United States Patent [19]

Ruble

[11] **3,896,591**

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[54] **MACHINE FOR SHARPENING DISC BLADES**

[76] Inventor: **Lloyd J. Ruble,** 225 S. California, Tulare, Calif. 93274

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[52] **U.S. Cl.** ..... **51/126;** 51/132; 51/209 R; 51/266

[51] **Int. Cl.** **B24b 3/60**

[58] **Field of Search** ..... 51/132, 106 R, 51, 356, 51/266, 124 L, 124 R, 209 R, 126, 237 R, 225

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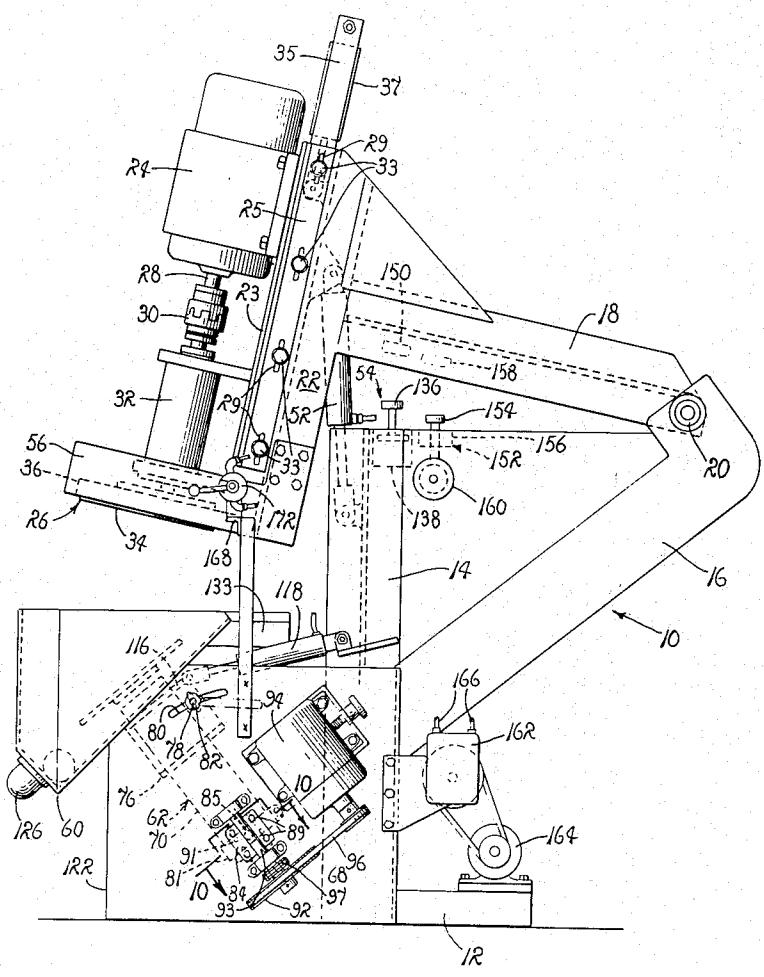
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Primary Examiner—Al Lawrence Smith
Assistant Examiner—Nicholas P. Godici
Attorney, Agent, or Firm—Vergil L. Gerard

[57] **ABSTRACT**

A machine for sharpening disc blades consisting of a base, a lower frame, and an upper frame. The upper frame has a drive motor which drives a vertically disposed shaft with a grinding stone mounted on the lower end. The lower frame has a mandril which extends upwardly toward the grinding stone with its support shaft disposed at an angle with respect to the grinding stone shaft. The angle of the mandril shaft with respect to the grinding stone shaft is variable by an adjustment mechanism and the upper end of the mandril has a clamp for securing disc blades to the mandril. The mandril is rotatably driven by a mandril drive motor mounted on the base. The upper end of the mandril shaft is disposed in a liquid tank so that the disc blade is submerged during the grinding contact, thus eliminating noise and flying chips. Effective sharpening of the disc blades is accomplished by rotating the mandril holding the disc blade more slowly than the grinding wheel is rotated and by varying the angle of contact between the disc blade edge and the grinding stone by adjusting the angle between the mandril shaft and the grinding wheel shaft.

20 Claims, 10 Drawing Figures



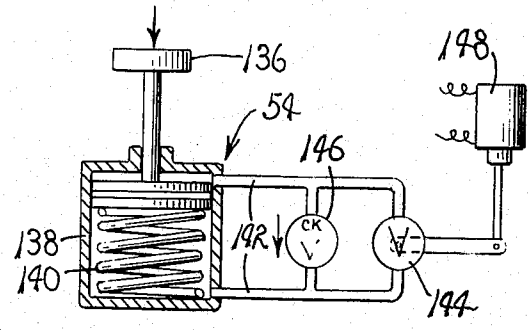


FIG. 9.

FIG. 1.

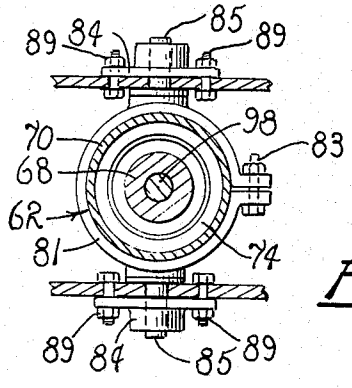


FIG. 10.

FIG. 8.

