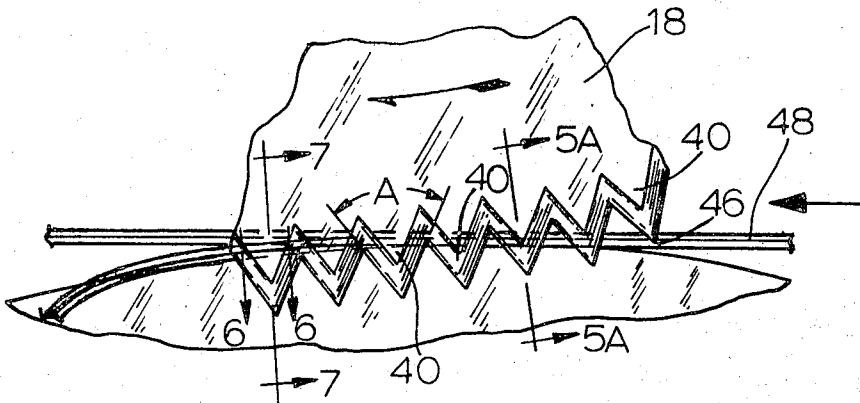
Attorney, Agent, or Firm—C. Hercus Just

[57] **ABSTRACT**

A rotary cutting knife for trimming signatures of mul-

tiple thicknesses of paper, such as folded press products, said knife having sharply pointed teeth around the periphery thereof, one surface of each tooth being planar, within the plane of one surface of said knife, and the edges of said teeth being beveled from the opposite surface at an acute angle to said one surface of said knife to provide camming surfaces on said teeth operable to engage a plurality of superimposed sheets of paper, including especially sheets folded upon themselves, and prevent the same from moving away from said planar surfaces of said teeth while shearing such paper by coaction of said teeth with a rotary bed knife having a planar face slidable in shearing relationship with said planar surfaces of said teeth on said cutting knife. During a rotary shearing operation, leading teeth of said cutting knife engage and progressively pierce the adjacent surfaces of said sheets of paper to maintain an intended line of cut accurately in alignment with the planar surface of said cutting knife and such penetrating movement into said paper continuing at least to the full depth of said teeth for shearing coaction with said rotary bed knife and thereby form a smoothly sheared accurate edge along one side of said paper.

