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Smith et al.

[11] **3,861,037**

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[54] **NIBBLING TOOL**

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[73] Assignee: **Lockhead Aircraft Corporation**, Burbank, Calif.

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[21] Appl. No.: **333,483**

[52] **U.S. Cl.** **30/228**, 30/241, 83/621

[51] **Int. Cl.** **B26b 15/00**

[58] **Field of Search** 30/228, 241, 242, 243; 83/621, 670

[56] **References Cited**

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[57] **ABSTRACT**

An improvement in a throatless nibbling tool by means of which fibrous and composition sheets may be efficiently cut and which leaves clean, sharp edges along the face of the cut. A cylindrically notched punch member reciprocates within the bore of a coaxial cylindrical die member to provide the desired omnidirectional shearing action. No supporting yoke or throat is utilized since both the punch and the die are supported for relative movement from a common end.

3 Claims, 8 Drawing Figures

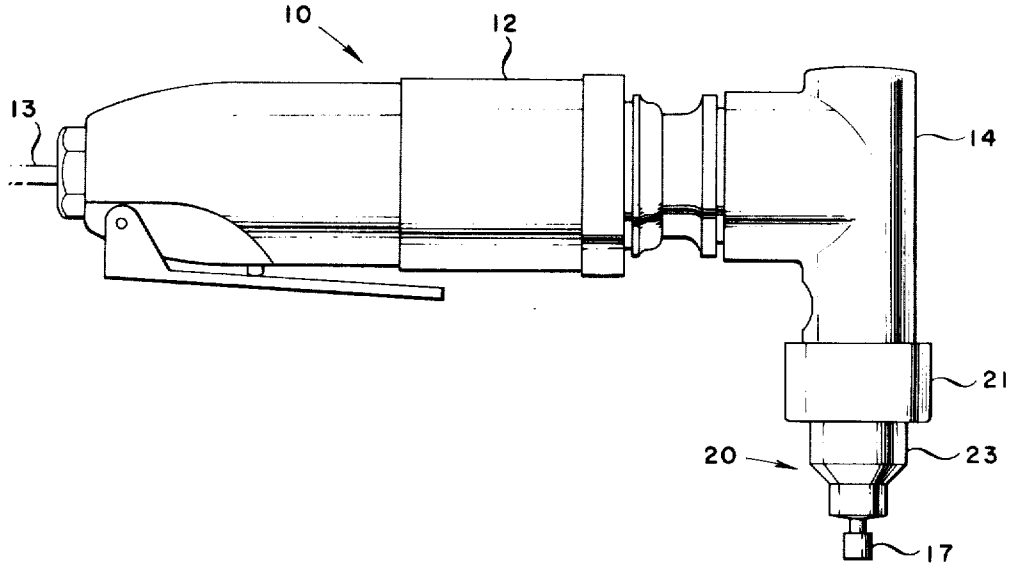
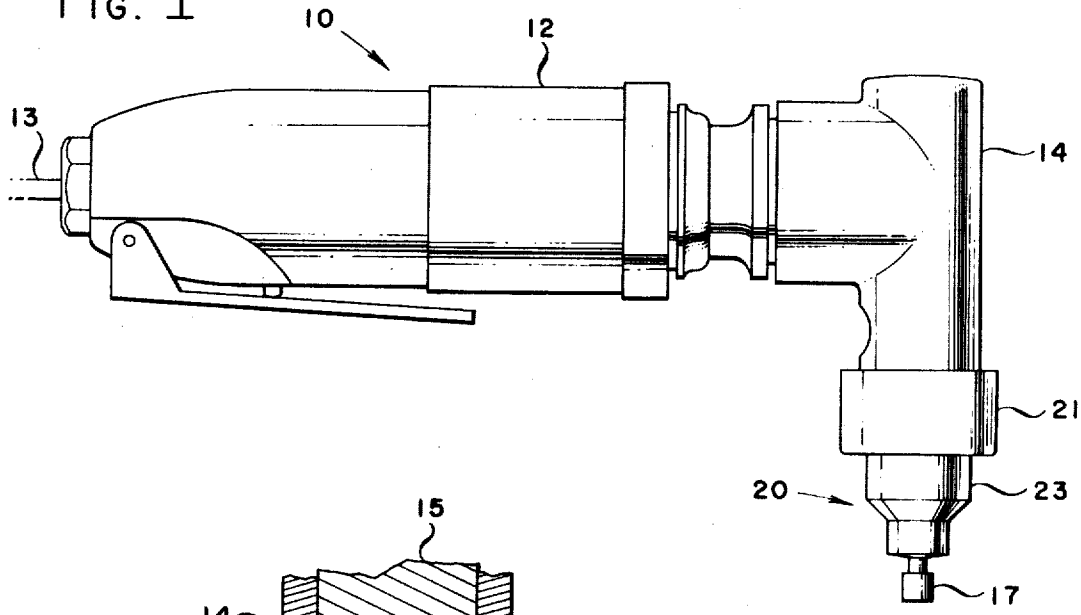


