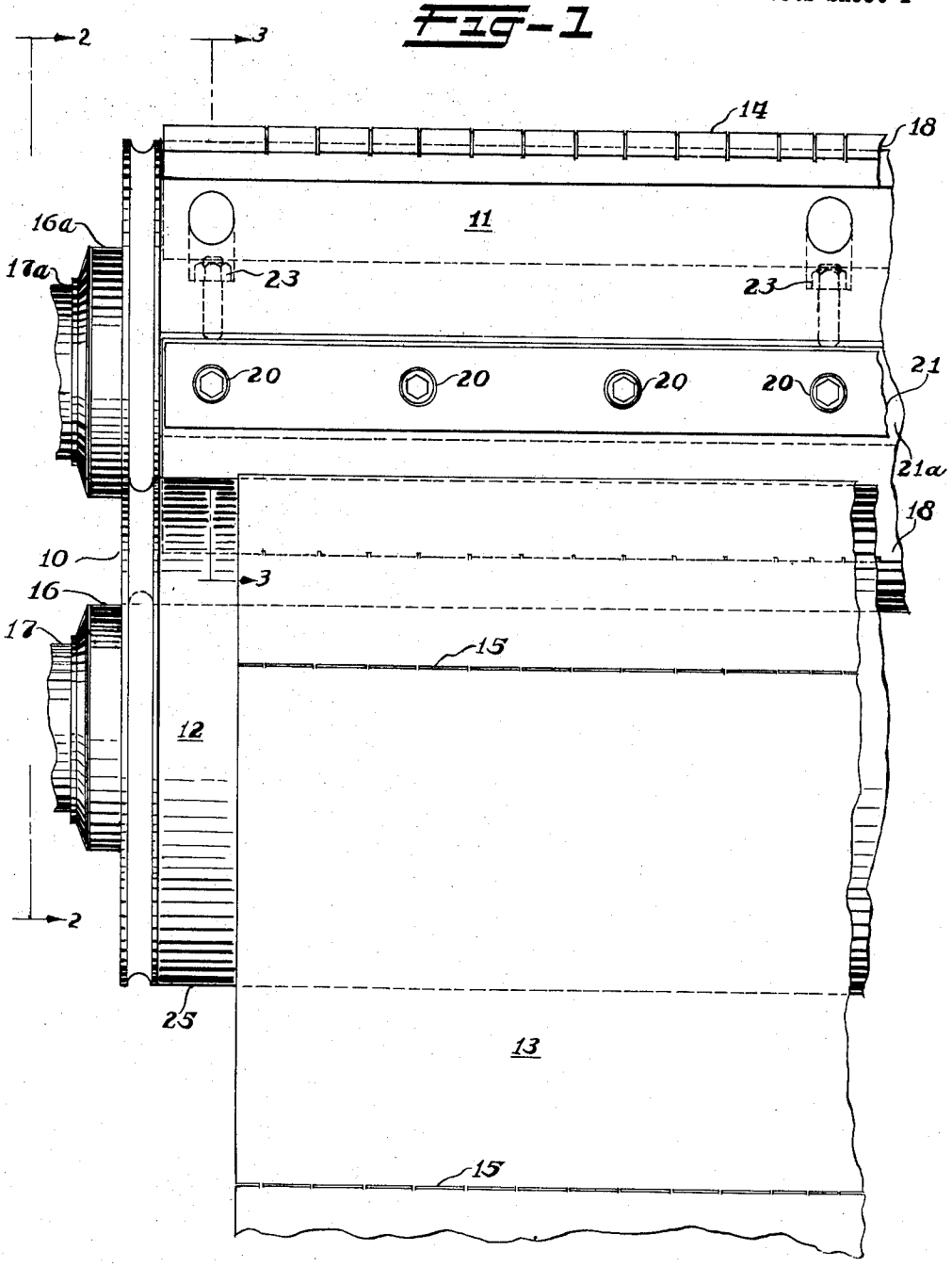
April 23, 1963 R. G. MINARIK 3,086,416

CUTTING DEVICE FOR PAPER MAKING MACHINE

Filed Dec. 12, 1958 4 Sheets-Sheet 1

Fig-1



April 23, 1963 R. G. MINARIK 3,086,416