5 Claims, 8 Drawing Figures



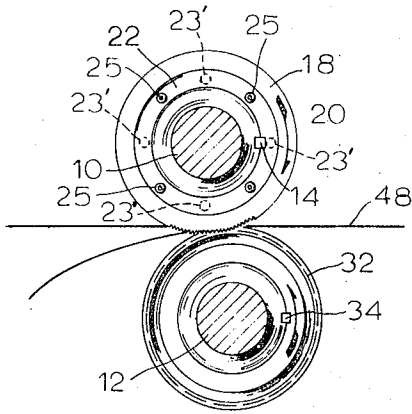


Fig-1

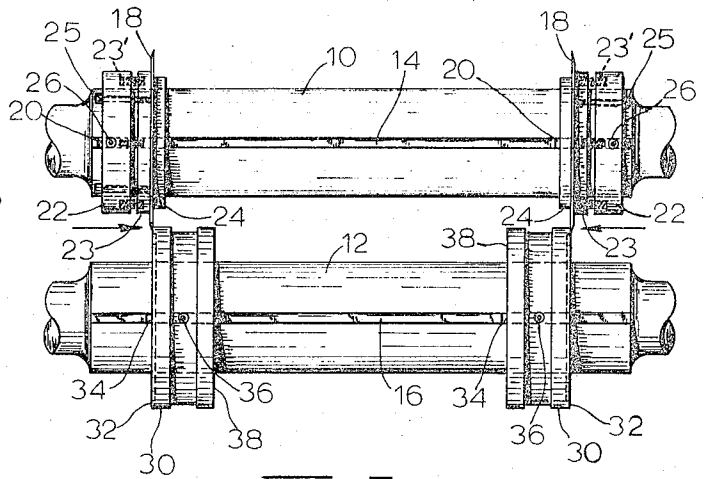


Fig-2

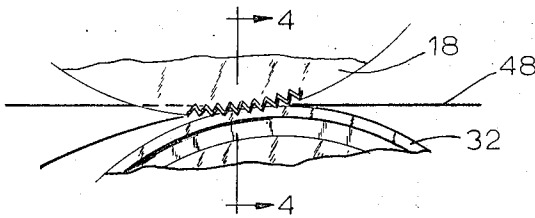


Fig-3

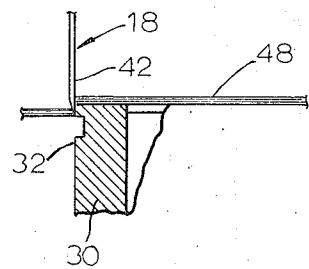


Fig-4

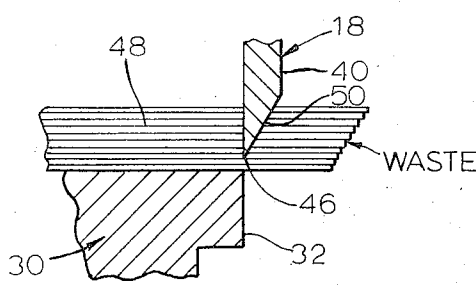


Fig-5A

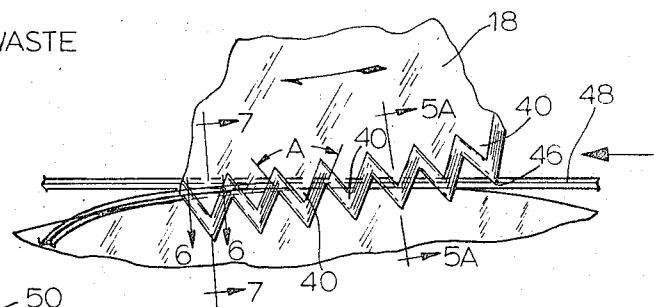


Fig-5

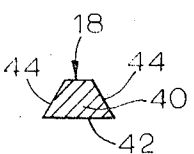


Fig-6

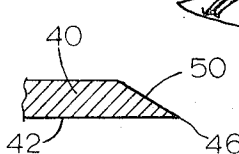


Fig-7

PAPER TRIMMING KNIFE SYSTEM

BACKGROUND OF THE INVENTION

This invention pertains to the shearing of sheets of paper and similar material of a relatively stiff nature and adapted to be fed to shearing and trimming knives. For many years, the shearing of a plurality of folded sheets of paper, such as folded press products, by rotary knives, especially at high speeds, has presented substantial problems not experienced in trimming one or more edges of a continuous web or strip of paper or superimposed continuous webs or strips thereof which normally are positively fed and placed under tension which aids in maintaining the webs or strips in line with rotary disc-like trimming knives. Trimming individual, separated assemblies of sheets is difficult, due to the tendency of the uppermost sheets, in particular, moving or skidding away from the intended cutting line when using disc-type knives, thus causing the upper sheets to buckle, resulting in many of the sheets not being trimmed similarly along a desired line.

This problem is particularly evident in trimming the edges of separate assemblies of superimposed sheets or brochures and especially those comprising a series of sheets which have been folded, for example, along one or more lines and the sheets being glued or stapled at that line, whereby the edges around three sides of the brochure are required to be trimmed. Such an assembly is also known as a signature. The problem is accentuated when attempting such trimming at high speeds, due to the foregoing tendency of the uppermost sheets tending to skid away from the upper knives, for example, as when the sheets are fed substantially horizontally between pairs of cooperating cutting and bed knives which are rotated in opposite directions on axes which are spaced apart vertically.

Various attempts have been made in the past to solve the problem of overcoming the tendency for the upper sheets, for example, of a stack of laminated sheets to skid away from a desired shear line, but the problem still persists. The present invention has solved this problem successfully by utilizing a circular cutting knife which cooperates with a rotary bed, the rotary knife having sharp teeth thereon, details of which are described hereinafter.

