MATERIAL CUTTING APPARATUS
WITH RECIPROCATING CUTTING ELEMENTS

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ABSTRACT

Hole cutting and perforating apparatus including one or more suitably configured cutting members which are comprised of two or more cutting elements that are alternately displaced relative to each other as they are caused to impact, perforate and pass through a given work material so that each cutting element independently cuts through a portion of the work material and the sum of the independent cuts forms the desired hole or cut out.

22 Claims, 31 Drawing Figures
MATERIAL CUTTING APPARATUS WITH RECIPROCATING CUTTING ELEMENTS

BACKGROUND OF THE INVENTION

The present invention relates generally to hole cutting and perforating apparatus and, more particularly, to a novel high speed material cutting device which operates in a novel manner to progressively perforate various layers of a work material as it cuts therethrough so that one or more holes or cut designs can be simultaneously provided through thicker materials than could heretofore be effected using prior art hole punching or die cutting devices.

Heretofore, multiple hole punching devices have been, by necessity, very heavy, rugged and costly structures because of the forces required to drive a plurality of punching heads through the work material. In most of these punching devices, each punching member is comprised of a single solid element having a transverse cross section which is identical to that of the hole punched. In order to perform its intended function the punching member requires a complementary platform with holes which mate with the punching member so that when the material to be punched is placed therebetween, the punching member can be driven through the material to shear away that material which lies beneath the end of the solid element and above and mating female die of the platform.

Because of the nature of this type of device, i.e., the shear cut method of punching, the thickness of the material which can be punched is limited to a relatively small thickness depending, of course, upon the shear characteristics of the work material. As a rule of thumb, the thickness of the work material punchable with a given prior art device is usually equal to or less than the diameter of the punching member and is directly related to the hole spacing where a plurality of holes are to be simultaneously punched. The reasons for such limitations are obvious to those knowledgeable in the art.

Furthermore, where the number of holes to be punched in the work material is large and the holes are relatively closely spaced together, the mere force required to drive the plurality of punching members through the material becomes quite large and necessitates a very sturdy punching structure. In order to reduce this required punching force, certain prior art devices, one of which is illustrated in the Widell U.S. Pat. No. 2,825,407, use staggered lengths of punching members suitably ganged together so that the various punching members successively engage the work material. Although this feature does tend to reduce somewhat the overall force which must be supplied to perform the punching operation, it still does not enable thicker material to be punched since as pointed out above this is primarily determined by the shear characteristics of the work material, i.e., paper, soft plastics and other compressible material are resistant to shearing when in multiple layers.

One of the basic problems encountered in punching through large thicknesses of work material, be it paper, plastic, metal or whatever, is the difficulty in removing the material which is cut away during the punching operation. Obviously, in the types of punching devices discussed above the waste material is compacted beneath the male punching element until it is driven through the female die as the element penetrates the work material. This, of course, reduces the effectiveness of the punching element as the thickness of work material is increased.

One attempt to overcome the thickness limitation has been to utilize a series of closely spaced rotary drill bits, but this is, of course, quite expensive and severely limits the choice of hole configuration. Various other attempts have been made to utilize a unitary hollow punching member wherein the cut away material is driven through the hollow punching member. This, however, has been found to be almost completely unsatisfactory since the dimensions of the cut away material must necessarily be larger than the interior passage through the punching member and thus, the waste material becomes clogged within the passage rendering the punch inoperative unless the driving forces are substantially increased.

OBJECTS OF THE PRESENT INVENTION

It is therefore a principal object of the present invention to provide a novel hole cutting apparatus which enables one or more holes of any suitable configuration to be provided in any thickness of work material.

Another object of the present invention is to provide a novel hole cutting apparatus for book binding applications, and the like, which enables a plurality of holes of any predetermined configuration to be cut through any desired thickness of work material.

Still another object of the present invention is to provide a novel high speed hole cutting apparatus which is compact and lightweight and which includes easily interchangeable cutting elements so that a single device may be utilized to cut variously configured holes through selected work materials.

Still another object of the present invention is to provide a novel hole cutting apparatus wherein the force required to perform the hole cutting operation is substantially less than that required utilizing prior art multiple hole punching devices.

