April 26, 1966 W. F. HUCK ET AL 3,247,744

APPARATUS FOR CROSS CUTTING TRAVELING STRIP MATERIALS

Filed May 11, 1964 4 Sheets-Sheet 1

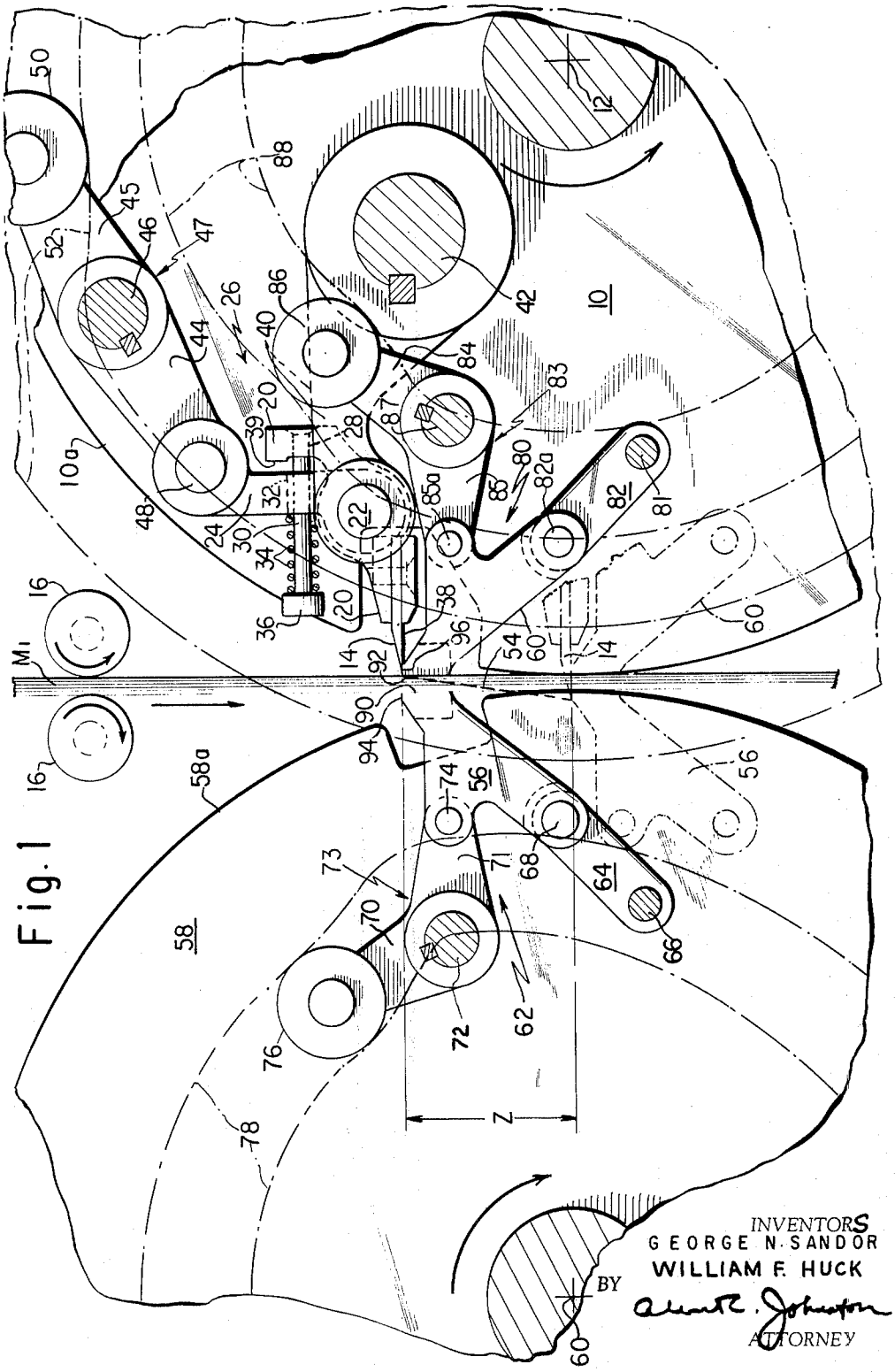


Fig. 1

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Fig. 2

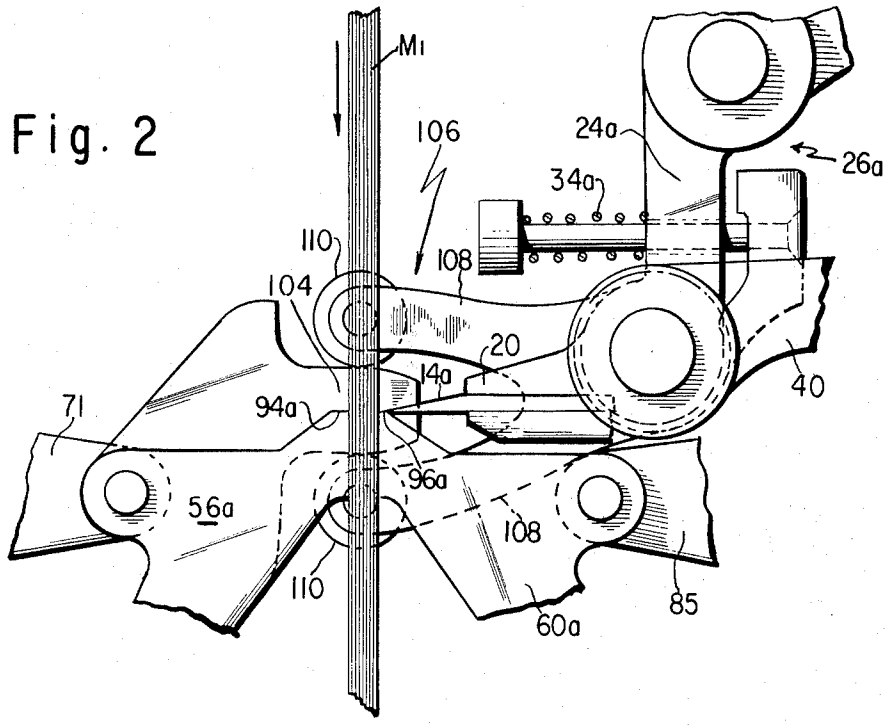
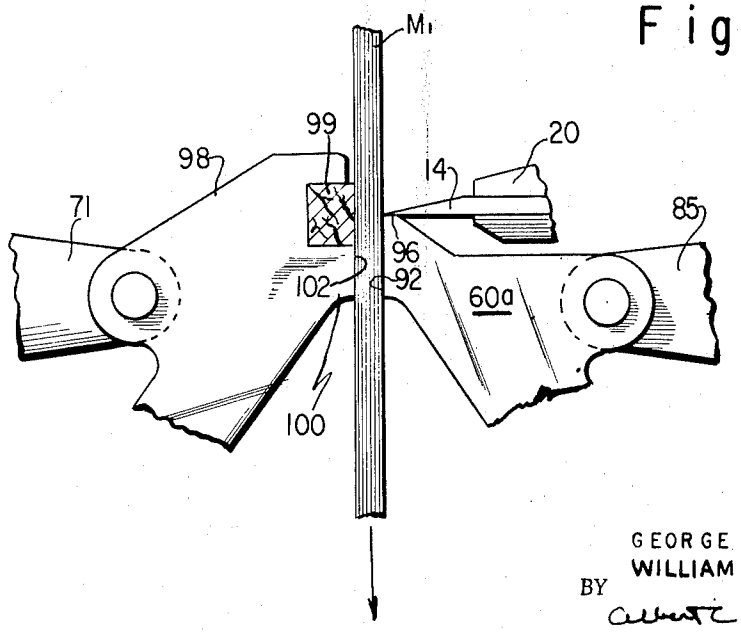