FIG. 1



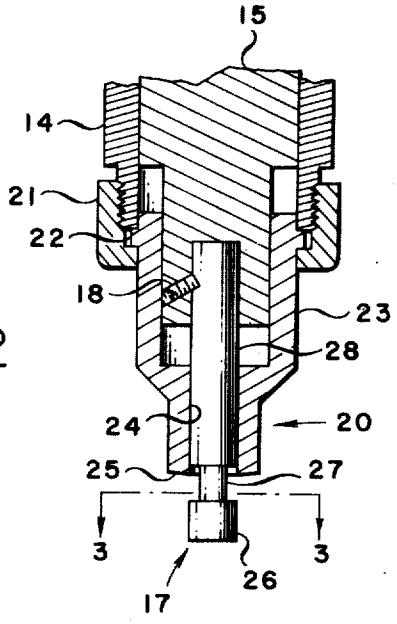
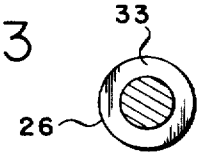


FIG. 2

FIG. 3



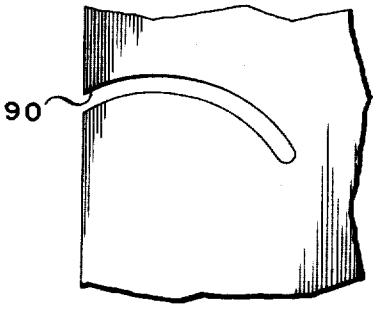


FIG. 4

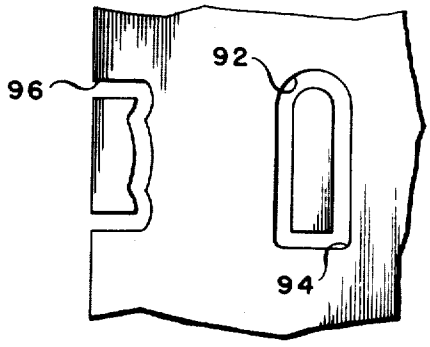


FIG. 5

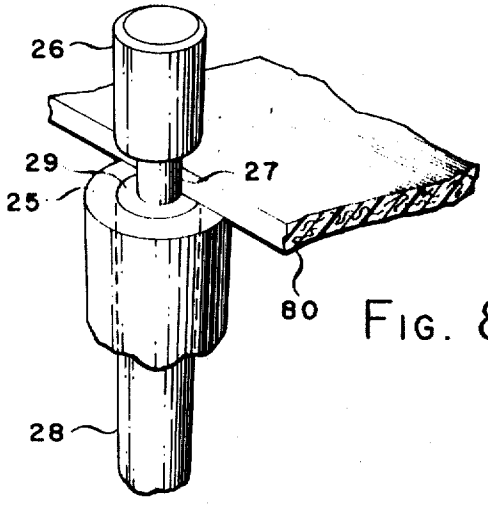


FIG. 8

FIG. 6

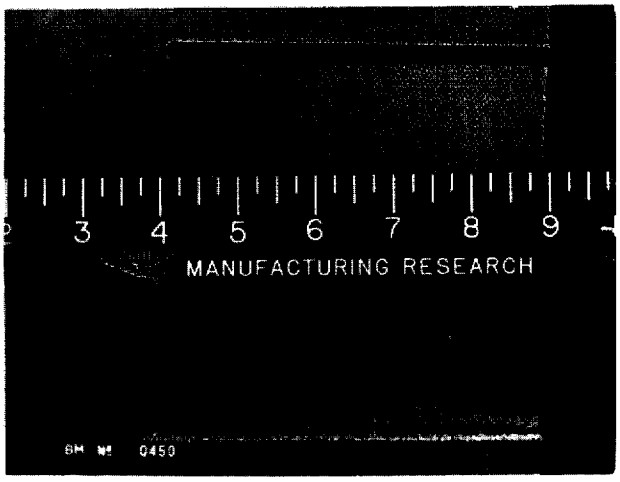


FIG. 7

NIBBLING TOOL

BACKGROUND OF THE INVENTION

1. Field of the Invention

The field of art to which the invention most likely pertains is powered sheet-cutting tools generally, and more particularly, hand-held nibbling machines.

2. The Prior Art

Examples of prior art devices indicative of the state-of-the-art to which this invention pertains, include U.S. Pat. Nos. 126,357; 2,364,334; 2,610,685; and 3,069,770.

3. Problems in the Prior Art

Recently developed fiber-reinforced the desired utilizing novel organic fibers, examples of which are identified as PRD-49 and Nomex, manufactured by the E. I. DuPont DeNemours & Co., Del., are replacing metallic and fiberglass parts, and the like, for weight savings desired in many components of large manufacturers. In particular, the aerospace industry is substituting these new fibrous laminates for fiberglass laminates in many applications. However, conventional manufacturing methods used in fabricating fiberglass components, such as sawing, routing, or drilling, do not produce the desired clean-cut edge when applied to these new laminates. As an example, in addition to producing ragged or frayed edges along a cut, conventional drilling techniques also causes delamination.

The fibers of these new materials do not adhere as strongly to the resin used in the laminates as do glass fibers. Cutting processes tend to separate the reinforcing fiber from its resin matrix. When not supported by the resin, these fibers are very difficult to cut because of their high tensile strength and extreme flexibility. On the other hand, glass fibers not only adhere well to the resin, but being brittle, can be machined by conventional methods and tools.

Fabrication processes involving the making of cut-outs in laminates, such as holes, edging, and trimming, to desired dimensions require novel tools and techniques to prepare these new fibrous laminates. Cut-out areas must be clean; that is, without any loose or uncut protruding fibers extending into the hole on along trimmed edges. By the present invention there is provided a novel and improved shearing action with practically zero tolerance between the cutting members, as distinguished from a sawing action, thereby resulting in a clean-cut hole, or a clean-cut edge, in the above-described new class of laminates.