Still another object of the present invention is to provide a novel means for producing a plurality of holes in a work material such as paper, plastics, metal, wood, and many other types of sheet material, utilizing cutter assemblies having at least two cutting elements per hole which reciprocally engage the work material as the hole cutting members pass therethrough.

Still another object of the present invention is to provide a novel cutting apparatus wherein each cutter assembly includes at least two cutting elements which are disposed in side-by-side relationship and are shaped to provide a passage therethrough so that as the cutting member passes through the work material, the cut portions of the material are caused to pass through the passage in the cutting member.

Still another object of the present invention is to provide a novel means for cutting predetermined designs from a given work material wherein the cut designs are caused to pass through a passage formed by and between two or more cutting elements which are caused to alternately engage the work material in cutting relationship.

SUMMARY OF THE PRESENT INVENTION

In accordance with the present invention, a novel material cutting apparatus is provided which includes one or more suitably configured cutter assemblies which are comprised of two or more cutting elements that are alternately displaced relative to each other as they are caused to impact, perforate and pass through a given work material so that each cutting element independently cuts through a portion of the work material and the sum of the independent cuts form the desired hole or cutout. The cutting elements are shaped so as to provide therethrough a passage through which cut material can be extracted during the cutting operation. The thickness of the material through which a cut may be provided is limited only by practical considerations of cutter element design since the work material itself tends to provide a guide means for aiding in the alignment of the cutting members as they pass therethrough.

One of the principal advantages of the present invention is that the thickness of the work material through which holes may be provided is limited only by the chosen design characteristics of the respective cutting members.

Another advantage of the present invention is that since much greater thicknesses of work material can be penetrated, the rate at which a given quantity of work material can be provided with the desired holes is considerably increased over that possible using prior art hole punching apparatus.

Still another advantage of the present invention is that because the cutter assemblies require no mating apertures and are lightweight in construction, cutter assemblies for providing alternative hole configuration can be easily interchanged by the user.
Still another advantage of the present invention is that in an alternate embodiment it can be used to cut designs of a predetermined configuration from a stack of sheet work material.

Still other advantages of the present invention will become apparent to those skilled in the art after having read the following detailed description of the preferred embodiments which are illustrated in the several figures of the drawing.

IN THE DRAWING

FIGS. 1(a), 1(b) and 1(c) schematically illustrates the manner in which the cutter assemblies of the present invention operate in cutting through a given thickness of work material.

FIGS. 2(a), 2(b), 2(c), 3(a), 3(b), 4(a) and 4(b) are cross sections taken through a multi-layered stack of work material to illustrate the manner in which the cutting elements pass therethrough.

FIGS. 5(a), 5(b) and 5(c) are cross sections taken through the end of a cutter assembly to illustrate the manner in which the cut material is removed from the hole sites after it is cut away.

FIG. 6 is a cross section taken through the end of a modified cutting element having means for expediting passage of the cut material away from the cut sites.

FIG. 7 is a perspective view of a hole cutting machine such as may be used to provide binding holes in the edge of book materials and the like.

FIG. 8 is a cross section taken through the apparatus illustrated in FIG. 7 illustrating the inner workings of the device.

FIG. 9 is a partial perspective view of the cutter actuating structure of FIG. 8 illustrating the manner in which the cutting elements are mounted in accordance with a preferred embodiment.

FIGS. 10(a) and 10(b) are partial perspective views illustrating single piece multi-element cutter assembly and the mounting means therefor. FIGS. 11(a) and 11(b) illustrate alternative cutting blade elements for use in the present invention.

FIGS. 12(a) and 12(b) illustrate snap-in mounting feature for the individual cutting elements illustrated in FIGS. 11(a) and 11(b).

FIGS. 13(a), 13(b) and 13(c) illustrate end views of several different configurations of cutters utilized in accordance with the present invention.

FIG. 14 illustrates an alternative manner in which the cutting elements may be reciprocated when in operation.

FIG. 15 illustrates a further modification of the invention wherein the drive motor which drives the cutting elements is also utilized to compress the work material down upon the reciprocating cutting elements.

