April 5, 1966 W. B. HANNUM, JR 3,243,920

CUTTING APPARATUS

Filed Sept. 27, 1963 2 Sheets-Sheet 1

FIG. 1.

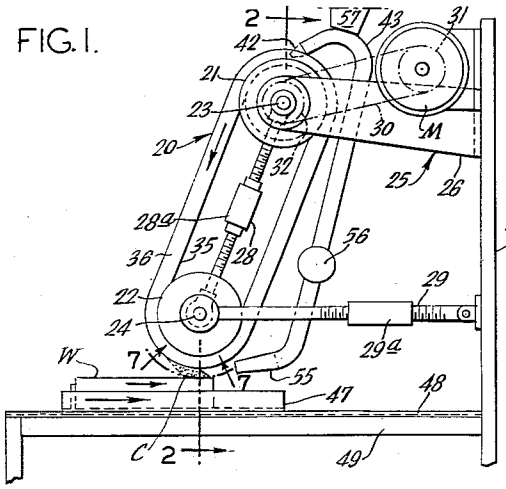


FIG. 2.

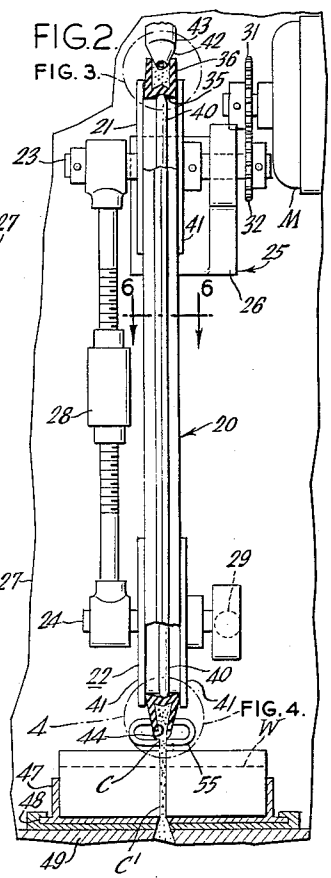
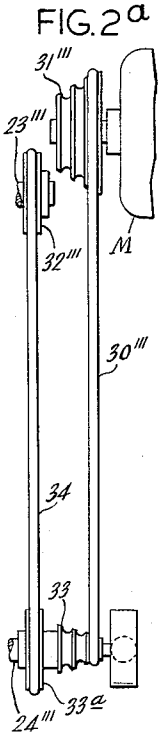


FIG. 3.

FIG. 2a



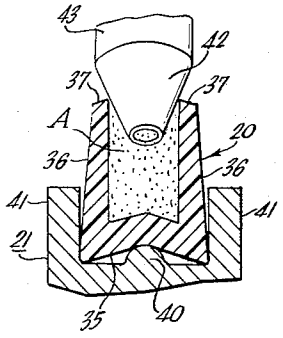


FIG. 6.

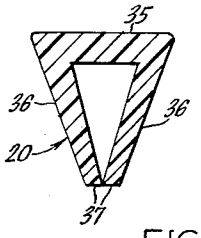


FIG. 4.

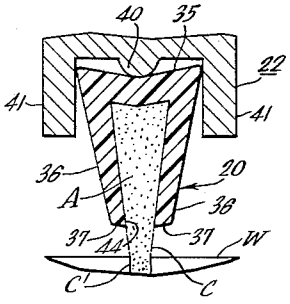


FIG. 15.

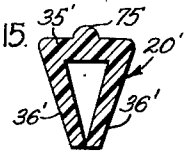


FIG. 16

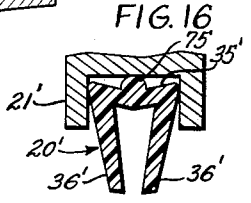


FIG. 8

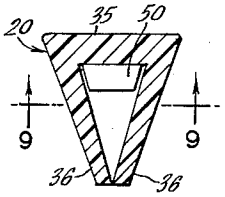


FIG. 7.

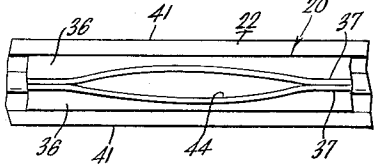


FIG. 5.