CUTTING DEVICE FOR PAPER MAKING MACHINE

Filed Dec. 12, 1958 4 Sheets-Sheet 2

Fig-2

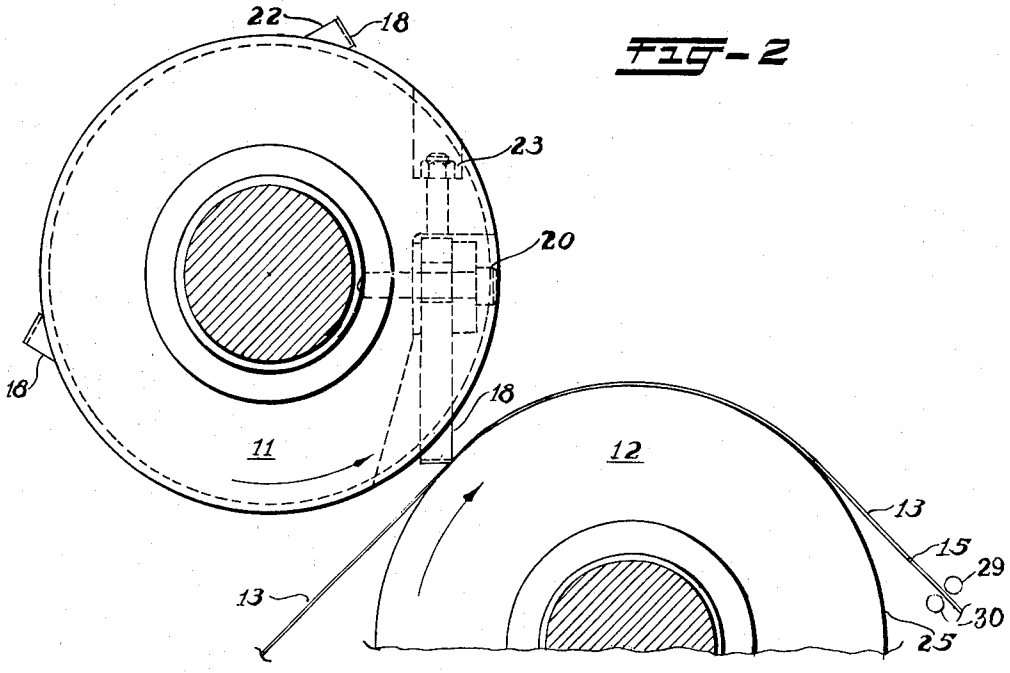


Fig-3

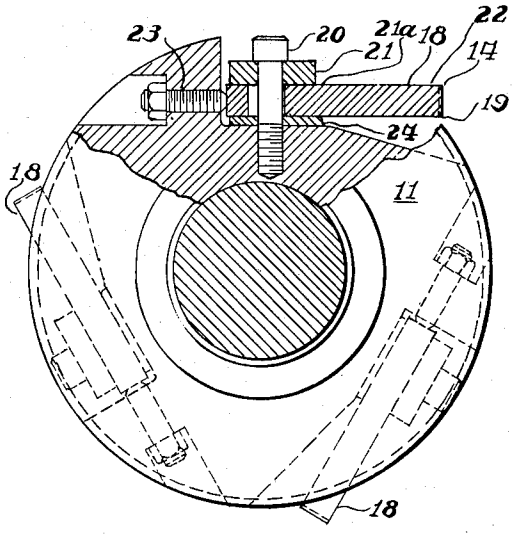
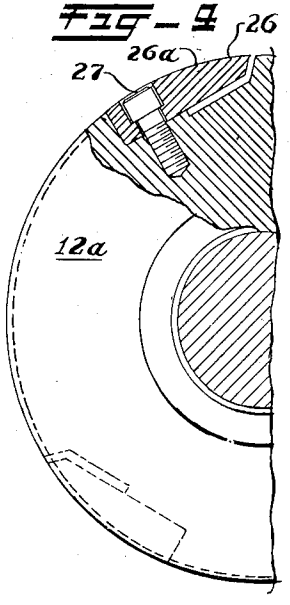