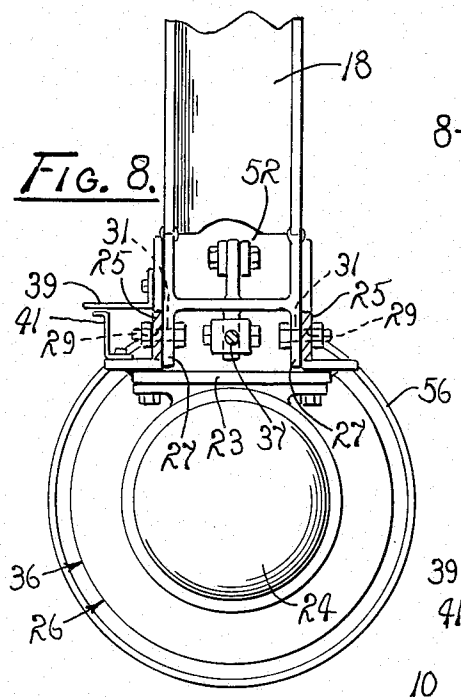
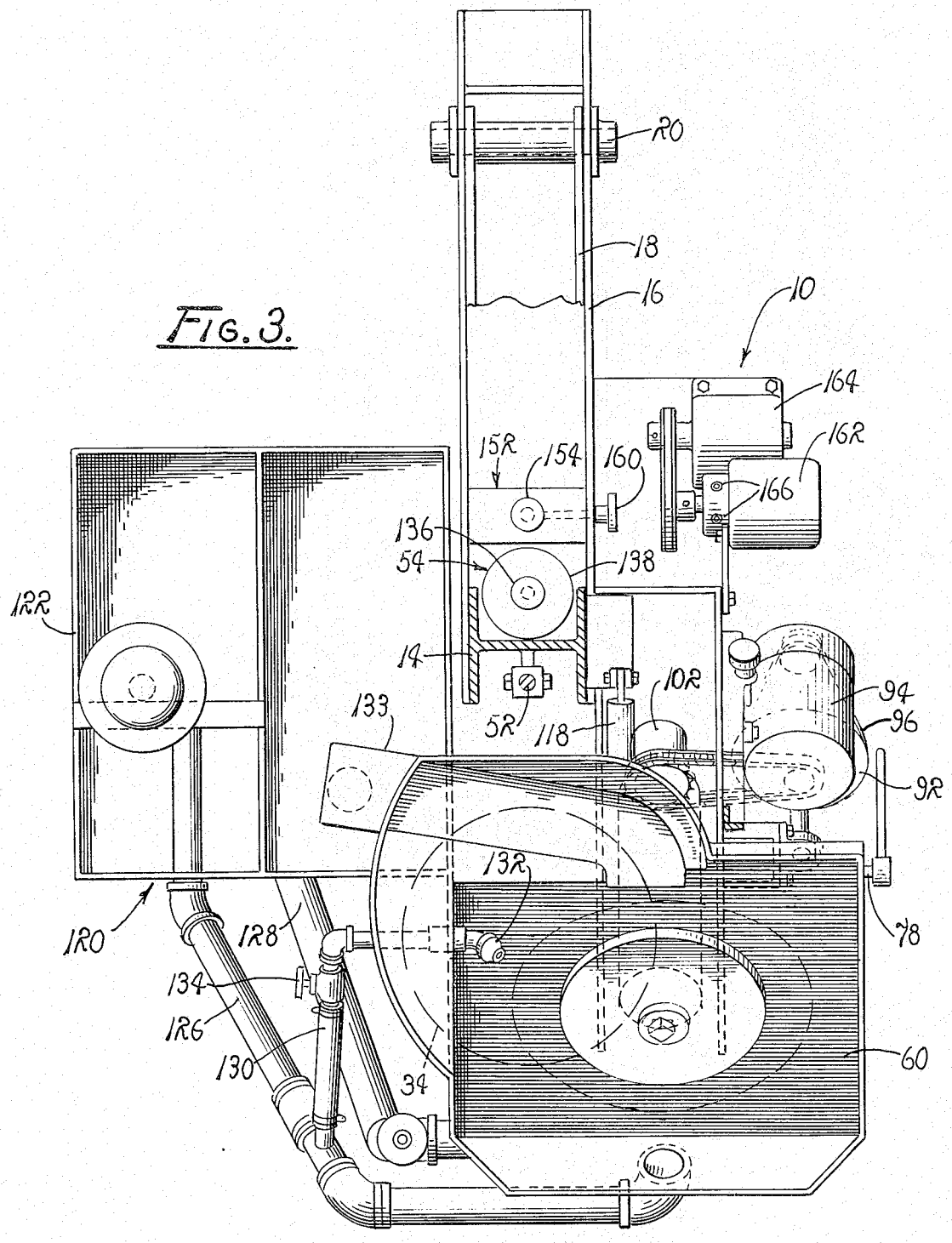

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FIG. 2.

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FIG. 3.


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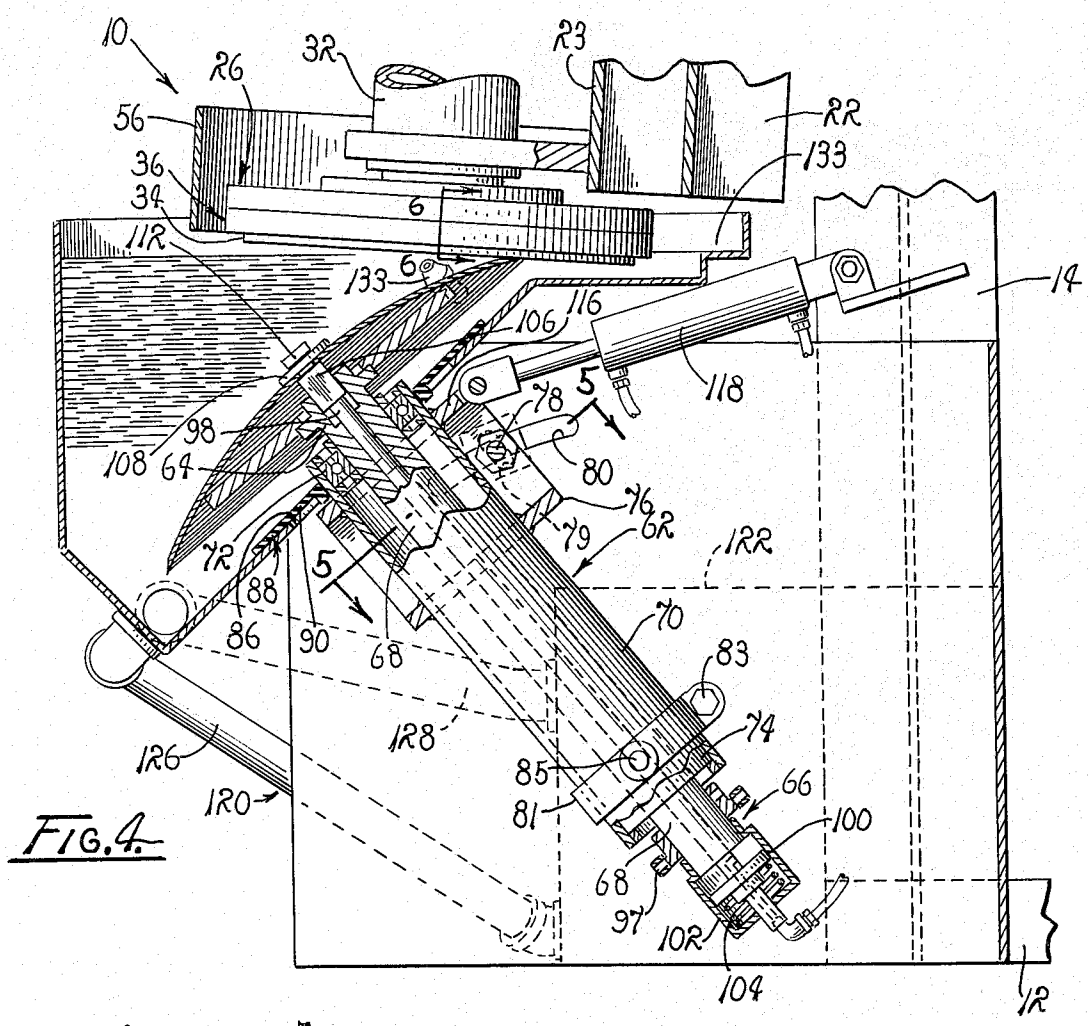


FIG. 4.

