

[54] **METHOD FOR IMPROVED
PRODUCTION OF WOOD FLAKES**

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144/118

[51] Int. Cl.**B27I 11/04**

[58] Field of Search.....144/326, 312, 176, 118, 162

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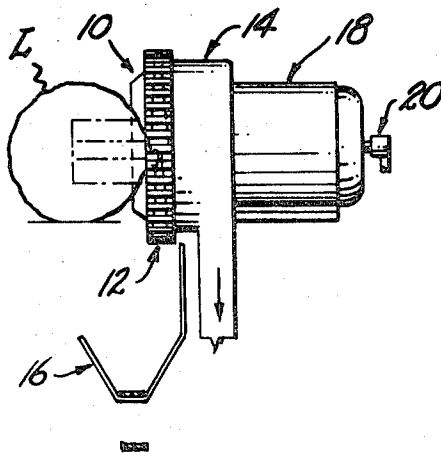
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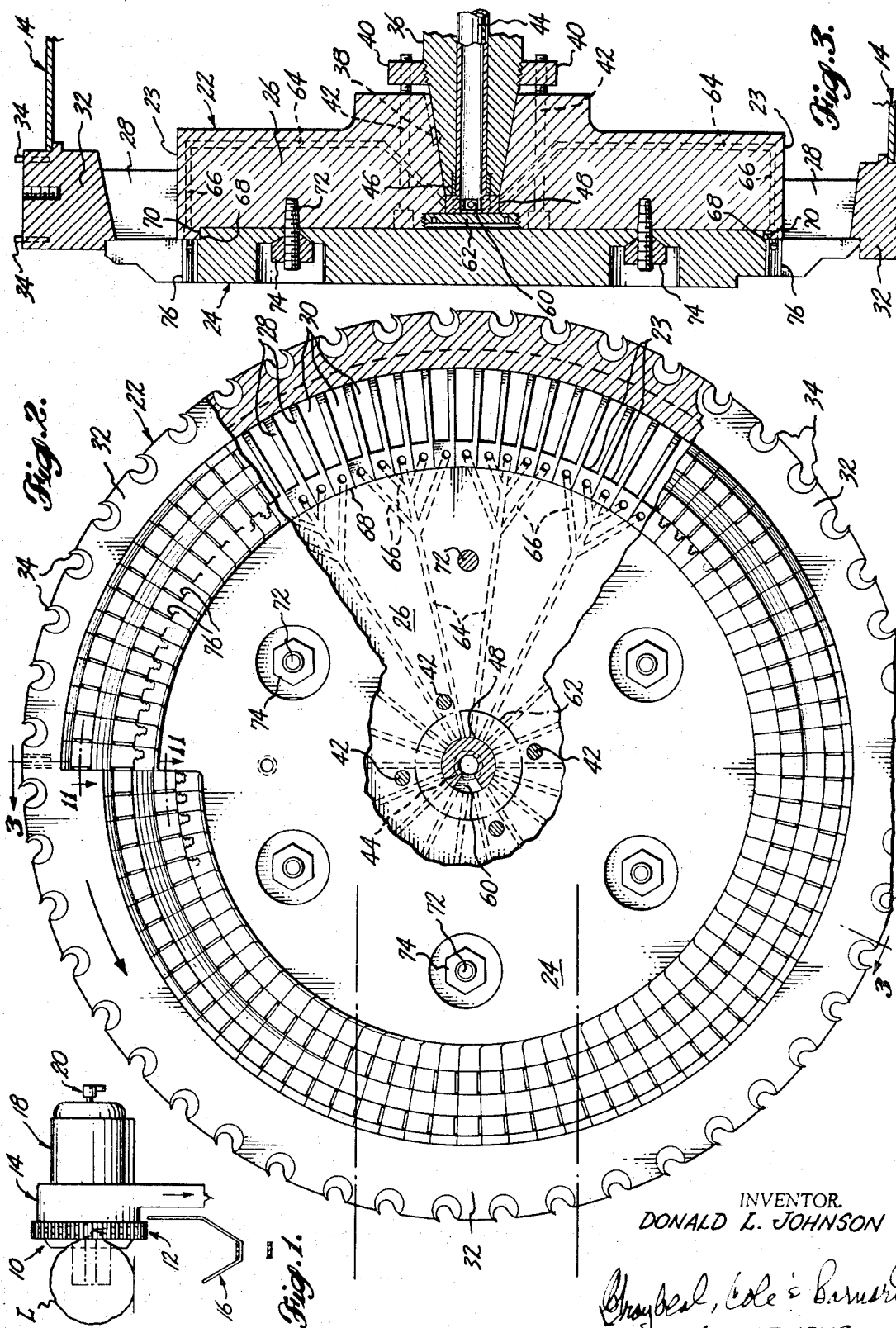
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[57] **ABSTRACT**

Method for producing a flat face on the side of a log or cant and including hogging away protuberances, slicing of wood flakes to a predetermined thickness and length, jet breaking of the flakes from the parent wood to desired width and then fluid conveying the flakes away from the cutterhead assembly.

3 Claims, 44 Drawing Figures





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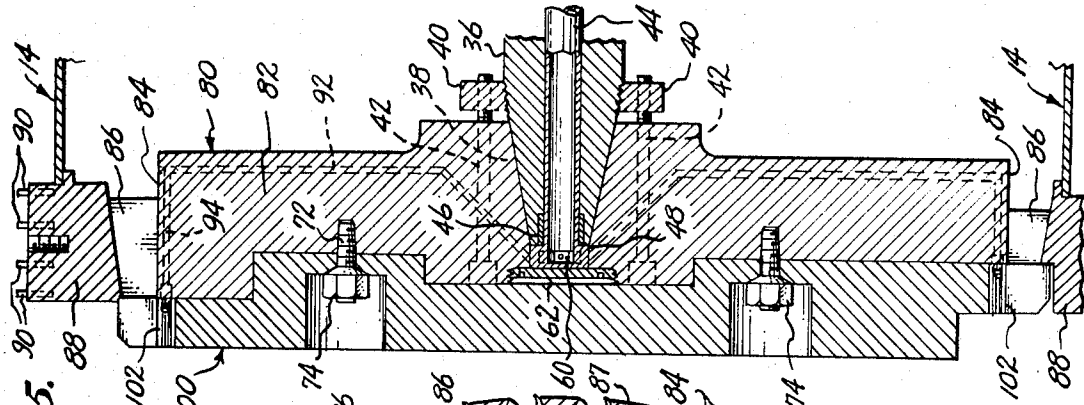


Fig. 5.