The prior art has suggested the use of teeth on rotary cutters or discs used in conjunction with perforating paper, for example, U.S. Pat. No. 167,308, to Daniels, issued Aug. 31, 1875, and U.S. Pat. No. 1,831,660, to Hancock, issued Nov. 10, 1931, respectively show toothed cutters and discs for such perforating purposes. These structures, however, do not solve the problem of shearing paper sheets, especially assemblies of overlying sheets of paper along a desired shear line so that all of the sheets are sheared equally along a desired line.

There also are other toothed cutters in structures for trimming or slitting fabric. For example, U.S. Pat. No. 1,806,458, shows a fabric slitting cutter having certain types of teeth which cooperate with a rotary platen, the teeth having cutting points along opposite edges, but the arrangement being such as to be inapplicable to solving the aforementioned problem. Similarly, U.S. Pat. No. 2,771,949, to Sigoda, dated Nov. 27, 1956, pertains to a shearing device to trim embroidery, wherein a toothed shear member rotates relative to a

stationary ledger plate to effect a shearing relationship therewith as the material to be trimmed is fed between said shearing edges. In this structure, however, there is no cutting relationship between a toothed rotary knife and a cooperating rotary knife of a nature which would be suited for trimming paper, especially a plurality of overlying sheets of paper in separate signature condition.

SUMMARY OF THE INVENTION

It is the principal object of the present invention to provide a paper trimming knife, which, in addition to being capable of accurately trimming single sheets of paper and similar material is adapted especially to accurately trim either a single edge or opposite parallel edges of an assembly of a plurality of superimposed sheets of paper, such as a folded press product or signature, to provide smoothly trimmed accurate edges along desired shear lines, either at one or opposite sides of said assembly, the structure of the knives being such as to prevent movement, especially of the uppermost sheets, away from the line of cut such as by buckling or otherwise skidding as the trimming of said assembly of superimposed sheets progresses.

It is another object of the invention to provide a paper trimming machine in which a rotary bed knife has a circular shearing edge at the periphery of a planar face thereon, and a circular rotary cutting knife has a planar face on one surface, the outer portion of which slidably coacts with said planar face of said rotary bed knife, the periphery of said rotary cutting knife having teeth provided with sharp apex ends and the side edges of said teeth are tapered in opposite directions at acute angles to the planar faces of the teeth, whereby said teeth terminate in sharp points in the same plane as the planar face of the rotary cutting knife, thus providing camming surfaces on said teeth, in addition to the sharp points, which progressively pierce the sheets of paper along a desired line and maintain the same against movement away from the rotary cutting knife, whereby a smoothly trimmed edge is formed uniformly upon the entire assembly of superimposed sheets.

Ancillary to the foregoing object, it is a related object to provide cutting edges on the teeth of the rotary cutting knife which extend transversely to the planes of the sheets being cut while coacting with the circular cutting faces of the rotary bed knives, thereby providing a much more efficient and effective type of trimming cut and requiring much less cutting pressure than that resulting from solely circular coacting trimming knives wherein, at the point where shearing takes place, the cutting edges are disposed at a very acute angle to each other which produces a tendency for such edges to cam the sheets away from the knives in a direction opposite to that of feeding the sheets to the knives.

It is a further object of the invention to mount the rotary cutting knife with respect to the rotary bed knife in such manner that the entire planar faces of the teeth on the rotary cutting knife slidably overlie the planar face of the rotary bed knife and, thus, insure formation of a smoothly sheared edge along all of said superimposed sheets in accurate alignment with each other.