It has also been determined that conventional manufacturing tools and methods are limited in terms of universality of application with respect to these new fibrous laminates. For example, conventional tools, whether stationary or portable, do not provide a full **360°** relative movement between the tool and the workpiece, as is desirable to make interior cut-outs or to trim irregular outlines without swinging the tool or machine in the direction of the cut. In particular, the yoke (or throat) supporting the die in such a conventional tool prevents this universality of movement. In effect, the yoke or jaws of prior nibblers limit their use. The nibbler of the present invention eliminates such a yoke and jaws, and is hereinafter generally described as a "throatless" nibbler. Furthermore, the limited extent of radius of cut afforded by conventional tools is overcome by the present invention which provides unlimited radii of cut to be obtained.

SUMMARY OF THE INVENTION

This invention relates to machines for nibbling sheet materials to form cut-outs or open portions therein, or therealong, and is particularly directed to a shearing attachment for hand-held power tools, the attachment having no yoke, thus providing a **360°** relative turning motion between the sheet material being cut and the attachment.

The novel geometry of the cylindrically notched reciprocating punch member and the relatively stationary coaxial die member, provides a novel and improved shearing action.

An object of this invention is to provide for the efficient, clean, and smooth cutting, shearing, or removal of sheet material constituting a non-metallic fiber-reinforced composition.

A further object of the invention is to provide the capability of omnidirectional or 360°cutting movement along the plane of a laminated comppsition sheet.

A still further object of the invention is to eliminate a yoke supporting the die member of a nibbling attachment so as to yield an unlimited radii of cutting on such a composition.

A further object of this invention is to eliminate threaded or loosely-remaining fibers along a cut-out or open portion, and to eliminate rough edges therealong, which otherwise remain with application of conventional tools.