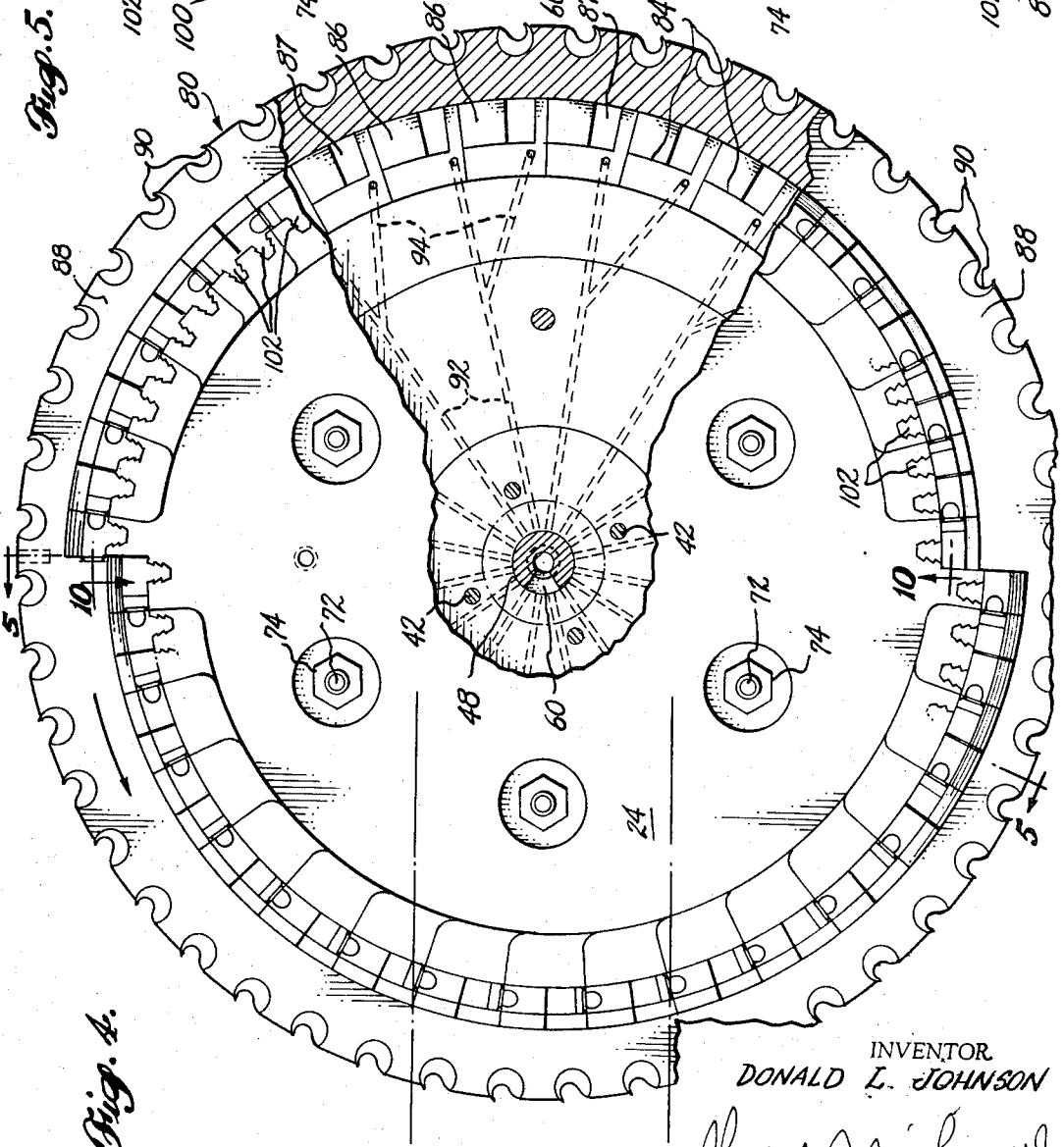
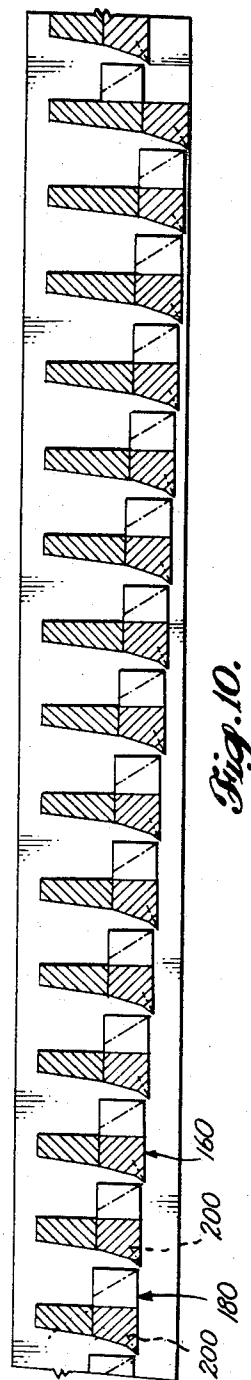
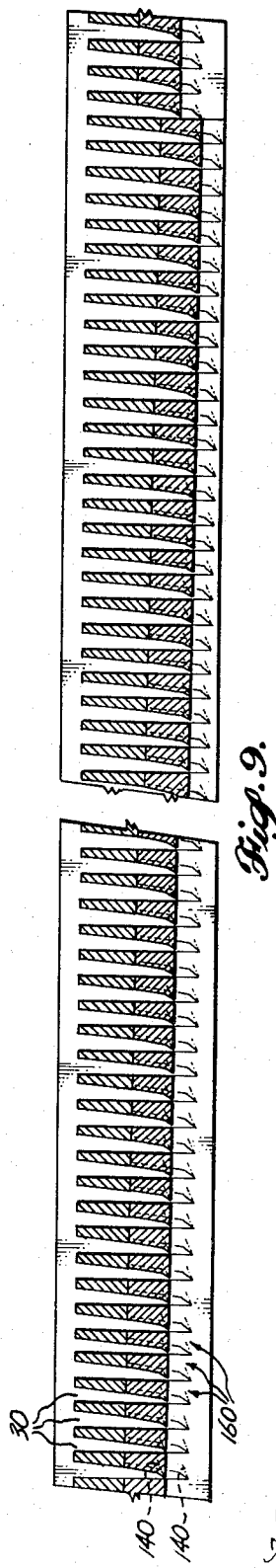
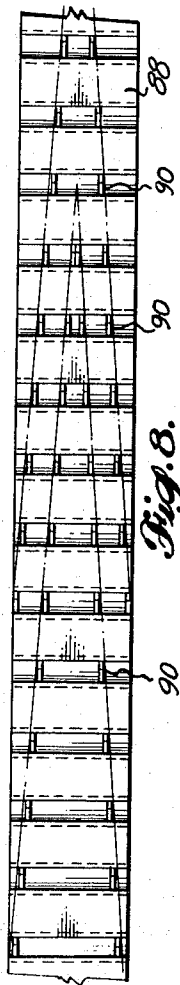
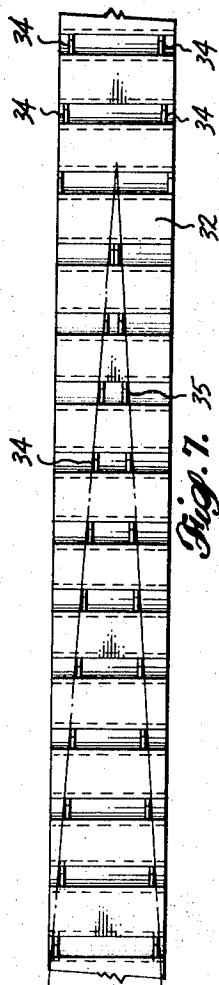
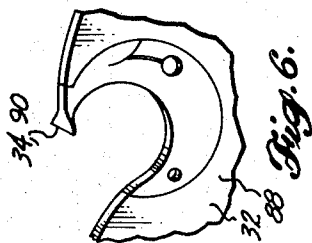
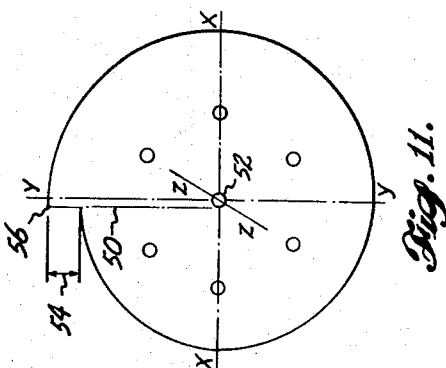


Fig. 4.