Fig. 3



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APPARATUS FOR CROSS CUTTING TRAVELING STRIP MATERIALS

Filed May 11, 1964 4 Sheets-Sheet 3

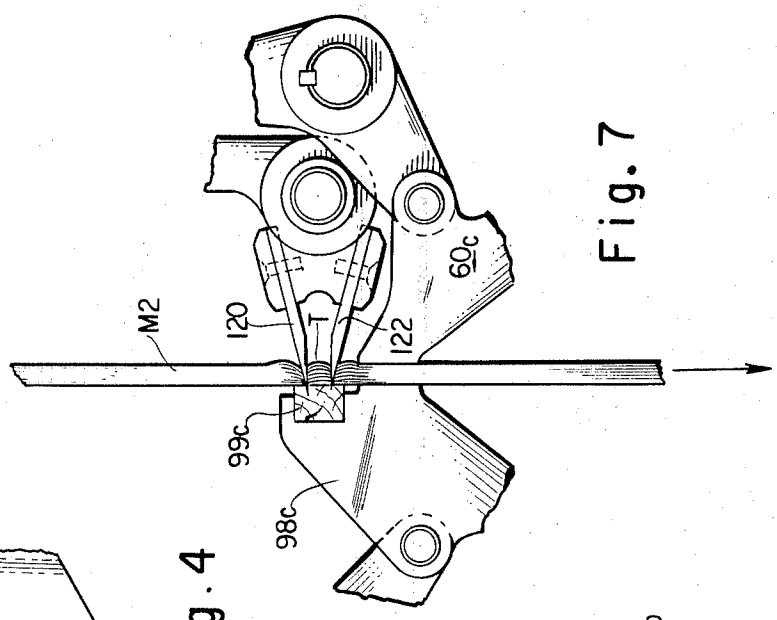


Fig. 7

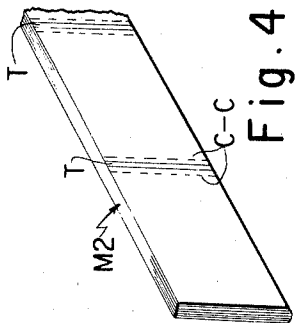


Fig. 4

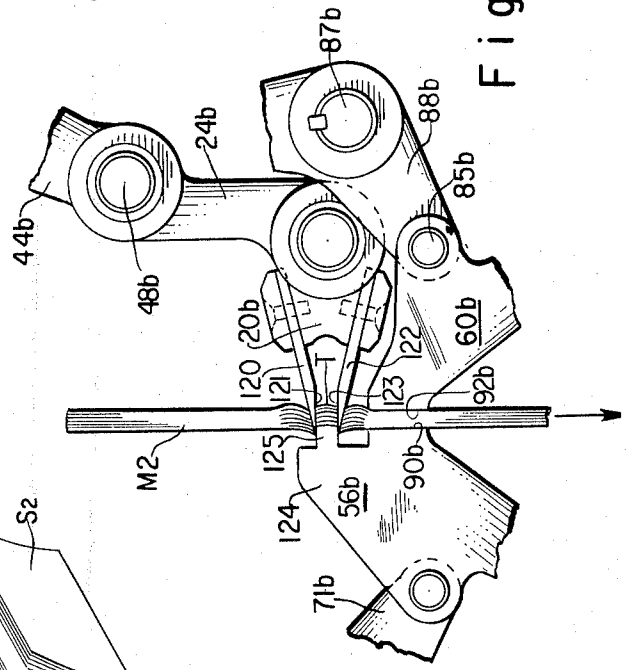


Fig. 6

Fig. 5

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APPARATUS FOR CROSS CUTTING TRAVELING STRIP MATERIALS

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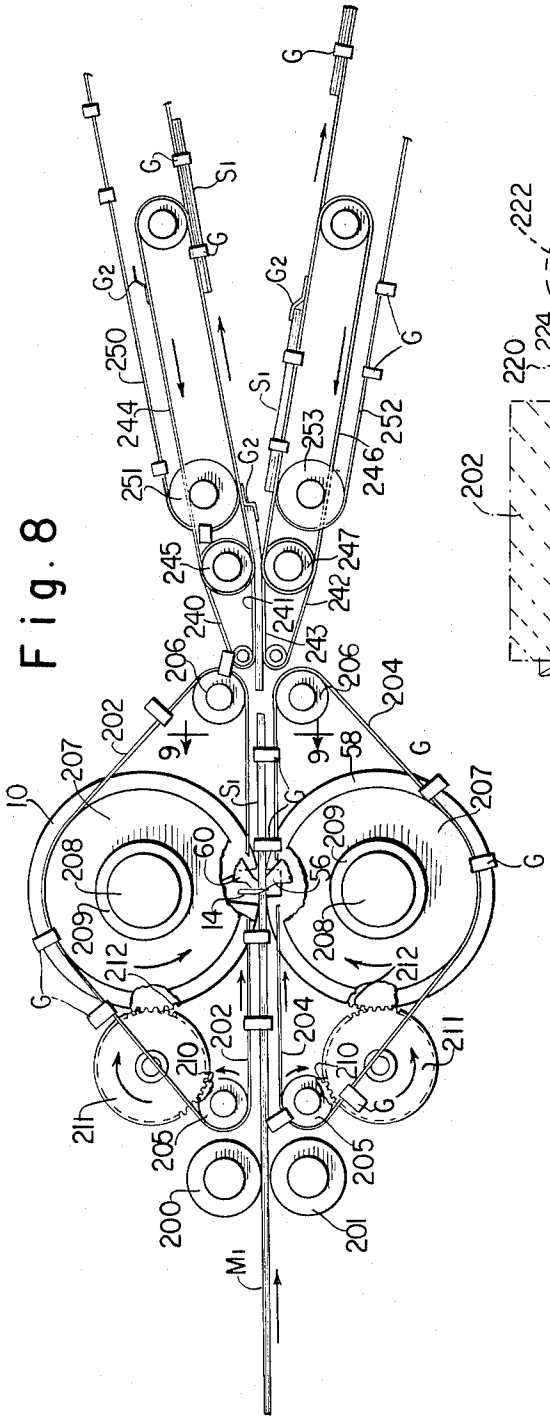