Fig-4

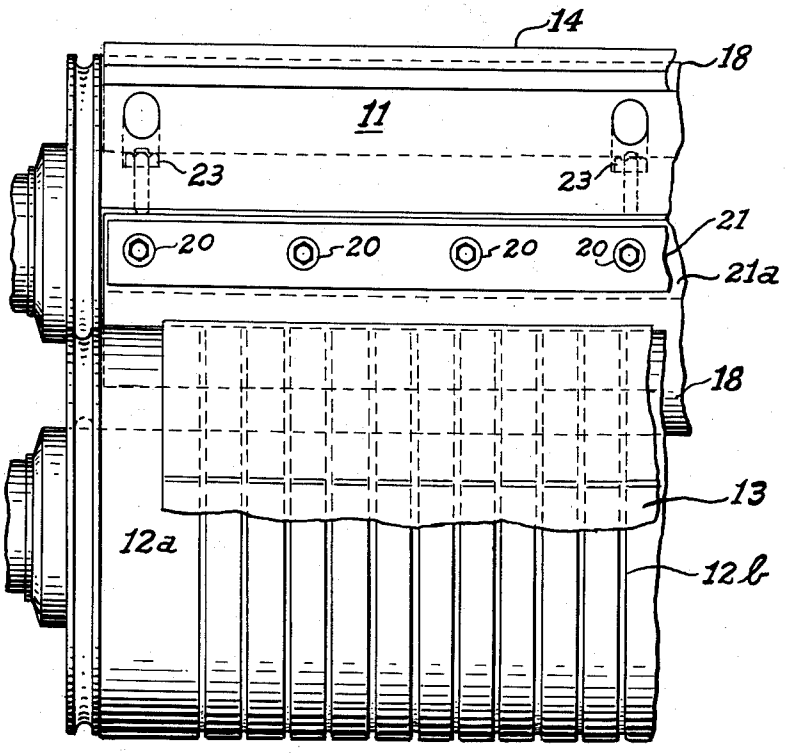


April 23, 1963 R. G. MINARIK 3,086,416

CUTTING DEVICE FOR PAPER MAKING MACHINE

Filed Dec. 12, 1958 4 Sheets-Sheet 3

Fig-5

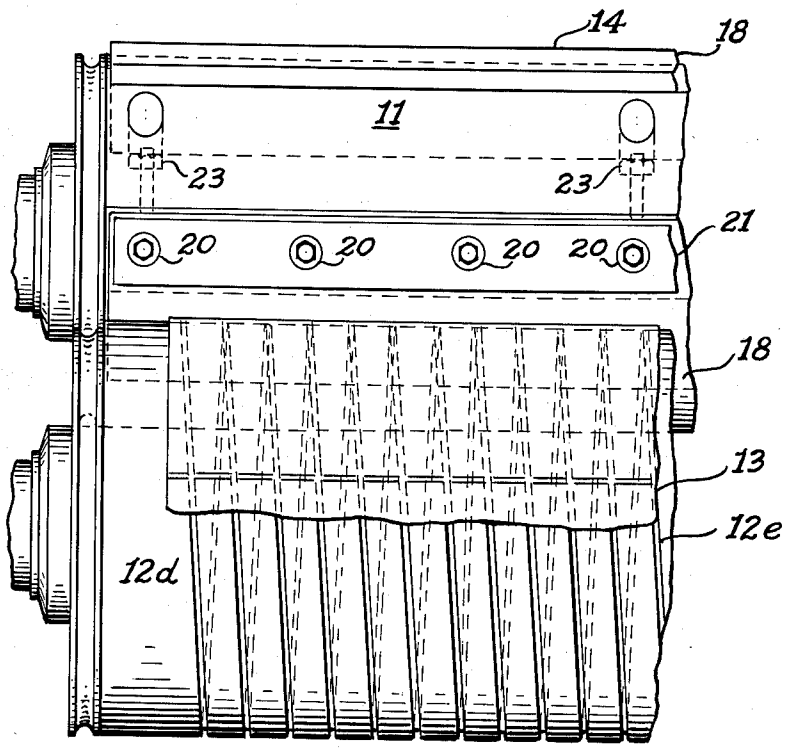


April 23, 1963 R. G. MINARIK 3,086,416

CUTTING DEVICE FOR PAPER MAKING MACHINE

Filed Dec. 12, 1958 4 Sheets-Sheet 4

Fig-6



United States Patent Office 3,086,416 Patented Apr. 23, 1963

3,086,416

CUTTING DEVICE FOR PAPER MAKING MACHINE

Rudolf G. Minarik, Menasha, Wis., assignor to Kimberly-Clark Corporation, Neenah, Wis., a corporation of Delaware

Filed Dec. 12, 1958, Ser. No. 780,133
16 Claims. (Cl. 83—345)

This invention relates to improvements in high speed rotary cutters particularly adapted for the partial or complete transverse severance of continuously moving sheet stock.

A major object of the invention is to provide a high speed rotary cutter which insures a very clean cut through a wide range of operating speeds for the complete or partial severance of lightweight paper or the like to produce a plurality of individual sheets, or alternately to provide interrupted transverse cuts therein. The cutter is particularly adapted for the high speed production of paper tissue products such as facial tissues, towels, and toilet paper.

A further object is to provide an improved rotary cutter which will satisfactorily perform in the above manner at an acceptable ambient noise level.

Another object is to provide an improved multiple blade rotary cutter the design of which permits easy access to the blades thereof for readjustment.