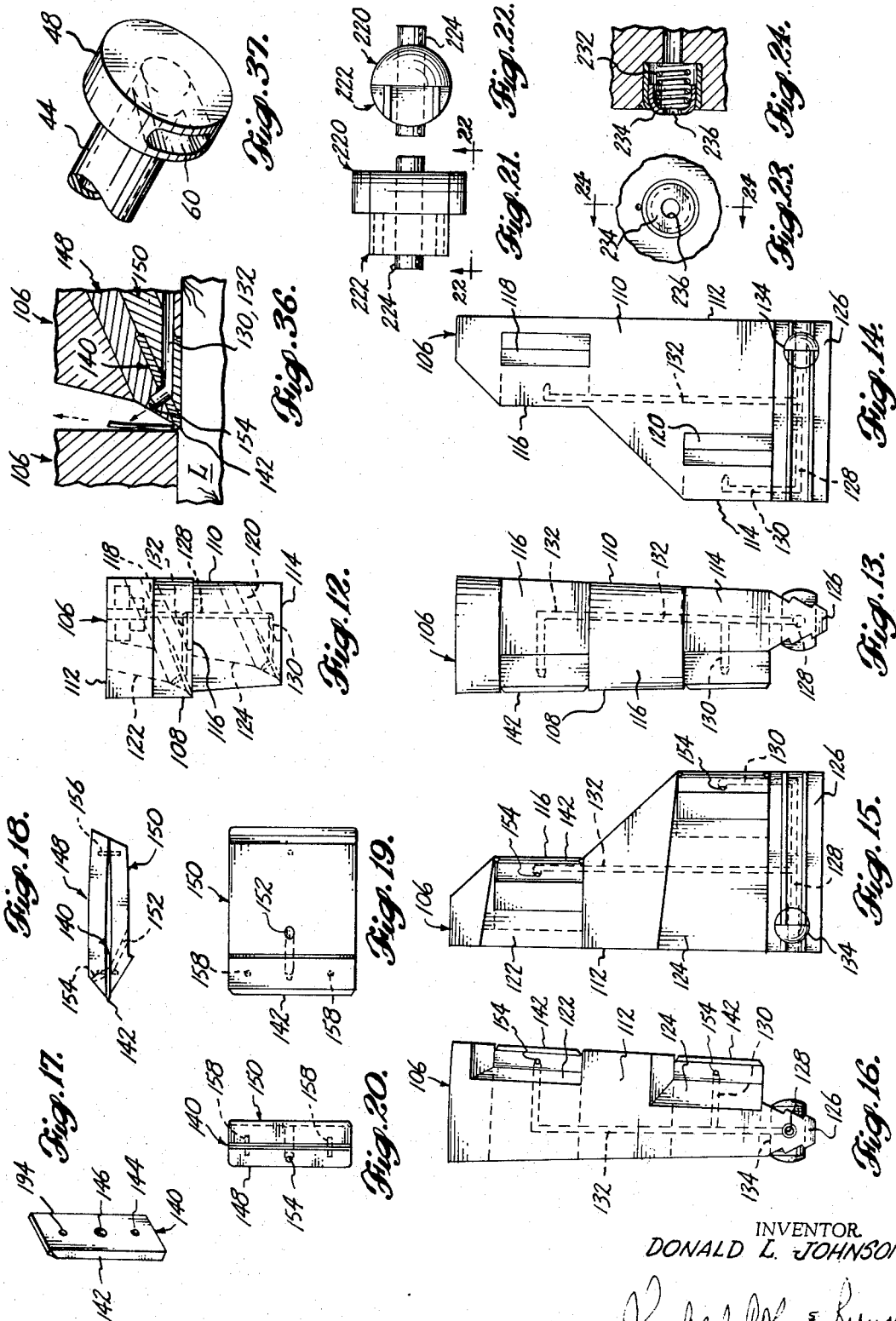
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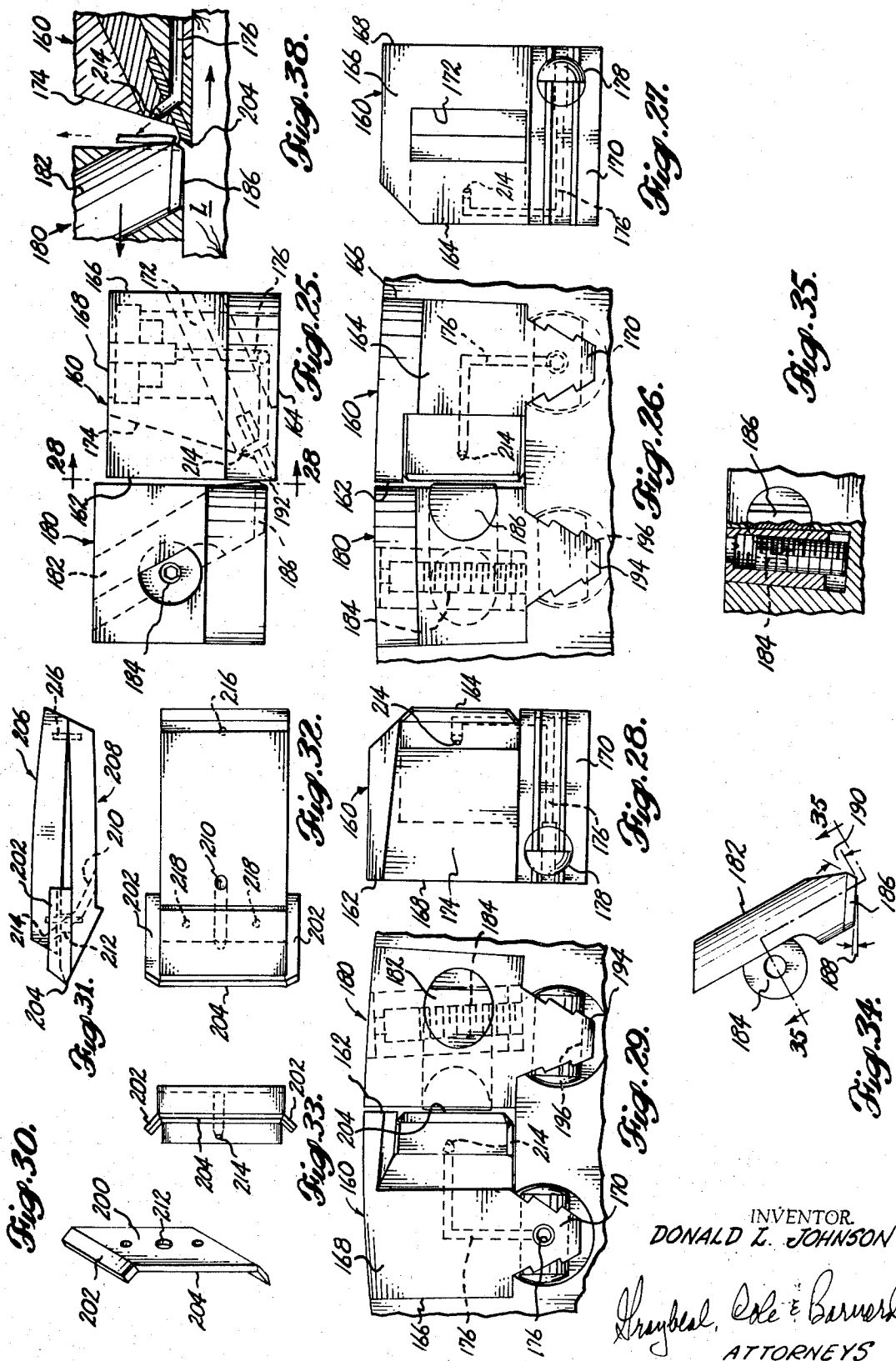
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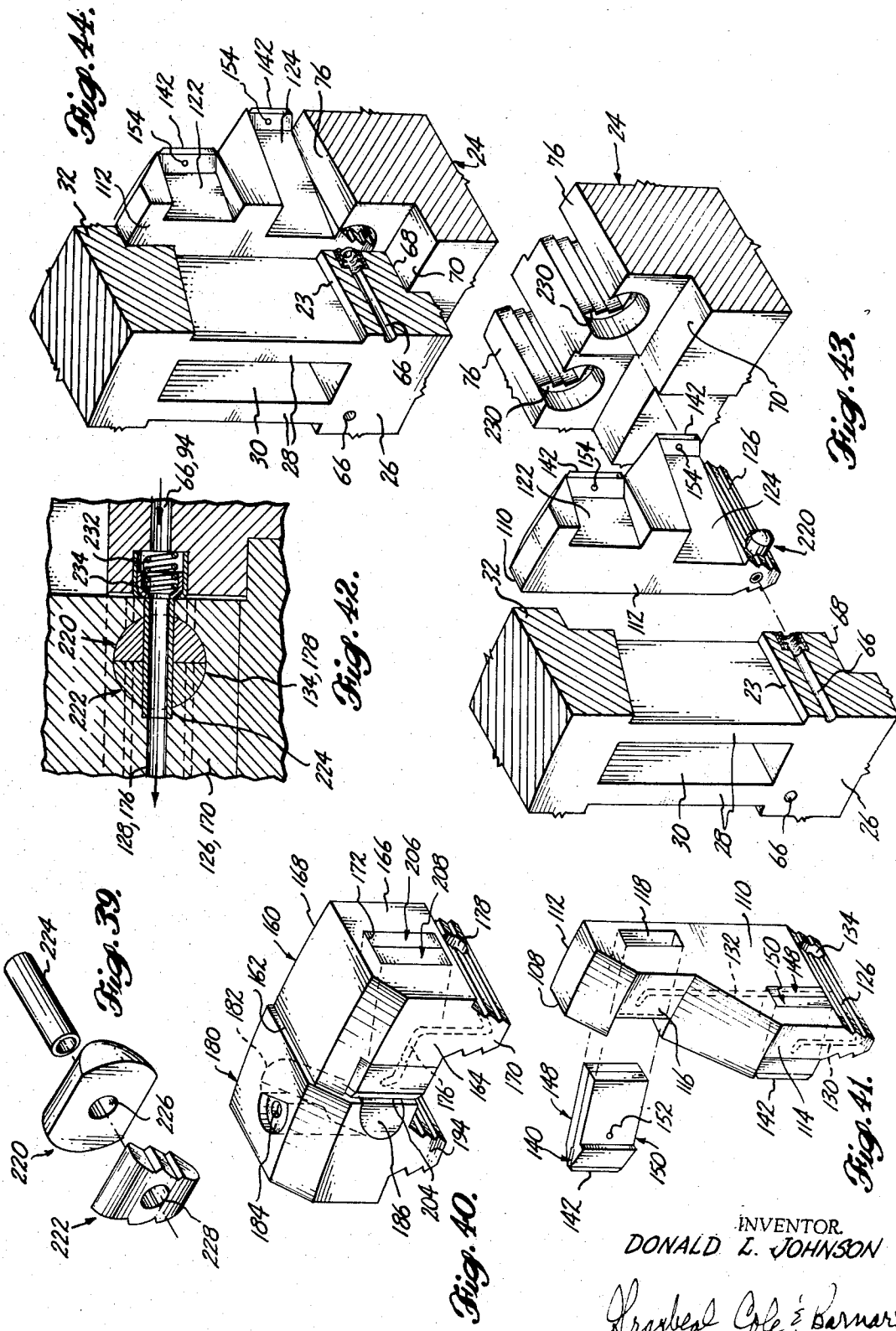
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METHOD FOR IMPROVED PRODUCTION OF WOOD FLAKES