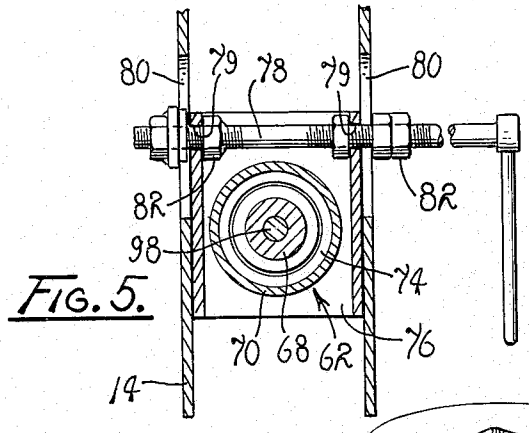


FIG. 5.

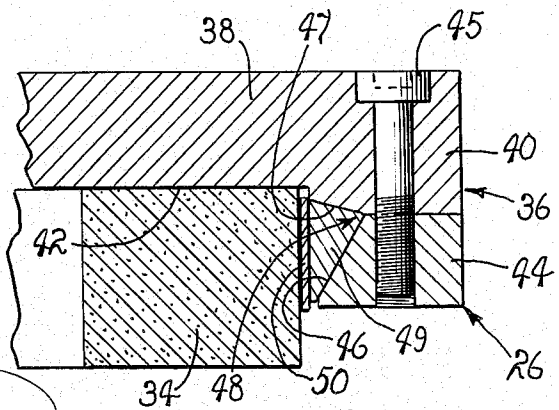


FIG. 6.

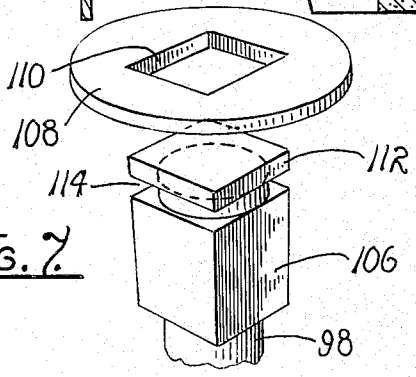


FIG. 7.

MACHINE FOR SHARPENING DISC BLADES

BACKGROUND OF INVENTION

This invention relates generally to grinding machines and more particularly to machines for grinding the peripheral edges of concave disc blades.

Circular concave steel blades ganged together to form a disc are used for a variety of purposes, including plowing earth for farming and tearing up an asphalt road surface for replacement or repair. The peripheral edges of the disc blades are sharpened to provide the necessary cutting action in performance of their work and with use become dull and must be resharpened. The disc blades are made of hardened steel and resharpening, therefore, requires a substantial amount of grinding. Since the disc blades are circular and concave an effective resharpening job requires that the grinding stone be moved around the periphery of the blade at varying tangential angles to the blade surface so that the peripheral edge of the blade is given substantially the same amount and angle of grinding at each point. Normally, the surface of the grinding wheel first engages the peripheral edge of the blade with the plane of the wheel disposed only at a slight angle to a plane normal to the axis of the disc and as the sharpening progresses the grinding wheel surface is moved to a greater angle to the normal plane as the grinding cut moves outwardly to the outermost periphery of the blade.

Various machines and equipment have been utilized to perform this grinding function. These vary from vertically mounted grinding wheels with the disc blades mounted on a supporting shaft and held against the wheel surface and at an angle to the wheel by hand, to machines which support the disc and the grinding wheel and bring them together for abrasive contact by moving the disc blade or the grinding wheel or both.

Because of the hot particles chipped away from the blade during grinding in the form of sparks, the heat which the grinding friction generates in the blade, and the noise produced, it is desirable to hold the blade in water or some other liquid during grinding.

The equipment heretofore known has not been effective in combining all these desired features into a grinding machine which can be operated by a single operator efficiently and with satisfactory results.

It is, therefore, a major object of my invention to provide a machine for grinding disc blades which can be operated by a single operator and will produce the desired sharpening in a minimum amount of time.

Another object of my invention is to provide a machine for grinding disc blades of the type described in which the disc blades are submerged in liquid during the grinding operation to trap hot particles, keep the blade steel cool, and minimize noise.

A further object of my invention is to provide a machine of the type described in which the disc is automatically rotated during the sharpening operation to provide uniform contact between all points on the blade periphery and the grinding wheel.

Still another object of my invention is to provide a machine of the type described in which the mandril which mounts the disc blade is movable angularly with respect to the surface of the grinding stone to vary the tangential angle of contact between the grinding stone and the blade edge.

Yet a further object of my invention is to provide a machine of the type described in which the blades can be readily mounted and dismounted from the support mandril and the grinding stone can be readily changed.

Still a further object of my invention is to provide a machine of the type described which is relatively inexpensive to manufacture and requires a minimum of time and operator skill in use.

These and other objects of my invention will become more readily apparent from the following detailed description of a preferred embodiment and the accompanying drawings in which:

FIG. **1** is a side elevational view of a preferred embodiment of my invention;

FIG. **2** is a front elevational view of the machine shown in FIG. **1**;

FIG. **3** is a sectional plan view taken on line **3—3** in FIG. **2**;

FIG. **4** is a partial sectional side elevational view taken on line **4—4** in FIG. **2**;

FIG. **5** is a partial sectional view taken on line **5—5** in FIG. **4**;

FIG. **6** is an enlarged partial sectional view taken on line **6—6** in FIG. **4**;

FIG. **7** is an exploded perspective view of the disc blade mounting mechanism in my preferred embodiment;

FIG. **8** is a partial sectional plan view taken on line **8—8** in FIG. **2** and showing the grinding wheel and its drive motor;

FIG. **9** is a schematic view of the hydraulic control for the grinder wheel feed mechanism; and

FIG. **10** is a partial sectional view taken on line **10—10** in FIG. **1**.

