

**May 4, 1954**

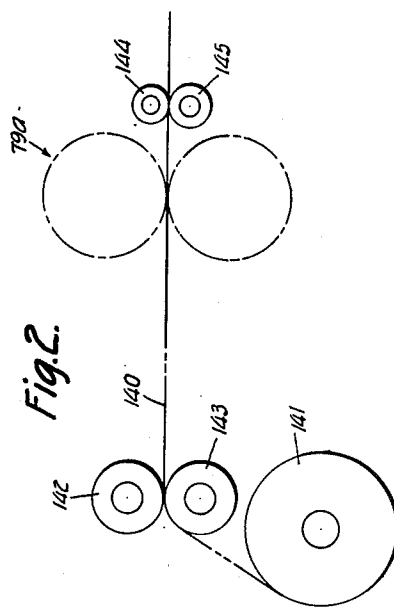
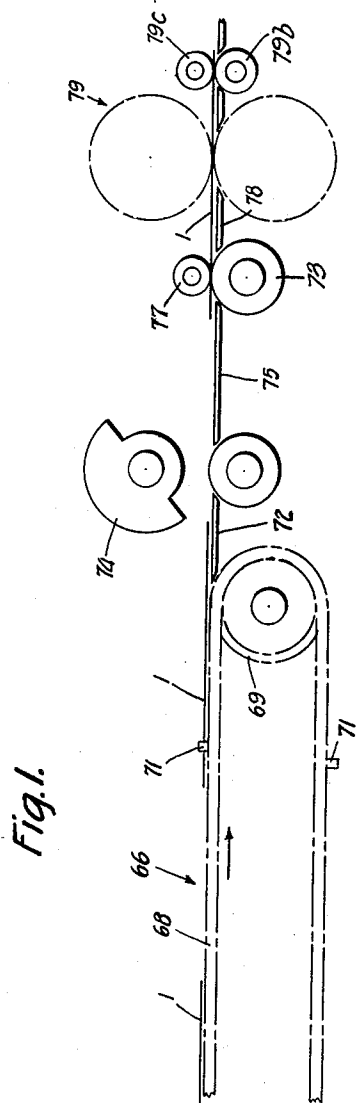
A. NOVICK

**2,677,422**

## ROTARY WINDOW CUTTING MECHANISM

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ROTARY WINDOW CUTTING MECHANISM

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Fig. 3.

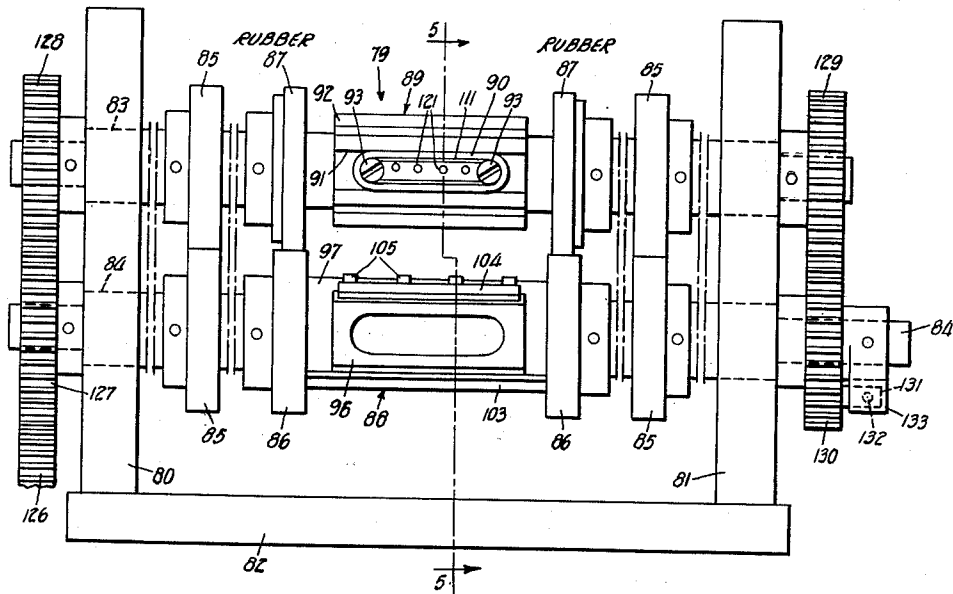
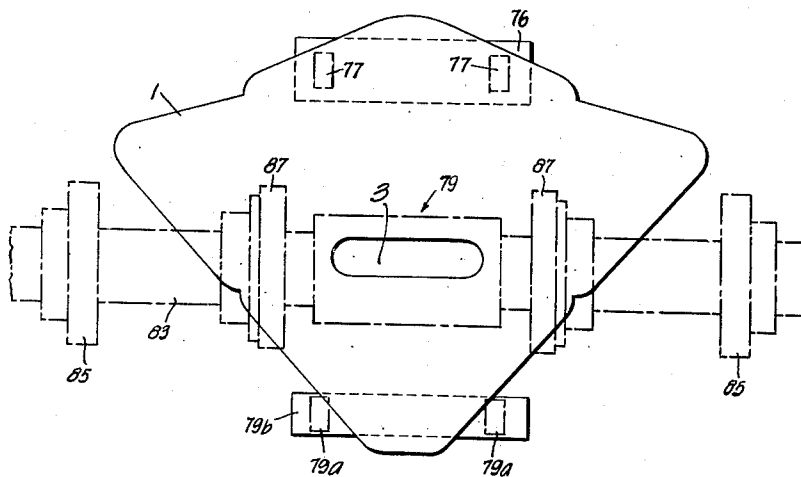