CROSS REFERENCES TO RELATED APPLICATIONS

This application is a division of U.S. Patent application entitled: METHOD AND MEANS FOR IMPROVED PRODUCTION OF WOOD FLAKES, filed Apr. 12, 1967; Ser. No. 630,696, now U.S. Pat. No. 3,526,258 and is related to my application entitled: PROCESS AND APPARATUS FOR PRIMARY BREAKDOWN OF ROUNDWOOD, filed Apr. 12, 1967; Ser. No. 635,639, now U.S. Pat. No. 3,472,296.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to a method for the production of wood flakes and cutting of a flat surface on a log or cant. More particularly does the invention relate to a method for the combined and simultaneous hogging away of limbs, flares and other protuberances on a log or cant; slicing flakes therefrom and jet breaking the flakes from the parent wood; and fluid conveying the flakes away from the cutting area so as to produce a flat face on the side of the log or cant.

The flaking and surfacing runner, pressure bar block and blade block assembly is related to my issued U.S. Pat. Nos. 2,889,859; 2,949,946; 2,964,079; 3,240,245; 3,245,442; 2,363,476, and also to U.S. Pat. No. 3,155,130 of Logan and Sepall.

The present invention pertains to the improved production of wood flakes, including thin flakes, for use in multi-ply plywood and as a new raw material for chemical processing. The thin flakes are under about one-twentieth inch in thickness and thick flakes, generally compatible with conventional chips for mechanical and chemical pulp, are about one-twentieth inch in thickness. Both types of flakes are cut from wood logs which are reduced to rectangular timbers and lumber as residuals of flake production.

2. Description of the Prior Art

While prior flaking and surfacing methods and devices have been operable, there have been many problems and difficulties in configuration, manufacture, and operation. In the prior art, as in conventional chippers, veneer lathes, flaking machines and the like, knives of quite substantial cross section have been employed. Cutting edges must be ground and reground for reuse until enough of the tool had been ground away as to render the part unusable and then discarded. This practice has some aspects which, upon analysis, are favorable and should be retained and others which are unfavorable and should be discarded.

The above practice requires that the knifebars be removable. However, a knifebar undergoing constant regrinding changes size and weight presenting problems in positioning and balancing. Applicant has concluded that it is not practical to require an operator to set up a cutterhead using reground knifebars of such precision that each knife is stepped, for example 1.100 inch from the next, and involving 100 or more such knifebars and that the device be in proper balance after assembly. Rather a machine should be designed so that its mere assembly places all cutting edges in proper position and balance and still be of sufficient durability to operate properly and reliably for a reasonably

adequate length of time. It is known that the best steel and other material for quality cutting tools is only available in thin sections. However, knifebars used heretofore have been so large in cross section that only certain kinds of relatively unsatisfactory material could be used because of limitations in manufacture, cost and other factors.

The regrinding of one or more inclined surfaces making up a cutting edge produces surfaces containing numerous small scratches and a "wire edge" which must be honed away by hand. This is so laborious and costly of time that it simply cannot be accomplished. Corrosion also causes deterioration which is hastened by the presence of grooves and scratches. Fatigue from rapid repetition of cutting loads is another factor limiting the life of a cutting edge such that a "resharpened" knifebar is not as good as a "new" knifebar other factors being equal.

The technique of "micro-sharpening" whereby the face side of the cutting edge as opposed to the veneer or flake side is shaped such that the face of the wood is compressed slightly as the knife passes through and along the wood has long been known in the art of slicing of conventional veneer. The slight compression provides more of a splitting action in slicing the flake from the wood which aids in producing quality flakes and surfaces and eliminates any tendency of the knife to pull into the work. It also means that a more blunt and therefore sturdier and more durable cutting edge may be employed. While it is very important, micro-sharpening is a detailed and delicate modification which cannot be employed in many cutterheads.

Small blades in the nature of razors have long been in other fields. They can be economically produced continuously from thin strip carbon, alloy, and stainless steels and possess properties not available in large sections. These can be micro-sharpened and produced in many combinations of cutting angles and variations for severing the ends of the flakes. Since a very small amount of metal is involved and manufacturing costs are low, the blades may be disposed of after one use rather than resharpended. The cutting edge may be heat treated, ground, honed and otherwise processed to a near perfect cutting tool.

The force required to cut flakes from wood decreases almost linearly with the thickness of the flake. A razor like knifebar or blade $1 \times 0.035 \times 0.5$ inches is as large and substantially a cutting tool relative to a 0.010 inch thick flake as a $\frac{1}{8}$ inch thick knifebar is to a $\frac{1}{4}$ inch thick pulp chip or piece of veneer. Blades and knives are subject to a rapid repetition of stress due to cutting loads. In the length of a full operating day of 24 hours, a desired length of service from a set of blades, a cutterhead would be in operation about 21 hours and would probably be in the cut about one-third of that time or 7 hours. At a speed or rotation, for example 1,800 rpm, the number of cycles equals 756,000 or considering cracks and other interruptions in the wood about 1,000,000 cycles. This is below a critical fatigue figure for steel blades. Holders for the blades, however, are more costly and must have a longer life than the blades. These should last for a long period, limited in most cases only by impact with embedded foreign objects causing severe mechanical damage.