A further object is to provide, in a high speed rotary cutter of the anvil roll and blade roll type, an improved anvil roll wherein cutter wear is confined to replaceable portions thereof and the extent of wear and noise generation is reduced throughout these portions.

Other objects and advantages will become apparent to persons skilled in the art, as will various modifications thereof without departure from the inventive principles as defined in the appended claims.

In the drawings:

FIGURE 1 is a fragmentary elevational view of a high speed rotary cutter with the invention incorporated therein,

FIGURE 2 is a vertical section taken along line 2—2 of FIGURE 1,

FIGURE 3 is a vertical section taken along line 3—3 of FIGURE 1 with portions of the structure partially broken away to best illustrate the construction,

FIGURE 4 illustrates in vertical section an anvil roll of alternate construction, partly broken away to best illustrate the constructional details, and

FIGS. 5 and 6 are fragmentary elevational views similar to FIG. 1 and illustrating anvil rolls of alternate construction.

In the paper industry, for example, there has arisen a need for an improved high speed cutter, preferably of the rotary type, which is capable of cleanly cutting lightweight sheet material such as facial tissue, the cut to be made transversely of the stock to provide either complete severance or a substantial severance with interconnecting bonds remaining between a plurality of sheets so formed. The apparatus as shown and described herein incorporates the inventive principles in a manner, for example, to permit a continuously moving web of a very lightweight, relatively flimsy paper stock, or alternately, a quite different type of sheet stock, rapidly to be processed in the above manner while insuring clean and attractive slitting of the stock over a wide speed range with an appreciable reduction in the operating noise level to a satisfactory value even at high operating speeds. Further, the invention taught herein facilitates start-up of the cutter by substantially reducing the required initial torque, thus permitting start-up with relatively thick stock in the cutter.

As shown in FIG. 1, a rotary cutter incorporating the invention includes a pair of rolls generally designated **10** comprising a knife roll **11** and an anvil roll **12**. As shown in FIGS. 1 and 2, sheet stock such as a paper web **13** is fed from a supply source over a driven roll **12** in the arrow direction to known apparatus, not shown, for further processing or rewinding. Web **13** may, for example, be drawn by rolls **29** and **30** from a driven stock roll which pays out the material at a metered speed with the web being maintained under slight tension between the metering apparatus and the anvil roll **12** to insure snug engagement between the web and the surface of roll **12** as the paper passes over a portion of that roll to a rewinder at a speed which may differ from the roll speed. For practical reasons, it is quite desirable that the rate at which web **13** is fed through the cutter be divorced from dependency upon the circumferential speed of anvil roll **12**, since the anvil roll periodically requires re-surfacing by grinding operations which progressively reduce the roll diameter. Under certain conditions the web speed might be synchronized with the roll speed in which instances roll **12** is in effect a feed roll, since there is no relative movement between the web and the roll surface, but this is not its primary purpose, nor is the operation of the cutter in any way dependent upon that condition.

Both cutter roll **11** and anvil roll **12** are preferably of solid construction, such as being formed from steel forgings or the like, with their journal shafts formed integrally of the rolls, it being understood that the rolls are suitably journalled in heavy-duty supporting structure to permit the rolls to withstand relatively large impact forces during the operation of the device while accurately maintaining their spaced relationship. Anvil roll **12** is provided with a smoothly ground generally cylindrical surface which minimizes friction between the web and that surface as the web moves over the roll surface under light tension.

The function of cutter roll **11**, which is driven in counter-rotation with respect to anvil roll **12** and carries one or more knife blades **18**, three being shown, is successively to move each of the outermost cutter knife edges **14** into pressure engagement with web **13** along a contact line transversely of the web at a position within the nip area between rolls **11** and **12** and slightly offset from the position of the narrowest nip dimension in a direction counter to roll rotation. At the position of initial blade edge contact, that portion of the web to be cut preferably has passed beyond the point of initial contact with the roll surface, hence is in contiguous engagement with and thus firmly supported by roll **12** along the line of knife edge engagement. The exact positioning of the line of initial knife engagement with the web is of course independent of the roll speeds or the relation of the web speed thereto, and may be selected, within limits, by a desired positioning of the knife which is adjustably mounted for that purpose, as more fully described below.