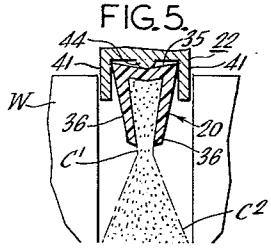
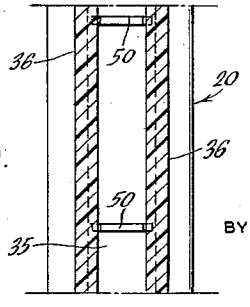


FIG. 9.



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April 5, 1966 W. B. HANNUM, JR 3,243,920

CUTTING APPARATUS

Filed Sept. 27, 1963 2 Sheets-Sheet 2

FIG. 10.

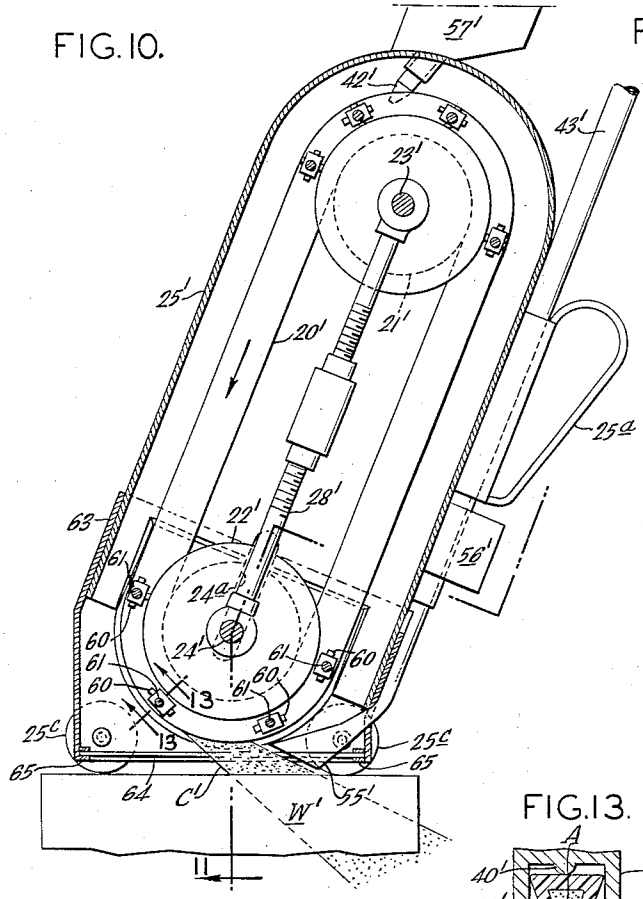


FIG. 11.

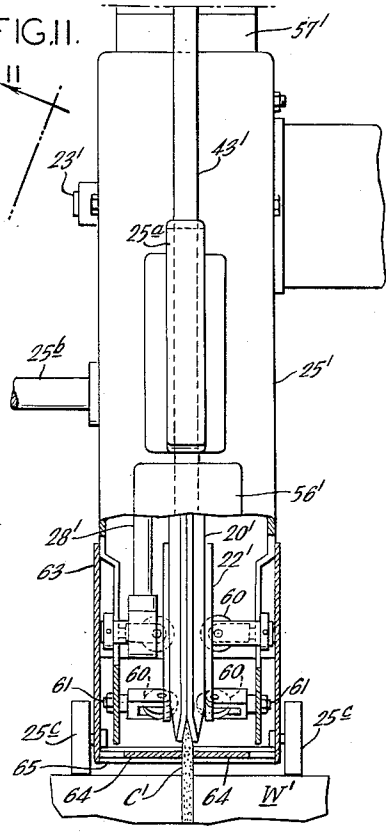


FIG. 13.

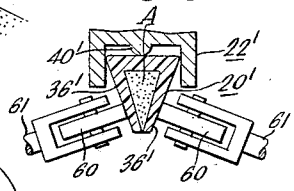


FIG. 14.