Screws and bolts used heretofore to hold knifebars in position, particularly small ones, require much labor time and at best are not reliable. When many are involved the possibility of an operator's leaving one or more loose with consequent loss of a knifebar is too great. Thus it is preferred that screws and bolts be eliminated in the positioning and holding of blades and other parts.

A blade holder should be preloaded so that the preload is greater than the cutting load and yet within the elastic limit of the material so as to provide adequate and firm clamping and eliminate repetitious fatiguing stresses on the lip of the blade holder. Pressure bars are necessary for production of quality flakes and surfaces in flake thicknesses over about one-twentieth inch but in prior art devices the bars have been difficult and costly to maintain in service.

Speed of cutting is another factor of importance. At high speeds, generally over about 10,000 feet per minute, thick flakes are shattered while thin flakes are cut and emerge undamaged in wide spiral ended flakes. The reason for this, to applicant's knowledge, has not been understood heretofore. At high speeds, the flake is "reflected" from the cutting angle or side of the blade much the same as light is reflected from a reflecting surface. This has the effect of doubling the cutting angle. Thin flakes, being flexible, simply bend, but thick flakes, being stiff and relatively rigid, break or shatter unless the speed is low enough so that the wood merely "flows" along the side of the cutting edge.

Means must be provided to break the flake from the parent wood simultaneously with the slicing of the flake. Applicant has observed that when a knife is in the cut the flake is flexed and under stress and is beginning to move away from the parent wood. Yet it is still attached and is entering a discharge passageway. A related problem, therefore, is the evacuation of the flake, particularly a thin flake, from the slicing area.

A flaking and surfacing head is similar in some respects to a runner for a steam or gas turbine. Peripheral speeds for a cutterhead are from about 8,000 to 30,000 feet per minute while turbine blade speeds now exceed 60,000 feet per minute. Common loading on a 1 inch turbine blade is 100 pounds or comparable to severe loading experienced by a 1 inch blade which is slicing flakes. Shock loading may be more severe, but on the other hand there are no high temperatures to weaken the metal. The fir tree root has proven to be most efficient and reliable for turbine blades. It has high joint efficiency. Strong, reliable and fully calculable centrifugal forces preload and hold the blade in proper position. It is the same situation for the pressure bar and blade blocks of the present invention. While the fir tree anchorage, generally parallel with the axis of rotation, is very good for resisting forces in the plane of rotation, another means is required to position and lock the root and block in proper axial position. An accurate and reliable lock is needed. Mere assembly should position and lock the root and block reliably in correct location.

Logs, even after delimbing and debarking, have limb projections on the surface together with flares and other protuberances causing the surface wood at these places not to be of proper grain direction and quality for the desired quality wood flakes. Since the depth of

cut made along the side of a traveling log by a flaking and surfacing cutter is limited, for example to 2 inches, in many cases it is necessary to take a pass along a log merely to remove these projections. Not only does this consume as much time as a productive cut, it also usually results in the cutting and discharge of knotty, cross grain and slant grain particles in flake supply. Thus, a companion closure and hogging head is needed capable of hogging away such projections, of discharging this material separately from the flakes. There is also need for removably supporting the flaking and surfacing runner and providing passages for discharge of the flakes and making a closure with a flake collector. A further requirement is a locking device between the closure head and the removable flaking and surfacing runner capable of positive and accurate axial positioning of the fir tree root in the fir tree anchorage of the runner.

Logs are sometimes slivered on the surface after debarking and handling. Decay also is sometimes prevalent. Loose slivers and seriously decayed wood, not adequate in support or strength to withstand the cutting forces, are simply brushed aside. It is important that this unwanted material be separated out and discharged separately from the desired flakes. A cutterhead assembly should be so constructed that only sliced flakes pass through and be admitted to the flake supply. Cutterheads will contain not only many cutting edges for flaking and surfacing, but also additional edges for hogging, all of which edges are subject to normal wear and tear plus damage from foreign objects of metal and rock sometimes embedded in logs. While this is the normal situation, damaging also to conventional equipment, provision must be made for mounting of the heads such that they may be easily and quickly exchanged for newly assembled heads for the above reasons as well as for change of flake size without lengthy and costly shutdown of the equipment.

The size of the cutterhead assembly is also important. Its size must be suited to manufacture and use. General overall rotating diameter, face diameter, and depth of the flaking assembly is desired varying only so as to produce desired differences in thickness, length and width of the flake product.

SUMMARY OF THE INVENTION

A method for jet breaking of wood flakes away from the parent wood to a predetermined range of width substantially simultaneously with slicing the flake to thickness and length. These steps are combined with fluid conveying of the flakes from the slicing and breaking area on the logs, cants or boards. The method includes hogging of protuberances beyond the axial slicing depth and discharging this material separately from desired flakes. At the instant of slicing a jet of compressed air, steam or other pressurized fluid is used to break the flake from the parent wood to a desired width range and to create a fluid flow to convey the flakes through the flake passageway in the cutterhead. The jet fluid also serves as a source of conveying medium for the flakes in the exhaustor or evacuator duct. Since the flaking and surfacing head has only about one-sixth of its circumference in the slicing area at one time, a lesser volume of pressurized jet fluid is needed so that the discharge can be confined to those nozzles in the

work area. Additionally, means are provided for passage of air or other fluid under pressure from a stationary source to the nozzles of the rotating cutterhead.

The cutterhead assembly comprises a shaft mounted closure and optional hogging head with through flake passageways. Axial blade block platforms are provided on its face together with studs for detachably securing a flaking and surfacing runner. The runner supports preloaded holders of disposable blades in a series on the periphery of the runner on a helical-spiral bladeline. The blade holders are mounted in blade blocks having fir tree anchorages to provide radial positioning and support while locks between the runner and closure head provide axial positioning. Pressurized fluid passages are provided in the closure head from an external source to seals at each of the blade blocks with passages leading to nozzles in the slicing area. Fluid flow is distributed only to those nozzles in the work area. Provision is made for sure bar blocks to be added ahead of each blade block for thick flakes.

Disposable blades, which may be mass produced in several variations of materials, cutting angles and means for severing the end of the flake, are also provided. The blades are firmly clamped in proper position in preloaded blade holders pressed into the blade blocks. Centrifugal forces preload the fir tree anchorages while a positive axial lock between the runner and the closure head secures each block in precise axial position. Mere assembly places all parts in proper position and balance. Once assembled no parts can be removed without removal of the few large taper seated mounting nuts. When necessary, hogging cutters are added to the periphery of the closure head for removal of limbs, flares and other protuberances occasionally prevalent on the surface of debarked logs.

Accordingly it is among the many features, advantages, and objects of the invention to provide a method of jet breaking away of flakes from the parent wood to a desired width range substantially simultaneously with slicing to thickness and length in combination with fluid conveying of the flakes from the slicing and breaking area. The method of this invention involves hogging away of protuberances together with slicing, breaking and conveying of flakes and producing flat surfaces upon the side of logs and cants. Distribution of pressurized jet fluid is made to jet nozzles only while they are in the slicing area. Small screws and bolts have been eliminated. The closure and optional hogging head is removable and has a stationary flake collector and means for detachably securing the flaking and surfacing runner thereto. The cutterhead includes disposable, high quality cutting blades, preloaded blade holders, centrifugally preloaded blade blocks for said holders, disposed on a helical-spiral bladeline. The invention allows the cutterheads to be replaced and substituted quickly. Assembly of the cutterhead components can be done rapidly and efficiently without necessity for tedious balancing and positioning of each blade and its holding and supporting structure. The cutterheads of the present invention may be quickly exchanged for replacement of cutting edges and for change of flake size. A single, standardized, easily maintained, safe and reliable configuration or cutterhead assembly for thin flakes, thick flakes and quality surfaces has been provided. It is universally useful and

suited to mass production techniques for quality and quantity manufacture at low cost.