Fig. 4.



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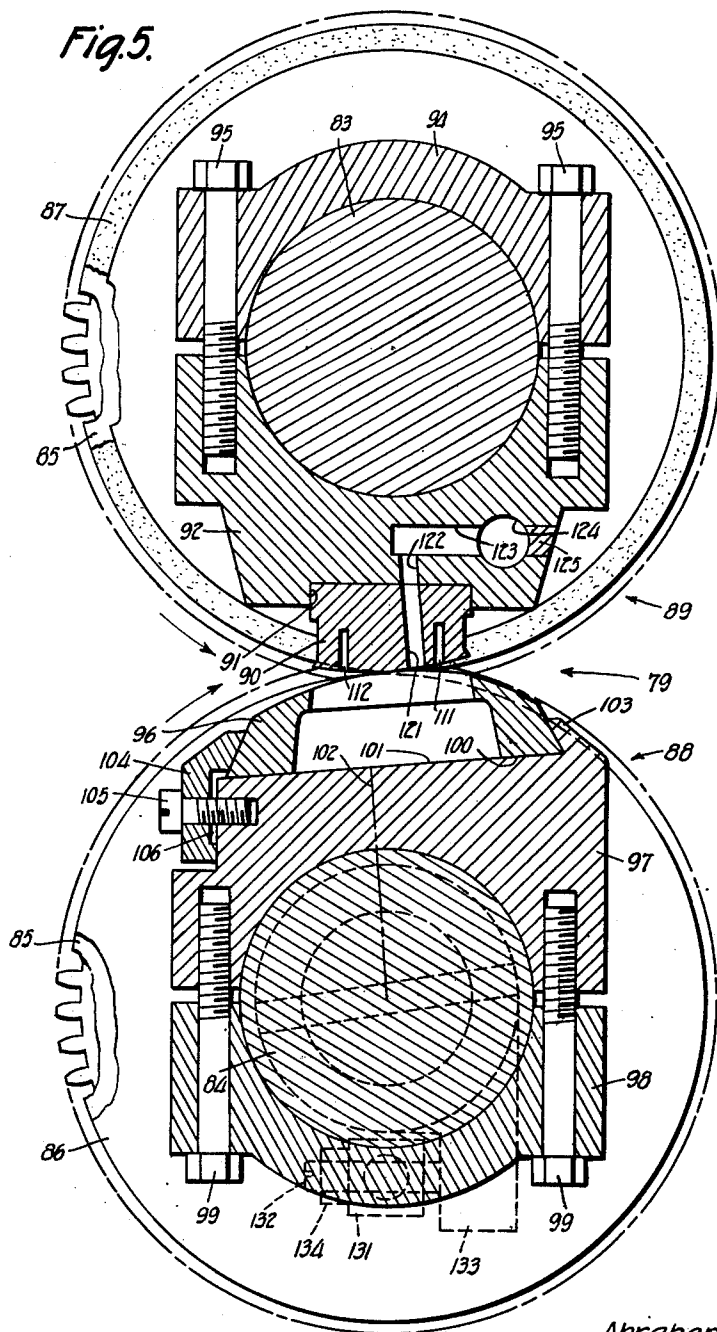
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## ROTARY WINDOW CUTTING MECHANISM