FIGS. 16 and 17 illustrate a still further modification of the invention which may be utilized to cut predetermined designs from sheet material.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

Referring now to the drawing, the basics of operation of the present invention will be described. In FIG. 1(a), there is shown an elongated hole cutter assembly 10 for cutting a generally rectangularly shaped hole through a stack of work material 12 comprised of several sheets of paper, plastic, etc. The cutter assembly 10 is comprised of a pair of elongated channel-shaped cutting elements 14 and 16 the ends 20 of which are sharpened in a suitable manner so that upon being impacted into the work material 12 they will be caused to progressively cut therethrough. The cutting elements 14 and 16 are held in parallel mating relationship by a suitable guide means (not shown) and the upper ends thereof are coupled to a drive means 22 which includes a pair of lever arms 24 and 26 which are driven in oscillatory fashion by the drive shaft 28 to which they are affixed.

As the material 12 and the cutter assembly 10 are moved relatively toward each other and the shaft 28 turned to the clockwise position, as illustrated in FIG. 2(a), the cutter element 14 will be caused to strike the work material and be driven a short distance thereinto causing a C-shaped perforation to be provided through one or more layers of the material 12. As the cutter assembly 10 and the material 12 continue to be moved into engagement with one another and the shaft 28 is caused to turn in the opposite direction to retract the cutter element 14 and drive the cutter element 16 into the material 12, a rectangular perforation is provided through the upper layers of the material as illustrated in FIG. 1(c).

In FIG. 2(a), a cross section through a stack of paper comprising the work material 12 is shown before cutting is commenced. In FIG. 2(b), the same cross section is illustrated after cutting element 14 has been driven thereinto, in the manner shown in FIG. 1(b), to make its first cut 30 through one or more layers of the material 12. In FIG. 2(c), cutting element 14 has been withdrawn and the other cutting element 16 has been driven into the material 12 forming its first cut 32.

In FIGS. 3(a) and 4(a), and 4(b), the manner in which the cutting elements 14 and 16 respectively, are successively driven through the stack of material 12 is sequentially indicated. In order to accomplish this cutting operation, the work material 12 may be maintained static and the cutter assembly 10 moved into engagement therewith, or the position of the cutter assembly 10 may be maintained fixed and the work material 12 moved into engagement with the cutter.

In either case, the opposed reciprocating action of the cutting elements 14 and 16 will cause the material cut from the material 12 to be displaced into the passage formed between the cutters and variously upsets so as not to become packed therein so that it can easily be removed from the passage.

Referring now to FIGS. 5(a), 5(b) and 5(c), one means of expediting the removal of the portions cut from the stack of work material 12 is illustrated. As indicated in FIGS. 5(a), 5(b) and 5(c), the portions cut from the material 12 will be individually upset by the frictional engagement with the reciprocating cutting elements 14 and 16 so that by turning the cutters upside down the cut away segments can be caused to drop through the passage formed between the cutting elements and thus be removed from the sites of the cut.

In FIG. 5(a), for example, the cutting elements 14 and 16 are shown disposed in side-by-side relationship after having been driven through a single layer of paper 34, or the like, so as to cut away a rectangular segment 36 therefrom. Noting that the cutting edges 37 of elements 14 and 16 are beveled so that the sharp edge is at the outer wall thereof, the dimensions of the particle 36 will be slightly larger than the interior dimensions of the space 38 between cutting elements 14 and 16. However, because of the manner in which the cutting surfaces are dressed the inclined faces of the edges 37 will cause a force to be exerted on the particle 36 which causes it to be deformed slightly so that it can easily be received within the smaller space of the passage 38.

As cutting element 16 is driven further into the material 12 so as to cut the second layer and cutting element 14 is withdrawn as illustrated in FIG. 5(b), the frictional engagement of the inner wall 40 of cutting element 14 will cause the particle 36 to be upset and thus be allowed to drop through the passage 38 as indicated in FIG. 5(c). Simultaneously, a second cut segment 41 is cut away and upon further relative translation of cutting elements 14 and 16 will likewise be upset and caused to drop through the passage 38. This cutting action and waste removal function will continue as the assembly 10 passes through the material 12 so that the waste material is continuously removed from the hole being produced.