BRIEF DESCRIPTION OF DRAWINGS.

FIG. 1 is a general elevational view of a log, cant or board feeding into a hogging, flaking and surfacing cutterhead assembly of the present invention together with drive means and other structure associated with the cutterhead;

FIG. 2 is a face elevational view of a thin flake head and a closure head with optional hogging cutters as part of the cutterhead assembly with a portion of the flaking head or runner broken away to show the face and additional features of the closure head;

FIG. 3 is a cross sectional view along 3—3 of FIG. 2 further clarifying details of the cutterhead assembly;

FIG. 4 is a face elevational view of a thick flake head and a closure head with optional hogging cutters comprising a cutterhead assembly of the same outer diameter, diameter of face and axial cut as the thin flake assembly of FIG. 2 with a portion of the flaking runner broken away to show the face and hidden features of the closure head.

FIG. 5 is a cross sectional view along 5—5 of FIG. 4 further clarifying details of the thick flake cutterhead assembly;

FIG. 6 is an isometric view of a conventional inserted saw tooth used as a hogging cutter;

FIG. 7 is a developed peripheral view of an inserted saw tooth hogging arrangement for a thin flake cutterhead assembly of FIG. 2;

FIG. 8 is a developed peripheral view of an inserted saw tooth hogging arrangement for a thick flake cutterhead assembly of FIG. 4;

FIG. 9 is a developed sectional view along 9—9 of FIG. 2 showing the axial advance of the blade blocks, the discharge passageways through the closure head and the flat closure back of the closure head for the thin flake assembly of FIG. 2;

FIG. 10 is a developed sectional view along 10—10 of FIG. 4 showing the axial advance of the pressure bar and blade blocks, the discharge passageways through the closure head and the flat closure back of the closure head for the thick flake assembly of FIG. 4;

FIG. 11 is a diagram of the helical-spiral bladeline on the x, y, z coordinates of analytic geometry used in the design of the cutterhead assembly;

FIG. 12 is a top plan view of a thin flake blade block;

FIG. 13 is a face elevational view of the thin flake blade block of FIG. 12;

FIG. 14 is a rear elevational view of a thin flake blade block;

FIG. 15 is a front elevational view of a thin flake blade block;

FIG. 16 is a back elevational view of a thin flake blade block;

FIG. 17 is an isometric view of a thin disposable blade for use in the cutting of thin flakes;

FIG. 18 is an edge view of a pair of preload holders of thin disposable blades for the thin flake blade blocks;

FIG. 19 is a side elevational view of the blade holder of FIG. 18;

FIG. 20 is an end view of the holder looking at the cutting edge of the disposable blade;

FIG. 21 is a plan view of an axial lock and fluid passageway for blade blocks;

FIG. 22 is an elevational view taken along the line 22—22 of FIG. 21;

FIG. 23 is an end view of the pressurized fluid seal used in the closure head to seal the fluid passage at the joint between the closure head and the blade blocks of the flaking and surfacing runner;

FIG. 24 is a sectional elevational view taken along line 24—24 of FIG. 23;

FIG. 25 is a top plan view of a pressure bar block and blade block for a thick flake head assembly of FIG. 4;

FIG. 26 is a face elevational view of the pressure bar block and thick flake blade block of FIG. 25;

FIG. 27 is a rear elevational view of a thick flake knife block of FIG. 25;

FIG. 28 is a front elevational view taken along the line 28—28 of FIG. 25;

FIG. 29 is a back elevational view of the pressure bar block and knife block of FIG. 25;

FIG. 30 is an isometric view of a disposable wing blade used for slicing of thick flakes;

FIG. 31 is an edge view of a pair of blade holders for the blade of FIG. 30 and the blade block of FIG. 25;

FIG. 32 is a side elevational view of the blade holder of FIG. 31;

FIG. 33 is an end view of the holder looking at the cutting edge of the disposable wing blade;

FIG. 34 is a plan view of the pressure bar and jack lock of the pressure bar block of FIG. 25;

FIG. 35 is a sectional view 35—35 of FIG. 34 through the jack lock and shank of the pressure bar;

FIG. 36 is a diagrammatic view showing a jet breaking a flake and fluid conveying simultaneous with the slicing of the flake from the parent wood;

FIG. 37 is an isometric view of the stationary tube and fluid distributor shown assembled in FIGS. 3 and 5;

FIG. 38 is a diagrammatic view showing jet breaking of a thick flake and fluid conveying simultaneous with the slicing of the flake from the parent wood;

FIG. 39 is an exploded isometric view of the axial lock and fluid passage for the blade blocks;

FIG. 40 is an isometric view of the pressure bar block and blade block for the thick flake cutterhead assembly;

FIG. 41 is an isometric view of the thin flake blade block showing the upper blade holder removed or ready for installation in the rectangular slot of the blade block while the lower blade holder and blade is already in position;

FIG. 42 is a partial cross sectional view further illustrating the fluid seal and passage between the closure head and the fir tree root of the blade block;

FIG. 43 is an exploded partial perspective showing a thin flake blade block ready for insertion of the fir tree root into the anchorage of the runner; and

FIG. 44 is a partial perspective view showing a blade block in place and fixed in radial position.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Cutterhead Assembly

a. Closure and Optional Hogging Head

The closure and optional hogging head for the thin flake cutterhead assembly is shown as 32 in FIGS. 2 and 3, and as 88 for thick flake assembly in FIGS. 4 and 5. The closure heads are basically the same in either

case varying only in the number of flake passageways, axial lock platforms and other variations necessary to make various sizes of flakes.

The closure head is preferably a single casting of ductile iron or other suitable material with a tapered central bore with a suitable keyway for removable mounting and true running on extended motor shaft 36. Bolts 42 threaded into shaft collar 40, taper threaded to shaft 36, serve to hold closure head removably to the shaft and, by variable tightening, provide some slight adjustment to a true running condition.

Spokes 28 for the thin flake head and 86 for the thick flake head delineate the flake passageways and serve to attach the outer rim to the central body of the closure head. In case the hogging cutters are desired, the flange or rim is made large enough to accommodate inserted tooth cutters 34, 90 shown in detail also in FIG. 6. When hogging cutters are not needed the head may simply be smaller in diameter as shown in dotted lines in FIG. 2.

A collector hood 14 meets with a closure ridge on the flat discharge side of closure head serving to seal off the discharge flakes, permit rotation of the head, and prevent contamination of flake supply by uncut material.

Hogging is the reduction of material presented to the hogging cutters to coarse sawdust. Saw teeth or any other suitable cutters may be employed. Inserted saw teeth commonly used on circular saws are satisfactory and may be removed and inserted without removal of the closure head.

Since the feed speed is controlled and synchronized with the speed of rotation of the cutterhead assembly, the cutters may best be arranged as shown in FIG. 7 for the thin flake assembly and as shown in FIG. 8 for the thick flake assembly rotating at half the speed of the thin flake assembly.

b. Flaking and Surfacing Runner

The flaking and surfacing runner 24 is shown for the thin flake head assembly in FIGS. 2 and 3 and for the thick flake assembly in FIGS. 4 and 5. Runner 24 is removably mounted on the face of the closure head by stud bolts 72 and taper seat nuts 74. The taper seats serve to center the runner and also to lock the nuts that they will not loosen in operation.