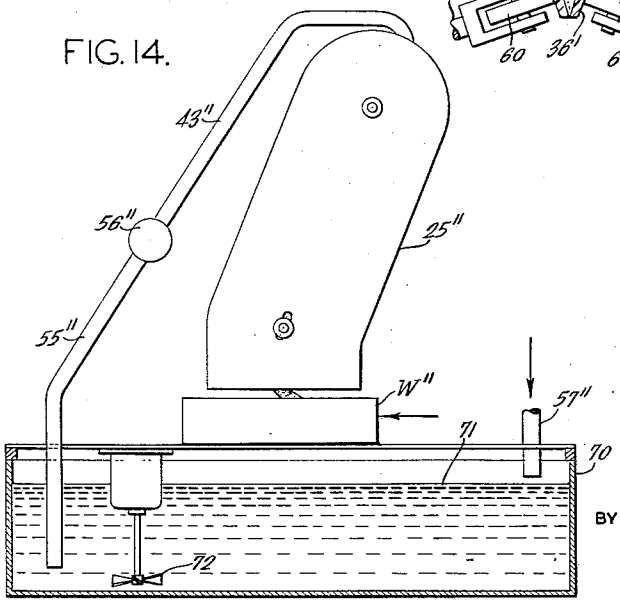
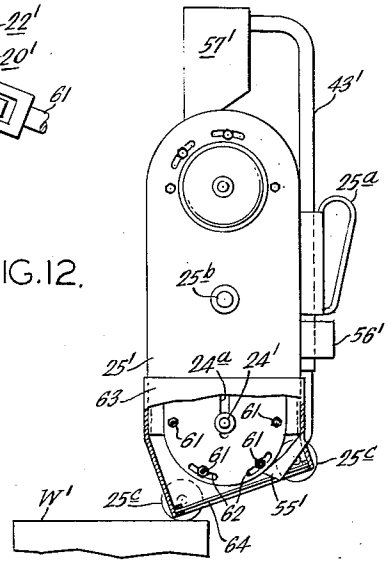


FIG. 12.



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3,243,920

CUTTING APPARATUS

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Filed Sept. 27, 1963, Ser. No. 312,237
9 Claims. (Cl. 51—9)

This invention relates to cutting apparatus and particularly to cutting by fluent material transported and accelerated by a flexible conveyor.

According to the present invention, a conveyor is used employing two pulleys, preferably with parallel axes of rotation, which pulleys are urged apart and each of which is preferably provided with ridge means to open the conveyor as it passes over the pulley. The conveyor is driven at relatively high speed, preferably by means driving one of the pulleys, and the material is discharged in such manner and with such centrifugal force that the material serves as a cutting or blasting means, particularly when abrasive material is used either dry or in a fluid slurry.

More particularly, spaced pulleys are provided over which the hollow deformable conveyor travels, one of the pulleys driving the conveyor at high speed. At one of the pulleys the conveyor is opened and abrasive material fed in and at the other pulley the conveyor is opened and the abrasive material ejected by centrifugal force at high speed against the article to be cut in order to cut it. Additional pulleys may be used but without changing the principle.

The invention, in detail, provides means for controlling the point of discharge of material for cutting, means for controlling the opening of the conveyor, and means for controlling the width of the cut made by the device.

The invention will best be understood from the following description of certain exemplary embodiments thereof, reference being made to the accompanying drawings, wherein:

FIG. 1 is a side elevation of a stationary cutting device embodying the invention relative to which work to be cut must be moved;

FIG. 2 is a vertical transverse section and elevation taken on the line 2—2 of FIG. 1;

FIG. 2*a* is a view like part of FIG. 2 but showing a modified drive arrangement;

FIG. 3 is an enlarged view of parts shown in circle 3 of FIG. 2, with abrasive material being fed into the conveyor;

FIG. 4 is an enlarged view of parts shown in circle 4 of FIG. 2, with abrasive material being discharged for cutting;

FIG. 5 is a view similar to FIG. 4 but showing how it is possible to cut through material of relatively greater thickness;

FIG. 6 is an enlarged section taken on the line 6—6 of FIG. 2, showing the conveyor in closed condition;

FIG. 7 is an enlarged bottom plan view of the conveyor at the discharge opening, the view taken on the line 7—7 of FIG. 1;

FIG. 8 is a cross sectional view of a conveyor like FIG. 6 but showing a modification;

FIG. 9 is a longitudinal section taken on the line 9—9 of FIG. 8;

FIG. 10 is a side elevation with a section taken through the cover of a portable cutting device;

FIG. 11 is a transverse section taken on the line 11—11 of FIG. 10;

FIG. 12 is a reduced side elevation, partly in section, showing how a cut is started with the device of FIGS. 10 and 11;

FIG. 13 is a partial enlarged transverse section taken on the line 13—13 of FIG. 10;

FIG. 14 is a side elevation and section of a device for cutting with fluid-borne abrasive material;

FIG. 15 is an enlarged sectional view corresponding to FIG. 6 showing a modified form of the conveyor in closed condition; and

FIG. 16 is a view similar to FIG. 4 showing the conveyor of FIG. 15 in open position as it passes over a pulley.