Fig. 8

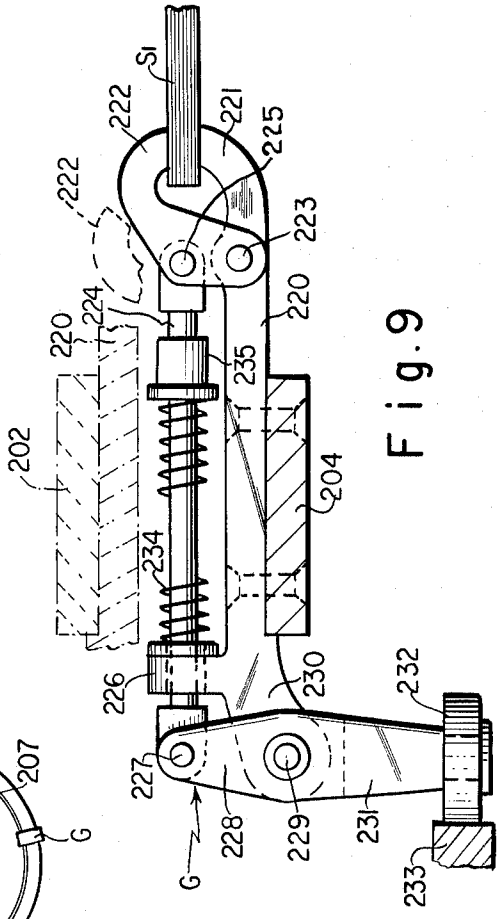


Fig. 9

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United States Patent Office 3,247,744 Patented Apr. 26, 1966

3,247,744

APPARATUS FOR CROSS CUTTING TRAVELING STRIP MATERIALS

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13 Claims. (Cl. 83—107)

This invention relates to apparatus for cross cutting traveling strip materials to sever them into repetitive lengths or sections having evenly cut edges. The invention is applicable to the cutting of various materials having the form of continuous strips or bundles of strips, whether made of paper, cloth, felt, metal or plastic foil, or other cuttable material. It is more particularly related, however, to apparatus for cross cutting collections of printed webs or ribbons employed in the production of booklets, magazines or the like.

In the production of booklets and magazines, the material from which the booklet or magazine is to be formed is customarily unwound in web form from one or more supply rolls and then printed, slit into ribbons of standard page length and thereafter collated. The collection of ribbons is fed at press speed through a cross cutting mechanism which severs it transversely at regular intervals to form cut sections which are folded into groups known as signatures. The signatures thereafter are stapled or bound and delivered as finished magazines or books, when products having rough edges are acceptable.

The cross cutting mechanisms currently employed in work of this type produce rough and uneven edges which give the folded printed products an unattractive appearance. This uneven edge condition is not commercially acceptable in the case of books and magazines of high quality. For this reason, it is customary in the production of such publications to remove the signatures from the delivery end of the printing press, stack them upon skids and transport them to other locations where they are unloaded, jogged in stacks and placed upon semi-automatic trimming machines, all by manual labor. These machines then trim the ends of the signatures and the side opposite their folded edge, giving them squared edges having a commercially acceptable appearance. Although this trimming operation is done semi-automatically and at a good production rate, it is nevertheless time consuming and costly because of the very considerable amount of handling, manual labor and paper waste involved.

It is an object of the present invention to provide an apparatus for cross cutting traveling strip materials by which the moving materials, though of very considerable thickness and traveling at high speed, can be cut through crosswise to form cut lines or edges which lie evenly at a desired angle, such as perpendicularly, to the faces of the materials.

It is a more specific object of the invention to provide a cross cutting apparatus which will attach to a printing press or other web processing machine and operate in unison with it to cross cut collated printed web materials as they are delivered by the machine and convert them continuously into severed sections which are so squarely and cleanly cut as to form acceptable booklets, magazines or like products of high quality without need for further trimming.

A further object is to provide a continuously operated rotary cross cutting apparatus which is effective to sever continuously moving strip materials of considerable thickness, at any deired speed of movement of the material, into sections having a squareness and evenness of the cut edges equal or superior to that obtained by the use of stationary trimming machines.

Still another object of the invention is to provide a system of conveyors and grippers for carrying the strip material to and through the cutting zone of the cross cutting cylinders and for carrying away the separate sections formed by the cross cutting operations.

According to the present invention, a suitable cutting means, for example a knife of blade form, is mounted on a continuously rotating carrier by which the knife is moved periodically through a cutting zone elongated in the direction of the movement of the strip material to be cut, through which zone the material is fed continuously in a substantially straight path, and during each orbital pass of the knife through the cutting zone the knife is moved bodily relative to the carrier and across the path of the strip material by means rotated with the carrier which maintain the cutting edge of the knife, throughout its travel in said path, in a cutting path or plane lying at a constant angle to the material and advancing through said zone tangentially to the path of the carrier at a linear speed in the direction of the movement of the strip material that is kept precisely equal to the speed of the material and in a constant proportion to the angular speed of the carrier. By feeding the material in a straight path through the cutting zone and holding the cutting edge of an orbiting knife blade in a plane perpendicular to the material, the knife is caused to cut through the material entirely at right angles thereto, thus producing in each pass through said zone a cross cut or series of cuts quite perpendicular to the faces of the material.

According to another feature of the invention, the knife is moved through the strip material at a speed that is kept constant in the direction of its cutting motion, so that it cuts through the material at a constant rate proporionate to the rotational speed of the carrier. This rate can be selected to give assurance that clean square cuts will be made at either low or high speeds of the material and even though the material being cut forms a body of very considerable thickness, as in the case of an assemblage or collection of many ribbons of printed paper passing together from collating apparatus to be formed into booklets, magazines, or the like.