Still another object of the invention is to provide a pair of shafts supported in parallel relationship and spaced apart transversely a desired distance, one of said shafts supporting a pair of said circular cutting knives with the planar surfaces thereof facing each

other and axially spaced upon said shaft a distance precisely equal to the desired width of a superimposed assembly of sheets to be trimmed by the machine, the other shaft supporting a cooperating pair of rotary bed knives, the outer faces of which are spaced axially a distance precisely equal to the width of the sheets desired when trimmed at opposite edges, said rotary bed knives cooperating in shearing relationship with the rotary cutting knives in the manner described above, whereby the shearing teeth upon the rotary cutting knives respectively tend to effect camming action in opposite directions with respect to each other and thereby maintain the superimposed sheets being sheared in flat, taut condition, whereby accurate high speed trimming of opposite sides of a brochure or other assemblies of superimposed sheets is possible.

Details of the foregoing objects and of the invention, as well as other objects thereof, are set forth in the following specification and illustrated in the accompanying drawing comprising a part thereof.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a vertical elevation of a rotary bed knife and a circular rotary cutting knife embodying the principles of the present invention and shown somewhat in diagrammatic manner to illustrate a method of shearing provided by the invention.

FIG. 2 is a side view of the rotary bed knife and rotary cutting knife shown in FIG. 1 and further illustrating pairs of the same mounted upon suitable supporting shafts which are shown in fragmentary manner.

FIG. 3 is a fragmentary enlarged end view of the rotary knives shown in FIG. 1, on a substantially larger scale than employed in FIG. 1 and illustrating in greater detail the manner of shearing relationship afforded by the machine.

FIG. 4 is a fragmentary vertical sectional view of the structure shown in FIG. 3 as seen on the line 4—4 thereof.

FIG. 5 is a fragmentary end view somewhat similar to that shown in FIG. 3 but illustrated on a substantially larger scale than employed in FIG. 3 for purposes of illustrating the progressive penetration of shearing teeth upon the rotary cutting knife with respect to sheets being sheared thereby.

FIG. 5A is an enlarged fragmentary sectional view showing the camming effect of the beveled teeth of the rotary cutting knife, as seen on the line 5A—5A of FIG. 5.

FIG. 6 is a further enlarged sectional view of a portion of an individual tooth of the rotary cutting knife as seen on the line 6—6 of FIG. 5.

FIG. 7 is another enlarged, fragmentary sectional view of a portion of a tooth of the rotary cutting knife shown in FIG. 5 and illustrating the terminal point of the tooth, as seen on the line 7—7 of FIG. 5.

DETAILED DESCRIPTION

Referring to FIGS. 1 and 2, it will be seen that a pair of shafts 10 and 12 are provided of conventional construction to comprise the principal supporting means for the trimming members of the machine comprising the present invention. The shaft 10 is provided with a longitudinal spline 14 extending the full length thereof, and shaft 12 is provided with a similar longitudinal spline 16 extending for the full length thereof.

Shaft 10 supports a pair of similar circular rotary cutting knives 18 which have a large central opening complementary to the diameter of shaft 10. The opening also has a keyway in the periphery thereof for purposes of engaging a key 20. Pairs of clamping collars 22 and 24 also are mounted upon the shaft 10 with respect to each of the knives 18, at opposite sides thereof, said collars having keyways therein to receive the keys 20. Collars 22 have auxiliary clamping collars 23 associated therewith to directly engage each knife. Springs 23' extend between collars 22 and 23, and guide pins fixed to collars 23 extend slidably through collars 22, whereby collars 23 yieldably clamp knives 18 against collars 24. The collars 24 comprise seats for knives 18. Set screws 26 are threaded into the clamping collars 22 and 24 for engagement with the keys 20 and thereby prevent marring the surface of the shaft 10 in any way, while securely clamping collars 22 and 24 to the shaft 10 at desired longitudinal positions thereon. The yieldable mounting of collars 23 relative to clamping collars 22 is for purposes of insuring effective shearing relationship between cutting knives 18 and the outer faces of the rotary bed knives 30 which are mounted upon shaft 12.

The rotary bed knives 30 have a central opening complementary to the diameter of shaft 12 and are longitudinally adjustably movable thereon in order to dispose the outer faces 32 in slidable shearing, as well as self-sharpening honing, relationship with the planar faces of the rotary cutting knives 18, details of which are described hereinafter. The rotary bed knives 30 have openings therethrough closely complementary in diameter to the outer diameter of the shaft 12. Also, said openings therein have a keyway to accommodate the keys 34 which also are received within the longitudinally extending spline 16 of shaft 12.