Another object of this invention is to provide true portability for a nibbler attachment tool whereby a composition sheet can be worked from any angle by an efficient cutting action to achieve a clean-cut edge thereon.

These and other objects and advantages of the invention will become more apparent upon a full and complete reading of the following description, the appended claims thereto, and the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a full side elevational view of a portable nibbling machine embodying the invention.

FIG. **2** is an enlarged fragmentary view, partly in section of an attachment tool incorporating the invention in the device shown in FIG. **1**.

FIG. **3** is a view taken on line **3—3** of FIG. **2**.

FIGS. **4** and **5** are examples of the types of cuts obtained in the practice of the prior art and this invention, respectively.

FIG. **6** is a side elevational view, partly in section, of another embodiment of the invention.

FIG. **7** photographically illustrates the results obtained by practice of this invention as compared with that obtained by a conventional device.

FIG. **8** is a perspective view of the punch and die members shown in their cooperative positions and relative to a non-metallic sheet to-be-cut.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing in which reference characters correspond to like numerals hereinafter, reference character **110** identifies generally a hand-held portable power tool to which the invention is readily adaptable. The device **10** comprises a pneumatic (air

driven) apparatus **12** to which air under pressure is supplied through a line **13** for operating its motor (not shown), all in conventional and known fashion. A casing **14** is suitably secured at the one end of the apparatus **12** for the purpose of mounting and supporting the subject matter of this invention. A ram member **15** is slidably received in the casing **14** at a right angle to the motor shaft (not shown) of the apparatus **12.** An eccentric projection **16** (FIG. **6**) is operatively connected in known manner, say, by a desired ratio of gearing, to the motor shaft and couples the ram member **15** thereto. A punch member **17** is securely mounted on one end of the ram member **15** by suitable means, such as by a set screw **18,** and extends forwardly of an end of the casing **14.** Acircular A circular member **20** is secured to such end of the casing **14** by means of a flanged nut **21** threaded thereto. The flanged nut **21** frictionally engages a circular boss **22** protruding from along a sleeve portion **23** supporting the die member **20.** Sleeve portion **23** snugly fits within the casing **14.** The punch member **17** is slidably received within a bore **24** provided in the die member **20,** and at the end of which bore **24,** a continuous annular surface **25** (FIGS. **2, 8**) is provided on the die member **20.** Both the die continuous annular surface **25** and punch member **17** are concentrically or coaxially mounted about an axis which is also coincident with the axis for the ram member **15** and the casing **14.**

The punch member **17** comprises a cylindrical head **26** having its diameter substantially that of the bore **24,** an annular notch or cylindrical neck **27** of reduced diameter, and a cylindrical body **28** having a terminal shoulder **29** (FIG. **8**) to which the neck **27** is attached. The diameter of the body **28** is the same as the diameter of the head **26.** In the assembly of the punch member **17** to the ram **15,** the neck **27** is juxtapositioned with respect to the annular surface **25** defining the end of the bore **24.** The portion of the head **26** which cooperates with surface **25** die annular surface**25** comprises a circumferential marginal surface **33** (FIG. **3**) disposed normal to the axis of its punch member **17.** Thus, as the punch member **17** is caused to reciprocate, the required cutting or shearing action may be characterized by the juncture of the circumferential marginal surface **33** about the neck **27** and the die annular surface **25.**

The preferred embodiment of the die member is that shown in FIG. **6** wherein the die member includes a shouldered base **70** integrally fashioned with the wall forming the die bore in which the punch member reciprocates. The shoulder **72** on the base **70** is firmly secured to the end of the casing **14** by the flanged nut **21.**

The assembly of the nibbling attachment tool should now be apparent; however, briefly, after the punch member **17** is secured to its ram **15,** the ram is slidably inserted within the casing **14.** The casing **14** is then secured to the housing of the apparatus **12** in known fashion so as to cause cooperative coupling between the eccentric projection **16** and the ram **15.**

The assembly and securement of the respective die members mounted about their corresponding punch members and shown in FIGS. **2** and **8** are readily performed by threading the flanged nut **21** to the casing **14** and upon the portions formed on the respective die members for engagement therewith.