As shown in FIGS. 2 and 3, knives **18** are symmetrically disposed chordally rather than radially in respect to the circular cross section of roll **11**, with the three knives shown in 120° angularity. The knife blades may be of relatively heavy bar stock of generally slab configuration and of a material such as tool steel which may permit the cutting edge **14** to be formed directly on the bar, or alternately, the cutting edge may be formed of carboloy or other hard metal suitably fixed to one end of the blade as shown at **19**, FIG. 3. The cutter performs well with knives, the flexible portions of which range in thickness between ⅛" and 1" for cutting of paper tissue. A typical blade may be of tool steel of a total width of 3" and a free width of 2" and of a length in excess

of the width of sheet stock to be cut. The blades may extend substantially the length of roll **11**, with either a continuous edge or a serrated edge as shown in FIG. 1, to leave interconnecting bonds in the stock material, with the base of each blade securely clamped to the cutter roll in channel-like relieved areas formed therein to position substantial unsupported portions of the blades free of the roll structure, with those portions terminating in cutting edges disposed radially outwardly of the cylindrical roll surface. Alternately, uncut bonds may be left in the stock by providing spaced circumferential grooves or a single spiral groove in the anvil roll to permit use of a knife with a continuous edge. A modified rotary cutter according to the invention is illustrated in FIG. 5, and this cutter is similar to that illustrated in FIG. 1 but includes an anvil roll **12***a* having a plurality of such spaced circumferential grooves **12***b* in its outer surface, and another modified rotary cutter according to the invention is illustrated in FIG. 6 which includes an anvil roll **12***d* with such a spiral groove **12***e*.

FIG. 3 shows in detail a cantilever type knife mounting which has been found quite satisfactory for its intended purpose, namely to positively anchor the base of the blade to the solid blade roll in a manner to permit the outer blade portion freely to flex under force components imparted by contact between the blade and the surface of the anvil roll. Such contact is made in a position to deflect the edged portion of each blade downwardly as viewed in FIG. 3, or to the left as viewed in FIG. 2 during each revolution of roll **11**. Each knife mount is disposed in an axially extending channel of the cross sectional configuration shown. Blade **18** is bored along its inner edge to receive a plurality of clamp bolts **20** the shanks of which are of less diameter than the blade bores to permit blade adjustment, with bolts **20** extending through a suitably bored bar clamp **21**. As shown, the bolts also project through a supporting shim **24**, or the knife blade may rest directly on the roll if desired. The bolt ends threadedly engage the roll to provide a strong clamp.

Selective adjustment of blade **18** to position the cutting edge **14** thereof is facilitated by studs **23** which when adjusted and locked in place by their nuts insure proper positioning of the blade during tightening of studs **20**. When securely clamped in that position, the free blade portion may be flexed downwardly, the chordal platform upon which shim **24** rests being relieved beneath the free blade portion as shown to assure free blade flexure. Alternate types of mountings which position the blade to allow flexure, with the cutting edge outwardly of the roll surface, may be employed without departure from the invention.

Operation of the cutter shown in FIGS. 1 through 3 is as follows. With the rolls **11** and **12** power driven in counter rotation as indicated by the arrows, FIG. 2, and with sheet stock material **13** to be processed moving over roll **12** in the arrow direction of that roll, but not necessarily at roll speed, initial contact between the cutting edge of knife **18** and the outer surface of material **13** will occur approximately at the position shown in FIG. 2. Assuming first that rolls **11** and **12** are rotating at the same peripheral speed, and that material **13** is sheet stock such as facial tissue which is travelling in this instance at roll peripheral speed, the cutting action is as follows.

Initial contact between knife edge **14** and the web stock **13** occurs along a line slightly below the position of minimum nip clearance or roll spacing as shown in FIG. 2, as the knife is rotated counter-clockwise toward the clockwise rotating anvil roll. The free end of knife **18** extends outwardly from the knife roll sufficiently that edge **14** thereof transcribes an arc, a minor portion of which intersects a minor portion of the circumferential circle of anvil roll **12**. The initial contact of edge **14** with moving stock **13** is followed by a cutting of the

stock as further rotation of roll **11** forces the knife edge through the stock and against the surface of anvil roll **12**. With rolls **11** and **12** traveling at the same peripheral speed and with no relative movement between stock **13** and the surface of the anvil roll, the cut is made with a relatively small amount of wiping action occurring between the knife edge and the stock and anvil roll surfaces.

Knife edge **14** is positioned outwardly of roll **11** to an extent that upon severance of the stock and positive engagement with the anvil roll surface, edge **14** has not moved into alignment with the narrowest portion of the nip, hence continued rotation of roll **11** results in lateral flexing of the free portion of blade **18** in a direction away from the surface of anvil roll **12** with a consequent movement of edge **14** to a position closer to its axis of rotation. With the knife and anvil rolls rapidly rotating concurrently with the flexing of blade **18**, the free end of the knife, hence edge **14**, is flexed by the rotational forces involved only to the extent necessary to permit edge **14** to pass through the nip while remaining in firm engagement with the surface of roll **12** until the nip diverges in the machine direction and the knife is eventually withdrawn from both the roll and stock as it continues its rotation. The deflection of blade **18** is of course just sufficient to permit edge **14** to clear the surface of roll **12**, and since the applied forces are a function of the dimensions involved there is little tendency toward relative movement between the knife edge and the anvil roll surface during passage of the blade through the nip. The knife may be spirally ground if it is desired to employ a progressive cut.