The body of the runner is preferably made in one piece of rolled steel plate or steel forging. Disposed about the periphery of the runner are the fir tree anchorages with bored seats 230 for the axial locks shown in greater detail in FIG. 43. The blade blocks 112 for the thin flake assembly are simply inserted into the fir tree anchorages of the runner from the back side. In the case of the thick flake head, pressure bar blocks 180 and blade blocks 160 are both inserted into fir tree anchorages from the back side of the runner.

c. Pressure Bar and Blade Blocks, Fir Tree Anchorages and Axial Locks, Blades and Preload Blade Holders

FIGS. 12—16, together with 41—44, illustrate a thin flake blade block 106. Blade block 106 has a front side 108, a rear side 110, a back side 112, a lower front face 114 and an upper front face 116. The block has a lower blade holder slot 120 and an upper blade holder slot 118 extending at an angle to the face generally from the front working edge through to the rear of the block. The slots are so located that each conforms to the heli-

cal-spiral bladeline. Each slot has its own flake passageway 122, 124 expanding to the back and cooperating with the flake passageway of the closure head when assembled. Fir tree root 126 extends across the lower end of block 106 from face 114 to back side 112. Near back side 112 and in the fir tree root is a transversely cut round hole 134 for receiving the axial lock to be described in detail hereinafter.

The thin flake blade and blade holder is shown in FIGS. 17-20. Thin flake blade 140 is a flat strip of suitable material having cutting edge 142 and mounting pin holes 144. The holders for blade 140 are generally rectangular plates 148 and 150 of spring steel or like material. The blade is placed on the locator pins in one of the pair of holders on the pins. The blade holders are arched with concave surfaces opposing each other and against the blade. When the pinned together assembly is pressed into the blade holder slots of the blade blocks, the arches are depressed gripping the blade firmly between the inner and now parallel faces of the blade holders. A stop on blade holder 150 positions the assembly in the precisely located slot of the blade block. Arch deflections of 0.003 inches and higher for each half of the blade holder with resulting pressures of 1,000 pounds and more are attainable within the elastic limit of spring materials. Blade holder assemblies may be pressed into position and removed using a small hydraulic cylinder or other pressure means holding jig.

FIGS. 25-29, 34 and 35 show the thick flake blade block and its cooperating pressure bar block. The blade block 160 has front side 162, face 164, back 168 and rear side 166. A blade holder slot 172 extends to an angle to the face generally from the front working edge through to the rear of the block. A flake passageway expands to the back side and cooperates with the passageway in the closure head when assembled. Fir tree root 170 extends across the lower end of block 160 from face 164 to back side 168. Near back side 168 in the fir tree root is a transversely cut round hole 178 for receiving the axial lock.

Pressure bar block 180 contains pressure bar 182 which positions the carbide pressure face slightly rearwardly and less than the thickness of the flake axially from the cutting edge of the blade in the blade block. Pressure bar 182 is set into a bored hole in the pressure bar block and locked into position by means of a jack lock 184 as shown in FIGS. 25-29, 34 and 35. Carbide portion 186 is attached to the end of bar 182 by braxing or other means. An approach compression angle 188 (FIG. 34) of about 2° with a relief angle 190 with the cutting angle of the blade, is satisfactory in most cases. Pressure bar block also has fir tree root with a transversely cut hole 196 to receive the axial lock.

FIGS. 30 to 33 show the thick flake disposable blade and blade holders. The blade 200 is similar to the thin flake blade, but heavier and includes the wing at one end of the cutting edge 204 or at both ends as shown so that a single blade may be used for both right and left hand heads. Arched blade holders 206 and 208 also are similar to those for thin flakes, but heavier and larger.

The fir tree roots are a relatively loose fit in the anchorages of the runner permitting easy installation and removal of the blocks. When at operating speed, however, fully reliable and calculable centrifugal forces preload the fir tree anchorages supporting the blade

blocks against overturning cutting forces and in proper radial and angular position.

Axial position is determined by the axial lock shown in FIGS. 21-24, 39, 42-44. The axial lock consists of two half round members 220 and 222, each with abutting flat surfaces and matching center holes through the flat faces. Half round 222, preferably, is cut on its ends to the profile of the fir tree root so that it contributes to the fir tree anchorage. Half round 220 extends outwardly at each side when assembled into the transverse hole of the fir tree anchorage. Half round 222 is mounted in the hole opposed to half round 220. Half round 220 has its flat face to the front side of the block providing a flat seating surface. A tube 224 is then inserted into a bored hole in the end of the fir tree root and through holes 226 and 228 locking them in proper central location within the hole in the fir tree root of the block.

As noted in FIG. 43, the runner 24 has a bored seat 230 in the fir tree anchorage bored from the back side of the runner. The axial lock seats at the end of bored hole 230 are stepped to conform to the axial advance of the bladeline. Stepped surfaces at the face of the closure head are also stepped to conform with the bladeline and the end of the blocks. When the runner with the blade blocks for the thin flake assembly and with pressure bar and blade blocks for the thick flake assembly is installed on the face of the proper closure head, all of the blades are held in proper and precise position conforming to the helical-spiral bladeline. The axial locks allow for some slight movement in seating of the fir tree roots in the anchorage of the runner as the cutterhead assembly accelerates to operating speed.

d. Jet Fluid Distributor, Seals and Passages

A ½ inch nozzle, the approximate size required for jet breaking and fluid conveying of thick flakes, discharges about 20 cubic feet of air per minute at 80 pounds per square inch gage pressure. About three horsepower is required to compress this quantity of air. In the case of thin flakes, smaller nozzles may be used, but then more nozzles are required.

The thick flake head shown employs 32 blade blocks and nozzles. While improved nozzles might reduce the quantity of pressurized fluid required, only about one-sixth of the nozzles are in the slicing area at one time. The quantity of fluid in any case can be reduced many times if a means is provided to distribute the flow only to those nozzles in the working area.

In FIG. 1 a rotary shaft seal 20 is shown mounted upon the extended hollow shaft at the front of the driving motor attached by a flexible hose or other means to a stationary source of compressed air or other pressurized fluid. This rotary shaft seal is of the type commonly used to provide steam to, and removal of condensate through a stationary pipe or tube from, a rotary steam heated drum.

The stationary tube of the rotary seal, shown as 44 in FIGS. 3 and 5, is mounted within the hollow motor shaft terminating at a bearing support 46 and a distributor disc 48 shown in greater detail also in FIG. 37. Disc 48 has a distributor aperture 60 leading from the tube to the outer cylindrical surface. The rotary seal, stationary tube and distributor are normally mounted as a unit on and within the hollow shaft of the driving motor.

The tapered bore of the closure head is the same for thin and thick flake assemblies shown in FIGS. 3 and 5. The tapered bore seats on the shaft end and is closed at its end by threaded plate 62 leaving space for the distributor disc between the plate and the end of the shaft. Fluid passages 64, 92 lead from the central bore at the distributor to the periphery branching out as required to axial passages leading to each tube portion of each axial lock and blade block fir tree root of the runner when attached to the face of the closure head.

When installed on the extended shaft by means of bolts 42, the head and shaft rotate while the tube and distributor remain stationary. When compressed air or other fluid is admitted to the rotary seal, it travels through the tube and the aperture 60 of the distributor and is allowed to flow only to those passages leading to the nozzles of the blade holders only in the working area. The close fit of the distributor disc in the bore of the closure head prevents most all of the fluid from escaping out the other passages. end

At the joint between the stepped platforms of the closure head and the fir tree root of the blade blocks, a fluid seal is provided. The seal comprises a housing or tube with a rolled internal flange at one end, a resilient cup 234, having a central aperture 236 and an internal compression spring 232 shown in FIGS. 23 and 24. The seal is mounted in a bored hole central to the passage and pressed into place so that the flange end of the housing tube is flush with the face of the closure head. When flaking and surfacing runner is attached to the face of the closure head, the resilient seal makes contact with the end of the fir tree root sealing the joint while air or other fluid passes through aperture 236 and tube 224 of the axial lock. Slight movement of the fir tree root in the anchorage of the runner may occur without disrupting the seal.

Passages 128, 130 and 132 in the thin blade blocks cooperate with the tube of the axial lock allowing fluid to flow to the blade holder slots. Comparable passages 176 are provided in the thick flake blade block.

In the thin flake blade holders, passages 152 and blade passage 146 terminate in nozzle 154 and also cooperate with the above passages in the blade holder slots providing a continuous passage of pressurized fluid from a stationary source to the nozzles in the slicing area.