In operation of the FIG. **2** embodiment, as shop air (viz., compressed air) is supplied through theline **13** to the motor of the pneumatic apparatus **12,** the motor's shaft rotates the eccentrically mounted projection **16.** The ram **15** thus reciprocates as the projection revolves about the axis of the motor shaft. The punch member **17** likewise reciprocates within the bore **24** of its cooperating die member **20.** FIG. **8** illustrates the cutting or shearing action between the continuous annular surface **25** of the die member **20** and the circumferential marginal surface **33** (FIG. **3**) of the punch head **26** upon a laminated sheet **80,** such as may be fabricated from PRD-49 fiber-reinforced resin composite. As the punch **17** translates in the withdrawal movement of its stroking cycle into the die member **20,** the thickness of the sheet **80,** inserted towards and abutting the neck **27,** is caught between the surfaces **25, 33.** A very quick shearing action occurs, to cleanly cut off the reinforcing fibers of the laminate and the resin forming the sheet **80.**

The adaptability of an air motor, such as a Rockwell model No. 3IN-502C, with 100 psi pressure applied (14 cubic feet/min.) to the nibbling attachment tool assures a punching cycle of well-over 2,000 strokes per minute, thus assuring a complete and sharp shearing of the fibers of the laminated sheet **80.**

The material out of which the punch and die members is preferably made, to avoid heating problems as much as possible, is non-deforming AISI A10 die steel, heat treated to a Rockwell value of 55/60 in a vacuum furnace with an Argon quench. A bright finish without scale is produced by such a quench after the furnace treatment. The punch and die members may be ground to a desired size before heat treatment, and only polishing thereof is required to obtain the desired cylindrical interface clearance.

It has been determined that the maximum thickness of a laminate **80** that can be sheared without crushing the resin out of the laminate is about one-tenth inch. Also, a maximum feed rate of the nibbler to the material, without developing a ripple along the cut, is about 175 inches per minute.

FIG. **7** is an actual photographic reproduction showing cuts made in PRD-49 fiber-reinforced laminate with the nibbler of this invention and with conventional tools. FIG. **7** shows a ¼ inch nibbler cut in the upper half of the photograph and disclosing cut edges of definite, sharp, and clean dimensions. In the lower half of the photograph, a standard ¼ inch router cut was made in accordance with customary practice, leaving frayed and loose uncut, protruding fibers extending from the edges.

FIGS. **4** and **5** illustrate the advantage that may be obtained with respect to turning radius of the present invention as compared to that obtained by conventional tools. FIG. **4** shows a cut **90** of the shortest practical radius obtainable by use of a typical cutting tool of the prior art. Cut **92** in FIG. **5,** having a substantially shorter radius than that shown in FIG. **4,** was obtained by use of the instant invention. The cut **94** illustrated in FIG. **5** represents a right-angled cut, and the curvature of its corner is limited only by the curvature of a particular configured neck for the punch member. The cut-out portion **96** in FIG. **5** illustrates the varied and irregular outlines or cuts made possible by utilization of the omnidirectional characteristics of the present invention.

Pursuant to the requirements of the patent statutes, the principle of this invention has been explained and

exemplified in a manner so that it can be readily practiced by those skilled in the art to which it pertains, or with which it is most nearly connected, such exemplification including what is presently considered to represent the best embodiments of the invention. However, it should be clearly understood that the above description and illustrations are not intended to unduly limit the scope of the appended claims, but that therefrom the invention may be practiced otherwise than as specifically described and exemplified herein, by those skilled in the art and having the benefit of this disclosure.

Therefore, what we claim as patentably novel is:

1. A nibbling tool comprising:

a circular die member having a hollow cylindrical bore and a continuous annular surface defining the exposed end of said bore;

a cylindrical punch having a driven end slidably supported within said bore for reciprocation therein, and a shearing end extending beyond said annular surface;

a cylindrical notch in said punch interposed between said driven end and said shearing end, and in confronting juxtapositioned relationship with respect to said continuous annular surface; and

means for reciprocating said punch through a displacement sufficient to initially extend said notch beyond said annular surface and thereafter retract said notch within said bore.

2. The tool of claim **1** wherein said cylindrical punch comprises a right cylinder having a circumferential marginal surface parallel with said continuous annular surface.

3. The tool of claim **1** wherein said die member and said punch are supported from the same end of the nibbling tool.

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