Where the present invention is to be utilized for cutting through relatively stiff resilient material such as layers of plastic, for example, it may be desirable to serrate or otherwise prepare at least one wall of the inner surface of the cutting elements 15 and 17, as illustrated in FIG. 6, so as to insure that the cut away particles are displaced away from the hole cut through the material. In accordance with this embodiment,
ment, during the downstroke of one of the cutting elements the sawtooth edges 42 will engage the edge of the cut away material and cause it to be displaced downwardly, while on the upstroke the material will be allowed to slip off with a ratchet-like action and displacement thereof through the aperture 38 will be effected.

Also illustrated in the enlarged cross section of the encircled portion of FIG. 6 shown in FIG. 6(a), is the manner in which the actual cutting edges of the elements 15 and 17 may be prepared in order to assist in the alignment of the elements 15 and 17 as they penetrate into the work material. In this embodiment the outer edges 43 are bevelled at a slight angle so that as the cutting edge initially penetrates the work material the lateral forces exerted on the cutting edge will be substantially balanced so that the tendency for the elements 15 and 17 to be separated as they enter the work material is reduced. Furthermore, since the initial cut is slightly smaller than the outer dimensions of the cutting elements there will be a small inward lateral force applied to the outer walls which will tend to counter the outward force on the elements produced by the waste chips before they are upset and fall through passage 38.

Turning now to FIG. 7 of the drawing, a perspective view of a simple ganged pulping apparatus for use in cutting a plurality of holes along the edge of a plurality of sheets of paper, or the like, such as is required to enable ring binding thereof. The simple device illustrated is comprised of a rectangularly shaped housing 44 having a lever 46 pivotally mounted thereto to pivot about point 48. Telescopically mounted over the upper portion of the housing 44 is a platform 50 which is spring biased upwardly by suitable means contained within the housing 44.

Attached to the lever 46 at the point 52 is one end of a shaft 54 which is used to draw down the press foot 56 when the lever 46 is rotated forwardly. A plurality of cutters, such as have been described above, are mounted beneath the platform 50 and within the housing 44 in inverted relationship, such that when a stack of work material 58 is disposed upon the platform 50 and beneath the presser member 56 as illustrated, and the lever 46 is rotated forwardly, the platform 50 will be driven downwardly so that the cutters extend through a slot along the back side of the platform 50 and are caused to engage the work material 58 to cut the desired plurality of holes therethrough.

In FIG. 8 of the drawing, which is a cross section of the device depicted in FIG. 7 taken along the lines 8—8, the inner workings of the apparatus are illustrated in detail. The housing 44 is open at the top and includes at the four corners thereof spring means 60, or the like, suitable for upwardly biasing the platform 50 which covers the opening. The platform 50 is adapted to telescopically fit within the housing 44 as force is applied to the top thereof by the foot 56 via the work material 58. Presser member 56 is normally maintained in its upward position by the spring means 53 (illustrated in FIG. 7) so that the work material 58 may be positioned on the platform 50 and slid under the shoe 56 to abut the guide wall 62.

Positioned beneath the platform 50 are a plurality of cutters 70 which include front and rear cutting elements 14 and 16, which are respectively mounted to a pair of bars 72 and 74 which are shown in cross section (see also FIG. 9). The bars 72 and 74 include slots along the sides thereof for receiving the spurs 76 and 78 of the drive rods 80 and 82 respectively. The lower ends of the drive rods 80 and 82 include pinions 84 and 86 that engage slots in the yoke 88 which is keyed to the shaft 90. The drive members 80 and 82 are maintained in alignment by the bearing surfaces 92 and 94 of the bracket 96 which also serves as the mounting means for the shaft 90 as is more clearly indicated in FIG. 9.