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ROTARY WINDOW CUTTING MECHANISM

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4 Sheets-Sheet 4

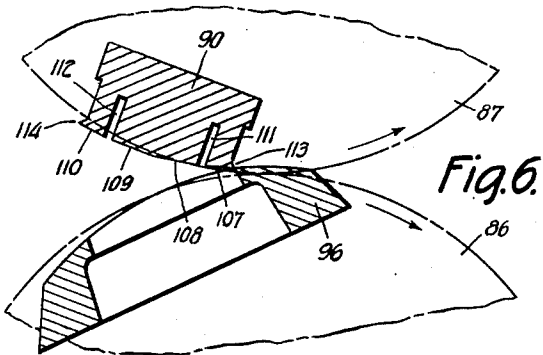


Fig. 6.

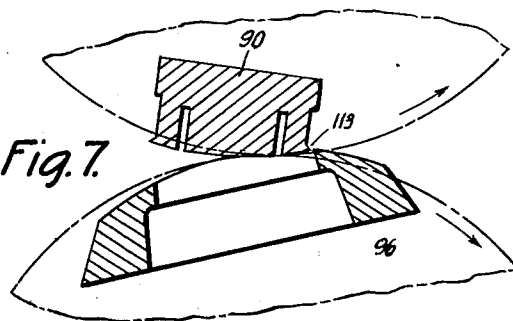


Fig. 7.

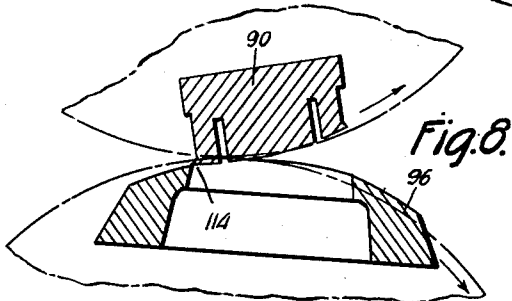


Fig. 8.

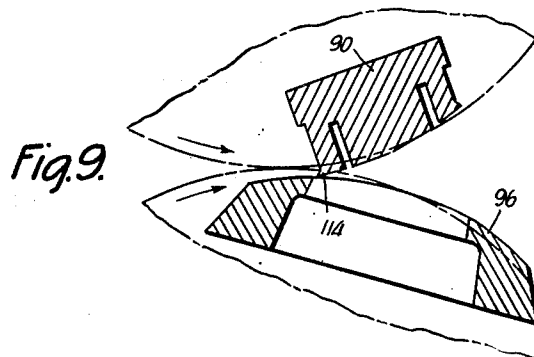


Fig. 9.

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## UNITED STATES PATENT OFFICE

2,677,422

## ROTARY WINDOW CUTTING MECHANISM

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Application April 23, 1950, Serial No. 158,830

4 Claims. (Cl. 164—28)

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This invention relates to rotary die mechanism designed for cutting openings in paper sheets or webs and particularly openings which will afterward appear as the windows of window envelopes. The invention is equally applicable whether the dieing operation is to be performed upon previously cut envelope blanks or upon continuous webs which are subsequently to be made into envelope blanks. It is to be understood, however, that the invention is not restricted to operation upon envelope blanks or upon webs which are destined to form envelope blanks, but that it is adapted also for other uses.