Referring now to the drawings, and particularly FIGS. **1** and **2** thereof, the numeral **10** designates my disc blade grinding machine generally. The machine **10** has a base **12** with a lower frame **14** extending upwardly therefrom. The lower frame **14** is generally V-shaped upwardly and has a rearwardly directed structural support portion **16.** An upper frame **18** is mounted on the lower frame **14** by a hinge **20** connected to the upper end of the lower frame structural support **16.**

The upper frame **18** has a grinding wheel support head **22** on its distal end with respect to the hinge **20.** The grinding wheel support head **22** is disposed generally vertically and has a grinding wheel mounting plate **23,** movably mounted thereon. The grinding wheel mounting plate **23** carries a grinding wheel drive motor **24** on its upper portion and a grinding wheel **26** on its lower portion. The grinding wheel **26** is connected to a shaft **28** of the drive motor **24** by means of a coupling **30.** Below the coupling **30,** the drive shaft **28** passes through a bearing housing **32** with thrust bearings (not shown) which support the weight of the grinding wheel. The grinding wheel mounting plate **23** is secured to the grinding wheel support head **22** by a pair of mounting plate flanges **25** positioned on each side of the grinding wheel mounting plate **23.** The mounting plate flanges **25** extend rearwardly, substantially normal to the grinding wheel mounting plate **23** and overlap support head flanges **27** on the grinding wheel support head **22.** The mounting plate flanges **25** have vertically extending slots **29** which align with holes **31** in the support head flanges **27.** Bolts **33** are disposed through the slots **29** and holes **31** to releasably secure the flanges together. A mounting plate lift frame **35** is attached to both sides of the grinding wheel mounting plate **23** and

extends upwardly therefrom above the grinding wheel support head 22. A hydraulic mounting plate adjustment cylinder 37 is connected between the grinding wheel support head 22 and the mounting plate lift frame 35 and, upon actuation, moves the grinding wheel mounting plate 23 vertically with respect to the grinding wheel support head 22 when the bolts 23 are released to permit movement. Movement of the grinding wheel mounting plate 33 with respect to the grinding wheel support head 22 adjusts the vertical position of the grinding wheel 26 and compensates for wear as more fully explained later. The vertical adjustment position of the grinding wheel is indicated by a scale plate 39 mounted on the grinding wheel support head and disposed in indicating relationship with a pointer 40 mounted on the grinding wheel mounting plate (see FIGS. 2 and 8).

The grinding wheel 26 consists of a torodial grinding stone 34 mounted in a grinding wheel chuck 36 attached to the lower end of the shaft 28 below the bearing housing 32. As best shown in FIG. 6, the grinding wheel chuck 36 has a backing plate 38 connected to the shaft 28 with a peripheral rim 40 projecting normal thereto to provide a cavity 42. An annular retaining ring 44 is secured to the face of the peripheral rim 40 by bolts 45, and has a beveled surface 46 on its inner edge which tapers outwardly and upwardly toward the rim 40. The rim 40 has a beveled surface 47 on its inner edge which tapers outwardly and downwardly to meet the uppermost end of the surface 46 and form a wedge shaped annular slot 48. A wedge shaped split ring 49 is disposed in the slot 48 and has mating surfaces which are engaged by the beveled surfaces 46 and 47. The beveled surfaces 46 and 47 are so disposed that tightening the bolts 45 to draw the annular retaining ring 44 toward the rim 40 forces the split ring 49 radially inward into the cavity 42 to engage and grip the periphery of the grinding stone 34. To prevent damage to the grinding stone 34 by this griping action of the split ring 49, a gasket 50 is mounted on the periphery of the stone. The gasket 50 does not extend to the face of the stone so that it produces no interference with its grinding function, and further, even if the stone face is worn to the point where the gasket is exposed to the grinding area, the gasket merely wears off without effect on the grinding. The upper bevel 47 is made very slight to avoid pressing the grinding stone upward into the chuck when the split ring 49 is driven inwardly.

The torodial grinding stone 34 has an outside diameter substantially the same as the inside diameter of the peripheral rim 40 on the grinding wheel chuck 36 and a thickness substantially greater than the depth of the cavity 42 so that the grinding stone can be fitted into the cavity and retained there by the griping action of the jaw members 49, and when so retained the lower portion of the stone will project downwardly therefrom beyond the lowermost portion of the retaining ring 44.

The upper frame 18 is pivotally movable about the hinge 20 by means of a hydraulically operable grinding wheel contact cylinder 52 which is connected between the upper portion of the lower frame 14 and the distal portion of the upper frame 18. In its lowermost pivotal position the upper frame rests upon the lower frame and the shaft 28 is positioned substantially vertical, disposing the lower surface of the grinding stone in a substantially horizontal plane. By activation of the grinding wheel control cylinder 52, the upper frame can be moved pivotally upward from the lower frame, tilting the lower end of the grinding wheel drive shaft 28 outwardly from the lower frame and swinging the lower surface of the grinding stone so that its plane is angularly offset from the horizontal. Swinging the upper frame 18 between its lower and upper positions thereby causes the lower surface of the grinding stone to trace an arcuate path.

The pivotal movement of the upper frame 18 with respect to the lower frame through activation of the grinding wheel control cylinder 52 is achieved by a grinding wheel position control 54 hereafter described in greater detail.

To protect the operator from injury, the grinding wheel is covered by a band-shaped guard 56 which leaves the lower surface of the grinding stone exposed for engagement with the disc blade. Below the grinding wheel and mounted on the lower frame 14 is a grinding wheel pan 58 into which the grinding wheel fits when the upper frame 18 is in its lowermost position. The grinding wheel pan 58 has a semicircular lower surface which drops off into a tank 60.

A disc blade support mandril 62 has an upper end 64 which projects upwardly into the tank 60 and has a lower end 66 which extends downwardly outside the tank toward the base 12 of the machine. The mandril 62 has a hollow driveshaft 68 which is rotatably mounted in a mandril support housing 70 by means of an upper end bearing 72 and a lower end bearing 74. The mandril support housing 70 has its upper end mounted in the lower frame 14 by means of a mounting frame 76 which is secured to the lower frame by a locking stud 78. The locking stud 78 passes through an arcuate slot 80 in the lower frame and a vertically disposed linear slot 79 in the mandril upper end 64. A lock nut 82 is provided to thread onto the locking stud 78 and secure the stud in a particular position in the arcuate slot. The lower end of the mandril support housing 70 is mounted on the lower frame by means of a trunion bearing 84 which permits movement of the upper end of the mandril in an arcuate direction so that proper positioning of a disc blade with respect to the grinding wheel 26 can be achieved, as later explained.

The trunion bearing 84 is mounted on the mandril support housing 70 by means of a releasable clamping band 81 secured by a band bolt 83 (see FIG. 10). Since the clamping band 81 is releasable by means of the band bolt 83 it is slidable up or down on the mandril support housing 70 to adjust its mounting point. Also, the stub shafts 85 of the trunion bearing 84 are mounted to the lower frame 14 by means of bearing caps 87 which are secured to the frame by bearing cap bolts 89. (See FIGS. 1 and 2) The bearing cap bolts 89 are mounted in frame slots 91 in the lower frame which are generally aligned with the axis of the mandril support housing 70, so that the mounting point of the stub shafts 85 in the lower frame 14 is also adjustable. The adjustability of the clamping band 81 on the mandril housing 70 and the stub shafts 85 in the lower frame 14 permit adjustment of both the radius and the center point of the arcuate movement of the upper end 14 of the mandril, as more fully explained later.