The knife on the rotary knife carrier cuts through the strip material by a compressive cutting action against the resistance of a backing member which presents in the cutting zone an anvil or backing surface moving with the material at the side of the material opposite to the side thereof occupied by the knife carrier. For continuous operations at high speed, the backing member is mounted on a second carrier which rotates counter to the knife carrier and carries means operative as it rotates to move the anvil surface through the cutting zone in the direction of and in continuing engagement with the strip material at a linear speed which, like that of the knife, is precisely equal to the speed of the strip material.

According to a further feature of the invention, the backing member on the second carrier is formed as a clamping member to coact with a clamping member provided on the knife carrier. As the two carriers are rotated the respective clamping members converge in the cutting zone to clamp the strip material tightly between them, and then are moved through said zone in continued clamping relation to the material, in the same direction as the material and at a speed precisely equal to the speed of the material. In this way, the strip material is gripped and held relatively rigid at a location fixed relative to the cutting path of the knife, so that the knife cuts through the material not merely with a compressive cutting action but also with a shearing action across the part of the material gripped by the clamping members. The shearing

action is conducive to the production of a clean, evenly cut edge.

The clamping members can be formed to present lateral surfaces aligned in a plane contiguous to a face of the knife, against which surfaces the knife is pressed during its cutting movement so that it will be guided positively in the desired cutting plane and will cut largely with shear action across the part of the material gripped by the clamping members.

In an alternative construction, the backing member on the second carrier comprises an anvil in the form of a cutting block which is held against the strip material at a location across the cutting path of the knife, so as to sustain the cut of the knife. This cutting block preferably is made of a rigid substance soft enough to be penetrable by the knife at the end of its cutting stroke, such as closely grained hardwood.

Such a cutting block advantageously is a part or an extension of a backing member having a clamping portion that coacts with a clamping member on the knife carrier as above described. In this case, however, the clamping member on the knife carrier is the only one to be provided with a lateral surface for guiding the knife, and the cutting action is largely compressive.

According to still another feature of the invention, which may be advantageous when the strip material is relatively thick and strongly resistant to the cutting action, complementary positioning elements which move in fixed positions relative to the knife and the backing member, respectively, are arranged to interengage and hold those parts positively in accurate alignment during their movement into and through the cutting zone. By providing interfitting male and female elements for this purpose, the positioning elements are made to move into and out of engagement as the knife is orbited into and out of the cutting zone. For example, one of the positioning elements may have the form of a yoke carrying rollers in its arms; and the other the form of a tooth fitting into the space between the rollers.

For the purpose of carrying the strip material to and through the cutting zone of knife and anvil cylinders and carrying away the separate sections cut successively from the material, the apparatus may be provided with a system of endless gripping conveyors some of which will clamp the strip material at locations spaced apart along an edge thereof and hold it positively at the required position and speed during each cross cutting operation, while others of these conveyors will accelerate the separate sections away from one another and then carry them away individually to suitable points of delivery.

The foregoing and other objects, features and advantages of the invention will be apparent from the following detailed description and the accompanying drawings of illustrative embodiments thereof. In the drawings:

FIG. 1 is a plan view of a rotary cross cutting apparatus according to the invention;

FIGS. 2 and 3 are plan views of modifications of the apparatus of FIG. 1;

FIGS. 4 and 5 are schematic views, respectively, of a special form of strip material imprinted so as to be cut into signatures having "bleed" pages, and of a signature cut from this material;

FIGS. 6 and 7 are plan views of modifications of the cross cutting apparatus which adapt it for the cutting of a strip material such as that of FIG. 4;

FIG. 8 is a schematic plan view of a system of gripping conveyors coacting with the cutting apparatus; and

FIG. 9 is an elevational view, partly in section, of one of the grippers provided on some of the conveyors.

The invention as illustrated in FIG. 1, is embodied in a rotary cross cutting apparatus adapted for cutting relatively thick continuous strip material M1, such, for example, as a collection or assemblage of many printed webs or ribbons advancing to the apparatus at high speed to be cut into sections such as signatures for the production of booklets, magazines or the like.

The apparatus includes a rotary knife carrier or cylinder **10** arranged for continuous rotation about a fixed axis at **12** and a counter rotating carrier or cylinder **58** for a backing member or backing and clamping member **56** which coacts with a knife **14** of blade form carried by the knife carrier. As shown, counter-rotating drive rollers **16** propel the strip material continuously in a substantially straight path extending to and through a cutting zone Z lying substantially tangent to the peripheral surfaces **10***a* and **58***a* of the two cylinders, and a square cut is made entirely through the material upon each movement of the knife **14** through this cutting zone. While only one knife is shown, it will be understood that two or more knives or the like may be mounted and operated similarly at locations spaced apart about the circumference of the knife cylinder.

The knife **14** is fixed to one end of an arm **20** which is pivoted intermediate its ends on a pivot pin **22** carried on one end of the coupler link **24** of a four-bar linkage indicated generally at **26**. The other end of the knife arm **20** is provided with a threaded bore **28** into which a bolt **30** is screwed. The shaft of bolt **30** is passed through an oversize bore **32** in the coupler link **24**, and a coil spring **34** on the bolt shaft is compressed between a nut **36** on the end of the bolt and the body of the coupler link **24** so as to urge the arm **20** and knife **14** continuously in counterclockwise direction relative to the pivot pin **22** and thus hold the knife blade strongly yet yieldable in cutting position.

The four-bar linkage **26** includes (1) the coupler link **24**, (2) a rocker link **40** carrying pivot pin **22** at one end and connected at its other end to a shaft **42** pivotally mounted in end structures of the knife cylinder **10**, (3) a driver link **44** which is formed as the forward arm of a lever **47** fixed to a shaft **46** rotatable in such structures, and (4)a follower link **45** provided by the backward arm of said lever. The driver link **44** and coupler link **24** are interconnected by pivot pin **48**. The follower link **45** carries a rotatable cam follower **50** riding in a cam track **52**, shown by phantom lines in the drawing, which is mounted in a fixed position, in well known manner, adjacent to one end of the cylinder **10**. It will be evident that as the cylinder **10** is rotated the position of the cam follower **50** relative to the axis **12** and the position of the knife **14** relative to the cylinder undergo changes in accordance with gradations of the profile of the cam track **52** and attendant displacements of the knife as produced by the four-bar linkage **26** through rocking motions of lever **47** about the axis of shaft **46**, relative pivotal motions of links **44** and **24** on pins **48** and **22**, and accompanying movements of rocker link **40** about the axis of its shaft **42**.

The profile of the cam track and the dimensions and mounting points of the elements of the four-bar linkage are so interrelated that in each revolution of the knife cylinder the knife **14** while being carried along the cutting zone Z is thrust across the path of the strip material M1 and is maintained throughout its travel thereacross in a cutting path or plane lying perpendicular to the material and advancing through the cutting zone at a speed in the direction of travel of the material therethrough that is precisely equal to the speed of movement of the strip material.