In order that the blade assembly may be easily removed from the bracket 96, a wedge shaped insert 98 is provided as a portion of the bracket 96. The wedge shaped insert 98 whose inner face supports and provides a bearing surface for bars 72 and 74, may be held in its illustrated position by any suitable means which when removed or released allow insert 98 to move upwards and thereby release the pressure on drive rods 80 and 82 so that bars 72 and 74 may be easily withdrawn from the end. In the apparatus described, at least two of the brackets and drive mechanisms as illustrated in FIG. 9 are utilized and each is substantially identical to that illustrated so that the cutter assemblies can be quickly and easily removed. Coupled to the shaft 90 is a bell crank 102 and linkage 104 which operatively connects the crank 102 to an eccentric drive mechanism 106. The eccentric drive mechanism 106 is driven by an electric motor 108 (see FIG. 7) and imparts an oscillatory motion to the shaft 90 as it is turned at a predetermined speed. A suitable frequency of oscillation of the shaft 90, and thus the reciprocating frequency of the cutters 14 and 16, has been found to be within the range of 1,000 to 3,000 cycles per minute. The housing 44 may also include a suitable drawer type receptacle 107 which can be used for collecting the chips cut from the work material and providing easy disposal thereof.

In operation, the work material 58 is placed on the platform 50 and displaced leftwardly, as illustrated in FIGS. 7 and 8, to abut the stop 62. The motor is then turned on to start the reciprocating action of the cutting elements 14 and 16 and the lever 46 is rotated forwardly causing the foot 56 to press the work material 58 against the platform 50 driving it downwardly so that the material 58 progressively engages cutting members 14 and 16 as they pass through the aperture 110 in the platform 50.

At the rear of the foot 56, a strip of firm, but resilient material 112 is provided so that the cutting edges of elements 14 and 16 may engage this strip after passing through the material 58 without causing damage thereto. After the hole has been cut through the material 58, the lever 46 is returned to its upper position, and the springs 60 have driven the platform and work material upwardly and out of engagement with the cutters, the perforated work material may be removed from the device.

Turning now to FIGS. 10(a) and 10(b), exemplary multiple cutter assemblies and the manner of mounting them to the carrying bar are illustrated. In the embodiment of FIG. 10(a), a plurality of cutter elements 114, 115, etc., are formed from a single piece 116 of tempered steel by cutting out a predetermined configuration and then bending the side edges 118 thereof forwardly to form the channel-shaped cutting elements. The ends 120 thereof are then suitably configured and the inner edges thereof dressed to provide the most suitable cutting edge for penetrating the work material. It should also be noted that in addition to the angled cutting edges provided at the end of the side portions 118, the portion of the cutting edge 120 formed in the flat side 122 may be V-shaped so that the cutting forces are progressively engaged through the material as it strikes and thus provides a cutting action rather than an abrupt cleavage over the entire edge thereof.

In accordance with this embodiment, the plural cutter blade assembly 116 is received within a recessed edge 124 of the bar 126 and is securely mounted thereto by a plurality of spacer segments 128 which fasten the composite cutting element assembly 116 into place. The depth of the recess 124 is the same as the width of the side portions 118 so that when the bar 126 is placed into facing engagement with its complement, the edges 130 of the cutting elements will slidably engage the like edges of the mating cutting element assembly. It should also be noted that transverse channels 132 are cut through the bar 126 so that the chips of waste cut from the work material may drop through the cutter assembly to be received in a chip collection compartment of the device. The end portions of the spacers 128 adjacent the cutter 115 are shown broken away to illustrate the manner in which the unitary cutter assembly fits into the recess in the bar 126 as well as to illustrate the configuration of the cutting element assembly 116 per se.

In FIG. 10(b) an alternate embodiment of a unitary cutting element assembly is illustrated which is formed by corrugating a length of suitable material 200, cutting away the unwanted
portion to leave the cutting elements 202, 204, 206 . . . , and then sharpening the ends 210 of the cutting elements. This assembly is then spot welded at points 212 to the carrying bar 214. It should be understood that although the composite cutting element assemblies illustrated have channel-shaped cutting elements to produce a rectangularly shaped hole when coupled with its complement, either assembly could be modified to provide other cutting configurations. Channel-shaped cutting element is intended to mean any of the cutting element configurations illustrated in the drawing as well as obvious modifications thereof and is not intended to be limited to elements having a semicircular cross section, semirectangular cross section, or other particular configuration.