The upper end of the mandril support housing 70 projects into the tank 60 through an opening 86 which is substantially larger than the mandril support housing to accommodate arcuate movement at the upper end of the housing, as previously explained. A seal 88 is

provided about the opening **86** to prevent leakage of liquid from the tank **60.** The seal consists of a flanged collar **90** disposed normal to the driveshaft of the mandril and mounted on the upper end of the mandril support housing **70.** The collar **90** is of sufficient size to overlap the peripheral edges of the opening **86** through which the mandril support housing passes and to permit movement of the mandril support housing in the opening without exposing the opening for the tank.

To rotate the mandril driveshaft **68,** a drive pulley **92** is provided on a power transfer shaft **93** adjacent the lower end of the mandril **62** and is driven by a mandril drive motor **94** through a drive belt **96** (see FIG. **1**). The mandril **62** is, in turn, driven by the power transfer shaft **93** through a chain and sprocket drive **97.**

To hold a disc blade on the upper end of the mandril **62,** a lock shaft **98** is provided in the bore of the mandril driveshaft **68.** The lock shaft **98** moves reciprocally in the mandril driveshaft bore from an extended position in which the upper end of the lockshaft projects upwardly beyond the upper end **64** of the mandril, to a retracted position where the upper end of the lock shaft is withdrawn into the upper end of the mandril. The reciprocal movement of the lockshaft **98** is powered by a hydraulically actuated piston **100** attached to the lower end of the lockshaft and enclosed by a housing **102.** The piston **100** is biased by a spring **104** to drive the lockshaft upwardly and is powdered hydraulically to drive the lock shaft downward against the spring bias in a manner well known in the art (see FIG. **1**).

At the uppermost end of the lockshaft, a sloted head **106** is formed which cooperates with a lock plate **108** to lock disc blades to the lockshaft. The lock plate **108** has a square center bore **110** which fits over the square flange **112** on the sloted head **106** but is locked on the head by one quarter rotation in the slots **114** (see FIG. **7**). The slotted head **106** is small enough to pass through the bore in a disc blade but the lock plate is larger than the disc blade bore so that when the slotted head **106** is moved to its upper position a disc blade may be mounted on the lockshaft by inserting the slotted head through the disc blade bore, setting the lock plate **108** over the slotted head and rotating it one quarter turn to lock it in the slots **114** and then retracting the lockshaft **98** to engage the upper surface of of the blade with the lock plate. To support the lower surface of the disc blade and provide secure clamping of the disc blade to the blade and provide secure clamping of the disc blade to the mandril **62,** a mandril mounting plate **116** is affixed to the mandril driveshaft **68** at its upper end. The mandril mounting plate **116** projects radially outward from the mandril drive shaft a distance sufficient to provide a secure mounting base for the disc blade but less than the disc blade diameter to avoid interference with the grinding of the peripheral edges (see FIG. **4**).

The disc blade is thus clamped between the lock plate **108** engaged in the slots **114** on the slotted head **106** on the upper end of the lockshaft and the periphery of the mandril mounting plate **116** on the upper end of the mandril driveshaft, when the lockshaft is driven to its retracted position by actuation of the piston **100.**

To vary the angular dispostion of the axis of mandril **62,** a mandril position cylinder **118** is provided. The mandril position cylinder **118** is hydraulically actuated and is connected between the lower frame **14** and the upper end **64** of the mandril, so that extension of the cylinder arm drives the upper end **64** downwardly and retraction draws it upwardly along the arc defined by the arcuate slot **80.** The locking stud **78** and its locknut **82** releasably secure the mandril upper end **64** in its desired position, and the vertically disposed linear slot **79** allows adjustment of the locking stud **78** in the mandril upper end **64** during its arcuate movement in slot **80.**

The tank **60** is filled with water by means of a water supply system **120.** The water supply system **120** includes a reservoir **122,** and a water pump **124** (see FIG. **2**). The reservoir **122** is connected to the tank **60** by means of a main supply line **126,** a return line **128,** and an upper supply line **130** which branches off of the main supply line and delivers water under pressure to the grinding wheel pan **58** by means of a nozzle **132.** The nozzle **132** directs water against the lower surface of the grinding stone **34** so that the point of grinding action is cooled and the generated sparks are contained and noise controlled (see FIG. **4**). The water delivered by the nozzle **132** runs off from the grinding wheel pan **58** into the tank **60.** A flow control valve **134** is provided in the return line **128** to control the water circulation and maintain the water in tank **60** at a constant level. Regulation of the flow control valve **134** with the capacity of the pump **124** will assure prompt filling and emptying of the tank **60** and will limit the high water level to the height of the grinding wheel pan **58.** To remove any excess water from the grinding wheel pan **58** an overflow drain **133** is provided.

The grinding wheel position control **54** consists of a control plunger **136** mounted in a cylinder **138** on the upper surface of the lower frame **14** (see FIGS. **1** and **9**). The plunger **136** is biased to an upper position by a spring **140** in the cylinder **138.** The cylinder **138** is filled with hydraulic fluid and has bypass lines **142** which connect the upper portion of the cylinder to its lower portion through a control valve **144.** The control valve **144** permits fluid flow from the lower to the upper portion of cylinder **138** at a controlled rate so that the travel of the plunger **136** from its upper position to its lower position in cylinder **138** against the bias of spring **140** is restricted in speed. A check valve **146** is provided which is a one-way valve and permits free flow of fluid from the upper to lower portions of cylinder **138,** for free return of the piston to its upper position. Thus, after the plunger **136** has been driven to its lower position in the cylinder **138,** it can be quickly returned to its upper position under the bias of spring **140** as soon as the driving pressure on the piston is released. The control valve **144** is regulated by a control valve solenoid **148.** The solenoid **148** can be electrically connected with the drive motor **24** so that the feed rate of the grinding wheel is controlled by the load on the motor.

The plunger **136** of the grinding wheel position control **54** is engaged by a control foot **150** on the upper frame **16** when the upper frame is lowered into grinding position by the grinding wheel cylinder **52,** and controls further downward movement of the grinding wheel **26.** To limit the extent of downward movement of the grinding wheel **26,** a limit stop **152** is provided on the upper surface of the lower frame **14** adjacent the grinding wheel position control **54.** The limit stop **152** consists of a limit stud **154** which is vertically adjustable by threading in a stud base **156** on the lower frame **14,** and is engaged by a limit foot **158** on the upper frame **16.**

A limit stop adjustment wheel **160** is provided to readily adjust the position of the limit stud **154** through a worm gear (now shown).