Appropriate set screws 36 engage the keys 34 to secure the rotary bed knives 30 in desired longitudinal positions upon shaft 12 for coaction with the rotary cutting knives 18 as referred to above. Accordingly, no marring of the exterior surface of shaft 12 occurs while also providing for firmly clamped positioning of the female rotary anvil 30 at the desired locations upon shaft 12. Further, to increase the life and versatility of the bed knives 30, the faces 38 thereof which are opposite the faces 32 are preferably identical with the faces 32, whereby the bed knives may be reversed end-for-end upon the shaft 12 and thereby double the effective life of the bed knives for shearing engagement with the rotary cutting knives 18.

The most important feature of the present invention comprises the teeth 40 which are provided on the periphery of the rotary cutting knives 18. As can best be seen from FIG. 5, the opposite sides of each tooth subtend an angle A, as shown in exemplary manner in FIG. 5, which is illustrated as being approximately 60°. However, this angle may vary, for example, from between 45° and 70°. Teeth within said range have sharp apexes for the desired purpose explained hereinafter. It also is to be understood that the face 42 of the rotary cutting knives 18 is planar. In addition to the opposite sides of the teeth being angularly disposed, said sides are beveled as shown at 44 in FIG. 6, the beveled surfaces being at an acute angle to the planar surface 42 of the teeth 40, as shown in FIG. 6.

As a result of the beveling of the sides 44 of the teeth, the teeth 40 terminate in a sharp point 46 which is

within the plane of the planar face 42 of the teeth 40 and, correspondingly, of the rotary cutting knives 18. Further, the angular side edges of teeth 40 extend transversely to the planes of the sheets being cut, as well as transverse to the cooperating shearing edge of the rotary bed knife 30, thus, providing a more efficient shearing and cutting action than that afforded by two coaxing circular cutting knives, and also providing a greater length of cutting edge than on a circular cutting blade.

The disposition of the points 46 of the teeth 40 within the plane of the planar faces of the teeth 40 results in said points initially piercing or penetrating the uppermost sheet 48 of an assembly of superimposed sheets of paper or similar material, as best visualized from FIG. 5, and the sloping sides 50 of the point 46 of each tooth 40, as shown in FIG. 7, together with the beveled sides 44 of the teeth, function in a camming manner by the point initially piercing and progressively penetrating successively the various sheets 48 of said superimposed assembly thereof, for example, as shown in FIG. 5A, thereby preventing movement of the sheets 48 in a direction away from the planar face 42 of the rotary cutting knives 18, as well as the teeth 40, thus insuring that the shearing of the sheets will occur along a desired line in an accurate manner. No migrating or skidding movement of the trimmed sheets is possible and, in effect, as the teeth 40 progressively penetrate the assembly of superimposed sheets, they function somewhat as aligning pins being driven into the sheets, but in view of the planar face 42 of the teeth determining the shear line, a smoothly trimmed surface of the entire assembly of sheets is effected. The strips trimmed from the sheets will not necessarily have a smooth edge but in view of the fact that they are waste, this is of no consequence.

It also can be appreciated from FIG. 2 that in view of the fact that the planar faces of the rotary cutting knives 18 face each other, whereby the sloping sides of the teeth 40 and the points 46 extend away from said planar faces of the knives 18, the penetration and shearing of the assembly of superimposed sheets will occur in a manner in which there is a tendency for the camming action of the teeth to pull equally in opposite directions from midportions of the sheets being sheared and thereby further assure accurate trimming along desired shear lines, as well as prevention of buckling or skidding of any of the sheets of the laminated assembly thereof. However, accurate trimming along a desired precise shear line or lines is possible by the present invention even when only a single rotary cutting knife 18 is used in conjunction with the cooperating rotary bed knife 30, due in part to the sheets normally being fed to said knives between opposing belts.