To effect a cutting action between the rotary elements, it is necessary for their cutting edges to overlap at the cutting operation, and hence for the cutting edges of one or both of them to project beyond the circular pitch line between the rolls. When both the dies are made to project uniformly and equally beyond the pitch line each has projecting parts which travel faster than the pitch line speed. It is necessary then, in order to prevent interference between the rapidly traveling overlapping edges, to allow so much backlash in the gearing for driving the dies that a consistently clean cutting action cannot be obtained. Even with the allowance of such backlash, however, the dies wear away rapidly. The difficulty is especially pronounced with respect to the cutting edges which extend parallel to the roller axes or which include substantial axial components, because a greater overlap is required along these edges than along edges which are designed to produce circumferentially extending cuts.

The present invention has for its primary object to provide an improved die combination in which the parts are adapted to cut cleanly throughout, and in which no allowance of backlash is required in order to overcome interference. The parts are so constructed and arranged for mutual cooperation that they exert relatively little rubbing and wearing action upon one another.

A further object is to provide for die reshaping and resharpening as required.

Other objects and advantages will hereinafter appear.

In the drawing forming part of this specification:

Figure 1 is a fragmentary view in side elevation, diagrammatically showing a portion of an illustrative machine which is designed to act upon separate envelope blanks and which embodies features of the invention;

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Figure 2 is a fragmentary diagrammatic view of another machine embodying features of the invention, the mechanism of Figure 2 differing from that of Figure 1 in the fact that it is designed to act upon the webs, rather than upon separate envelope blanks;

Figure 3 is a fragmentary view in elevation of a die set employed in Figure 1, together with the supporting and operating mechanism therefor; Figure 4 is a fragmentary plan view showing an envelope blank in cutting position with relation to the lower die, and the feeding instrumentalities located at that point below the path of blank travel;

Figure 5 is a fragmentary sectional view taken upon the line 5—5 of Figure 3, looking in the direction of the arrows, the view being upon a substantially larger scale than Figure 3 and showing the dies in different positions; and

Figures 6, 7, 8 and 9 are fragmentary, sectional views illustrating the coaction of the die at successive stages of the cutting operation.

An illustrative machine embodying the invention and adapted to act upon envelope blanks is shown in Figures 1 and 3 to 9, inclusive. Envelope blanks, like the blank 1 of Figure 4, are fed individually from a stack onto a conventional pin conveyor 68 by any suitable mechanism such, for example, as the mechanism disclosed in United States Patent No. 2,315,646 granted to me on April 6, 1943. The blanks are advanced continuously through die mechanism by which the window openings 3 (see Figure 4) are cut.

The blanks are advanced, bottom flaps first, by the chain conveyor 63, the chains being provided with pins 71 which engage in the angles formed at the junctions of the side flaps with the sealing flaps. The pins serve to perfect the timing and the alignment of the blanks. At the delivery end the chains 63 run upon sprockets 69. Each blank is thrust forward across a table 72 and onto a feed roll 73 where it is engaged and driven forward by cooperating feed segments 74. The blanks are further advanced across a table 75, whence they are drawn forward by a lower feed roller 76 and two upper feed rollers 77 cooperating therewith. The blanks are advanced by the feed rolls 76 and 77 across a table 78 to rotary die mechanism 79. The blanks are then fed away from the rotary die mechanism 79 by opposed feed rollers 79b and 79c. It is the rotary die mechanism 79 with which the invention is really concerned.

Upright frame members 80 and 81 supported upon a base 82 provide bearings for upper and

lower parallel shafts 83 and 84. The upper and lower shafts have bearers 85 affixed to them which are adapted to engage one another at all times. Between the bearers, the lower shaft 84 has metallic feed rolls 86 secured to it, while the upper shaft 83 has correspondingly located, rubber tired feed rolls 87 secured to it. Between the feed rolls 86, female die mechanism 88 is secured upon the shaft 84, and between the feed rolls 87, male die mechanism 89 is secured upon the shaft 83.

The male die 90 is seated in a recess 91 of a block 92, being held in place by countersunk headed screws 93. The block 92 is formed with a substantially semi-cylindrical groove which fits the shaft 83 and is opposed by a similarly grooved block 94. Clamping screws 95 are passed through flanges of the block 94 and threaded into flanges of the block 92 to secure the blocks 92 and 94 firmly in place upon the shaft 83.