To provide actuation for the hydraulic controls and actuators, a hydraulic pump **162** is provided on base **12** which is driven by an electric motor **164** and supplies hydraulic fluid through lines **166.**

To control the hydraulic actuators, control valves are also provided on a platform **168** at a convenient position on the machine (see FIG. 2). These control valves include a grinding wheel position control valve **170** which controls the actuation of the grinding wheel positioning cylinder **52,** a lockshaft control valve **172** which controls the reciprocal positioning of the lockshaft **98** through piston **100** in cylinder **102,** and a mandril position control valve **174** which controls the angular dispostion of the axis of the mandril **62** through mandril position cylinder **118.** A control valve for the bypass valve control **148** and electric switches for controlling the hydraulic pump drive motor **164,** the water pump **124,** the grinding wheel drive motor **24,** and the mandril drive motor **94,** are provided at other appropriate places on the machine and are not shown by the drawings.

OPERATION

Having described the various parts of my machine I will now describe its operation.

To sharpen the peripheral edges of a disc blade, the blade is placed in the tank **60** over the upper end **64** of the mandril **62** with concave shape directed downwardly and slotted head **106** on the lockshaft **98** projecting through the bore in the center of the disc blade. During this installation the grinding wheel **26** is swung to its upper position, away from the point of installation, by pivoting the upper frame **16** upwardly about the hinge **20** by actuation of the grinding wheel positioning cylinder **52** (see FIG. 1). The lockshaft **98** of the mandril **62** is reciprocated to its upward position with the slotted head **108** projecting above the upper end of the mandril, by release of the piston **100** in the cylinder **102** to the biasing of spring **104.** And, the grinding wheel position control **54** is reset by raising the grinding wheel head to permit plunger **136** to be driven to its upper position by the bias spring **140.** Also, though the water pump **124** and the hydraulic pump drive motor **164** are in operation, the grinding wheel drive motor **24** and the mandril drive motor **94** are off.

With the disc blade positioned on the upper end **64** of the mandril **62** and over the slotted head **106** of the lockshaft **98,** as described, the blade is brought to rest on the mandril mounting plate **116.** The lock plate **108** is then placed over the slotted head **106** and rotated a quarter turn to secure it in the slots **114.** Next, the lockshaft control valve is actuated to draw the lockshaft **98** downward by action of hydraulic fluid on the piston **100,** and thus clamp the disc blade on the upper end **64** of the mandril between the locking plate **108** and the mandril mounting plate **116.**

With the grinding wheel drive motor **24** still off, the grinding wheel is then lowered into contact position with the disc blade and the angular and axial disposition of the mandril axis adjusted by releasing the lock nut **82** on locking stud **78** and tilting the mandril upper end **64** in the trunion bearing **84** by means of mandril positioning cylinder **118** and its control valve **174,** and if necessary, by adjusting the position of the trunion on the mandril housing and in the lower frame. When the proper contact angle is established between the lower surface of the grinding stone **34** and the peripheral edge of the disc blade to provide the desired sharpening, the mandril is locked in this position by tightening the lock nut **82** on the locking stud **78,** and the mandril positioning cylinder **118** is deactivated.

The grinding wheel is then raised again by the grinding wheel position control valve **170,** and the grinding wheel position control is set for the desired feed rate. Also, the limit stop **152** is adjusted to the desired maximum depth of cut.

With the machine thus set up, the grinding wheel drive motor **24,** and the mandril drive motor **94,** are turned on to commence rotation of the grinding stone and the disc blade.

By proper drive connection means the grinding stone **34** is made to rotate many times faster than the disc blade so that adequate grinding is provided along the peripheral edge of the blade.

Next, the grinding wheel is lowered by grinding wheel position control valve **170** into contact with the peripheral edge of the disc blade and the water pump **124** is started so that the tank **60** is filled and a water spray is delivered to the point of contact by the nozzle **132.**

As the grinding wheel **26** reaches its lower position, the control foot **150** on the upper frame **16** engages the plunger **136** of the grinding wheel position control **54** and the weight of the upper frame drives the plunger downward in the cylinder **138.** Since the fluid in the cylinder **138** must transfer from the lower to the upper portion of the cylinder through the control valve **144** in order for the plunger **136** to move downwardly, the speed of downward movement of the upper frame, and, therefore, of the grinding wheel, is controlled by the control valve.

When sufficient time has passed the plunger **136** will be driven downward far enough for the limit foot **158** on the upper frame **16** to engage the limit stud **154** and further downward movement will be thereby prevented.

At this point, the disc blade edge will be inspected and if necessary to achieve the proper sharpening, the grinding operation can be recycled with the blade edge positioned at a different angle to the stone surface by resetting the angular disposition of the mandril axis.

When the desired sharpening is achieved, the disc blade is removed and a new blade applied to the mandril **62** in the manner previously described.

It will be understood, of course, that during the grinding operation, all of the disc blade except the small portion at the point of contact with the stone will be submerged in the water in tank **60,** and even the portion at the point of contact will be subject to water spray from the nozzle **132.** The sparks, noise and heat normally which accompany grinding will, therefore, be virtually eliminated.

Furthermore, it will be seen that disc blades can be rapidly applied to and removed from my machine, the grinding can be carefully controlled as to both rate and angle, and all this can be achieved by one operator without any substantial manual effort.

When the grinding stone **34** becomes sufficiently worn to merit it, a new stone can be applied by merely loosening the bolts **45** which hold the retaining rim **44** of the grinding wheel chuck **36** to release the worn stone, inserting a new stone banded with the gasket **50**

and securing it in the chuck by tightening the bolts **45** to drive the split ring **49** against the gasket.

It will thus be understood that I have provided a machine for sharpening disc blades which is fully capable of achieving the objects and providing the advantages heretofore attributed to it.

I claim:

1. A machine for sharpening disc blades comprising:

a frame;

grinder means operatively associated with said frame;

said grinder means having a grinding surface disposable in a generally horizontal grinding plane and rotatable about an axis, said grinder surface having a configuration sufficient to grind the edges of a disc blade;

mandril means operatively associated with said frame and said grinder means, said mandril means includes a mandril housing with a mandril rotatable therein about an axis, said mandril having a proximal end disposed adjacent said frame and a distal end disposed adjacent said grinding plane, and disc blade mounting means on the distal end of said mandril disposed to releasably mount a disc blade for engagement by said grinder means;

grinder mounting means mounting said grinder means in said frame for linear movement in alignment with said grinding surface axis and for pivotal movement to swing said grinder means between a work position with said grinding surface in said grinding plane and a rest position with said grinding surface remote from said grinding plane; and

mandril mounting means mounting said mandril means in said frame with the axis of said mandril means disposed to form an acute angle with said grinding plane, said mandril mounting means having arc adjustment means operable to pivot said mandril means about a pivot point disposed along the axis thereof to vary said acute angle between said grinding plane and said mandril axis, and axial adjustment means operable to vary the position of said pivot point along said mandril axis, said mandril mount-means including a pivotal mounting mounted on said mandril housing adjacent the proximal end of said mandril and supported in said frame, said pivotal mounting being movable axially with respect to said mandril housing in alignment with said mandril axis and being movable with respect to said frame to vary the distance between said point of support in said frame and said grinding plane.