Depending upon the stock material involved and the type of cut desired, wiping action during a cutting operation may or may not be desirable. While the above described cut has been made under conditions which minimize or eliminate such wiping action, other operating conditions may however be selected to permit such action. For example, by operating rolls **11** and **12** at different circumferential speeds or by moving stock **13** over roll **12**, as by feed rolls **29** and **30** at a speed different from the roll speed any desired degree of wiping action may be introduced, and such action may be caused to occur either counter to or in the direction of stock feed through the cutter. For example, if roll **11** is driven at a greater circumferential speed than is roll **12**, with stock **13** driven at the speed of roll **12**, a wiping action will occur in the direction of the stock feed, due to relative movement between the blade edge and anvil roll surface, whereas with roll **11** driven at a slower speed than roll **12** under like circumstances the wiping action will be counter to the direction of stock feed.

In the above examples, the stock speed is synchronized with the circumferential speed of the anvil roll, but as above stated the stock speed may be controlled independently of the anvil roll speed. When the stock speed is substantially greater than the anvil roll speed, with rolls **11** and **12** rotating at the same circumferential speed, cutting of the stock is followed by a slight pulling of the stock material over the top of roll **12** and away from edge **14** as the edge firmly engages the surface of the anvil roll during travel through the nip. Such a pulling action, at least when relatively non-elastic material is being cut, will be accompanied by a slight slackening of the stock material below the knife, since the stock feed rate is higher than the circumferential speed of the anvil roll surface to which it is being applied, and relative movement between the stock and the anvil roll surface is momentarily arrested as edge **14** makes the cut and moves through the nip. The type of wiping which takes place differs from that caused by knife edge movement over the anvil roll surface, since the stock is actually pulled outwardly of the blade. Wiping from the opposite side of the blade edge will result when the anvil roll speed exceeds the stock rate of speed, and under other conditions the movement of the stock in respect to the blade results in

a somewhat different type of action which resembles in effect a wiping action.

The cutter is thus adapted to a wide range of flexibility in respect to the control of the type of cut to be made, through selection of desired relationships between anvil roll speed, stock feed speed, and cutter speed, and as is further evident the type of cut may also be controlled through the adjustment of knife **18** since it is the positioning of the cutting edge **14** thereof which controls the magnitude of intereference between that edge and the surface of the anvil roll, hence the deflection thereof, as the knife edge passes through the nip. It is further apparent that any suitable number of knives **18** may be employed so long as the cutting edges thereof are positioned to transcribe a common circumferential path. The knives need not necessarily be mounted on a generally cylindrical roll, such as shown at **11**, it being merely necessary to suitably fix the knives to a rotatable member in a manner to permit free portions thereof which terminate in the knife edges to be flexed in the manner above described upon contact with the stock and the anvil roll surface.

As shown in FIG. 4, anvil roll **12***a* is modified in a manner to provide a plurality of cantilever mounted inserts **26** providing bed plates with the outer surfaces **26***a* thereof in circumferential registry with the roll surface. The inserts are recessed in axially extending channels which form mounting shoulders as shown to which base portions of the bed plates are securely clamped by bolts **27** to position the non-supported portions laterally of the shoulders. FIG. 4 illustrates an anvil roll as viewed for counter-clockwise rotation, it being understood that if mounted as shown in FIG. 2 the free portion would trail the clamped portion during clockwise rotation. With the anvil roll **12***a* switched end for end and substituted for **12** in the structure of FIG. 2, operation is as follows. Bed plates **26**, corresponding in number to knives **18**, are circumferentially spaced for registry therewith, blade edges **14** preferably engaging the free or unsupported portions of the bed plate near the trailing edge thereof. As rotational forces are progressively applied by a knife **18**, as it starts a cut, to the trailing surface of a bed plate, the free portion of the plate is flexed inwardly when those forces become of a sufficiently high order simultaneously to also cause the knife to flex in a counter direction. Since the effective radii of both the anvil and knife rolls is simultaneously reduced by the enlarged members, both of which yield, no relative movement, hence no wiping action, occurs therebetween. The above described combination of a flexible knife and a yieldable bed plate results in a reduction in both knife edge wear and operating noise level and may be employed with the various stock and roll speed combinations above described to alter the nature of the cut as desired.