The female die 96 is mounted upon a block 97 having a substantially semi-cylindrical groove formed in it which fits the shaft 84. A block 98 having a similar groove is opposed to the block 97 and is secured to it by clamping screws 99 which may be turned to cause the blocks 97 and 98 to grip the shaft firmly between them.

It is important that the leading cutting edge of the female die travel more rapidly than the corresponding edge of the male die so that these edges may cut the blank as they move into overlapping relation, as illustrated in Figure 6, and the leading edge of the female die may then move forward away from the leading edge of the male die to prevent these edges from clashing or rubbing as their paths again cross (see Figure 7). It is similarly desirable that the trailing cutting edge of the male die move faster than the trailing cutting edge of the female die so that these edges may cooperate to cut the blank as they move into overlapping relation, as illustrated in Figure 8, but will then be caused to separate by the faster travel of the trailing cutting edge of the male die to prevent these edges from clashing or rubbing as their paths again cross in the position illustrated in Figure 9.

In order to bring about this kind of operation, it is necessary that the leading cutting edge of the female die be made to protrude beyond the pitch line of the gears (to be later described) by which the shafts 83 and 84 are caused to travel at equal rotary speeds and that the trailing cutting edge of the male die be also caused to protrude beyond the pitch line. In other words, the effective radii of the leading edge of the female die and of the trailing edge of the male die are each greater than half the distance between the axes of the shafts 83 and 84.

In order to effect cutting, there must necessarily be overlapping of the male and female dies at every point and this necessarily means that at each point at which cutting occurs, one or both of the dies must protrude beyond the pitch line. If the leading cutting edge of the female die is made to protrude only to the minimum extent necessary for cutting, while the leading cutting edge of the male die is made to coincide with the pitch line, the difference of speed of these two edges can only be equal to  $2\pi nx$ , where  $n$  is the number of revolutions per second, and  $x$  is the amount of overlap essential for cutting.

If, however, the male die is made to fall short of the pitch line by, say,  $x/2$ , and the corresponding portion of the female die is extended to maintain the same overlap,  $x$ , as before, the protrusion

of the female die will amount to  $3x/2$  and the difference of radii will be  $2x$ . The difference of speeds now becomes  $4\pi nx$  or twice as great as before, a result which is somewhat surprising in view of the fact that the protrusion of the female die was increased only fifty percent.

To make the analysis more general, let the cut back of the leading edge of the male die be  $m \cdot x$ . Then the protrusion of the female die must be  $x(m+1)$  in order to provide the overlap,  $x$ . The difference of radii becomes  $x(2m+1)$  and the difference of speed  $2\pi nx(2m+1)$ . This principle is utilized to make the leading edge of the male die travel substantially slower than the leading edge or the associated pitch line portion of the female die and to make the trailing edge of the female die travel substantially slower than the trailing edge or the associated pitch line portion of the male die.

Although the leading edge of the female die 96 is made protruding and the trailing edge receding, as the die is mounted in the machine, the die is desirably made symmetrical in construction for economy of manufacture, and the desired protrusion and recession are brought about by mounting the die non-symmetrically upon the block 97. This will be made clearer by reference to Figure 5.

In Figure 5 it will be observed that the die 96 has a flat inner face 100 and that the block 97 has a flat supporting face 101 that extends along a chord of the pitch circle. If the die were supported upon the block 97 with its longitudinal median plane in coincidence with the radial plane 102, the arcuate outer face of the die would coincide throughout with the circumference of the pitch circle, the radial plane 102 being the perpendicular bisector of the chord along which the face 101 extends.

The die, however, is mounted with its longitudinal central plane substantially to the right of the plane 102, as seen in Figure 5, so as to cause the leading cutting edge to protrude in the illustrative construction three sixty-fourths of an inch beyond the pitch circle and the trailing cutting edge to fall three sixty-fourths of an inch short of the pitch circle.