2. A machine for sharpening disc blades as described in claim **1**, in which:

said mandril mounting means further includes a trunnioned collar releasably clamped to said mandril housing adjacent said proximal end and axially movable on said housing for adjustment of said point of clamping, trunnion bearings on the trunnions of said collar, bearing housings operatively associated with said trunnion bearings and releasably attachable to said frame, elongated slots in said frame disposed to receive said trunnions and permit movement of said trunnions in said slots upon release of said attachment of said bearing housings, all operatively associated to pivotally mount the proximal end of said mandril to said frame.

3. A machine for sharpening disc blades as described in claim **1**, in which:

said mandril means includes a mandril having a proximal end mounted to said frame and a distal end disposed adjacent said grinding surface with disc blade clamp means thereon, said disc blade clamp means having a lock shaft interconnected with said mandril with a proximal end adjacent the proximal end of said mandril and a distal end adjacent the distal end of said mandril and disposed for reciprocating axial movement with respect to said mandril from an extended position with said distal end of said lock shaft extended outwardly from the distal end of said mandril to a retracted position with the distal end of said lock shaft substantially coextensive with the distal end of said mandril, and having a disc blade mounting plate on the distal end of said mandril, and further includes a lock plate releasably attachable to the distal end of said lock shaft to engage and clamp said disc blade against said disc blade mounting plate when said lock shaft is in its retracted position, and further includes drive means operatively associated with said mandril and said lock shaft and disposed to reciprocate said lock shaft as aforesaid.

4. A machine for sharpening disc blades as described in claim **1**, in which:

said mandril means includes a mandril having a proximal end and a distal end, a housing, a hollow drive shaft rotatably mounted in said housing, a disc blade mounting plate attached to the distal end of said drive shaft, a lock shaft disposed in the bore of said drive shaft and reciprocally movable with respect thereto from an extended position with the distal end of said lock shaft projecting outwardly beyond the distal end of said drive shaft to a retracted position with the distal end of said lock shaft substantially coextensive with the distal end of said drive shaft, a clamp plate releasably interlocked with the distal end of said lock shaft and disposed to engage a disc blade about its center opening and clamp said disc blade to said disc blade mounting plate when said lock shaft is reciprocated to its retracted position, lock shaft drive means operatively associated with said drive shaft and mandril housing and actuable to reciprocally drive said lock shaft between said extended and retracted positions, and drive shaft drive means operatively associated with said mandril housing and said drive shaft and disposed to rotate said drive shaft and a disc blade mounted thereon; and

said axial adjustment means of said mandril mounting means includes a trunnioned collar releasably clamped to said mandril housing adjacent said proximal end and axially movable on said housing for adjustment of said point of clamping, trunnion bearings on the trunnions of said collar, bearing housings operatively associated with said trunnion bearings and releasably attachable to said frame, elongated slots in said frame disposed to receive

said trunnions and permit movement of said trunnions in said slots upon release of said attachment of said bearing housings, all operatively associated to pivotally mount the proximal end of said mandril to said frame; and

said arc adjustment means of said mandril mounting means further includes a mandril slot operatively

associated with the distal end of said mandril including a mandril slot operatively associated with said mandril housing and disposed substantially parallel to the axis of said mandril, a slot operatively associated with said frame and disposed substantially parallel to an arcuate path described by the distal end of said mandril upon pivotal movement about said point of pivot mounting of said mandril, and lock bolt means disposed in said mandril slot and frame slot and releasably lockable to secure said distal end of said mandril to said frame at a predetermined position along said arcuate path.

5. A machine for sharpening disc blades as described in claim **4**, in which:

said grinder means includes a grinder means mounting arm interconnected with said frame and pivotally movable with respect thereto to move said grinding surface from said grinding plane position juxtaposed the peripheral edge of a disc blade mounted on said mandril to a shut down position with said grinding surface removed from juxtaposition with said disc blade peripheral edge, a grinder means mounting plate movably mounted on said grinder means mounting arm for adjustment of the proximity of said grinding surface to said disc blade peripheral edge, and feed control means operatively associated with said grinder means mounting arm and said frame and disposed to control the rate of pivotal movement of said arm with respect to said frame when said grinding surface is juxtaposed said disc blade peripheral edge.

6. A machine for sharpening disc blades as described in claim **1**, which further includes:

a liquid reservoir disposed to submerge a disc blade mounted on the distal end of said mandril.

7. A machine for sharpening disc blades as described in claim **1**, in which:

said grinder mounting means includes feed means disposed to move said grinder means against the periphery of a disc blade mounted on said mandril means at a controlled rate.

8. A machine for sharpening disc blades as described in claim **6**, in which:

said liquid reservoir includes a liquid tank operatively associated with said frame and disposed to receive a disc blade mounted on said mandril means, and liquid supply means interconnected with said liquid tank and disposed to supply liquid thereto to a level sufficient to submerge substantially all of said disc blade.

9. A machine for sharpening disc blades as described in claim **6**, in which:

said liquid reservoir includes a liquid tank operatively associated with said frame and disposed to receive a disc blade mounted on said mandril means with a portion of said mandril means projecting through a wall of said liquid tank and movable with respect to said wall, a liquid seal interconnected between said wall and said mandril means, liquid supply means interconnected with said liquid tank and disposed to supply liquid to said liquid tank to a level sufficient to submerge substantially all of said disc blade, level control means operatively associated with said liquid tank and said liquid supply means and disposed to regulate the level of liquid in said liquid tank, and an auxiliary liquid conduit operatively associated with said liquid supply means and said liquid tank and disposed to supply a stream of liquid to the point of contact between said grinding surface and said disc blade peripheral edge.

10. A machine for sharpening disc blades as described in claim **1**, in which:

said grinder means includes grinder drive means, a grinder chuck drivingly interconnected with said grinder drive means and having a circular cavity and releasable clamping means and a circular grinding stone secured in said chuck cavity by said releasable clamping means with an exposed planar grinding surface.

11. A machine for sharpening disc blades as described in claim **10**, in which:

said grinder chuck releasable clamping means includes an annular face surface surrounding said cavity and disposed substantially normal to the walls of said cavity, and a beveled surface interposed between said cavity walls of said face surface and extending axially and radially inwardly, a retainer ring juxtaposed the face surface of said cavity with a beveled surface on its inner face extending axially inwardly and radially outwardly, said retainer ring having adjustable securing means disposed to tighten and loosen said retainer ring against said chuck face surface, and a split ring disposed about the periphery of said cavity and having an inner face disposed to engage said grinding stone and a wedge on its outer face having tapered surfaces disposed for engagement by said beveled surfaces on said chuck and retainer ring to force said split ring radially inwardly against the periphery of said grinding stone upon tightening of said retainer ring against said chuck face surface.