With the cutter operating in a manner completely to sever the sheet stock, that portion of the stock, held under tension from the feed roll, after severance from that portion of the stock passing over the top of the anvil roll, must of course be momentarily held in contiguous engagement with the surface of the anvil roll by a bond capable of counteracting the stock tension which would otherwise pull the stock clear of the roll surface. It has been found that at least when fibrous materials such as tissue paper, light webbing, and other paper stock are processed through the cutter, the knife action during each cut adequately serves to adhere the stock marginally of the cut sufficiently to resist the tangentially applied forces of tension, hence the feed stock from which a portion has been cut moves over the top of the anvil roll preparatory to a subsequent cut. FIG. 2 shows only the manner in which interconnected stock is taken off the anvil roll. The removal of separate sheets may be done in a known manner which forms no part of this invention.

I claim:

1. In a rotary cutter, a rotatably mounted member, an inherently flexible knife mounted on said member

for rotation about an axis with the major plane of the knife disposed chordally of a circle transcribed about said axis, and an anvil roll mounted for rotation about an axis in parallel spaced relation to the axis of knife rotation and having a hard surface on its periphery, said knife having a cutting edge positioned radially of its axis of rotation at a distance to transcribe a path, a minor portion of which intersects a minor portion of the circumferential path of said anvil roll, with the knife cutting edge having a clearance with said member and being freely movable toward said axis against the flexing action of the knife, and means driving said member and anvil roll in counter rotation so that said cutting edge strikes said hard anvil surface and flexes to have a cutting action with the anvil roll.

2. In a rotary cutter, a knife roll, a hard surfaced anvil roll, means rotatably mounting said rolls in parallel spaced relation to form an open nip therebetween, means driving said rolls in counter rotation, a substantially flat inherently flexible knife having a base fixed to said knife roll and a non-supported portion disposed chordally of the roll and having a clearance with the roll and terminating in a cutting edge positioned outwardly of the circumferential surface thereof and slightly beyond the minimum transverse nip dimension so that the knife flexes toward the roll when the cutting edge contacts said anvil roll to have a cutting action therewith, and means for feeding sheet stock through said nip and over said anvil roll for severance by said knife when rotated into said nip and into contacting engagement with said anvil roll.

3. In a rotary cutter, a rotatably mounted anvil roll having a hard surface on its periphery, a rotatable member in parallel spaced relation thereto, means driving said roll and member in counter rotation, an inherently flexible knife and means fixing said knife to said member with an unsupported portion of the knife extending chordally with respect to a circle about the axis of said member and having a clearance with the member and terminating in a cutting edge extending substantially parallel to the surface of the anvil roll and positioned radially of the axis of member rotation to prevent clearance past said hard surface of the anvil roll upon rotation of said member, whereby rotation of said member causes said cutting edge to engage the anvil roll and to be deflected thereby sufficiently toward the axis of member rotation against the inherent flexibility of said knife to allow the knife to pass through the nip of the knife and anvil roll, and means for passing sheet stock over said anvil roll to be cut by said edge as it rotates into engagement with said anvil roll.

4. The device of claim 3 wherein said knife edge is provided with an interrupted edge.

5. The device of claim 3 wherein said anvil roll is provided with axially spaced circumferential grooves.

6. The device of claim 3 wherein said anvil roll is provided with helical grooves.

7. The device of claim 3 wherein said knife is provided with a spirally ground cutting edge.

8. The device of claim 3 wherein said knife is provided with a discontinuous edge and means are provided for continuously feeding sheet stock through the nip of said knife and anvil roll while engaging the nip of said knife and anvil roll while engaging the nip defining surface of the anvil roll for the interrupted transverse cutting of said stock.

9. The device of claim 3 wherein said roll and member are driven at such speeds that said knife edge has a greater speed than said anvil roll at its peripheral surface.

10. The device of claim 3 wherein said roll and member are driven at such speeds that said knife edge has a slower speed than said anvil roll at its peripheral surface.

11. In a rotary cutter, a knife roll, an anvil roll provided with an inherently flexible bed plate mounted on the anvil roll as a cantilever with an unsupported portion so as to extend substantially circumferentially thereon with a clearance being provided between the unsupported portion of the bed plate and the anvil roll to permit flexing of the unsupported bed plate portion toward the anvil roll, means for rotatably mounting said rolls in parallel spaced relation to form an open nip therebetween, a knife fixed to said knife roll and terminating in a cutting edge positioned outwardly of the knife roll at a distance slightly beyond said nip, and means for driving said rolls in counter rotation with said cutting edge positioned for contacting engagement with the unsupported portion of said bed plate so that stock fed through said nip is severed by said knife when rotated into said nip to contact said bed plate and flex the bed plate against its inherent resiliency.