This speed equalization is assured for all speeds of the material by the fact that the linkage keeps the speed of advancement of the blade or cutting path of the knife in the said direction in a constant proportion to the angular speed of the cylinder, while the rollers **16** or other suitable means for propelling the strip material keep the material advancing at a speed bearing a constant relation to the angular speed of the cylinder.

When the cut is to be perpendicular to the material, as in the embodiment shown, the knife edge is moved

along the zone Z constantly at the same linear speed as the material and, although the linkage shafts 42 and 46 are in circular motion, the linkage 26 causes the knife blades to undergo a clockwise rotation, about its cutting edge as the axis, opposite in direction and equal in angular magnitude to the counterclockwise rotation of cylinder 10. In this way the required perpendicularity of the cutting path is maintained throughout the travel of the knife through the cutting zone.

Further, the linkage 26 thrusts the cutting edge of the knife blade across the path of the strip material at a speed that is substantially constant in the direction of this cross cutting motion, so that the cutting edge acts in essentially the same manner upon every part or layer of the strip material lying across its path and thus will make a clean, even cut entirely through the material as the material and the knife advance together through the cutting zone.

The attendant path of movement of the knife edge, considered in relation to space, is a straight line inclined across the cutting zone Z from one to the other end thereof as indicated at 54 in FIG. 1.

The dimensions, parameters and proportions of a rotary linkage providing the described motions of the knife in an apparatus of given size can be computed by known methods of kinematic synthesis. For a method adaptable to this computation see Freudenstein and Sandor, "On the Burmester Points of a Plane," Transactions of the American Society of Mechanical Engineers, Journal of Applied Mechanics, March 1961.

Similar considerations apply to the provision of the linkages hereinafter described for moving material engaging parts of the backing and clamping members 56 and 60 along the cutting zone in strictly linear paths at precisely the speed of the strip material being cut.

The backing and clamping member 56 on the second cylinder 58 serves as an anvil to sustain the strip material M1 against the thrust of the knife 14. This member is positioned by another four-bar linkage 62, of which member 56 constitutes a coupler link, so that upon each revolution of cylinder 58 about its axis at 60 a support surface 90 of member 56 will be moved into butting relation to one side of the material entering the cutting zone Z as the knife is about to cut into the opposite side of the material. The support surface 90 then is moved along the cutting zone in this same relation to the material and the cutting plane of the knife, and at precisely the linear speed thereof, throughout the cutting operation.

The linkage 62 includes: (1) member 56 as the coupler link; (2) a rocker link 64 pivotally mounted at one end on a shaft 66 carried in end structures of cylinder 58, the other end of this link being connected by pivot pin 68 with a part of member 56; (3) a driver link 71 formed as one arm of a lever 73 fixed to a shaft 72 pivotally mounted in such end structures, link 71 being connected with a part of member 56 by pivot pin 74; and (4) a follower link 70 provided by the backward arm of lever 73. The follower link 70 carries a rotatable cam follower 76 riding in a cam track 78, shown in phantom lines, which is mounted in a fixed position adjacent to one end of cylinder 58.

The rotation of cylinder 58 synchronously with the knife carrier 10 carries the shafts 66 and 72 in continuous circular motion and carries the cam follower 76 continuously along its track 78, thus causing the linkage 62 to dispose the support surface 90 of member 56 in the position shown in full lines in FIG. 1 when it reaches the cutting zone and to hold surface 90 in this same position relative to the strip material and the cutting plane of the knife 14 during its travel tangentially along the cutting zone to the location shown in broken lines in FIG. 1. The surface 90 thus gives constant backing support for the strip material to sustain it against the thrust of the knife throughout the length of the elongated cutting zone required for the even movement of the knife entirely across a thick body of strip material advancing through the apparatus at high speed.

Further, backing member 56 in the apparatus of FIG. 1 not only gives backing support for the material but also serves as a clamping member which coacts with a similar clamping member 60 carried by the knife cylinder 10. The two clamping members converge upon the strip material as they reach the cutting zone so as to grip the material at the leading side of the cutting path of the knife and to advance the material in a perfectly straight path from one end to the other of the cutting zone. Further, in the form shown they serve to guide the knife moving through the material so that the knife will be assured of making an even square cut and will cut not merely by compressive cutting action but also by shearing the gripped material along the trailing edge 94 of the clamping members.

The clamping member 60 is formed as the coupler link of a four-bar linkage 80 arranged in the same manner as but in mirror symmetry to the linkage 62 of cylinder 58. The linkage 80 further includes a rocker link 82 pivotally mounted by shaft 81 and connected with member 60 by pivot pin 82*a*, and a lever 83 fixed to shaft 87 with one of its arms forming a driver link 85 pivoted to member 60 by pin 85*a* and its backward arm forming a follower link 84 that carries a rotatable cam follower 86 riding in a fixed cam track 88.

The respective trailing edges 94 and 96 of the clamping members 56 and 60 are maintained in lateral alignment during their movement along the cutting zone so as to define in contiguous relation to the flat forward face 38 of the knife blade a plane that is kept perpendicular to the path of the strip material. The knife blade is pressed constantly against the edge 96 of member 60 by the force of spring 34. This edge therefore serves as a guiding surface for the cutting motion of the knife. The knife blade slides over it in perpendicular relation to the strip material, so as to pass over the edge 94 of member 56, in the manner of a shear blade, as the knife is thrust through the material by the linkage 26.

When the clamping members 56 and 60 have reached the forward end of the cutting zone, which in the apparatus shown is approximately at the location of a plane joining the axes of the two cylinders, the cutting edge of the knife blade 14 has been passed entirely across the path of the strip material and a slight distance beyond it, so as to lap over the trailing edge 94 of member 56 as indicated by the broken line showing of these elements in FIG. 1. The continued rotation of the cylinders then moves the knife 14 and clamping members 56 and 60 forwardly along and angularly away from the path of the strip material, and finally it returns them, by the action of suitable falling portions (not shown) of the cam tracks, to positions in which they will converge to grip and cut another section or signature from the strip material as above described when they again reach the cutting zone.

When the strip material to be cut is strongly resistant to the cutting action, as in the case of a relatively thick assemblage of collated paper webs or ribbons, it may be advantageous to provide additional means for maintaining the cutting knife in accurate alignment with the material and the backing member. A modification of the described apparatus provided with means of this nature is shown in FIG. 2 of the drawings.