12. A machine for sharpening disc blades as described in claim **5**, in which:

said grinder means includes grinder drive means, a grinder chuck drivingly interconnected with said grinder drive means and having a circular cavity and releasable clamping means and a circular grinding stone secured in said chuck cavity by said releasable clamping means with an exposed planar grinding surface.

13. A machine for sharpening disc blades comprising:

a frame;

grinder means operatively associated with said frame and having a grinding surface disposable in a generally horizontal grinding plane;

grinder mounting means interconnected with said frame and said grinder means and disposed to movably mount said grinder means on said frame;

a mandril operatively associated with said frame and said grinder means and axially disposed in acute angular relationship with said grinding plane, said mandril having an upper end disposed adjacent said grinder means and a lower end disposed below said upper end and juxtaposed said frame, said mandril having a disc blade mounting means disposed to mount a disc blade on the upper end thereof;

mandril mounting means interconnected with said frame and said mandril and having a pivotal mounting adjacent the lower end of said mandril and disposed to permit arcuate movement of the upper end of said mandril to change the angular relationship between said mandril and said grinding sur-

face, and said pivotal mounting being axially movable with respect to said mandril to change the radius of said arcuate movement; and

a liquid containing tank operatively associated with said frame, mandril and grinding surface, and disposed about the upper end of said mandril for submersion of substantially all of a disc blade mounted on said mandril.

14. A machine for sharpening disc blades as described in claim **13,** in which:

said grinder means includes a drive motor having a drive shaft interconnected therewith, and a grinding wheel mounted on said shaft and having a grinding stone and a chuck disposed to releasably mount said grinding stone; and

said grinder mounting means includes feed control means having a hydraulic ram interposed between said grinder means and said frame and interconnected with variable valve means disposed to regulate the speed of travel of said ram.

15. A machine for sharpening disc blades as described in claim **13,** in which:

said mandril includes a housing and a hollow drive shaft rotatably mounted in said housing, and said disc blade mounting means includes a disc blade mounting plate affixed to the upper end of said drive shaft inside said tank, a lock shaft disposed in the bore of said hollow drive shaft, lock shaft drive means interconnected with said mandril housing and said lock shaft and actuatable to axially reciprocate said lock shaft from an extended position with the upper end of said lock shaft projecting upwardly beyond said disc blade mounting plate to a retracted position with the upper end of said lock shaft substantially co-extensive with said disc blade mounting plate, and a clamping plate releasably engagable with the upper end of said lock shaft when said lock shaft is in its extended position and disposed to engage a disc blade about its center opening and clamp said disc blade to said disc blade mounting plate when said lock shaft is reciprocated to its retracted position.

16. A machine for sharpening disc blades as described in claim **13** in which:

said pivotal mounting of said mandril mounting means is pivotal for arcuate movement of said distal end of said mandril with respect to said proximal end, and being releasably secured to said mandril for axial adjustment with respect thereto to vary the distance between said pivotal mounting and said mandril distal end, and being adjustably mounted to said frame for movement of said point of mounting toward and away from said grinder means.

17. A machine for sharpening disc blades as described in claim **13** in which:

said liquid containing tank includes a liquid seal interconnected between said wall and said mandril, liquid supply means interconnected with said liquid tank and disposed to supply liquid to said liquid tank to a level sufficient to submerge substantially all of said disc blade, level control means operatively associated with said liquid tank and said liquid supply means and disposed to regulate the level of liquid in said liquid tank, and an auxiliary liquid conduit operatively associated with said liquid supply means and said liquid tank and disposed to supply a stream of liquid to the point of contact between said grinding surface and said disc blade peripheral edge.

18. A machine for sharpening disc blades as described in claim **13,** in which:

said grinder mounting means includes a grinder means mounting arm interconnected with said frame and pivotally movable with respect thereto to move said grinding surface from a grinding position juxtaposed the peripheral edge of a disc blade mounted on said mandril to a shut down position with said grinding surface removed from juxtaposition with said disc blade peripheral edge, a grinder means mounting plate movably mounted on said grinder means mounting arm for adjustment of the proximity of said grinding surface to said disc blade peripheral edge, and feed control means operatively associated with said grinder means mounting arm and said frame and disposed to control the rate of pivotal movement of said arm with respect to said frame when said grinding surface is juxtaposed said disc blade peripheral edge; and

said mandril mounting means includes said pivotal mounting being pivotal for arcuate movement of said distal end of said mandril with respect to said proximal end, and being releasably secured to said mandril for axial adjustment with respect thereto to vary the distance between said pivotal mounting and said mandril distal end, and being adjustably mounted to said frame for movement of said point of mounting toward and away from said grinder means.

19. A machine for sharpening disc blades as described in claim **13,** in which:

said mandril mounting means includes a trunnioned collar releasably clamped to said mandril housing adjacent said proximal end and axially movable on said housing for adjustment of said point of clamping, trunnion bearings on the trunnions of said collar, bearing housings operatively associated with said trunnion bearings and releasably attachable to said frame, elongated slots in said frame disposed to receive said trunnions and permit movement of said trunnions in said slots upon release of said attachment of said bearing housings, all operatively associated to pivotally mount the proximal end of said mandril to said frame; and

said mandril mounting means further includes arc positioning means operatively associated with the distal end of said mandril including a mandril slot operatively associated with the distal end of said mandril including a mandril slot operatively associated with said mandril housing and disposed substantially parallel to the axis of said mandril, a slot operatively associated with said frame and disposed substantially parallel to an arcuate path described by the distal end of said mandril upon pivotal movement about said point of pivot mounting of said mandril, and lock bolt means disposed in said mandril slot and frame slot and releasably lockable to secure said distal end of said mandril to said frame at a predetermined position along said arcuate path.

20. A machine for sharpening disc blades as described in claim **15,** in which:

said mandril mounting means includes a trunnioned collar releasably clamped to said mandril housing

adjacent said proximal end and axially movable on said housing for adjustment of said point of clamping, trunnion bearings on the trunnions of said collar, bearing housings operatively associated with said trunnion bearings and releasably attached to said frame, elongated slots in said frame disposed to receive said trunnions and permit movement of said trunnions in said slots upon release of said attachment of said bearing housings, all operatively associated to pivotally mount the proximal end of said mandril to said frame; and

said mandril mounting means further includes arc positioning means operatively associated with the distal end of said mandril including a mandril slot operatively associated with said mandril housing and disposed substantially parallel to the axis of said mandril, a frame slot operatively associated with said frame and disposed substantially parallel to an arcuate path described by the distal end of said mandril upon pivotal movement about said point of pivot mounting of said mandril, and lock bolt means disposed in said mandril slot and frame slot and releasably lockable to secure said distal end of said mandril to said frame at a predetermined position along said arcuate path.

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