Referring first to FIGS. 1–7, there is shown a cutting device comprising a flexible deformable hollow conveyor 20 passing over spaced pulleys or sheaves 21 and 22 rotatably mounted on spindles 23 and 24 carried by a frame 25. The frame preferably includes a suitable bracket 26 rigidly fixed to a rigid upright support 27 to carry one spindle 23 and pulley 21. An adjustable-length spacer 28 rigidly separates the spindles and holds the pulleys a predetermined distance apart to achieve a given amount of tension in the conveyor supported thereon. An adjustable-length bracket 29 permits shifting of the position of the lower pulley 22 of the device laterally and vertically with respect to the work but once the position is selected it holds the spindle 24 rigidly in position.

A motor M drives the spindle or shaft 23 of the upper pulley 21 through a chain 30 and sprockets 31 and 32 on the motor shaft and conveyor pulley spindle 23, respectively. The motor must be capable of driving the conveyor at the high speed needed for cutting or sandblasting, as required.

As shown in FIG. 6, the conveyor 20 comprises a base 35 and sidewalls 36, preferably an integral structure of resilient material such as rubber or rubber like material which is flexible and deformable longitudinally and transversely. The sidewalls extend from the ends of the base and converge to a point of positive closure at their outer edges or lips 37 when the conveyor is in closed condition, as shown in FIG. 6, preferably under the urging of the natural resilience of the material of the conveyor. The conveyor may have other cross-sectional shapes but the triangular shape shown provides certain advantages in control of width of cut, as will be explained. The belt may be reinforced to strengthen it and prevent permanent deformation.

Means are provided for deforming the conveyor at the upper pulley 21 for feeding in abrasive material and at the lower pulley 22 for discharging that material. The means here shown, FIGS. 3 and 4, comprise an annular ridge 40 on the cylindrical face of a pulley intermediate the guiding side flanges 41, said ridge being adapted to engage and apply pressure against the base of the conveyor which rides between the flanges to urge the base toward the lips of the sidewalls. This pressure thus applied has the effect of overcoming the resilience of the sidewalls and separating them.

As shown in FIGS. 1 and 3, the point of opening at the top and the extent of opening are controlled partly by the action of the pulley ridge 40 and partly by auxiliary means. The opening need only be large enough to accommodate the filling nozzle 42 which is preferably oriented in a direction to inject material into the conveyor cavity in the direction of travel of the conveyor. FIG. 6 shows the conveyor in closed condition.

As shown in FIGS. 1, 4 and 7, the orientation of the conveyor is highly specific in a number of important respects. The point of discharge of material is preferably nearly always at the bottom. The feed is preferably at the top and at least partially by gravity. Preferably only two pulleys are used, although more could be conceivably added for special effects. The conveyor is quite short and preferably in a single plane with the spindle axes of the pulleys parallel to one another. The extent of opening of the conveyor is controlled partly by the pressure

and the depth of the ridge which is preferably a ridge **40** on the pulley but may alternatively be a ridge on the base of the conveyor. The spreading of the sidewalls tends to be greatest on a line through the pulley spindle axes, and converges back to total closed condition either side thereof. The opening **44** under these influences will be about like the illustration in FIG. 7. If desired, to shorten the overall length of the opening, auxiliary means, FIG. 10, which bear against the sidewalls and tend to hold them closed despite the contrary urging of the ridge, may be used to assist in defining the length and width of the discharge opening. The high velocity stream of abrasive material ejected by centrifugal force from the discharge opening is shown in FIGS. 1, 2, 4 and 5 and is designated as C.