In the thick flake blade holders, like passages 210 and blade passage 212 terminate in nozzle 214.

Assembly of the closure head on the extended shaft of the motor and of the runner and its related parts places the distributor, the passages, the seals and other parts in proper position and operating order.

Geometry and Principles of Design

The helical-spiral (radially retreating-axially advancing) blade line, the basis for the flaking and surfacing head design, may best be considered first as a plane spiral (radially retreating) on which the helix (axial advance) is later superimposed.

The spiral is the Spiral of Archimedes having a constant rate of retreat or advance corresponding to the polar equation r equals $a\theta$ wherein r is the radius, a is a constant, i.e., the advance or retreat per revolution and θ is the angle of rotation.

The spiral is related to the circle. The spiral in this case is made up of a series of circular arcs, one for each blade block, each of decreasing radius and—since for manufacturing reasons the blocks must all be identical—of increasing included angle.

The spiral corresponding to the above equation may best be generated by a point on the end of a thread as it unwinds from or winds upon a cylinder having a circumference equal to (a) in the formula or the retreat (or advance) per revolution.

The helix or axial advance is simply the thickness of the flake desired or the axial advance per blade block superimposed upon the spiral.

The spiral is shown in FIG. 11. The x , y , z coordinates of analytic geometry are used. The x , y plane is the plane of rotation of the cutterhead and the plane of the spiral. The z coordinate is the axis of rotation of the assembly and also represents the "offset" from the plane of the spiral. A positive z coordinate offset and a positive rotation of the x , y plane results in a right hand cutterhead while a negative offset and a negative rotation results in a left hand cutterhead. In FIG. 11, the thread line of the spiral is represented by 50, the thread cylinder by 52, the retreat of the spiral per revolution by 54. The retreat 54 is equal to the circumference of thread cylinder 52.

The cutting edges are on the thread line or radius from the point of tangency to the thread cylinder. The cutting edges or blades mounted in identical blade blocks must be equally spaced linearly along the spiral.

The linear space available for each blade block is the length of the spiral divided by the number of blade blocks desired. The length of the spiral is the average length of all of the circular arcs making up the spiral.

Arc length per blade block

$$= \frac{3.1416 (\text{maximum radius} + \text{minimum radius})}{\text{Number of blade blocks}}$$

Using lengths of circular arcs for unit radius available in engineering handbooks and degrees rather than radians, the position in angle and radius is calculated for each blade along the spiral. The helical position or axial advance is superimposed on the spiral along the z — z axis.

The results of these calculations are best compiled into a chart locating each blade, black block and fir tree root by radius from the point of tangency to the thread cylinder, by included angle from zero and by axial offset from the x , y plane.

In the case of the thick flake head, the procedure is the same except for half rather than a full revolution.

While a circle is closed a spiral is open permitting work to be introduced and removed at the open ends. The spiral is of little use near its point of origin, but improves with size. Therefore, there is a minimum practical size or radius to the spiral configuration. Because of physical limitations in use and manufacture, it cannot be too large either. The size outlined is best suited to the cutting of quality flakes from and surfaces upon residual lumber products generally not over 16 inches wide and produced in two inch multiples of width.

In FIG. 1, a log, a cant or a board is shown supported by suitable means moving longitudinally away from the observer and into the cutterhead assembly of the flaking and surfacing unit 10 and closure and hogging head 12. Protuberances, hogged away by hogging head 12

are discharged to waste conveyor 16. Flakes, sliced and broken away from the parent wood and fluid conveyed through the passageways of the cutterhead assembly, are discharged to flake collector 14 and thence to an exhaust duct. Motor 18 drives the cutterhead assembly mounted on its extended driving shaft. A pressure joint 20 at the front of the motor provides for introduction of pressurized fluid to the rotating motor shaft.

In some soft woods, for example, a cutting force of 12 pounds is required to cut thin flakes $0.011 \times b \times 1$ inches using a micro-sharpened blade. The assumed maximum cut is of a 2×12 area at 100 feet per minute. In the case of the thin flake assembly, 19 blades would be in the cut at an average radius of 1.5 feet. At 1,200 rpm, the power requirement computes to 72 horsepower. Ordinarily a full cut would not occur together with a hogging cut. The intermittent hogging cut does not enter into horsepower computations. Some power is used to accelerate the flakes and to overcome friction and windage losses.

For thick flakes $\frac{1}{2} \times 1$ inch, the cutting load, including the friction load of the pressure bars approximates 50 pounds per blade. For the same 2×12 area and 100 feet per minute feed speed, with four pressure bar and blade assemblies in the cut and at 600 rpm, the power requirement computes to 37 horsepower. A 100/50 HP, 1,200/600 rpm, 250 percent pullout squirrel cage motor of low slip design will serve to drive the interchangeable cutterhead assemblies.

Method of Operation

FIGS. 36 and 38 present a simplified picture of thin and thick flake cutting respectively. As the log or cant L progresses past the cutterhead 22, 80 the blades 140, 200 are moving in a downward path and slice the flakes from the parent wood. Note in FIGS. 2 and 4 the horizontal spaced dash-dot lines which represent a typical cutting area in relation to total cutterhead size. As a cutting edge 142, 204 slices through the wood the severed material enters a discharge passage on the rear side of the cutting edge. The nozzles or orifices 154, 214 and passages are formed in the blade blocks, holders and blades to direct a jet of fluid against the severed flake material as it enters the evacuation passage so that a flake is broken off the severed material. As mentioned above, the thin flake cut is inclined to be severed from the parent wood in the form of a long spiral while the thicker cut tends to break into a variety of lengths as it is severed. The angle and location of the fluid jet therefore will determine the approximate range of width to which a flake is broken from the parent wood. The jet from the nozzles or orifices, which preferably is compressed air but which may be steam or other fluid under pressure, impinges on the

side of the wood flake bending it and thus breaking it from the sliced material. In the case of the thin flakes cut at higher speed the flake is bent further than the reflected angle and is snapped off. In the case of the thick flakes cut at slower speeds the jet bends the flake at a greater angle than the cutting angle thus breaking it from the parent wood. Also in the case of the thicker flake, and for reasons described above, a pressure bar 180 is used to insure a quality cut and to give more consistent and smoother flow of severed material from the parent wood.

It will be appreciated that the fluid jet into the discharge passage not only breaks the flake but conveys it away from the cutting area. The jet in effect pulls the wet, sticky flake from the parent wood and jet streams it through the discharge passages and into the exhaust or evacuator duct 14 and from thence to appropriate conveyors. Here the fluid serves as a conveyor medium which is necessary in the evacuator equipment.

Those skilled in the art will understand that the optional hogging cutters may be installed on the cutterheads to hog away flares and other protuberances on the log.

With thin flakes, the nozzles are located to break the flakes to a preferred $\frac{1}{2} \times \frac{1}{2}$ range of width and with thick flake to a $\frac{1}{2}$ to 1 inch range. Obviously the nozzles may be moved to produce other desired flake widths.

I claim:

1. In the production of wood flakes from and a flat surface upon the side of a log, cant or board by a limited succession of across-the-grain slicing cuts, in parallel planes respectively, while moving the wood in a direction substantially parallel to said cutting planes and at a speed synchronized with the speed of cutting, the process steps of:

- hogging away and discharging excess material, thereby preparing a surface for a first slicing cut;
- slicing a first flake to predetermined thickness and length;
- severing the end of the flake;
- discharging said flake separately from hogged off material;
- following said first slicing cut by a limited succession of additional slicing cuts which when terminated results in a flat surface having been cut on the side of a log, cant or board.

2. The process steps of claim 1, wherein said severing step comprises jet breaking of the flake of predetermined thickness and length from the parent wood along the grain to a predetermined range of width.

3. The process steps of claim 2 including the fluid evacuation of said flake of predetermined thickness, length and width individually from the slicing and breaking area.

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