The block 97 is formed with an undercut rib 103 against which the leading face of the die is placed. The die is secured in position by means of a clamp bar 104 and screws 105. The clamping bar is formed with a recess 106 so that it bears only at one margin against a face of the block 97 and only at the opposite margin against the trailing face of the die 96. The screws 105 are passed freely through the bar 104 and threaded into the block 97.

The male die 90, on the other hand, is mounted with its longitudinal median plane radially disposed. The leading edge of the illustrative male die is made to fall short of the pitch circle by one sixty-fourth of an inch, while the trailing edge of the male die is made to protrude beyond the pitch circle by five sixty-fourths of an inch (Fig. 5). It will thus be seen that an overlap of one thirty-second of an inch is provided at the leading cutting edges of the dies and at the trailing cutting edges.

The protrusion of the trailing edge of the male die is however greater than that of the leading edge of the female die and, since the overlap is the same at the leading and trailing edges, the recession of the trailing edge of the female die

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is greater than that of the leading edge of the male die. This is a desired relationship because there is a greater need for disparity of speed between the trailing edges of the dies than between the leading edges of the dies. The principal reason for the disparity is, however, that it follows logically from the symmetrical construction of the female die 96 and the non-symmetrical mounting of that die.

While the external face of the female die is arcuate this is not true of the exterior of the male die. The male die 90 has four external plane faces 107, 108, 109, 110. The formation of the die with these plane faces results in a somewhat irregular amount of overlap between the leading and trailing cutting edges of the die. This is not disadvantageous, however, because the maximum overlap is required only at the leading and trailing edges which run parallel to the roll axes.

The fact that the plane faces 107 and 110 are provided contributes importantly to the convenient and practical resharpening and reconditioning of the die. Two slots 111 and 112 are provided which extend parallel to the leading and trailing edges and which penetrate the die 90 to a considerable depth. The slot 111 is disposed between the faces 107 and 108 while the slot 112 is disposed between the faces 109 and 110. When it is desired to resharpen and reshape the leading edge of the die 90, a wedge may be driven at intervals into the slot 111 so as to displace the edge 113 outward by a slight but important amount. The edge is then reground and the face 107 is smoothed out so as to relocate the edge 113 precisely in its original position. A similar procedure is followed in resharpening and reshaping the trailing edge 114.

Both dies are desirably undercut adjacent their leading and trailing edges, as shown. This is particularly important in the case of the leading edge of the male die and the trailing edge of the female die, for avoiding interference and affording easy and comfortable clearance.

The male die 90 is formed near its leading edge with a series of suction passages 121 which communicate through passages 122 and 123 with a longitudinal bore 124 of the block 92. The passages 123 cross the bore 124 but are plugged to the right of the bore by plugs 125 as seen in Fig. 5. The bore 124 communicates through suitable valve mechanism (not shown) with a source of suction (not shown). At the time when the die is in cutting position the suction is applied in the passages 121 to secure to the die the piece which is cut from the blank to form the window opening. At a subsequent point in the cycle the suction is broken in the passages 121 so that the cut-out piece can be removed from the die and disposed of in an orderly manner.

The mechanism for driving the shafts 83 and 84 is designed to eliminate all back lash. A drive gear 126 drives a gear 127 which is fast upon the shaft 84. The gear 127 drives an equal gear 128 which is fast upon the shaft 83. The shaft 83 has fast upon it a gear 129 which is in mesh with an equal gear 130, the latter gear being mounted with capacity for rotative adjustment upon the shaft 84.

The gear 130 carries a lug 131 through which a screw 132 is threaded. The screw bears at one end against an arm 133 which is fast upon the shaft 84. When the screw is turned in a direction to press it toward the arm 133 the block 131 is caused to recede from the arm and hence to adjust the gear 130. Since the gear 130, is in

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mesh, however, with the gear 129, the capacity for adjustment is a limited one, and the turning of the screw is persisted in only to the point of eliminating all back-lash from the gearing. When this has been achieved the screw 132 is fixed in its adjusted position by the tightening of a lock nut 134.