In this modification, a male guide element in the form of a tooth 104 is made integral with a backing member 56*a* corresponding in other respects to member 56 on the cylinder 58 of FIG. 1; and a complementary female guide element 106 in the form of a yoke to receive the tooth 104 is provided by spaced arms 108 which are made integral with coupler link 24*a* of the knife operating linkage 26*a*, and which carry rollers 110 at their free ends.

Link 24*a* and linkage 26*a* correspond in other respects to the structures 24 and 26 of FIG. 1.

As the knife and clamping members of this modified apparatus approach the cutting zone, the tooth 104 is moved into the yoke 106, its convexly curved lateral faces coming into firm rolling contact with the rollers 110 on the free ends of the arms 108. When the knife starts to cut and throughout each cutting operation the tooth and the rollers are inter-engaged, substantially as illustrated in FIG. 2, so as to hold the knife quite firmly and securely in the required cutting plane as it cuts through the strip material.

While the cutting zone Z in the form of apparatus shown terminates at approximately the locus of the plane joining the axes of rotation of the two cylinders 10 and 58, the several systems of linkages and cams can be so located and proportioned that the cutting zone will be in symmetrical relation to that plane. Such an arrangement may be advantageous for some uses of the invention, because of its tendency to minimize torsional vibrations that otherwise may occur in the apparatus under severe operating conditions.

The modified apparatus shown in FIG. 3 is similar to the embodiment of FIG. 1 excepting that, in place of the backing member 56 having a clamping surface 90 formed with a trailing edge 94 to coact with the knife edge, a backing member 98 is provided which presents a cutting block 99 across the cutting path of the knife, so that the knife will cut through the strip material largely with compressive cutting action. The block 99 is made of a rigid substance, such as a closely grained hardwood, strong enough to hold the strip material in place against the thrust of the knife and yet soft enough to be penetrable by the knife at the end of its cutting stroke. The backing member 98 as shown not only carries the cutting block 99 but also has a clamping portion 100 which presents a clamping surface 102 coacting with the clamping surface 92 of member 100 to grip and move with the strip material while the material is being cut by the knife.

While the knife 14 as shown has a straight edge for severing the strip material into separate pieces or sections, knives of other forms can be used, and cuts of other forms can be made through the material. For example, a knife having an interrupted edge, as of saw-tooth type, can be used to form interrupted cut lines through this material at regular intervals.

By virtue of the basic mode of operation of the invention as hereinabove described, various kinds of cross cutting operations can be performed through suitable modifications of the coacting knives and backing members carried by the linkages of the cutting cylinders.

Among the desirable applications of the invention is the cutting of a continuous strip material of the form shown schematically at M2 in FIG. 4 to produce separate sections or signatures of the nature indicated at S2 in FIG. 5. This strip material is an assemblage of printed and folded paper ribbons or webs on which the printed areas run to the edges of the signature pages to form what is known in the trade as "bleed" pages. The printed areas normally are separated by gaps such as indicated at T in FIG. 4. These must be removed when forming the signatures, as by making two parallel cuts across the strip material at locations C—C near the edges of each gap. For this purpose a modification of the cross cutting elements of the nature shown in FIG. 6 or FIG. 7 may be utilized for each cutting operation.

According to FIG. 6, a knife arm 20*b* operated similarly to arm 20 of the embodiment of FIG. 1 carries two knives 120 and 122 having their cutting edges spaced apart by the distance of the gap to be cut out of the strip material in each cross cutting operation. The opposing faces 121 and 123 of these knives are held aligned with and substantially parallel to the trailing and leading side faces, respectively, of a rigid anvil member 125 of tongue-like form that protrudes into engagement with one side of the strip material M2 from a backward extension 124 of a backing member 56*b* that in other respects is similar to member 56 of FIG. 1. The reference numerals suffixed with the letter *b* in FIG. 6 designate parts which correspond in function to parts in FIG. 1 designated by corresponding numerals without the suffix.

It will be evident that the two knives 120 and 122 in the modification of FIG. 6 will make parallel cuts perpendicularly across the strip material M2 during each passage of these knives through the elongated cutting zone of the cross cutting apparatus. Each of these knives acts in essentially the same manner as the single knife 14 of the embodiment of FIG. 1. Each movement of the two knives across the path of the moving material to the side faces of the anvil member 125 severs a narrow gap portion T from the material and produces a separate signature S1, the gap portion meanwhile being constrained against displacement with the knives by its engagement with the top face of the anvil member. In other respects, the modification of FIG. 6 operates in essentially the same manner as the apparatus of FIG. 1.

The modification shown in FIG. 7 also makes use of two knives 120 and 122. It does so in essentially the same manner as the structure of FIG. 6 excepting that in FIG. 7 the knives cut through the strip material by compressive action against the resistance of a cutting block 99*c* bearing against the opposite side of the material. This cutting block is similar to cutting block 99 of the modification shown in FIG. 3, and it coacts with each of the two knives in the manner described in reference to knife 14 and block 99 of FIG. 3.

For various uses of the described cross cutting apparatus it is advantageous to assure more positively that the strip material will be positioned properly during its travel into and through the cutting zone of the rotary cylinders and that the separate sections or signatures formed by the cutting operations will be carried away from the cylinders as fast as they are formed, for delivery into stacks or collectors or for further processing into finished products such as magazines, books or the like.

These functions may be attained according to the invention by a system of endless gripping conveyors as shown schematically in FIG. 8 of the drawings.

The crosscutting cylinders in FIG. 8 correspond essentially to those shown at 10 and 58 in FIG. 1. The strip material is fed continuously to these cylinders by propelling rollers 200 and 201 from which the material passes in an upright on-edge posture to endless gripping conveyors 202 and 204 which positively grip and position the material along its upper edge during its travel through the cutting path. The separate sections or signatures S1 formed by the cutting operations are then passed one after another from the conveyors 202, 204 to accelerating conveyors 240 and 242 which grip each section by facial contact, and then onward individually to suitable points of delivery by end gripping conveyors 244 and 246 and further edge gripping conveyors 250 and 252.

The gripping conveyors 202 and 204 are endless belt conveyors arranged at opposite sides of the desired cutting path of the strip material M1. Each of them has an inner flight which lies above and parallel to that path and is driven continuously in the direction of travel of the material at a speed always equal to the peripheral speed of the rollers 200, 201 and the cutting cylinders. For example, each conveyor is trained about pulleys 205 and 206 at the backward and forward ends of its inner flight, either of which may be a driving pulley. As shown, an outer flight between those pulleys passes about an idler pulley 207 held concentric with the related cutting cylinder by a top member 208 and bearing 209 on the cylinder, and each pulley 205 is driven through gears 210, 211 and 212 located at the lower end of the related cylinder, the gears 212 having the same pitch diameter and the same peripheral speed as the cutting cylinders.