In FIGS. 11(a), 11(b), 12(a) and 12(b), an alternate cutting element structures and methods of assembling the same to the carrying bar is illustrated. In FIG. 11(a), a single cutting element 134 for cutting a rectangular hole is shown independently mounted in a slot 136 in the bar 138. A suitable means for attaching cutting element 134 to the bar 138 is illustrated in FIGS. 12(a) and 12(b) wherein tabs 140 and 142 are provided in cutting element 134 for receipt within appropriate slots in the bar 138.

In FIG. 11(b), a cutting element of the type used to form a cutter 144 for cutting a round or oval hole is illustrated. Element 144 may be affixed to the slot 137 in the bar 139 in a manner similar to that illustrated in FIG. 12, or by any other suitable mounting arrangement. These individual snap-in cutter elements offer the advantage that a single element can be replaced without requiring replacement of the entire assembly wherein only one element is damaged.

In FIGS. 13(a), 13(b) and 13(c) of the drawing, the cutting ends of three different exemplary configurations of cutters are illustrated. In FIG. 13(a) the mating halves 146 and 148 are shown abutting each other at 150 to form the desired rectangularly shaped hole. Similarly, in FIG. 13(b) the semicircular halves 152 and 154 are shown engaging each other at 156 so as to provide a circular hole of a diameter substantially equal to the outside diameter of the cutters.

In FIG. 13(c), still another cutter configuration is illustrated to show that arbitrary hole configurations can likewise be provided. In this embodiment, which is used to produce an aperture known to bookbinders as a hammerhead aperture, three cutting elements 158, 159, and 160 slidably engage one another at 162, 163, and 164 as in the other embodiments. In order to illustrate an additional modification which might be found suitable for certain applications, it will be noted that the engaging edges of the cutting elements which meet at 162 and 163 are bevelled so as to assist in maintaining the lateral alignment of the elements. This has not been found necessary, however, in the simple cutter structures for cutting relatively small apertures since the cutters are, in most cases, sufficiently rigid to maintain their own alignment. In addition, as pointed out above, the apertures cut through the first few layers of the material serve as a guide means for assisting in the maintenance of alignment of the cutters as they penetrate deeper into the work material.

The elements 158 and 159 may be either independently driven out of phase with each other by a suitable triple drive apparatus or may be attached to each other and driven simultaneously and out of phase with the element 160. In order to produce the hammerhead apertures, the cutter assembly is positioned so as to slightly overlap the edge 166 of the work material as illustrated.

In FIG. 14 of the drawing, still another manner of imparting reciprocals motion to the respective cutting elements 164 and 166 is illustrated. In this embodiment, the cutting element carrying bars 168 and 170 are attached to drive members 172 and 174 which are themselves driven by an eccentric cam 176 which imparts to the cutting elements 164 and 166 the desired oscillatory motion.

Refferring now to FIG. 15, there is shown a still further modification of the invention wherein the drive motor 180 drives a rack and pinion 184 via a gear reduction and clutching means 182 which is designed to rapidly accelerate the presser member 186 until it engages the work material 188 at which time the downward speed thereof is decreased at a rate suitable for causing the work material to engage the cutters 190 so that the desired holes may be cut in the work material.

The same motor is coupled through the gear reduction means 182 to drive the oscillatory drive shaft 90 as illustrated in FIGS. 8 and 9. In accordance with this embodiment, the entire hole cutting operation is performed electrically once the work material 188 is positioned on platform 190 and the motor 180 energized.

Where it is desirable that the cutter of the present invention be utilized to cut from a stack of sheet stock pieces of material, such as labels or the like, having a predetermined configuration rather than to cut finished holes in the material a cutter embodiment such as is illustrated in FIGS. 16 and 17 may be employed. In accordance with this modification, the cutting elements 200 and 202 have their cutting edges dressed to the outside so that the cutting edges 204 and 206 are along the inner walls 208 and 210, respectively, of the cutting elements 200 and 202. This, of course, is to be contrasted with the devices illustrated in FIGS. 5 and 6 which have the sharp cutting edges substantially disposed along the outer wall of the cutting elements so that the finish cut is provided in the sheet material rather than on the cut away portions as in the instant embodiment.