The machine of Fig. 2 employs a die unit 79a which may be in all respects a duplicate of the die unit 79 shown in, and described in connection with, Figs. 1 and 3 to 9 inclusive. In this form of embodiment, however, a work web 140 is fed from a reel 141 by means of pull rolls 142 and 143. The web is advanced through the die unit 79a and is further fed away from the die unit by opposed feed rollers 144 and 145. After passing the latter rollers the web may be rewound or may be cut into lengths or treated in any other manner suitable to the purpose which it is designed to serve.

I have described what I believe to be the best embodiments of my invention. I do not wish, however, to be confined to the embodiments shown but what I desire to cover by Letters Patent is set forth in the appended claims.

I claim:

1. In rotary cutting mechanism the combination with two rolls having their axes parallel, of cooperating male and female window cutting dies carried by the respective rolls, said dies having cooperating cutting edges at their leading and trailing ends that extend in part at least axially of the rolls, the cutting edges of said dies being of such effective radii that they are caused to overlap slightly in all cutting positions, the cutting edge of the male die at the leading end falling short of the pitch line of its supporting roll and the cutting edge of the female die at the leading end extending beyond the pitch line of its supporting roll by a corresponding amount plus the overlap; and the cutting edge of the female die at the trailing end falling short of the pitch line of its supporting roll by an amount in excess of the overlap and the cutting edge of the male die at the trailing end extending beyond the pitch line by a corresponding amount plus the overlap, both the male die and the female die being undercut adjacent the leading and trailing cutting edges thereof to avoid interference and to assure comfortable clearances.

2. In rotary cutting mechanism the combination with two rolls having their axes parallel, of cooperating male and female window cutting dies carried by the respective rolls, said dies having cooperating cutting edges at their leading and trailing ends that extend, in part at least, axially of the rolls, the cutting edges of said dies being of such effective radii that they are caused to overlap slightly in all cutting positions, the cutting edge of the male die at the leading end falling short of the pitch line of its supporting roll by a substantial amount so that it will travel substantially more slowly than die parts which reach to or beyond said pitch line, and the cutting edge of the female die at the leading end extending beyond the pitch line of its supporting roll by a corresponding amount plus the overlap; and the cutting edge of the female die at the trailing end falling short of the pitch line of its supporting roll by an amount substantially greater than the amount by which the cutting edge of the male die at the leading end falls short of the pitch line, so that the cutting edge of the female die at the trailing end will travel substantially more slowly than die parts which

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reach to or beyond said pitch line, and the cutting edge of the male die at the trailing end extending beyond the pitch line by a corresponding amount plus the overlap, both the male die and the female die being undercut adjacent the leading and trailing cutting edges thereof to avoid interference and to assure comfortable clearances.

3. In rotary cutting mechanism the combination with two rolls having their axes parallel, of cooperating male and female window cutting dies carried by the respective rolls, said dies having cooperating cutting edges at their leading and trailing ends that extend in part at least axially of the rolls, the cutting edges of said dies being of such effective radii that they are caused to overlap slightly in all cutting positions, and the female die having an arcuate outer face and means mounting the female die unsymmetrically upon its supporting roll to cause the leading and trailing cutting edges respectively to protrude beyond and fall short of the pitch line by substantially equal amounts, each in excess of the overlap, both the male die and the female die being undercut adjacent the leading and trailing cutting edges thereof to avoid interference and to assure comfortable clearances.

4. In rotary cutting mechanism the combination with two rolls having their axes parallel, of cooperating male and female window cutting dies

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carried by the respective rolls, said dies having cooperating cutting edges at their leading and trailing ends that extend in part at least axially of the rolls, the cutting edges of said dies being of such effective radii that they are caused to overlap slightly in all cutting positions, and the female die having a flat supporting face and an arcuate outer face and being of symmetrical construction, and means mounting the female die unsymmetrically upon its supporting roll to cause the leading and trailing cutting edges respectively to protrude beyond and fall short of the pitch line by substantially equal amounts, each in excess of the overlap, the male die and the female die being undercut adjacent the leading and trailing cutting edges thereof to avoid interference and to assure comfortable clearances.

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