The conveyors 202 and 204 carry sets of grippers G, preferably arranged in pairs, which are spaced apart so that the gripper or grippers of each set will engage a portion of the strip material that is to become a separate section S1, and so that the knife 14 and members 56 and 60 of each cross cutting mechanism will act upon the material at locations between those of the sets of grippers engaging the material.

A suitable construction of the grippers G is shown in FIG. 9.

Each gripper G has a body member 220 that is firmly secured to the belt 204 or 202. The lower end of this member defines a relatively fixed jaw 221 that coacts with a relatively movable jaw pivoted to the body member at 223.

An actuating rod 224 is pivoted at its lower end to the movable jaw, as at 225, and passes near its upper end through a guide 226 on member 220 to a pivotal connection at 227 with one arm 228 of a lever fulcrumed at 229 on the upper end of the body member. The other arm 231 of this lever carries a cam follower 232 that rolls along an overhead cam track 233. A compression spring 234 surrounding rod 224 and bearing constantly against a collar 235 on this rod urges the jaws 221 and 222 strongly into clamping relation to an upper edge portion of the strip material, or of a section S1 cut from the material, when permitted so to do by the contour of the cam track 233.

Through movement of the gripper G along a portion of the cam track that suitably depresses the follower 232, the rod 224 is lifted against the compression spring 234, thus lifting the movable jaw 222 away from jaw 221 to an open position in which jaw 222 lies entirely above the upper edge of the strip material, as indicated by the broken lines in FIG. 9.

Accordingly, whenever any of the grippers G carried by one of the conveyors 202 and 204 is moved about the backward pulley 205 into the inner flight of the conveyor, a suitable cam track located above the conveyor holds the gripper in open position until its movable jaw has passed over the top edge of the strip material M1 to the farther side thereof, its fixed jaw thus being brought into contact with the nearer side thereof. Then the track releases the follower, whereupon the spring 234 brings the two jaws 221 and 222 into strong gripping engagement with an upper edge portion of the material.

The sets of grippers G are so located on the conveyors 202 and 204 that a set on one conveyor is followed by a set on the other conveyor into and along the cutting path of the strip material. At least two sets of the grippers are always advancing with the inner flights of the conveyors, so that each section S1 cut from the strip material continues to be gripped and positioned by a set of grippers G engaging its upper edge until these grippers reach the forward end of the conveyors. At that point a cam track such as track 233 depresses the follower 232 so as to open the movable jaw of each gripper and let the conveyor belt carry the gripper away from the cut section and about pulley 206 into the return flight of the conveyor.

Meanwhile, the leading end of the cut section has been propelled into engagement with the inner flights 241 and 243 respectively of the accelerating conveyor belts 240 and 242. These flights grip the section at its opposite sides and propel it forwardly at a speed greater than that of the strip material M1, thus creating a space between the trailing edge of the accelerated section and the leading edge of the next section being cut from the strip material.

The forward pulleys of the accelerating belts are concentric with the backward pulleys 245 and 247 respectively of the end gripping conveyors 244 and 246. The latter carry end grippers G2 suitably spaced apart thereon, and they are so synchronized with the other conveyors that upon the arrival of the leading end of each accelerated section S1 at the pulleys 245, 247 an end gripper G2 on either conveyor 244 or conveyor 246 will be passing around the related pulley 245 or 247 in a relatively open position so as to receive the leading end of the accelerated section in a pocket between this gripper and the conveyor belt. Then, as the gripper advances into the inner flight of the belt carrying it, it closes upon the end of the section to grip the same tightly and carry the section along that flight.

The end gripping conveyors extend divergently away from their backward pulleys, with their respective inner flights lying below and aligned with the inner flights of divergent edge gripping belt conveyors 250 and 252. Each of the latter comprises sets of grippers G of the character hereinbefore described, which are so arranged relative to coacting cam tracks (not shown), that as each cut section S1 is carried past the backward pulley 251 or 253 of conveyor 250 or 252 a set of two grippers G on the latter will be moved into clamping engagement with the upper edge portion of the section. The successive cut sections S1 thus are brought alternately under the control of divergent conveyor flights which grip the sections along their upper edges and carry them away individually to suitable points of collection or delivery.

Although preferred embodiments of the invention have been shown and described in detail, it is to be understood that the invention may be utilized in various other ways. It is not intended to be restricted to particulars of these embodiments except as required by a fair construction of the appended claims.

What is claimed is:

1. Apparatus for cross cutting strip material traveling lengthwise in a substantially straight path through a cutting zone, comprising

a rotary carrier carrying a cross cutting knife,

and means on and operated by rotation of said carrier for moving said knife across the path of the strip material and maintaining the knife throughout its travel across said path in a cutting path lying at a constant angle to said material and advancing through said zone tangentially to said carrier at a speed in the direction of travel of said material that is precisely equal to the speed of said material and in a constant proportion to the angular speed of said carrier,

whereby said knife will cut straight through relatively thick, rapidly moving strip material at a certain angle to the faces of the material.

2. Apparatus for cross cutting strip material traveling lengthwise in a substantially straight path through a cutting zone, comprising

a rotary carrier carrying a cross cutting knife,

and means on and operated by rotation of said carrier for moving said knife across the path of the strip material and maintaining the knife throughout its travel in said path in a cutting path lying perpendicular to said material and advancing through said zone tangentially to said carrier at a speed in the direction of travel of said material that is precisely equal to the speed of said material and in a constant proportion to the angular speed of said carrier,

whereby said knife will cut straight through relatively thick, rapidly moving strip material perpendicularly to the faces of the material.

3. Apparatus for cross cutting strip material traveling lengthwise in a subsantially straight path through a cutting zone, comprising

a rotary carrier carrying a cross cutting knife,

and means on and operated by rotation of said carrier for moving said knife across the path of the strip material and for maintaining the knife throughout its travel in said path at a constant speed in the direction of its cutting path and in a cutting path lying at a constant angle to said material and advancing through said zone tangentially to said carrier at a

speed in the direction of travel of said material, precisely equal to the speed of said material,

whereby said knife will cut straight through relatively thick, rapidly moving strip material at a certain angle to the faces of the material.

4. Apparatus according to claim 1, said means on said carrier including a four bar linkage having a coupler link on which said knife is mounted and having a driving link carrying a cam follower positioned on a fixed cam surface by rotation of said carrier.