In this embodiment, since the dimensions of the material 212 cut from the stock material 214 are substantially equal to the interior dimensions between the inner walls 208 and 210 of the cutting elements 200 and 202, respectively, the tendency to upset the pieces 212 cut from the stock 214 is reduced in favor of simply allowing it to be displaced through the passage 216 formed between the cutting elements. However, because of the necessary thickness of the cutter elements 200 and 202, it will be noted that the layers of stock material 218 from which the pieces 212 have been cut will be warped slightly and possibly even torn as they are displaced by the cutting element.

To provide such cuts, as would be the case where the device is used to cut out oval or circular labels, or the like, it may be found desirable to cut the stock material into relatively small squares having at least one edge positioned very close to a cutting edge of the device so as to induce a tear in the stock material in order to reduce the frictional engagement between the waste stock material and the outer surfaces of the cutters where the depth of the cut is substantial. In the alternative, an additional reciprocating single or multiple blade perforating means 228 and 230 might be provided adjacent to the design cutting elements either separate from or integral therewith, so as to perforate the waste material 231 and allow it to deform away from the cutting elements 200 and 202, thus reducing the frictional engagement therein.

A top view of an oval design cutting device is illustrated in FIG. 17. This embodiment comprises a pair of cutting elements 220 and 222, which are similar to the cutting elements 200 and 202 illustrated in FIG. 16, and are for cutting the oval shaped work material 224 from the stack of rectangular stock material 226. In order to allow the waste material to be cut away from the outer edges of the cutting elements 220 and 222, a pair of additional cutters is intended to engage the outer edges 232 and 233, which may be integral with the elements 220 and 222 respectively or independent thereof, are provided for producing a cut through the portions 232 and 234 of the waste material to allow it to be discarded to the sides as indicated by the dashed lines. A side view of the cutting edge 228 is illustrated by the dashed lines 228 in FIG. 16.

In accordance with this modification of the present invention, the cutting elements 220 and 222 need not be oval as shown but may be of any selected configuration and may include more than two cutting elements. The particular oval configuration is shown for purposes of illustration only.
In accordance with the present invention, many other alternate embodiments are contemplated which may include other features such as providing sawtooth edges on the reciprocating cutters so as to further increase the cutting speed of the device through the work material. In addition, in order to increase the cutting speed of the cutters through the work material by reducing the frictional engagement between the work material and the surfaces of the cutting elements, the surfaces of the cutting cutters may be impregnated with a lubricant coating such as is known in the trade as Microseal.

Furthermore, it is contemplated that a manual embodiment for light work may be designed by providing a suitable gear reduction drive system whereby the cutters are manually driven as a manual lever such as lever 46 of FIG. 7 is depressed. Moreover, for certain embodiments, it may be found desirable to provide an electrical vibratory drive means or a hydraulically actuable drive means for the cutting blades so as to produce the desired reciprocating motion described above.

In still other embodiments, it might be found desirable to provide a cutting element reciprocation ratio of greater than 1:1 so as to cause one element to strike the work material several times during the time it takes for the other blade or blades to strike the work material once. This would be practical for example, in the case where multiple cutting elements of differing shapes are combined to cut an odd shaped design and one or more of the cutting elements are required to make substantially larger cuts than the others.

In embodiments where the peripheral design of the hole to be cut through the material is irregular to the extent that more than two cutting elements are required, I foresee that any suitable number of interrelated cutting elements can be provided so as to produce the desired aperture or edge scalloping required.

While the invention has been described with reference to specific preferred embodiments, many other alterations and modifications of the invention will be apparent to those of skill in the art after having read the foregoing description. I, therefore, intend that the appended claims be interpreted as covering all modifications which fall within the true spirit and scope of my invention.