The teeth on the rotary cutting knife 18 also preferably are disposed around the periphery thereof with the side edges disposed substantially equally on opposite sides of the central radial axes of the teeth, whereby the cutting edges cut more efficiently than a circular disc knife due to being transverse to the circumference of the circular bed knife with which said teeth coast. Further, due to the acute angle between the sharpened side edges of each tooth, the total length of cutting edge on said rotary cutting knife is very substantially greater than the circumferential edge of a beveled edge disc knife of comparable diameter.

From the foregoing, it will be seen that the paper trimming machine of the present invention, the most essential features of which comprise pairs of coaxing rotary cutting knives having beveled edged, sharply pointed teeth and a rotary bed knife, provides a combined efficient shearing action and camming function which prevents movement of the sheets being trimmed from moving laterally from the intended shear line. This is especially advantageous when trimming either one side or a pair of opposite sides of an assembly of superimposed sheets, such as in a brochure or pamphlet. The improved results essentially are attributable to the shape of the teeth on the rotary cutting knife, including the planar face, the beveled edges and the sharp penetrating points which lie within the plane of the planar surface for cooperation with the planar face of the rotary bed knife in a manner to cause the cutting edges of said teeth to extend transversely to the coaxing edge of the rotary bed knife and eliminate the tendency of circular disc cutting knives to urge the sheets outwardly from the shearing point of the knives.

While the invention has been described and illustrated in its several preferred embodiments, it should be understood that the invention is not to be limited to the precise details herein illustrated and described since the same may be carried out in other ways falling within the scope of the invention as illustrated and described.

I claim:

1. A paper trimming system comprising in combination, a rotary bed knife having a substantially cylindrical surface terminating at least at one end in a planar face to provide a smooth circular shearing edge, and a circular rotary cutting knife having at least one planar surface the outer portion of which slidably overlies said planar face of said rotary bed knife in shearing relationship therewith, said knives having central openings to adapt the same to be mounted upon shafts and be driven in directions to effect shearing of separate assemblies of superimposed sheets of paper; the periphery of said cutting knife having gripping and shearing teeth formed thereon, the sides of said teeth subtending equal angles between 45° and 75° to provide sharp apex ends, one face of each tooth being planar within the plane of said planar face of said cutting knife and the opposite edges of said teeth being similarly beveled at an acute angle to the plane of said planar face to provide sharp cutting edges on each side of said teeth which meet at a sharp point within said planar face; said teeth in cutting operation slidably overlying said planar face of said rotary bed knife for at least the full length of said teeth to form a smoothly trimmed edge upon separate assemblies of sheets fed to said knives and also providing a total extent of shearing edge upon said cutting knife which is greatly in excess of the circumference of said cutting knife, and said sharp points and beveled edges of said teeth providing camming means operable to penetrate the sheets being trimmed in a manner to maintain the intended line of cut for said sheets accurately aligned with the coaxing shearing edges of said knives.

2. The paper trimming machine according to claim 1 in which the sides of said teeth subtend an angle of substantially 60° .

3. The paper trimming machine according to claim 1 in which the sides of said teeth respectively are dis-

7

posed substantially evenly on opposite sides of the radial axes of the teeth.

4. The paper trimming machine according to claim 1 in which the opposite faces of said rotary bed knife are planar and said bed knife being reversible end-for-end upon a shaft respectively to present the opposite faces of said bed knife for shearing cooperation with said rotary cutting knife.

5. The paper trimming machine according to claim 1 further including a pair of parallel shafts, means on one of said shafts providing seats spaced longitudinally thereon a distance equal to the trimmed width of sheets

8

of paper to be trimmed by said machine, a pair of said rotary cutting knives respectively being mounted upon said seats with the planar surfaces of said knives facing each other, means to clamp said knives to said seats, and means to clamp a pair of said rotary bed knives on the other shaft with the outer faces thereof spaced a distance substantially equal to the trimmed width of sheets to be trimmed by said machine for shearing cooperation with said rotary cutting knives on said first-mentioned shaft.

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