The conveyor can be opened to various extents, depending on the height of the ridge **40** and the tension on the conveyor produced by the adjusting turnbuckle **28***a* of the spacer **28**. When it is opened to the extent that the interior surfaces of the sidewalls **36** are still convergent, as shown in FIG. 4, the stream C of material will narrow for a distance and will form at that point a minimum cutting width C1 which may be focused on a workpiece W to make a narrow cut. In the device of FIGS. 1 and 2 the workpiece is mounted on a carrier **47** movable along a guide **48** supported on a table **49**. Beyond the convergent point C1 the stream widens out again by crossover flow of material, as shown at C2 in FIG. 5; and the stream may be so directed against the workpiece, as by changing the setting by the turnbuckle **29***a* of brace support **29**, that a cut is made of sufficient width to allow the conveyor and pulley to enter the cut and continue to cut the work. The conveyor shown in FIGS. 8 and 9 is the same shape as that shown in FIG. 6, but longitudinally spaced transverse partitions **50** of desired height aid the driving force of the conveyor on the material and to minimize unwanted longitudinal flow of more fluent or even liquid materials.

It may be desirable to return abrasive material to the device for reuse and this can be done soon after use. It has been found that a suction nozzle **55** (FIGS. 1, 2) placed near the discharge point along the cut will pick up a large part of the previously used material and by the use of the material supply device or pump **56** will return used material or particle from the article being cut through the supply tube **43** and filling nozzle **42**, additional material as needed being taken from the make-up supply hopper or bin **57** into which the material being recirculated is also fed.

The form shown in FIGS. 10 to 12 is like that of FIGS. 1 to 9 in principle of operation but is a portable device having a casing **25'** with handles **25***a* and **25***b* and base support and guide rollers **25***c*. The belt **20'** operates over pulleys **21'**, **22'** operating on shafts **23'**, **24'** respectively with a rigid spacer **28'** between pulleys. The cutting stream C' is shown cutting a workpiece W'. Used material is picked up by a suction nozzle **55'** and returned by a circulating device **56'** through a supply tube **43'** to a material injecting nozzle **42'**, make-up material being taken from a container **57'**.

At selected points along the conveyor around the circumference of the pulleys **21'** and **22'** where the ribs **40'** exert a spreading influence on the conveyors, except where it is desired to open the conveyor for the supply or discharge of material, there are provided side auxiliary rolls **60** directed to exert closing pressure on the sidewalls and mounted on stems **61** adjustably secured to the casing, as in arcuate slots **62**, for pressing against selected points along the sidewalls **36'** of the conveyor. The rolls **60** are preferably mounted at such an angle that their treads press squarely on the conveyor sidewalls in closed position. The rolls **60** effectively overcome the effect of the ridge **40** over a short length of conveyor and hence are useful to control and adjust the length of the filling and/or discharging opening.

As shown in FIG. 12, the tool is angled up and supported on the front roller **25***c* when the device is started up for making a cut in the workpiece. When the cut reaches sufficient depth to correspond to that cut in a normal traverse of the work it may be returned to the normal position shown in FIG. 10.

A slot **24***a* is provided in each side of the casing **25'** for the adjusting movement of the roller shaft **24'** of the lower pulley **22'** when the spacer **28'** is adjusted.

Means are provided for adjusting the cutting stream C' relative to the workpiece W'. This is here accomplished by providing a lower casing part **63** which carries the rollers or wheels **25***c* and which is slidably adjustable on the upper part **25'** of the casing. Any suitable means, such as clamp screws in slots (not shown), is provided for securing the casing parts together in their selected relative position after adjustment.

Means are provided for regulating the width of the cutting stream, as here shown, FIGS. 10 and 11, the adjusting means including laterally movable plates **64** slidable along guides **65** and lockable in adjusted positions.

In the form shown in FIG. 14 the workpiece W'' is supported above a vat **70** which holds a supply of abrasive slurry **71** of liquid and abrasive. The slurry is pumped through a tube **55''** by a suitable pump **56''** and forced through the tube **43''** to the supply nozzle. A stirrer **72** keeps the abrasive suspended in the liquid and a pipe **57''** supplies make-up material. The casing **25''** may be either mounted as a fixture or portable.

The speed of movement of the belt in conjunction with the large size of arc (over 45°) on which the conveyor is turned and small diameter (down to 6") of the pulley over which the conveyor runs provide high speed and directed generally tangential ejection of the cutting material. The arcuate adjustment of the conveyor opening control rollers **60** controls the arcuate location and length of the ejection opening; the plates **64** limit the width of the cutting stream; and the adjustment of the casing part **63** with the support rollers controls the length of the stream before it strokes a workpiece.