I claim:

1. Apparatus for simultaneously cutting a plurality of openings through a work material, comprising:
   a plurality of elongated, generally tubular cutter assemblies of substantially uniform transverse cross section disposed in spaced apart relationship and having a cutting end and a discharge end, each cutter assembly including at least two elongated channel-shaped cutting elements disposed in parallel adjacent relationship and having facing surfaces defining an open passageway communicating said cutting end and said discharge end, the extremities of said cutting elements at said cutting end providing cutting edges for cuttingly engaging the work material;
   a platform for supporting the work material at a fixed angular relationship with respect to said cutter assemblies;
   drive means for imparting opposed reciprocative motion in parallel lines of movement to the cutting elements forming each cutter assembly; and
   means for continuously emerging the cut segments of the work material by discharging the discharge ends of each cutter assembly.

2. Apparatus as recited in claim 1 wherein at least a portion of the interior surfaces of said cutting elements are configured to engage and urge the cut away segments of work material through said passageway to said discharge end.

3. Apparatus as recited in claim 1 wherein the longitudinal axes of said cutter assemblies are vertically disposed with said cutting edges facing upwardly, and said platform includes openings for receiving said cutting ends whereby the undersides of work material supported by said platform is engaged by said cutting edges when said platform is moved downwardly.

4. Apparatus as recited in claim 3 and further comprising a presser member operative to move said platform downwardly.

5. Apparatus as recited in claim 4 wherein said presser member is activated by said drive means.

6. Apparatus as recited in claim 1 wherein said cutting edges are beveled to the inside of said cutting elements.

7. Apparatus as recited in claim 1 wherein said cutting edges are beveled to the outside of said cutting elements.

8. Apparatus as recited in claim 1 wherein said cutting edges are beveled to both the inside and outside of said cutting elements.

9. Apparatus for cutting an opening in a work material comprising:
   first and second channel-shaped cutting elements disposed in adjacent, parallel relationship to form an elongated, generally tubular cutter assembly having an open passageway communicating a cutting end and a discharge end and having a substantially uniform transverse cross section, the terminating portions of said cutting elements at said cutting end being configured to provide cutting edges for cuttingly engaging the work material; and
drive means coupled to said cutter assembly and operative to impart opposed reciprocative motion in parallel lines of movement to said cutting elements.

10. Apparatus as recited in claim 9 and further comprising means for transporting the work material into engagement with said cutting edges.

11. Apparatus as recited in claim 10 wherein said cutter assembly is disposed with said cutting edges facing upwardly and said means for transporting includes a movable platform having an opening for receiving said cutting end, whereby material transported by said platform is engaged by said cutting edges when said platform is moved downwardly.

12. Apparatus as recited in claim 11 and further comprising a presser member operative to move said platform downwardly.

13. Apparatus as recited in claim 9 wherein at least a portion of the interior facing surfaces of said cutting elements defining said passageway are configured to induce migration of segments cut from the work material through said passageway to said discharge end.

14. Apparatus as recited in claim 9 wherein said cutting edges are beveled to the inside of said cutting elements.

15. Apparatus as recited in claim 9 wherein said cutting edges are beveled to the outside of said cutting elements.

16. Apparatus as recited in claim 9 wherein said cutting edges are beveled to both the inside and outside of said cutting elements.

17. An apparatus for cutting through one or more sheets of work material and including reciprocating cutting means for operatively engaging the work material, an improved cutting means, comprising:
   a cutter assembly including at least two elongated channel-shaped cutting elements disposed in parallel adjacent relationship with the facing walls of said cutting elements forming an open passageway communicating one end of said cutter assembly with the other end, the terminating portions of said cutting elements at said one end being configured to provide cutting edges for cuttingly engaging the work material, said cutting elements having transverse cross sections substantially uniform over their lengths.

18. In an apparatus as recited in claim 17 wherein said cutting edges are beveled to the inside of said cutting elements.

19. Apparatus as recited in claim 17 wherein said cutting edges are beveled to the outside of said cutting elements.

20. Apparatus as recited in claim 17 wherein said cutting edges are beveled to both the inside and outside of said cutting elements.

21. In an apparatus as recited in claim 17 wherein at least a portion of the inside walls of said cutting elements defining said passageway are configured to induce segments cut from the work material to migrate through said passageway for discharge at said other end.
22. In an apparatus as recited in claim 17 wherein a plurality of said cutting elements are ganged together to simultaneously engage the work material.