12. In a rotary cutter, a rotatably mounted member a flat inherently flexible knife mounted on said member for rotation about an axis with the plane of the knife disposed chordally of a circle transcribed about said axis, and an anvil roll mounted for rotation about an axis in parallel spaced relation to the axis of knife rotation and having a hard surface on its periphery, said knife being mounted as a cantilever with a major portion of its length terminating in its cutting edge being unsupported and having a clearance with said member and being arranged to be free to move toward said axis with flexing of the knife with the cutting edge positioned radially of its axis of rotation at a distance to transcribe a path, a minor portion of which intersects a minor portion of the circumferential path of said anvil roll, and means driving said member and anvil roll in counter rotation so that said cutting edge strikes said hard anvil surface and flexes to have a cutting action with the anvil roll.

13. A rotary cutter having in combination, a knife roll, a hard faced anvil roll, means mounting said rolls to form an open nip therebetween, means driving said rolls in opposite directions, a plurality of substantially flat inherently flexible knife blades mounted as cantilevers on said knife roll with unsupported portions thereof having clearances with the knife roll and terminating in cutting edges positioned outwardly of the knife roll surface for contacting engagement with the surface of the anvil roll, the normal circular path transcribed by said knife edges intersecting a minor circumferential portion of said anvil roll adjacent the area of blade contact therewith, whereby contact between the cutting edges and anvil roll surface causes said blades to be flexed in a direction toward said knife roll to move the edges inwardly of said normal path to permit blade movement past the anvil roll and provide blade cutting action with said anvil roll.

14. In a rotary cutter, a knife roll, an anvil roll provided with a bed plate mounted thereto as a cantilever with an unsupported portion so as to extend substantially circumferentially thereof with the unsupported portion of the bed plate having a clearance with the anvil roll, means for rotatably mounting said rolls in parallel spaced relation to form an open nip therebetween, an inherently flexible knife having a base portion fixed to said knife roll and a non-supported portion terminating in a cutting edge positioned outwardly of said roll at a distance slightly beyond said nip with the non-supported portion having a clearance with respect to said knife roll, means for driving said rolls in counter rotation with said cutting edge positioned for contacting engagement with the free portion of said bed plate whereby said knife flexes towards said knife roll and said bed plate flexes toward said anvil roll, and means for feeding sheet stock through said nip and over said anvil roll for severance by said knife when rotated into said nip to contact said bed plate.

15. In a cutter, a rotatably mounted generally cylindrical anvil provided with a plurality of inherently flexible bed plates each of which is mounted as a cantilever on the anvil with an unsupported portion so as to extend substantially circumferentially thereof and with the unsupported part of each bed plate having a clearance with respect to the anvil, a knife roll in parallel spaced relation to said anvil, a plurality of inherently flexible knives extending chordally with respect to the axis of the knife roll and having base portions thereof fixed to the knife roll and substantially free portions terminating in cutting edges disposed parallel to the anvil roll axis and outwardly of the knife roll to transcribe a circular path, a minor portion of which intersects with the circumferential path of the anvil, with said substantially free portions of said knives having clearances with respect to the knife roll, and means for rotating said anvil in one direction and said knife roll in the opposite direction for pressure contacting engagement between said cutting edges and bed plates with resulting deflection of said knives towards said knife roll and said bed plates toward said anvil to provide a severing action between said knives and said bed plates.

16. In a device of the character described, first and second counter rotating rolls in parallel spaced relation to form an open nip therebetween, means for continuously feeding sheet material over said first roll, a substantially rigid but inherently flexible knife fixed to the second roll as a cantilever with an unsupported portion to extend chordally with respect to the axis of the second roll and with the unsupported portion of the flexible knife having a clearance with the second roll to permit flexing of the unsupported portion of the knife, the flexible knife terminating in a cutting edge positioned radially of said second roll slightly beyond the minimum transverse nip dimension, whereby counter rotation of said rolls causes engagement between the anvil roll and cutting edge and causes said knife to be flexed toward its supporting roll to permit movement of said knife through said nip.

References Cited in the file of this patent

UNITED STATES PATENTS

1,730,449	Campbell	Oct. 8, 1929
2,768,690	Roberts	Oct. 30, 1956
2,870,840	Kwitek	Jan. 27, 1959
3,056,323	Kwitek	Oct. 2, 1962