Material is introduced preferably at one pulley and ejected at the other. The nozzle is inserted into the opening of the conveyor preferably at an angle acute with the conveyor on the side advancing toward the nozzle and the conveyor is closed as quickly as possible after the nozzle to avoid any loss of material from the conveyor. The material is discharged at the other pulley and preferably well beyond the start of curvature to gain the centrifugal effect on the discharged material. The material is preferably discharged below the lower pulley (when the tool is disposed upright, as is usual) to gain the added effect of gravity on the ejected stream.

The device has proved to be very effective and versatile in sandblasting or cutting into or through materials and has a useful range of regulation, to permit some versatility in cuts.

Although this discussion has assumed a particular orientation of the device relative to the ground, that orientation may be changed, particularly when the device is used as a sandblaster or pointing aid on buildings.

FIG. 2*a* shows a modified form of drive for the device of FIG. 2 in which the motor M has a stepped drive pulley **31'''** which drives a V-belt **30'''** which drives a companion stepped pulley **33** on the lower shaft **24'''** on which conveyor pulley **22** is supported. The shaft **24'''**, in turn, carries a pulley **33***a* which drives a second V-belt **34** to drive a pulley **32'''** on the upper shaft **23'''** which also supports conveyor pulley **21**. In this manner both conveyor pulleys are positively driven while at the same time speed adjustment is provided.

FIGS. 15 and 16 show sectional views of a modified form of conveyor wherein instead of using an annular ridge on the pulley to open a conveyor, the conveyor **20'** has similar sidewalls **36'** connected to a similar re-

silient base 35' except that the base is provided with a ridge 75 which extends lengthwise around the length of the conveyor. Thus, as illustrated in FIG. 16, that part of the conveyor which passes over a pulley 21' has force applied through the ridge but not uniformly through the base. Due to tension in the conveyor, the base resists deformation with the result that the base 35' curves as shown in FIG. 16 and the walls 36' part to allow the contents of the conveyor to escape and be thrown outward by centrifugal force.

While certain embodiments of the invention have been described for purpose of illustration, it will be understood that there may be various embodiments and modifications within the general scope of the invention. All such embodiments within the scope of the claims are intended to be within the scope and spirit of the present invention.

What is claimed is:

1. Cutting apparatus, comprising in combination, an endless, flexible, resilient, hollow conveyor having a base and sidewalls converging together from the base and held closed against one another opposite the base by the resilience of the conveyor material and urged apart by pressure against the base in the region opposite the convergence of the sidewalls, spaced pulleys for supporting the base of the conveyor and applying pressure to the base in said region to open the sidewalls of the conveyor over a limited distance so that abrasive material may be introduced at one pulley and ejected at the other, means for introducing abrasive material into the hollow interior of the conveyor when its sidewalls are opened at one pulley, and motor means for driving said conveyor at sufficient speed to produce abrasion or cutting of a surface in proximity to the other pulley as the abrasive material is ejected by centrifugal force as the conveyor is opened by said other pulley.

2. Cutting apparatus as set forth in claim 1, which further comprises in combination, means engageable with the sidewalls of the conveyor for controlling the size and location of the opening produced in the conveyor by at least one of said pulleys.

3. Cutting apparatus as set forth in claim 2, in which said sidewall-engaging means is provided with arcuate adjustment around the circumference of the pulley and conforming thereto to change the length or location of the opening.

4. Cutting apparatus as set forth in claim 2, in which said sidewall-engaging means comprises a plurality of rollers spaced along the conveyor in the region of a pulley pressing against the sidewalls of the conveyor.

5. Cutting apparatus as set forth in claim 4, in which said rollers are arranged in opposed pairs to press opposed sidewalls together in selected locations along the periphery of a pulley.

6. Cutting apparatus as set forth in claim 1, which further includes in combination, means for regulating the width of the cut.

7. Cutting apparatus as set forth in claim 6, in which said means for regulating the width of the cut comprises means for changing the distance from the pulley to a workpiece producing the opening of the conveyor to permit ejection of the abrasive material.

8. Cutting apparatus as set forth in claim 6, in which said means for regulating the width of the cut includes laterally adjustable plates for changing the spacing between said plates through which the abrasive material must pass.

9. Cutting apparatus as set forth in claim 1, in which said conveyor when closed is triangular in cross section with a base supported on said pulleys and inclined sidewalls converging together from ends of said base, said base having ridge means extending the length of the conveyor for cooperating with an essentially flat pulley to spread the sidewalls apart.

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LESTER M. SWINGLE, *Primary Examiner.*