5. Apparatus for cross cutting strip material traveling lengthwise through a cutting zone, comprising

a rotary carrier at one side of the path of the strip material and carrying a cross cutting knife,

a second carrier rotating counter to said knife carrier at the other side of said path and carrying a backing member to engage said material and resist displacement thereof by said knife,

means on and operated by rotation of said knife carrier for moving said knife across said path and maintaining the knife throughout its travel in said path in a cutting path lying at a constant angle to said material and advancing through said zone at a speed in the direction of travel of said material that is precisely equal to the speed of said material and in a constant proportion to the angular speed of said knife carrier,

and means on and operated by rotation of said second carrier for bringing said backing member into engagement with said material at a location near the region of action of said knife and moving said backing member through said zone in continuation of such engagement at a speed in said direction that is precisely equal to the speed of said material and in a constant proportion to the angular speed of said second carrier,

whereby said knife will cut straight through relatively thick, rapidly moving strip material at a certain angle to the faces of the material.

6. Apparatus for cross cutting strip material traveling lengthwise through a cutting zone, comprising

a rotary carrier at one side of the path of the strip material and carrying a clamping member and a cross cutting knife,

a second carrier rotating counter to said knife carrier at the other side of said path and carrying a clamping member to coact with said clamping member on the knife carrier,

respective means on and operated by rotation of said carriers for converging said clamping members in said zone so as to clamp said material tightly therebetween and for moving said members through said zone in continuing clamping engagement with said material each at a speed in the direction of travel of said material that is precisely equal to the speed of said material and in a constant proportion to the angular speed of its carrier,

and means on and operated by rotation of said knife carrier for moving said knife across said path and maintaining the knife throughout its travel in said path in a cutting path lying near to said clamping members and at a constant angle to said material and advancing through said zone at a speed in said direction that is precisely equal to the speed of said material and in a constant proportion to the angular speed of said knife carrier,

whereby said knife will cut straight through relatively thick, rapidly moving strip material at a certain angle to the faces of the material.

7. Apparatus for cross cutting strip material traveling lengthwise in a straight path through a cutting zone, comprising

a rotary carrier at one side of the path of the strip material and carrying a clamping member and a cross cutting knife blade,

a second carrier rotating counter to said knife carrier at the other side of said path and carrying a clamping member to coact with said clamping member on the knife carrier,

respective means on and operated by rotation of said carriers for converging said clamping members in said zone so as to clamp said material tightly therebetween and for moving said members through said zone in continuing clamping engagement with said material at a speed in the direction of travel of said material precisely equal to the speed of said material,

and means on and operated by rotation of said knife carrier for moving said blade across said path and maintaining the blade throughout its travel in said path in a cutting plane which lies perpendicular to said material and is advanced through said zone at a speed in said direction precisely equal to the speed of said material,

said clamping members having lateral surfaces aligned in said zone in a plane perpendicular to said path and said knife carrier having means thereon for pressing said blade constantly against at least one of said surfaces to hold it to the plane thereof as it is moved across said path,

whereby said blade will cut straight through relatively thick, rapidly moving strip material perpendicularly to the faces of the material.

8. Apparatus for cross cutting strip material traveling lengthwise through a cutting zone, comprising

a rotary knife carrier at one side of the path of the strip material and carrying a clamping member and a cross cutting knife blade,

a second carrier rotating counter to said knife carrier at the other side of said path and carrying a backing member to engage said material and resist displacement thereof by said blade, said backing member including a clamping portion to coact with said clamping member and an anvil portion to sustain the cut of said blade,

respective means on and operated by rotation of said carriers for converging said members in said zone so as to clamp said material tightly between said clamping member and said clamping portion and for moving said members through said zone in continuing clamping engagement with said material at a speed in the direction of travel of said material precisely equal to the speed of said material,

and means on and operated by rotation of said knife carrier for moving said blade across said path to said anvil portion and maintaining the blade throughout its travel in said path in a cutting plane lying at a constant angle to said material and advancing through said zone at a speed in said direction precisely equal to the speed of said material,

whereby said blade will cut straight through relatively thick, rapidly moving strip material at a certain angle to the faces of the material.

9. Apparatus according to claim 8, said anvil portion comprising a cutting block penetrable by the cutting edge of said blade.

10. Apparatus according to claim 8, said clamping member having a lateral surface in a plane contiguous to said cutting plane for guiding said blade and said knife carrier having means thereon for pressing said blade constantly against said surface as it is moved across said path.

11. Apparatus according to claim 5, further including complementary male and female positioning elements one of which is connected for movement with said knife in a fixed position relative thereto and the other of which is connected for movement with and in a fixed position relative to said backing member, said positioning elements being arranged to interengage and hold said knife and said backing member in accurate alignment during movement of the knife into and through said cutting zone.

12. Apparatus for cross cutting strip material traveling lengthwise in a substantially straight path through a cutting zone, comprising

a rotary carrier carrying an assembly of two cross cutting knives having their respective cutting edges held spaced apart and at the ends of substantially parallel cutting faces,

and means on and operated by rotation of said carrier for moving said assembly across the path of the strip material and maintaining the assembly throughout its travel across said path in a cutting path lying at a constant angle to said material and advancing through said zone tangentially to said carrier at a speed in the direction of travel of said material that is precisely equal to the speed of said material and in a constant proportion to the angular speed of said carrier,

whereby said assembly will cut straight through relatively thick, rapidly moving strip material at a certain angle to the faces of the material.

13. Apparatus for cross cutting a continuous strip material, comprising

means including oppositely positioned endless conveyors carrying gripping elements for gripping the material at locations spaced apart along an edge thereof and propelling it in an upright on-edge posture in a straight cutting path,

rotary cutting cylinders disposed on vertical axes at opposite sides of said path to engage the opposite sides of said material,

means for counter rotating said cylinders at a peripheral speed always equal to the speed of said conveyors,

one of said cylinders carrying a first clamping member and a cross cutting knife blade and the other of said cylinders carrying a backing member, including a second clamping member, to resist displacement of said material by said blade,

respective means on and operated by rotation of said cylinders for converging said clamping members against said material so as to clamp the material tightly between them and for moving said clamping members along said path in continuing clamping engagement with said material at a speed precisely equal to the speed of said material,

means on and operated by each rotation of said one cylinder for moving said knife blade across said path to said backing member at a location between locations of said gripping elements and for maintaining the blade throughout its movement thereacross in a cutting plane lying at a constant angle to said material and advancing through said zone at a speed in the direction of travel of the material precisely equal to the speed of said material, whereby to form separate sections from the moving material by successive cuts made straight through the material,

and means driven in synchronism with said cylinders and said conveyors for accelerating, each away from another, the successive sections so formed and issuing from said path and for carrying said sections individually away from the cutting apparatus.

No references cited.

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